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Heterogeneous Communications in Industrial IoT: Trends, Challenges, and Opportunities

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The Industrial Internet of Things (IIoT) has introduced an unprecedented diversity of communication protocols that interconnect devices, systems, and applications across complex industrial environments. From lightweight messaging frameworks such as MQTT and CoAP to well-established standards like DNP3, Modbus, and OPC UA, these protocols each bring distinct strengths—and their own limitations. This paper offers a comprehensive survey of the methods and technologies that enable heterogeneous communications in industrial IoT deployments. We examine how protocols differ in their technical characteristics, including scalability, reliability, determinism, and security, and discuss the practical challenges of integrating them in real-world scenarios. To provide clarity, we classify the protocols into categories that span publish-subscribe messaging, request-response architectures, and time-critical fieldbus and SCADA systems. Beyond simply cataloging the options, we also explore emerging trends toward protocol convergence and middleware solutions that aim to bridge the gap between operational technology (OT) and information technology (IT). Drawing on recent research and industrial case studies, this survey highlights both the progress and the persistent obstacles in building secure and interoperable IIoT communication infrastructures. Ultimately, we hope this work will help practitioners and researchers navigate the evolving landscape of industrial connectivity and inspire new directions for more seamless and efficient integration.

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