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IEEE Recommended Practice for Network Communication in Electric Power Substations

IEEE Power and Energy Society

Developed by the
Power System Communications and Cybersecurity Committee

IEEE Std 1615™-2019
(Revision of IEEE Std 1615-2007)

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Power System Communications and Cybersecurity Committee
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Approved 5 September 2019

IEEE SA Standards Board

Abstract: Recommended practices for communication and interoperation of devices connected on an electric power substation Internet Protocol (IP) network are provided. An introduction to the concepts that need to be mastered as well as specific recommendations to follow when deploying the technologies are provided for the power engineer new to IP networking. Direction and requirements to facilitate interoperable electric utility information networks are provided for equipment manufacturers and system integrators.

Keywords: Distributed Network Protocol 3 (DNP3), Ethernet, fiber-optic, IEC 60870-5, IEC 61850, IEEE 1615™, intelligent electronic device (IED), Internet Protocol (IP), managed switch, network, network devices, noise sources, non-operational data, operational data, RS-232, RS-485, security awareness, Transmission Control Protocol (TCP), time synchronization, wireless network

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Introduction

This introduction is not part of IEEE Std 1615-2019, IEEE Recommended Practice for Network Communication in Electric Power Substations.

IEEE Recommended Practice for Network Communication in Electric Power Substations was first published in 2007. Much of the guidance in the 2007 version of this document remains important and necessary in continuing to support legacy equipment.

There has been a dramatic change in the networking technologies since 2007. Security requirements and tools to address them have impacted design philosophies. Technical requirements unique to power industry applications previously precluded certain uses of Ethernet and TCP/IP (Transport Control Protocol/Internet Protocol), and these are being resolved through the creation of other standards.

Many new applications have created the need for higher bandwidth to support real-time operational awareness and to make this data available to many users beyond the traditional "system operators". These include higher power system load factors, the introduction of distributed and variable generation, and the use of synchrophasors to support various power system applications.

Historically, serial connectivity (e.g., TIA-232-F) and protocols based on serial technology have dominated substation communications. Serial communication was taken to be inherently secure, both through limited physical accessibility and through obscurity of proprietary protocols. Substation inputs and control signals have been wired directly to protective relays, remote terminal units (RTUs), and recording/metering equipment.

The ability of Ethernet and TCP/IP to serve the large set of needs of the industry securely, reliably, and economically alters the landscape of electric utility communications. DNP3 IP is ubiquitous, and IEC 61850 (International Electrotechnical Commission) is designed as a network suite of functions. Historically, protective relays have been selected by power-system engineers without regard for network or protocol support, and communications have been accomplished using whatever adapters and converters were required. Now, although the protective functionality obviously remains paramount, lack of necessary network functionality may be used to disqualify equipment.

Contents

IEEE Recommended Practice for Network Communication in Electric Power Substations

1. Overview

1.1 Scope

This document defines a recommended practice for the design, testing, and operation of communications networks within, to, and from electric power substations. Security considerations are included in the above. It does not establish a new underlying communications standard. Instead, this document presents guidelines and best practices for designing these communication networks.

1.2 Purpose

This recommended practice provides direction for implementers who wish to produce interoperable and secure communications for an electric power substation network. It also provides direction for users, system integrators, and equipment manufacturers who need to establish requirements and design of communications networks within, to, and from the electric power substation. This is meant to address both the physical and logical elements of the network.

1.3 Preface

Network communications is an important component of substation design because of the reliance of many utility applications on a variety of communication networks. This recommended practice recommends proven methods to specify network requirements, specify network schema, design network schema, and mitigate hazards and threats to networks in electric utility substations, while controlling the cost of the network and maintenance of the network. It is impossible for this recommended practice to be inclusive of all types of communication networks and protocols that could exist inside of substations. For example, advanced metering infrastructure (AMI) equipment may be installed inside substations, provide no interaction with the substation local area network (LAN), and be independently connected to the wide area network (WAN). So while impossible to cover every possible technology and protocol, there are many common technologies typical to many substations.

Ethernet and the Transmission Control Protocol/Internet Protocol (TCP/IP) are by far the dominant technologies in office and home use. The cost-effectiveness of IP over Ethernet, including factors of