IEC 62439-7

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Industrial communication networks – High availability automation networks – Part 7: Ring-based Redundancy Protocol (RRP)

Réseaux de communication industriels – Réseaux de haute disponibilite pour l'automation – Partie 7: Protocole de redondance pour réseau en anneau (RRP)

IEC 62439-7:2011

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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

FDIS	Report on voting
65C/668/FDIS	65C/673/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.*

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

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

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- replaced by a revised edition, or
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The contents of the corrigendum of May 2015 have been included in this copy.

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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 8802-3:2000 (IEEE 802.3) with compatible, reliable data communications, and preserve determinism in real-time data communications. In cases of fault, removal, and insertion of a component, they provide deterministic recovery times.

These protocols retain fully the Ethernet communication capabilities typically used in the office world, to ensure that software that relies on these protocols will remain applicable.

The market is in need of several network solutions, each with different performance characteristics and functional capabilities, meeting diverse application requirements. These solutions support different redundancy topologies and mechanisms, which are introduced in IEC 62439-1 and specified in the companion International Standards. IEC 62439-1 also distinguishes between these different solutions, providing guidance for 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 patents concerning IEC 61158-4-21 given in Clause 4 and Clause 5.

Patent Number KR 0789444 “COMMUNICATION PACKET PROCESSING APPARATUS AND METHOD FOR RING TOPOLOGY ETHERNET NETWORK CAPABLE OF PREVENTING PERMANENT PACKET LOOPING,” owned by LS INDUSTRIAL SYSTEMS CO., LTD., Anyang, Korea

Patent Number KR 0732510 “NETWORK SYSTEM”, owned by LS INDUSTRIAL SYSTEMS CO., LTD., Anyang, Korea

Patent Number KR 0870670 “Method For Determining a Ring Manager Node”, owned by LS INDUSTRIAL SYSTEMS CO., LTD., Anyang, Korea

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INDUSTRIAL COMMUNICATION NETWORKS – HIGH AVAILABILITY AUTOMATION NETWORKS –

Part 7: Ring-based Redundancy Protocol (RRP)

1 Scope

The IEC 62439 series of standards is applicable to high-availability automation networks based on the ISO/IEC 8802-3:2000 (Ethernet) technology.

This part of the IEC 62439 series specifies a redundancy protocol that is based on a ring topology, in which the redundancy protocol is executed at the end nodes, as opposed to being built into the switches. Each node detects link failure and link establishment using media-sensing technologies, and shares the link information with the other nodes, to guarantee fast connectivity recovery times. The nodes have equal RRP network management functions.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 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*

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, and the following apply.

3.1.1
R-port
port in a communication device that is part of a line or ring structure

3.1.2
device address
2 octet address that designates the device associated with a single device on a specific local link

3.1.3
Gateway Device
GWD
RRP device that has more than 3 Ethernet ports on it. At least 2 ports have to support RRP protocol

3.1.4
Normal Device
ND
normal RRP device which has two RRP ports on it

3.1.5
Unique Identification
UID
Unique 8 octet identification used to identify a RRP device within a network segment. UID is combines a 2 octet device address and a 6 octet MAC address, so that it has a unique value in a network

3.2 Abbreviations and acronyms

For the purposes of this document, the abbreviations and acronyms given in IEC 62439-1 as well as the following, apply.

ASE Application Service Element
DLE Data Link layer Entity
FC Frame Control
FCS Frame Check Sequence
GD General Device
GWD Gateway Device
LNM Line Network Manager
MAC Media Access Control
MIB Management Information Base
NCM Network Control Message
NCMT Network Control Message Type
ND Normal Device
NMIB Network Management Information Base
PHY Physical Interface Transceiver
PO Power On
PRI Priority
RES Reserved
RNM Ring Network Manager
RRP Ring based Redundancy Protocol
SA Stand Alone
ToS Type of Service
VoE Validation of Extension code

3.3 Conventions

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

4 RRP overview

4.1 General

The RRP specifies a recovery protocol, based on a ring topology. All links in an RRP network shall be full duplex through the use of an internal hardware Ethernet switch. Thus, RRP provides a collision-free transmission mechanism between two nodes. Every RRP device detects link failure and link establishment using the rules specified in ISO/IEC 8802-3:2000 and shares this information with other RRP devices so that fast connectivity recovery time is also guaranteed in the ring network.

A RRP device is a dual-port switching device that receives and transmits standard ISO/IEC 8802-3:2000 Ethernet frames. It is intelligent and can control directional frame forwarding between its dual ports according to the network status and device status. RRP uses a special network management scheme specified in this standard. RRP also uses a network control based on device address and MAC address, and thus general bridge hub or switch might not be suitable for RRP network. However, when connecting a general Ethernet device to RRP network, Gateway Device (GWD) should be used.

4.2 Frame forwarding and receiving control

4.2.1 General

RRP provides a collision-free transmission mechanism with an internal full-duplex hardware switch with switching queue and dual MACs in a device. The switching priority method between Tx and Forwarding can be Round-Robin, Tx-First or Forwarding-First scheme. However RRP does not specify the switching method.

Thus, a RRP device transmits frames without the restriction of medium access, as soon as they appear in the transmit queue for each MAC. Figure 1 shows the forwarding and receiving control of the RRP device.

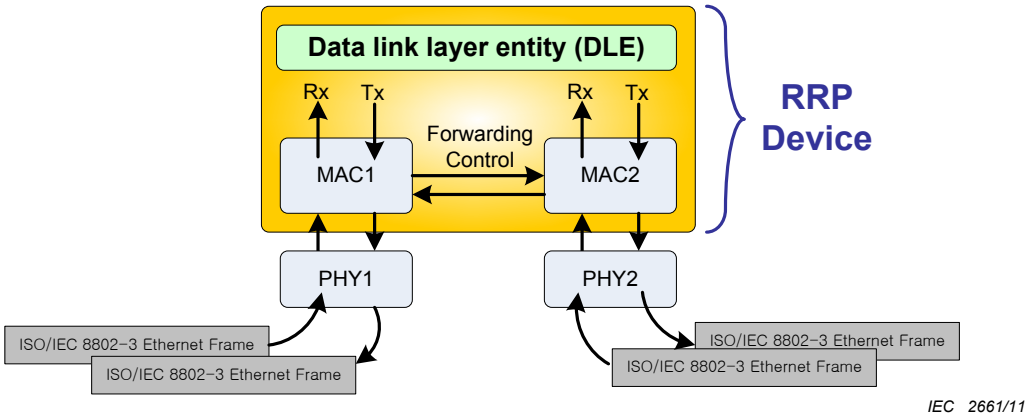

Figure 1 – Forwarding and receiving Ethernet frames

4.2.2 Normal Device (ND) and Gateway Device (GWD)

RRP is operated in a dual-port ring topology. A general Ethernet device can send standard Ethernet frames through RRP ring network with GWD. Multi-ring network can also be established using GWD.

GWD is responsible for switching Ethernet frames between RRP network and external Ethernet networks through application layer using a dynamic table. The dynamic table maps addresses to external Ethernet ports automatically. The dynamic table is automatically made by learning frame movements in the network. The GWD inspects both the destination and the source addresses. The destination address is used for the forwarding decision; the source address is used for adding entries to the table and for updating purposes. When an Ethernet

frame is received at the media access control (MAC) layer through the physical interface transceiver (PHY), a GWD handles the received frame by taking one of the following actions, depending on the destination MAC address and the source MAC addresses in the received frame:

- for a broadcast or multicast frame, accept and deliver the frame to the data link layer entity (DLE), and forward the frame to the other RRP port and external Ethernet ports;
- for a frame designated for the device itself, accept and deliver the frame to the DLE without forwarding;
- for a frame designated for another device, accept the frame to its application layer and inspect both the destination and the source addresses. When the destination address of the frame is in the dynamic table, the GWD delivers the frame to the corresponding port in the dynamic table without forwarding to other ports. Otherwise, the GWD delivers the frame to all other ports. The GWD adds this entry to the dynamic table with source MAC address and port number information.

NOTE Dynamic table entries are automatically removed after the Ageing Time which is specified in IEEE 802.1D.

Figure 2 shows different structures of ND and GWD. In GWD, external Ethernet connection is connected to RRP ring network through MAC_E and PHY_E.

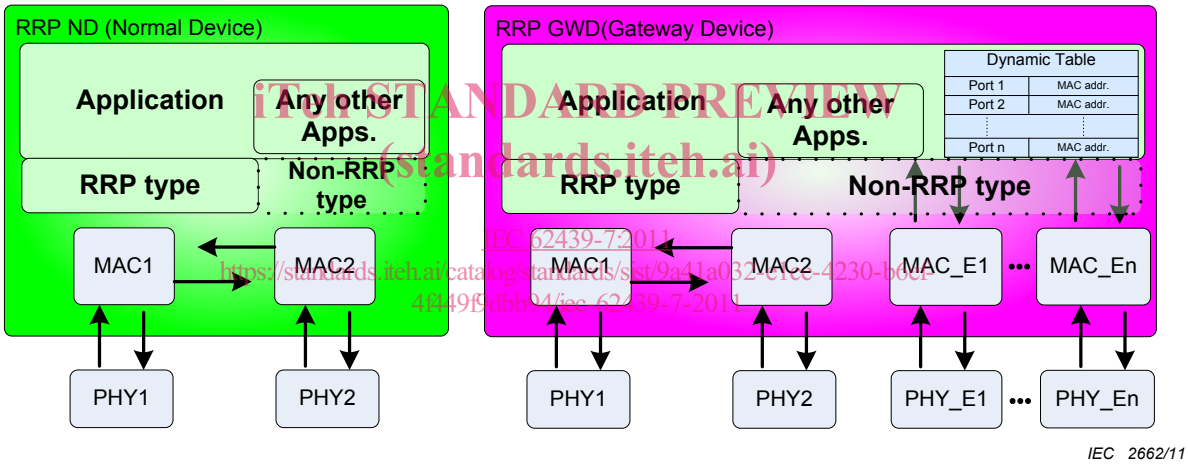

Figure 2 – Structures of ND and GWD

4.2.3 Behaviours of the General Device (GD)

When an Ethernet frame is received at the MAC layer through the PHY, a RRP general device other than the ring network manager (RNM) or the line network manager (LNM), handles the received frame by taking one of the following actions, depending on the destination MAC address and the device address in the received frame:

- for a broadcast or multicast frame, accept and deliver the frame to the DLE, and forward the frame to the other port;
- for a frame designated for the device itself, accept and deliver the frame to the DLE without forwarding;
- for a frame designated for another device, do not accept the received frame, but forward the frame to the other port.

This frame forwarding procedure is processed by the internal hardware switch, so that it has little impact on the performance of the RRP protocol.

4.2.4 Behaviours of the Line Network Manager (LNM)

As shown in Figure 3, the LNM disables the frame forward functions in both directions, so that frames are not forwarded to another port. In RRP networks, a LNM is automatically configured. When a device senses that only one port is connected, the device takes this to indicate that it is at the end of the line network. The LNM also becomes a control point of the hop count to other devices in a line network.

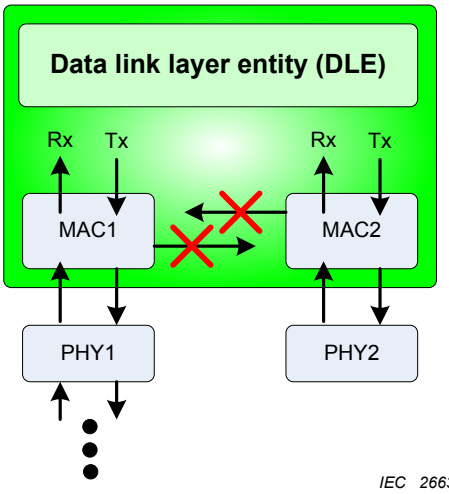

Figure 3 – LNM forwarding control

4.2.5 Behaviours of the Ring Network Managers (RNMs)

A frame in a ring network can be continuously circulated when the designated device is not found or when the frame is broadcast on the network. In a RRP ring network, two RNMs are automatically selected, and each RNM enables only one directional frame forward function to prevent infinite frame circulation, as shown in Figure 4.

The dual RNM structure is used to avoid message duplication. A primary RNM (RNMP) is selected with the highest UID device first, and then one of its neighbouring nodes is selected as a secondary RNM (RNMS). The RNMP and RNMS send Network Control Message Type (NCMT) messages to each other, to monitor network integrity.

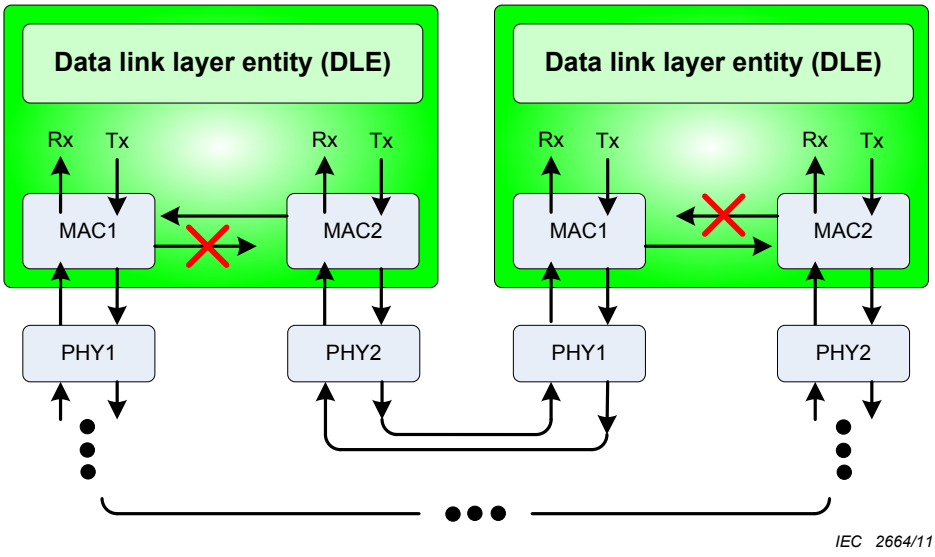

Figure 4 – RNM forwarding control