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INTERNATIONAL STANDARD

colour inside

Industrial communication networks – High availability automation networks – Part 5: Beacon Redundancy Protocol (BRP)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INDUSTRIAL COMMUNICATION NETWORKS – HIGH AVAILABILITY AUTOMATION NETWORKS –

Part 5: Beacon Redundancy Protocol (BRP)

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 62439-5 has been prepared by subcommittee 65C: Industrial Networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

This standard cancels and replaces IEC 62439 published in 2008. This first edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to IEC 62439 (2008):

– adding a calculation method for RSTP (rapid spanning tree protocol, IEEE 802.1Q),
– adding two new redundancy protocols: HSR (High-availability Seamless Redundancy) and DRP (Distributed Redundancy Protocol),
– moving former Clauses 1 to 4 (introduction, definitions, general aspects) and the Annexes (taxonomy, availability calculation) to IEC 62439-1, which serves now as a base for the other documents,
– moving Clause 5 (MRP) to IEC 62439-2 with minor editorial changes,

- moving Clause 6 (PRP) was to IEC 62439-3 with minor editorial changes,
- moving Clause 7 (CRP) was to IEC 62439-4 with minor editorial changes, and
- moving Clause 8 (BRP) was to IEC 62439-5 with minor editorial changes,
- adding a method to calculate the maximum recovery time of RSTP in a restricted configuration (ring) to IEC 62439-1 as Clause 8,
- adding specifications of the HSR (High-availability Seamless Redundancy) protocol, which shares the principles of PRP to IEC 62439-3 as Clause 5, and
- introducing the DRP protocol as IEC 62439-6.

The text of this standard is based on the following documents:

FDIS	Report on voting
65C/583/FDIS	65C/589/RVD

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

This International Standard is to be read in conjunction with IEC 62439-1:2010, *Industrial communication networks – High availability automation networks – Part 1: General concepts and calculation methods.*

A list of the IEC 62439 series can be found, under the general title *Industrial communication networks – High availability automation networks*, on the IEC website.

This publication has been drafted in accordance with ISO/IEC Directives, Part 2.

The committee has decided that the contents of this amendment and the base publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this standard may be issued at a later date.

IMPORTANT – The "colour inside" logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

INTRODUCTION

The IEC 62439 series specifies relevant principles for high availability networks that meet the requirements for industrial automation networks.

In the fault-free state of the network, the protocols of the IEC 62439 series provide ISO/IEC 8802-3 (IEEE 802.3) compatible, reliable data communication, and preserve determinism of real-time data communication. In cases of fault, removal, and insertion of a component, they provide deterministic recovery times.

These protocols retain fully the typical Ethernet communication capabilities as used in the office world, so that the software involved remains applicable.

The market is in need of several network solutions, each with different performance characteristics and functional capabilities, matching diverse application requirements. These solutions support different redundancy topologies and mechanisms which are introduced in IEC 62439-1 and specified in the other Parts of the IEC 62439 series. IEC 62439-1 also distinguishes between the different solutions, giving guidance to the user.

The IEC 62439 series follows the general structure and terms of IEC 61158 series.

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning fault-tolerant Ethernet provided through the use of special interfaces providing duplicate ports that may be alternatively enabled with the same network address. Switching between the ports corrects for single faults in a two-way redundant system. This is given in Clauses 5 and 6.

IEC takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured the IEC that he/she is willing to negotiate licences either free of charge or under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with IEC. Information may be obtained from:

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USA

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ISO (www.iso.org/patents) and IEC (http://www.iec.ch/tctools/patent_decl.htm) maintain on-line data bases of patents relevant to their standards. Users are encouraged to consult the data bases for the most up to date information concerning patents.

INDUSTRIAL COMMUNICATION NETWORKS – HIGH AVAILABILITY AUTOMATION NETWORKS –

Part 5: Beacon Redundancy Protocol (BRP)

1 Scope

The IEC 62439 series is applicable to high-availability automation networks based on the ISO/IEC 8802-3 (IEEE 802.3) (Ethernet) technology.

This part of the IEC 62439 series specifies a redundancy protocol that is based on the duplication of the network, the redundancy protocol being executed within the end nodes, as opposed to a redundancy protocol built in the switches. Fast error detection is provided by two beacon nodes, the switchover decision is taken in every node individually. The cross-network connection capability enables single attached end nodes to be connected on either of the two networks.

2 Normative references

The following referenced documents are indispensable for the application 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 60050-191, *International Electrotechnical Vocabulary – Chapter 191: Dependability and quality of service*

IEC 62439-1:2010, *Industrial communication networks – High availability automation networks – Part 1: General concepts and calculation methods*

ISO/IEC/TR 8802-1, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 1: Overview of Local Area Network Standards* (IEEE 802.1)

ISO/IEC 8802-3:2000, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

IEEE 802.1D, *IEEE standard for local Local and metropolitan area networks Media Access Control (MAC) Bridges*

IEEE 802.1Q, *IEEE standards for local and metropolitan area network. Virtual bridged local area networks*

3 Terms, definitions, abbreviations, acronyms, and conventions

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-191, as well as in IEC 62439-1, apply.

3.2 Abbreviations and acronyms

For the purposes of this document, the abbreviations and acronyms given in IEC 62439-1, apply, in addition to the following:

BRP Beacon Redundancy Protocol

DANB Double attached node implementing BRP

3.3 Conventions

This part of the IEC 62439 series follows the conventions defined in IEC 62439-1.

4 BRP overview

This clause specifies a protocol for an Ethernet network tolerant to all single point failures. This protocol is called Beacon Redundancy Protocol or BRP. A network based on the BRP is called a BRP network. The BRP network is based on switched ISO/IEC 8802-3 (IEEE 802.3) (Ethernet) and ISO/IEC/TR 8802-1 (IEEE 802.1) technologies and redundant infrastructure. In this network, the decision to switch between infrastructures is made individually in each end node.

5 BRP principle of operation

5.1 General

Subclauses 5.2 to 5.4 are an explanation of overall actions performed by the BRP state machine. If a difference in the interpretation occurs between these subclauses and the state machines in 7, then the state machines take precedence.

5.2 Network topology

The BRP network topology can be described as two interconnected top switches, each heading an underlying topology of star, line, or ring. Beacon end nodes shall be connected to the top switches. Examples of star, linear and ring BRP networks are shown in Figure 1, Figure 2 and Figure 3 respectively.

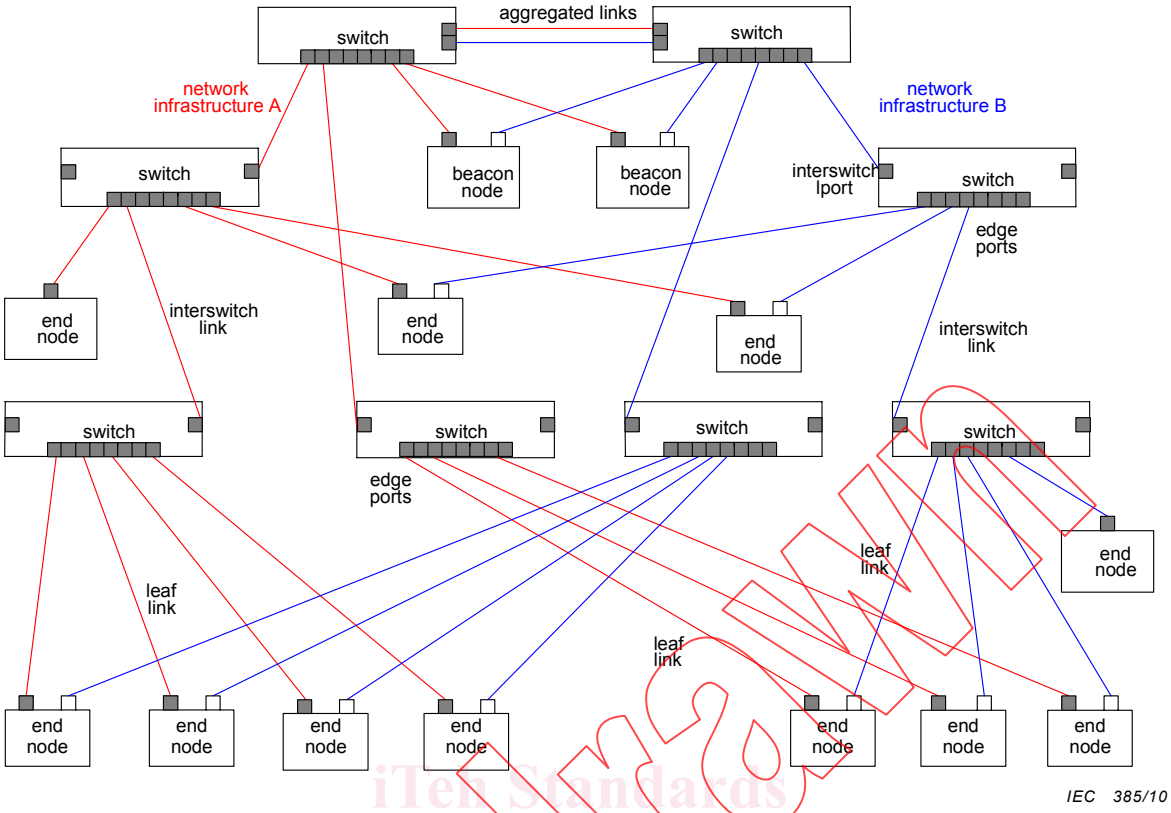

Figure 1 – BRP star network example

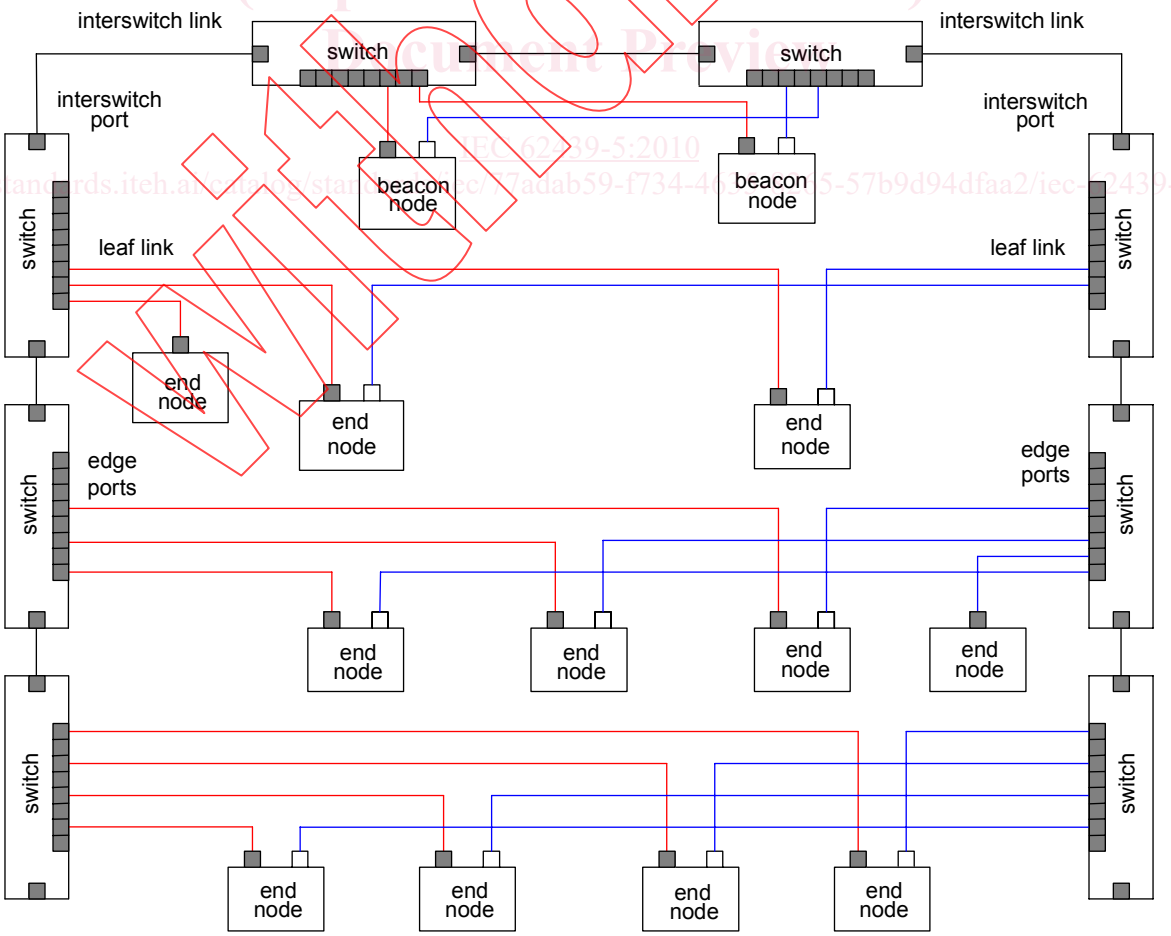

Figure 2 – BRP linear network example

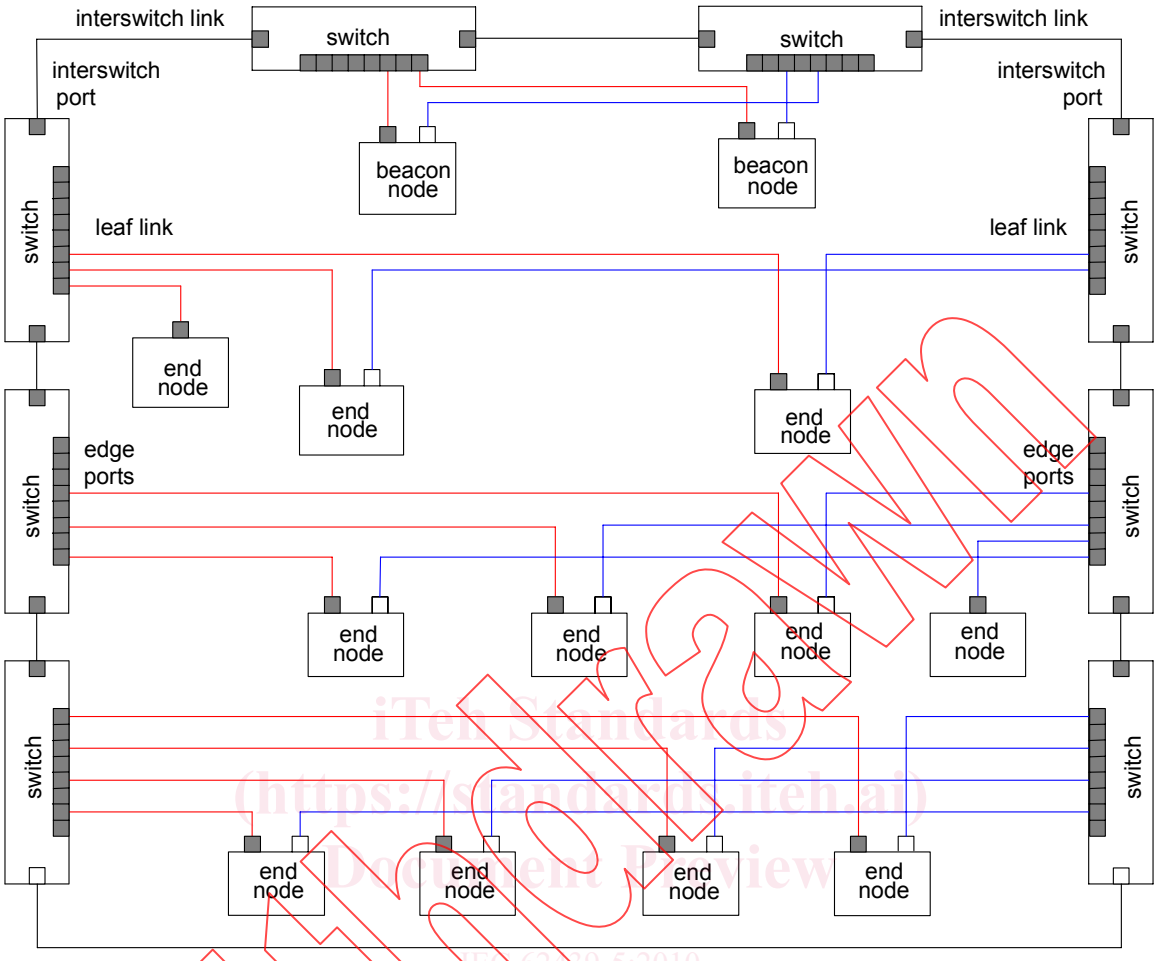

Figure 3 – BRP ring network example

5.3 Network components

The BRP network is built from layer 2 switches compliant with IEEE 802.1D and ISO/IEC 8802-3 (IEEE 802.3). No support of the BRP protocol in switches is required.

Figure 1 shows an example of a BRP star network in the 2-way redundancy mode. It uses two sets of network infrastructure A and B (shown in two different colours). The number of levels of switches and number of switches on each level are dependent only on application requirements. Even with three levels of hierarchy it is possible to construct very large networks. For example, a BRP star network built from switches with eight regular ports and one uplink port can contain 500 nodes maximum. Two switches at the top level shall be connected to each other with one or more links providing sufficient bandwidth. With link aggregation capability, traffic is shared among bundle of links and failure of one link does not bring the network down. With such an arrangement infrastructures A and B form a single network.

Two types of end nodes can be connected to the BRP network: doubly attached and singly attached. A doubly attached end node can function as a BRP end node or a BRP beacon end node. A BRP beacon end node is a special case of a doubly attached end node that is connected directly to the top switches. Though doubly attached BRP end nodes have two network ports they use only one MAC address.

At any given point in time a BRP end node actively communicates through only one of its ports, while blocking all transmit and receive traffic on its other port, with the exception of received beacon messages and Failure_Notify messages. Fault tolerance is achieved in a