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TECHNICAL REPORT

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Communication networks and systems for power utility automation – Part 90-22: SCD based substation network automated management with with visualization and supervision support

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COMMUNICATION NETWORKS AND SYSTEMS – FOR POWER UTILITY AUTOMATION –

Part 90-22: SCD based substation network automated management with visualization and supervision support

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The text of this Technical Report is based on the following documents:

Draft	Report on voting
57/2692/DTR	57/2737/RVDTR

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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- reconfirmed,
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INTRODUCTION

As an international standard, IEC 61850 currently serves thousands of substations around the world. Meanwhile, SCD configuration is subject to changes that could be brought up by retrofit, addition or removal of IED(s), etc., and the configuration of bridges needs to be updated accordingly. The procedures of these works have always relied on manual approaches.

Some questions raised naturally are the following.

– How does a bridge in the substation network update its configuration (e.g. VLAN setting) dynamically in case of SCD changes?
– How does a GOOSE/SV path rebuild automatically following the SCD update instead of being done manually?
– How does the bridge learn that a newly added IED is connected to it?
– How does a bridge discover the change in case of substation network connectivity changes?

These questions are the drivers to set up a Task Force to investigate the above questions and develop IEC TR 61850-90-22. These issues were demonstrated, gaps were identified, requirements were analysed and use cases are described in this document, which is a Technical Report.

To address these, the concept of auto-routing is introduced in this document.

At present, auto-routing is a system-level functionality of substation network performing through a combination of a variety of advantages of AR-Bridges as specified in this document. AR-Bridges could provide sophisticated function compared with IEC 61850 bridges that are employed in existing network systems. Auto-routing is an independent functionality and can co-exist with HSR/PRP and RSTP within a network.

The recovery time of auto-routing network is not addressed in this document. The key reason for this is that the system or AR-bridge should take out of service for the testing of the functionality after distribution or updating of the new SCD.

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 90-22: SCD based substation network automated management with visualization and supervision support

1 Scope

This part of IEC 61850, which is a Technical Report, aims to provide analysis, principles, use cases and guidance on how to use GOOSE/SV static-routing or auto-routing based on System Configuration Description (SCD) file to automated manage the substation network while without changing the requirements of IEDs. Furthermore, this document also intends to give novel practices on network and GOOSE/SV path condition monitoring which support visualization and supervision from higher level application side.

Using the concepts developed in the IETF's Transparent Interconnection of Lots of Links (TRILL) using IS-IS protocol that is defined in RFC 6326 and ISO/IEC 10589 standards, this document defines network and system management data object models that are specific to power system operations. These data objects will be used to monitor the health of networks and systems, to detect abnormal behaviours of IEDs which contradict SCD file, such as unexpected IEDs or unexpected GOOSE/SV flows, and to support the management of the performance and reliability of the information infrastructure.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61850 (all parts), *Communication networks and systems for power utility automation*

IEC 62351 (all parts), *Power systems management and associated information exchange – Data and communications security*

IEC 62351-7:2017, *Power systems management and associated information exchange – Data and communications security – Part 7: Network and System Management (NSM) data object models*

IEC TR 62351-90-3:2021, *Power systems management and associated information exchange – Data and communications security – Part 90-3: Guidelines for network and system management*

IEC 62439-1, *Industrial communication networks – High availability automation networks – Part 1: General concepts and calculation methods*

IEC 62439-3:2021, *Industrial communication networks – High availability automation networks – Part 3: Parallel Redundancy Protocol (PRP) and High-availability Seamless Redundancy (HSR)*

IEC 62443 (all parts), *Security for industrial automation and control systems*

IEEE Std 802.1AB™, *IEEE Standard for local and metropolitan area networks – Station and Media Access Control Connectivity Discovery*

IEEE Std 802.1D™, *IEEE Standard for local and metropolitan area networks –Media Access Control (MAC) Bridges*

IEEE Std 802.1Q™, *IEEE Standard for local and metropolitan area networks – Bridges and bridged networks*

IETF RFC 6325, *Routing Bridges (RBridges): Base Protocol Specification*

IETF RFC 6326, *Transparent Interconnection of Lots of Links (TRILL) Use of IS-IS*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in IEC TR 61850-90-4 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1 Terms and definitions

3.1.1
GOOSE/SV auto-routing
method of dynamic building of GOOSE/SV paths using VLAN/MAC tables in bridges, according to GOOSE/SV association together with the outcome from network topology discovery and IED learning, abbreviated as auto-routing in this document

3.1.2
GOOSE/SV static-routing
method of static building of GOOSE/SV paths using VLAN/MAC table in bridges according to the information defined in SCD file, abbreviated as static-routing in this document

3.1.3
AR-bridge
AutoRouting-bridge
bridge with sophisticated function extended from IEC 61850 bridge, that is the fundamental device or component to approach the performance of substation network auto-routing

3.1.4
AR-bridge neighbour
node that physically connects to the AR-bridge, and responds to the information it is advertising

3.1.5
bridge
network device that connects network segments at the data link layer (layer 2) of the OSI model, according to the principles of IEEE 802-2014

Note 1 to entry: A bridge is often referred to as a "layer 2 switch". In this document, the word "bridge" means the logic used to forward a frame from one port to another at layer 2, while "switch" designates a device with additional functionalities.
Note 2 to entry: In case of confusing with primary switch, bridge is used to represent switch in this document.

[SOURCE: IEC TR 61850-90-4:2020, 3.1.1, modified (addition of Note 2 to entry)]

3.1.6
diagnostic device
device/software that can capture arbitrary IEC 61850 packets, analyse the contents of packets, and reveal the transmission behaviour of packets

3.1.7
IEC 61850 bridge
subset of the IEEE 802.1 options with extensions defined in IEC 61850-8-1 and IEC TR 61850-90-4

Note 1 to entry: With the following functionality:

– A bridge port operates in full-duplex mode.

– A bridge supports loop prevention only through RSTP/MSTP; Compatible variants offered by vendors to speed up recovery are allowed, although the claimed performance is usually only achieved within a one-vendor environment.

– A bridge keeps MAC address filtering always enabled. The lifetime of a filtering database entry is limited to 10 seconds (IEEE 802.1Q recommends 300,0 s).

– A bridge supports VLAN traffic filtering, but contrarily to IEEE 802.1Q, an egress port may send a frame with VLAN ID = 0, although this practice is deprecated.

– A bridge (edge) port may forward frames with different VLAN ID to an end device (thus behaving as a trunk port). A bridge port is not obliged to remove the VLAN tags. Contrarily to the intention of VLANs, end devices may be attached simultaneously to several VLANs, but ignore the VLAN header.

– A bridge port accepts VLAN-tagged frames from an end device even when they do not match its default VLAN-ID.

– A bridge supports frames of at least 1 522 octets to allow redundancy control in HSR or PRP, support of up to 1 535 octets is recommended. Jumbo frames are not used.

– A bridge may start transmission of a frame over the egress port while the frame over the ingress port has not been completely received ("cut-through"), although IEEE 802.1 only allows sending after the frame has been completely received ("store-and-forward").

– A bridge acting as a Transparent Clock for the Precision Time Protocol modifies the time stamp in the frame body, but it is not allowed to modify the source address, contrarily to the debated IEEE 802.1 rule.

– A bridge supports network management by IEC 61850-90-4 especially for the purpose of ports and RSTP settings, VLAN and priorities settings and multicast filtering.

3.1.8
IED-learning
mechanism that learns by bridges of the port that IEDs are connected to by detecting the unique identity (for instance MAC, APPID, or a combination of elements) of GOOSE/SV packets, and mapping between them and the IED name, which are extracted from SCD file, similar to the MAC address learning

3.1.9
GOOSE/SV association
relation expressed in an SCD file between an IED (serving a data by publishing a GOOSE/SV control block containing this data in its dataset) and one or more IEDs (consuming this specific data by subscribing the GOOSE/SV)

Note 1 to entry: The consumption of this data by the IED subscribing to the GOOSE/SV is described by an ExtRef in the consuming IED referencing the data and the GOOSE/SV carrying the data.

3.1.10
GOOSE/SV path
GOOSE/SV multicast distribution tree created in substation network to implement GOOSE/SV association, rooted at source port of a GOOSE/SV packet from one publisher, ended at destination ports of all subscribers, including intermediate bridges

3.1.11
GOOSE/SV simulator
device/software that generates simulated GOOSE/SV packets for a given existing frame