IEEE 802.15 차세대 광 무선 통신(IG NG-OWC) 관심 그룹 응용 신청

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Call for Applications for IEEE 802.15 Interest Group on Next-Generation Optical Wireless Communication (IG NG-OWC)

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요 약

The exponential growth of connected devices and the demand for ultra-high-speed, low-latency wireless communication are driving the exploration of technologies beyond traditional radio frequency (RF) systems. Optical Wireless Communication (OWC), which leverages the visible light, infrared, and ultraviolet spectrum, offers a promising solution for 6G and beyond. This paper outlines the IEEE 802.15 Interest Group for Next-Generation Optical Wireless Communication (IG NG OWC) call for applications, focusing on Optical Camera Communication (OCC), Free-Space Optics (FSO), and advanced PHY/MAC protocols. The goal is to establish a roadmap for next-generation OWC systems to achieve scalability, mobility, and secure communications across diverse applications.

Keywords—Optical Wireless Communication, OCC, FSO, IEEE 802.15.7a, 6G, PHY/MAC.

Ⅰ. 서 론

The sixth generation (6G) of wireless communication will require extremely high data rates, very low latency, and massive device connectivity. Current RF spectrum resources, especially below 40 GHz, are congested and insufficient to meet the growing demands of IoT and smart city ecosystems [1]. Optical Wireless Communication (OWC) utilizes unlicensed optical spectrum, including visible light (VL), infrared (IR), and ultraviolet (UV) bands, offering terabit-level bandwidth, immunity to electromagnetic interference, and enhanced security [2].

Recent standardization efforts, such as IEEE 802.15.7a-2024, have introduced advanced modulation and coding schemes, including OFDM, MIMO, and NOMA, to overcome OCC's limitations in communication distance and mobility support [3]. Furthermore, IEEE 802.15 IG NG OWC was formed to promote collaboration and research on next-generation OWC technologies, targeting high-speed, high-mobility applications such as autonomous vehicles, drones, and smart factories [4].

This paper summarizes the focus areas of the NG OWC initiative and calls for innovative proposals to advance OWC technologies for 6G and beyond.

Ⅱ. 본론

Next-generation OWC aims to address the limitations of current systems by enhancing performance at both the physical (PHY) and medium access control (MAC) layers. Optical Camera Communication (OCC) is a key focus area, enabling low-cost communications using existing cameras and LEDs. Enhancements are needed to improve data rates, reliability, and mobility. Techniques such as OFDM, MIMO, and NOMA have been proposed to mitigate limitations like low data rates caused by camera frame rate constraints and vulnerability in non-line-of-sight (NLoS) environments [2],[3]. Additionally, deep learning has arisen as a powerful tool for data decoding, significantly improving OCC performance under high-mobility and harsh conditions [5].

Free-Space Optics (FSO) is another vital area, offering ultra-high-speed, long-range links suitable for drone networks, satellite communication, and high-speed trains. Challenges such as atmospheric interference and precise beam alignment must be addressed through adaptive protocols and hybrid integration with RF systems [2],[4]. Enhancements to IEEE 802.15.13-2023 will further enable ultra-reliable low-latency communications and secure industrial

networks [3]. Positioning and tracking systems, such as OCC-based indoor positioning and Time-of-Flight (ToF)-based methods, are critical for autonomous systems and IoT applications, providing centimeter-level accuracy for smart factories and mobility platforms [2].

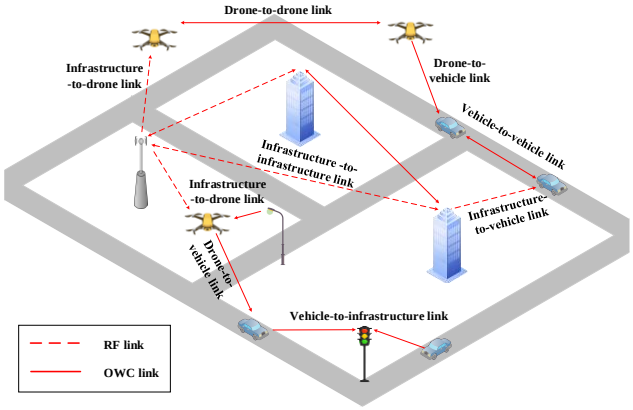

Figure 1. OWC services utilizing 6G and beyond technologies

OWC services-based UAV are a growing with applications in transportation, the military, and civilian life. Figure 1 shows that UAVs can also use for V2V, V2I, and I2I systems for 6G/beyond 6G technologies, Besides that, Table 1 show the recent advancements in NG OWC technologies for the NG-OWC technologies.

Table 1. Recent Advancements in NG OWC Technologies

Technology	Purpose / Benefit	Key Features	Reference
RS-OFDM (Rolling Shutter OFDM)	Overcomes OCC data rate limitations due to camera frame rate	Multicarrier modulation for OCC, improved data throughput	[5]
Hybrid RF/OWC Systems	Ensures reliability in dynamic and NLoS environments	Combines RF and OWC strengths for robust coverage	[2]
Deep Learning Decoders	Enhances performance in high-mobility and noisy environments	AI-based signal detection, lower BER, improved mobility support	[5]
Advanced IEEE Standards	Standardizes NG OWC for global adoption	IEEE 802.15.7a-2024, IEEE 802.15.13-2023 updates	[3],[4]

Ⅲ. 결론

NG OWC represents a paradigm shift in wireless communication, addressing spectrum scarcity and performance bottlenecks inherent to RF-based systems. By advancing OCC, FSO, and integrated sensing technologies, IEEE 802.15 IG NG OWC aims to deliver scalable, secure, and high-speed connectivity for 6G and beyond. Collaborative contributions from researchers and industry will be pivotal to shaping the future of optical wireless networks.

ACKNOWLEDGMENT

This work was supported by Korea Research Institute for defense Technology Planning and advancement (KRIT) grant funded by the Korea government (DAPA (Defense Acquisition Program Administration)) (KRIT-CT-23-041, 2025).

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