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DIN EN 62439-2:2018-07**Entwurf**

**Industrielle Kommunikationsnetze –
Hochverfügbare Automatisierungsnetze –
Teil 2: Medienredundanz-Protokoll (MRP)
(IEC 65C/997/CDV:2020);
Englische Fassung prEN IEC 62439-2:2020**

Industrial communication networks –
High availability automation networks –
Part 2: Media Redundancy Protocol (MRP)
(IEC 65C/997/CDV:2020);
English version prEN IEC 62439-2:2020

Réseaux de communication industriels –
Réseaux de haute disponibilité pour l'automatisation –
Partie 2: Protocole de redondance du support (MRP)
(IEC 65C/997/CDV:2020);
Version anglaise prEN IEC 62439-2:2020

Anwendungswarnvermerk

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Weil die beabsichtigte Norm von der vorliegenden Fassung abweichen kann, ist die Anwendung dieses Entwurfs besonders zu vereinbaren.

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Gesamtumfang 181 Seiten

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Nationales Vorwort

Die Englische Fassung des europäischen Dokuments prEN IEC 62439-2:2020 „Industrielle Kommunikationsnetze – Hochverfügbare Automatisierungsnetze – Teil 2: Medienredundanz-Protokoll (MRP)“ (Entwurf in der Umfrage) ist unverändert in diesen Norm-Entwurf übernommen worden.

Die Internationale Elektrotechnische Kommission (IEC) und das Europäische Komitee für Elektrotechnische Normung (CENELEC) haben vereinbart, dass ein auf IEC-Ebene erarbeiteter Entwurf für eine Internationale Norm zeitgleich (parallel) bei IEC und CENELEC zur Umfrage (CDV-Stadium) und Abstimmung als FDIS (en: Final Draft International Standard) bzw. Schluss-Entwurf für eine Europäische Norm gestellt wird, um eine Beschleunigung und Straffung der Normungsarbeit zu erreichen. Dem entsprechend ist das internationale Dokument IEC 65C/997/CDV:2020 „Industrial communication networks – High availability automation networks – Part 2: Media Redundancy Protocol (MRP)“ unverändert in den Entwurf prEN IEC 62439-2:2020 übernommen worden.

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Änderungen

Gegenüber DIN EN 62439-2:2018-07 wurden folgende Änderungen vorgenommen:

- a) Hinzufügen einer Protokoll-Erweiterung zur automatischen Auswahl des Medien-Redundanz-Managers;
- b) Hinzufügen eines Protokolls zur redundanten Verbindung von Medienredundanz-Protokollringen.

Nationaler Anhang NA (informativ)

Auszugsweise Übersetzung

Reihenfolge und Inhalt der folgenden Abschnitte sind identisch mit denen in den jeweiligen Abschnitten der Englischen Fassung.

Einleitung

Die Normenreihe IEC 62439 legt maßgebliche Prinzipien für hochverfügbare Netzwerke fest, die den Anforderungen an industrielle Automatisierungsnetze entsprechen.

Im fehlerfreien Zustand des Netzwerks stellen die Protokolle der Normenreihe IEC 62439 eine mit ISO/IEC/IEEE 8802-3 (IEEE 802.3) kompatible, zuverlässige Datenübertragung bereit und erhalten die Zufallsunabhängigkeit der Echtzeitdatenübertragung aufrecht. Für den Fall eines Fehlzustands und für das Entfernen und Hinzufügen von Komponenten stellen sie deterministische Wiederherstellungszeiten bereit.

Diese Protokolle behalten die typischen Ethernet-Kommunikationsfunktionen, wie sie in der Geschäftswelt eingesetzt werden, vollständig bei, sodass die verwendete Software weiterhin verwendet werden kann.

Auf dem Markt besteht Bedarf an verschiedenen Netzwerklösungen mit unterschiedlichen Leistungsmerkmalen und Funktionen, die vielfältige Anwendungsanforderungen erfüllen. Diese Lösungen unterstützen verschiedene Redundanztopologien und -mechanismen, die in IEC 62439-1 eingeführt und in den anderen Teilen der Normenreihe IEC 62439 festgelegt werden. IEC 62439-1 unterscheidet zwischen den verschiedenen Lösungen und dient dem Anwender als Anleitung.

Die Normenreihe IEC 62439 verwendet die allgemeine Struktur und die Begriffe der Normenreihe IEC 61158.

Die Internationale Elektrotechnische Kommission (IEC) weist darauf hin, dass die Übereinstimmung mit diesem Dokument die Verwendung eines Patents hinsichtlich der in Abschnitt 5 angegebenen Ringprotokolle bedeuten kann. Tabelle 1 gibt einen Überblick über die relevanten Patente.

Tabelle 1 – Informationen zu Patenten

Nr.	Status	Land	Nummer des erteilten Patents oder Anmeldungsnummer (bei laufenden Patentanmeldungen)	Titel
1	erteilt	US	US 6430151	Lokales Netzwerk, insbesondere Ethernet- Netzwerk, mit Redundanzeigenschaften sowie Redundanzmanager
	erteilt	CA	CA 2323429	
	erteilt	CN	CN 117195	
	erteilt	NO	NO 330908	
	erteilt	EP (AT, BE, CH, DE, DK, ES, FR, GB, IT, NL, SE)	EP 1062787	

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1 Anwendungsbereich

Die Normenreihe IEC 62439 gilt für hochverfügbare Automatisierungsnetzwerke auf der Basis der (Ethernet-)Technologie nach ISO/IEC/IEEE 8802-3 (IEEE 802.3).

Der vorliegende Teil der Normenreihe IEC 62439 legt ein Wiederherstellungsprotokoll auf der Basis einer Ringtopologie fest, das so konzipiert ist, dass es unter der Kontrolle eines fest zugeordneten Medienredundanz-Managerknotens deterministisch auf einen Einzelfehler einer Inter-Switch-Verbindung oder eines Switches im Netzwerk reagiert.

3 Begriffe, Abkürzungen, Akronyme und Vereinbarungen

3.1 Begriffe

Für die Anwendung dieses Dokuments gelten die Begriffe nach IEC 60050-191 und IEC 62439-1 sowie die folgenden Begriffe.

3.1.1

Inter-Verbindungsport

(en: interconnection port)

Port eines Switches, welcher verwendet wird, um zwei Ringtopologien zu verbinden

3.1.2

Inter-Verbindungstopologie

(en: interconnection topology)

Topologie, in welcher zwei Ringtopologien verbunden sind

3.2 Abkürzungen und Akronyme

Für die Anwendung dieses Dokuments gelten die Abkürzungen und Akronyme nach IEC 62439-1 und die folgenden Abkürzungen und Akronyme.

ASE	Anwendungsdienstelement	(en: application service element)
CCM	Durchgangsprüfungs-Nachrichten	(en: continuity check messages)
CFM	Konnektivitätsfehlermanagement	(en: connectivity fault management)
CFM-MRP	Konnektivitätsfehlermanagement für MRP	(en: connectivity fault management for MRP)
CPU	Zentraleinheit	(en: central processing unit)
FDB	Filterdatenbank	(en: filtering database)
LC-mode	Verbindungsprüfmodus	(en: link check mode)
LSB	niedrigstwertiges Bit	(en: least significant bit)
MAID	Wartungszuordnungs-Bezeichner	(en: maintenance Association ID)
MD	Wartungsdomäne	(en: maintenance domain)
MD Level	Wartungsdomänen-Ebene	(en: maintenance domain level)
MEP	Wartungs-Endpunkt	(en: maintenance end point)
MEPID	Bezeichner des Wartungszuordnungs-Endpunkts	(en: maintenance association end point ID)
MIB	Management-Informationsbasis	(en: management information base)
MRA	Medienredundanz-Automanager	(en: media redundancy automanager)
MRC	Medienredundanz-Client	(en: media redundancy client)

MRM	Medienredundanz-Manager	(en: media redundancy manager)
MRP	Medienredundanz-Protokoll	(en: media redundancy protocol)
MIC	Medienredundanz-Verbindungsclient	(en: media redundancy interconnection client)
MIM	Medienredundanz-Verbindungsmanager	(en: media redundancy interconnection manager)
RC-mode	Ringüberprüfungsmodus	(en: ring check mode)

3.3 Vereinbarungen

Das vorliegende Dokument folgt den in IEC 62439-1 festgelegten Vereinbarungen.

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**INDUSTRIAL COMMUNICATION NETWORKS –
HIGH AVAILABILITY AUTOMATION NETWORKS –**

Part 2: Media Redundancy Protocol (MRP)

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International Standard IEC 62439-2 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

This third edition cancels and replaces the second edition published in 2016. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- improvements for the Continuity Check Protocol,
- introduction of further specifiers for the rings, the interconnection links, and the device roles,
- extensions and informations on the use of baudrates smaller than 100 Mbit/s,
- informations on using MRP together with scheduling and shaping mechanisms,
- introduction of an MRP Interconnection profile for 30 ms reconfiguration time.

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

FDIS	Report on voting
65C/XXX/FDIS	65C/XXX/RVD

286
287 Full information on the voting for the approval of this standard can be found in the report on
288 voting indicated in the above table.

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

290 This International Standard is to be read in conjunction with IEC 62439-1.

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

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

- 297 • reconfirmed,
298 • withdrawn,
299 • replaced by a revised edition, or
300 • amended.

301

302 The National Committees are requested to note that for this document the stability date
303 is 2025.

304 THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE DELETED
305 AT THE PUBLICATION STAGE.

306

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307

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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/IEEE 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 the 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 ring protocol given in Clause 5. Table 1 gives an overview of the relevant patents.

Table 1 – Patent information

No.	Status	Country	Granted Patent Number or Application Number (if pending)	Title
1	granted	US	US 6430151	Local networking with redundancy properties having a redundancy manager
	granted	CA	CA 2323429	
	granted	CN	CN 117195	
	granted	NO	NO 330908	
	granted	EP (AT, BE, CH, DE, DK, ES, FR, GB, IT, NL, SE)	EP 1062787	

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347 patents relevant to their standards. Users are encouraged to consult the data bases for the
348 most up to date information concerning patents.

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INDUSTRIAL COMMUNICATION NETWORKS – HIGH AVAILABILITY AUTOMATION NETWORKS –

Part 2: Media Redundancy Protocol (MRP)

1 Scope

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

This part of the IEC 62439 series specifies a recovery protocol based on a ring topology, designed to react deterministically on a single failure of an inter-switch link or switch in the network, under the control of a dedicated media redundancy manager node.

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 60050-191, *International Electrotechnical Vocabulary – Chapter 191: Dependability and quality of service*

IEC 61158-6-10:2019, *Industrial communication networks – Fieldbus specifications – Part 6-10: Application layer protocol specification – Type 10 elements*

IEC 61784-1, *Industrial communication networks – Profiles – Part 1: Fieldbus profiles*

IEC 61784-2, *Industrial communication networks – Profiles – Part 2: Additional fieldbus profiles for real-time networks based on ISO/IEC 8802-3*

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

IEC 62439-1:2010/AMD1:2012

IEC 62439-1:2010/AMD2:2016¹

ISO/IEC 10164-1, *Information technology – Open Systems Interconnection – Systems Management: Object Management Function*

ISO/IEC/IEEE 8802-3 *Standard for Ethernet*

IEEE 802.1D:2004, *IEEE Standard for Local and metropolitan area networks – Media Access Control (MAC) Bridges*

IEEE 802.1Q:2018, *IEEE Standard for Local and metropolitan area networks – Media Access Control (MAC) Bridges and Virtual Bridge Local Area Network*

¹ A consolidated version of this publication exists, comprising IEC 62439-1:2010, IEC 62439-1:2010/AMD1:2012 and IEC 62439-1:2010/AMD2:2016.

387 IEEE 802.3:2018, *IEEE Standard for Ethernet*.

388 **3 Terms, definitions, abbreviations, acronyms, and conventions**

389 **3.1 Terms and definitions**

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

392 ISO and IEC maintain terminological databases for use in standardization at the following
393 addresses:

- 394 • IEC Electropedia: available at <http://www.electropedia.org/>
- 395 • ISO Online browsing platform: available at <http://www.iso.org/obp>

396 **3.1.1**

397 **interconnection port**

398 port of a switch that is used to interconnect two ring topologies

399 **3.1.2**

400 **interconnection topology**

401 topology in which two ring topologies are connected

402 **3.2 Abbreviations and acronyms**

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

405	ASE	Application Service Element
406	CCM	Continuity Check Messages
407	CFM	Connectivity Fault Management
408	CFM-MRP	Connectivity Fault Management for MRP
409	CPU	Central Processing Unit
410	FDB	Filtering Database
411	LC-mode	Link Check mode
412	LSB	Least Significant Bit
413	MAID	Maintenance Association ID
414	MD	Maintenance Domain
415	MD Level	Maintenance Domain Level
416	MEP	Maintenance End Point
417	MEPID	Maintenance Association End Point ID
418	MIB	Management Information Base
419	MRA	Media Redundancy Automanager
420	MRC	Media Redundancy Client
421	MRM	Media Redundancy Manager
422	MRP	Media Redundancy Protocol
423	MIC	Media Redundancy Interconnection Client
424	MIM	Media Redundancy Interconnection Manager
425	RC-mode	Ring Check mode

3.3 Conventions

This document follows the conventions defined in IEC 62439-1.

4 MRP Overview

This document specifies the Media Redundancy Protocol (MRP), a recovery protocol based on a ring topology, and the redundant interconnection of MRP rings via the Media Redundancy Interconnection Protocol as shown in Figure 1.

MRP is designed to react deterministically on a single failure of an inter-switch link or switch in the ring or interconnection topology.

MRP is based on functions of ISO/IEC/IEEE 8802-3 (IEEE 802.3) and IEEE 802.1Q including the Filtering Database (FDB) and is located between the Data Link Layer and Application Layer (see Figure 2).

NOTE Layering is assumed to be according to IEC 61158-1.

A MRP compliant network shall have a ring topology with multiple nodes.

One of the nodes has the role of a Media Redundancy Manager (MRM). The function of the MRM is to observe and to control the ring topology in order to react on network faults. The MRM does this by sending frames on one ring port over the ring and receiving them from the ring over its other ring port, and vice-versa in the other direction. To ensure the best results the test frames have to be prioritized in a way that they are exclusively handled as the highest priority traffic in the ring. The calculations for guaranteed recovery times given in clause 9.9 work under this assumption. If this is not the case, the potential interference test frames can experience from other traffic in the ring have to be taken into consideration when calculating the ring recovery time.

The other nodes in the ring have the role of Media Redundancy Clients (MRC). An MRC reacts on received reconfiguration frames from the MRM and can detect and signal link changes on its ring ports.

Certain nodes or all nodes in the ring may also start as a Media Redundancy Automanager (MRA). MRAs select one MRM among each other by using a voting protocol. The remaining MRAs transition to the role MRC.

Each node in the ring is able to detect the failure or recovery of an inter-switch link or the failure or recovery of a neighboring node.

To redundantly connect two MRP rings, two nodes of each ring are assigned additional roles.

One of the nodes has the role of a media redundancy interconnection manager (MIM), in addition to the role of a MRC or MRM. The function of the MIM is to observe and to control the redundant interconnection topology in order to react on interconnection faults. To cover a maximum of applications, two detection methods are provided by this international standard. The MIM can observe the interconnection topology by either reacting directly on interconnection port link change notification messages (LC-mode) or by sending test frames on the interconnection port over the connected rings and receiving them over its ring ports, and vice-versa in the other direction (RC-mode). The ring which contains the MIM of an interconnection is called the primary ring of this Interconnection.

The other three nodes in the interconnection topology have the role of media redundancy interconnection clients (MIC), in addition to the role of a MRC or MRM.

- The MIC which is located in the primary ring together with the MIM is called the primary MIC.

- The MIC which is opposite the primary MIC, sharing the primary link with it, is called the primary coupled MIC.
- The MIC which is opposite the MIM, sharing the secondary link with it, is called the secondary coupled MIC.
- The ring coupled to the primary ring, containing primary coupled MIC and secondary coupled MIC, is called the secondary ring.

The MICs react on received reconfiguration frames from the MIM, they can detect and signal link changes of their interconnection port, and they can issue link change notification messages.

LC-mode has the advantage of restricting the interconnection test frame load only to the interconnection links, whereas RC-mode has the advantage of deloading the MICs from interconnection test frame processing. The selection of the mode has to be made in accordance with the requirements of the application and is outside the scope of this international standard.

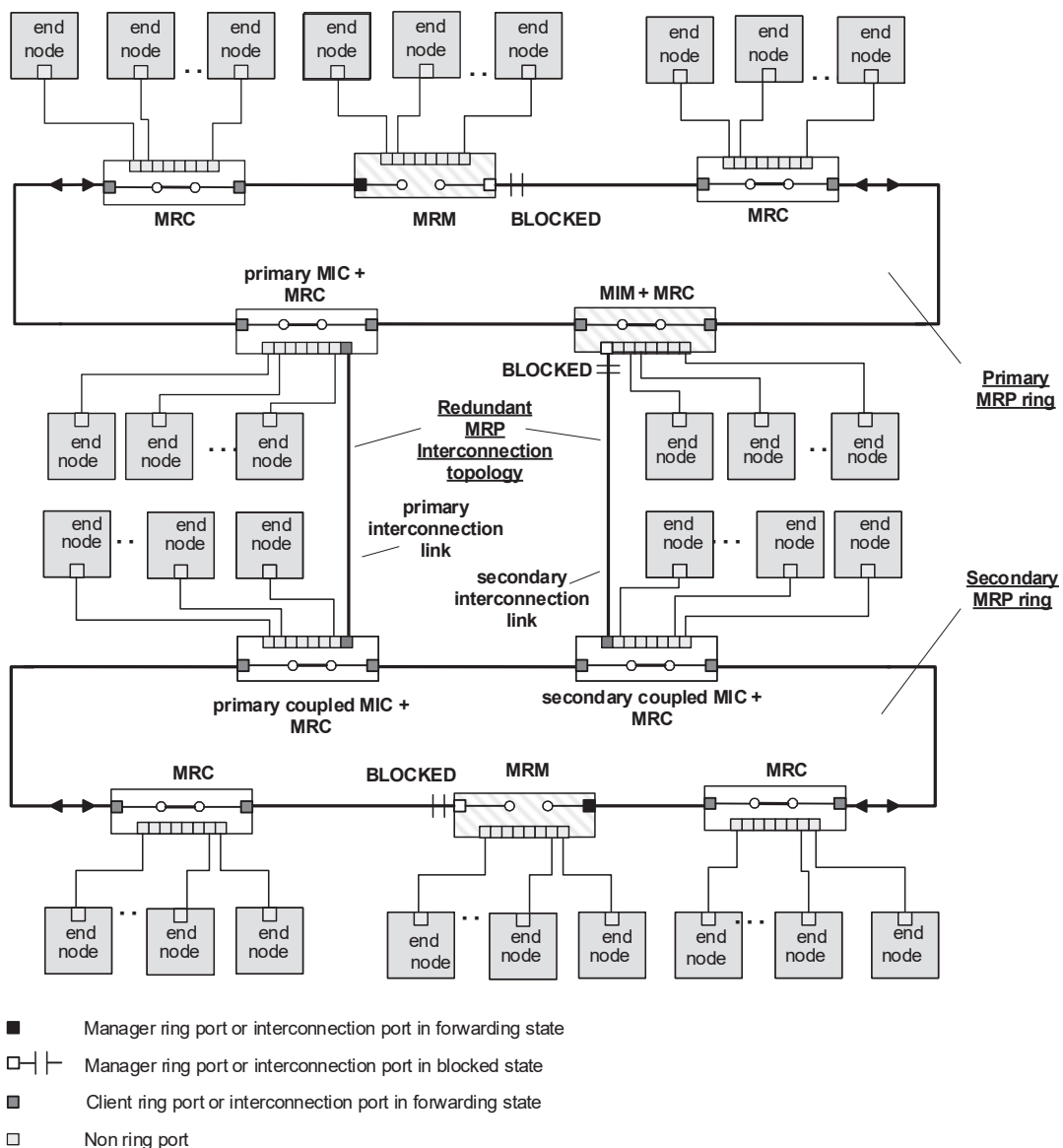


Figure 1 – Two MRP rings redundantly connected via MRP Interconnection

484 MRC, MRM and MRA which support to be operated in rings where an RC-mode MRP
485 Interconnection is applied, are “RC-mode aware”. MRC, MRM and MRA which support to be
486 operated in rings where an LC-mode MRP Interconnection is applied, are “LC-mode aware”.

487 The vendor may implement only the LC-mode or only the RC-mode or both modes. The MIM
488 and all MICs of one MRP interconnection topology shall be configured to the same mode. A ring
489 may contain multiple MRP Interconnections of only RC-mode MRP Interconnections or of only
490 LC-mode MRP Interconnections. A ring may also contain multiple MRP Interconnections of both
491 modes if all ring devices support this, i.e. all devices are at least RC-mode and LC-mode aware
492 (see chapters 5.3 and 5.4, LC-mode awareness and RC-mode awareness).

493 Each MRP compliant node requires an IEEE 802.1 compliant switch element with two ring ports
494 connected to one ring and shall have the ability to perform at least as one of the following:

- 495 • media redundancy manager (MRM); or
- 496 • media redundancy client (MRC); or
- 497 • both MRM or MRC (but both roles shall not be active at the same time for the same ring).

498 Each Media Redundancy Interconnection compliant node requires an IEEE 802.1 compliant
499 switch element with two ring ports connected to one ring, and with one interconnection port
500 connected to another MRP ring and shall have the ability to perform at least as one of the
501 following:

- 502 • both MRC and media redundancy interconnection manager (MIM) (both roles shall be active
503 at the same time); or
- 504 • both MRM/MRA and MIM (both roles shall be active at the same time); or
- 505 • both MRC and media redundancy interconnection client (MIC) (both roles shall be active at
506 the same time); or
- 507 • both MRM/MRA and MIC (both roles shall be active at the same time).

508 More than two MRP rings may be redundantly connected by applying the redundant
509 interconnection topology multiple times from one ring to other rings. This leads to rings
510 containing multiple nodes configured to MIM and multiple nodes configured to MIC. A redundant
511 connection of more than two rings may also be achieved by two nodes of a ring containing
512 multiple instances of MIMs or MICs.

513 An MRP compliant node may implement multiple instances of the MRC, MRM, MRA, MIM or
514 MIC functionality. In this case it shall obey the following configuration rules:

- 515 • if one or more MIM or MIC instances are active on one node, then there shall be only one
516 MRC or one MRM or one MRA instance active on this node at the same time;
- 517 • if more than one MRC or MRM or MRA instances are active on one node, then no MIC or
518 MIM shall be active on this node at the same time;
- 519 • if more than one MRC or MRM or MRA instances are active on one node, thereby connecting
520 the related rings connected to the ring ports of this node, then there shall be no other node
521 in the network connecting the same rings over its MRC or MRM or MRA instances.

522 The following definitions and chapters with MRP and MRP Interconnection definitions always
523 apply to one MRP instance or one MRP Interconnection instance per compliant node. Multiple
524 activation of MRP instances or MRP Interconnection instances, according to the configuration
525 rules stated above, might demand additional requirements to correct frame processing and
526 frame forwarding, which are out of the scope of this document.

527 NOTE Additional interconnection ports can be used to connect to additional rings.

528 The MRP consists of a service and a protocol entity, see stack model in Figure 2.

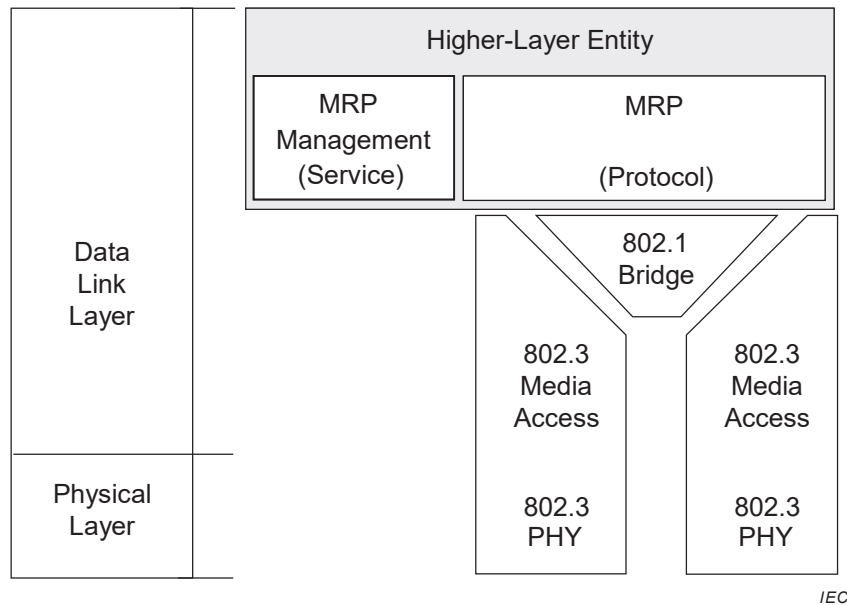
529 The service entity specifies, in an abstract way, the externally visible service provided by the
530 Data Link Layer in terms of:

- 531 • primitive actions and events of the service;
- 532 • parameters associated with each primitive action and event, and the form which they take,
533 and;
- 534 • interrelationship between these actions and events, and their valid sequences.

535 MRP defines the services provided to:

- 536 • the Application Layer at the boundary between the Application Layer and the Data Link
537 Layer; and
- 538 • the MRP Management at the boundary between the Data Link Layer and the MRP
539 Management.

540



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Figure 2 – MRP stack

543 5 MRP Media redundancy behavior

544 5.1 General

545 The following definitions for Media redundancy protocol roles always refer to one instance of
546 the MRP role.

547 5.2 Ring ports

548 The MRM and the MRC shall have two ring ports.

549 The MRM and MRC shall be able to detect the failure or recovery of a link on a ring port with
550 mechanisms based on ISO/IEC/IEEE 8802-3 (IEEE 802.3).

551 The MRM and MRC shall not forward MRP_Test frames, MRP_TopologyChange frames, and
552 MRP_LinkChange frames to non-ring ports.

553 NOTE Ring ports are expected to behave as if STP, RSTP or MSTP is disabled.

554 A ring port shall take one of the following port states:

555 – DISABLED

556 All frames shall be dropped.

557 – BLOCKED

558 All frames shall be dropped except the following:

- 559 • MRP_TopologyChange frames, MRP_Test frames and MRP_TestMgrNAck frames;
- 560 • MRP_LinkChange frames and MRP_TestPropagate from an MRC;
- 561 • MRP_Option frames;
- 562 • MRP_InTest, MRP_InTopologyChange and MRP_InLinkStatusPoll from an MIM;
- 563 • MRP_InLinkChange frames from an MIC;
- 564 • frames specified in IEEE 802.1D-2004 Table 7-10 to pass ports in “Discarding” state (e.g. LLDP, IEEE 1588-2008 PTP peer to peer frames);
- 565 • frames only produced or consumed by the higher layer entities of this node and never forwarded.

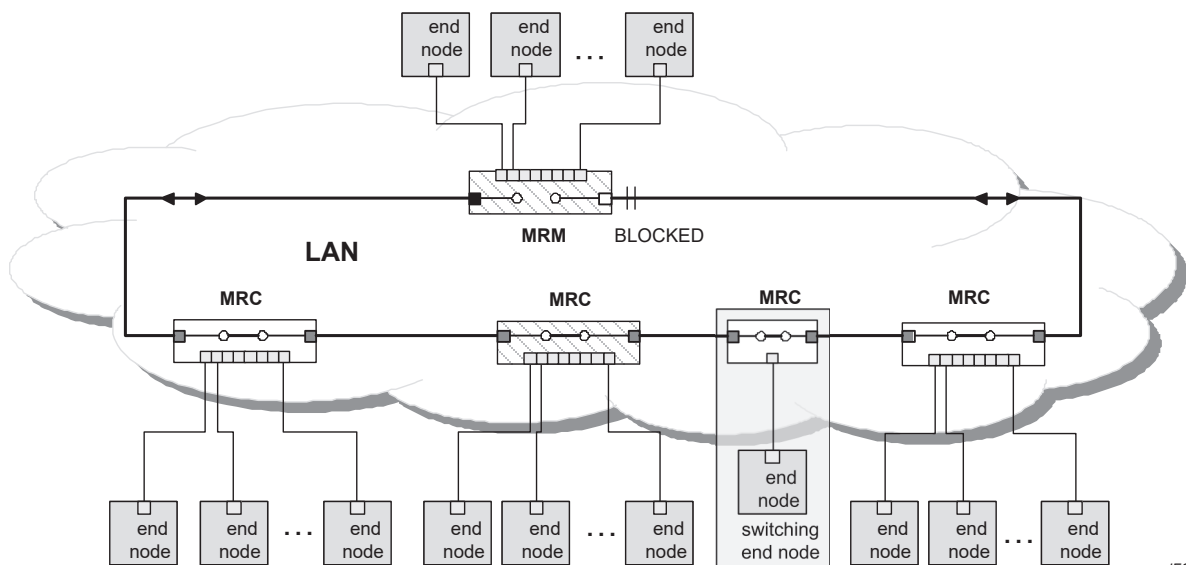
568 – FORWARDING

569 All frames shall be passed through according to the forwarding behavior of IEEE 802.1D.

570 NOTE IEEE 802.1D refers to the port state corresponding to BLOCKED as “Discarding”.

571 5.3 Media Redundancy Manager (MRM)

572 One ring port of the MRM shall be connected to a ring port of an MRC. The other ring port of
573 that MRC shall be connected to a ring port of another MRC or to the second ring port of the
574 MRM, thereby forming a ring topology as shown in Figure 3.



575

576 **Figure 3 – MRP ring topology with one manager and clients**

577 The MRM shall control the ring state by:

- 578 • sending MRP_Test frames at a configured time period in both directions of the ring;
- 579 • setting one ring port to FORWARDING state and the other ring port to BLOCKED state if it
580 receives its own MRP_Test frames (this means that the ring is closed, see Figure 3);
- 581 • setting both ring ports to FORWARDING state if it does not receive its own MRP_Test
582 frames on both ring ports within a configured time according to MRP_TestMgrNAck.

MRP_TSTshortT and MRP_TSTNRmax in Table 60 (this means that the ring is open, see Figure 4).

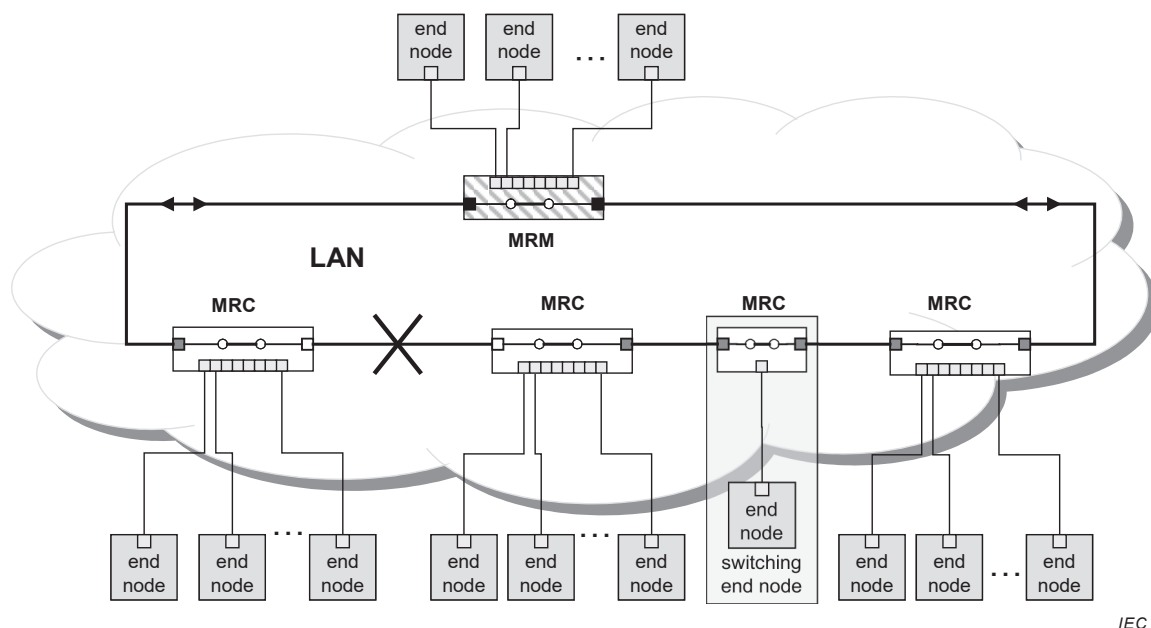


Figure 4 – MRP open ring with MRM

The following mechanism supports synchronization between MRM and MRC in ring topology changes.

The MRM shall indicate changes in the ring state to the MRCs by means of MRP TopologyChange frames.

The MRM shall not forward MRP specific frames (MRP_Test frames, MRP_TopologyChange frames, MRP_LinkChange frames) between its ring ports.

If the MRM receives an MRP_LinkUp or MRP_LinkDown frame, then the MRM shall reduce its test monitoring time according to Table 60 to accelerate the detection of the open ring. When the open ring is detected then the MRM shall set one ring port to forwarding state and shall send the MRP_TopologyChange frames through both its ring ports.

If parameter `MRP_REACT_ON_LINK_CHANGE` is set, see Table 42, the MRM shall, on receiving an `MRP_LinkDown` frame, immediately set one ring port to forwarding state and shall then send the `MRP_TopologyChange` frames through its ring ports.

The MRM shall send to the MRCs an MRP_TopologyChange frame containing the delay, after which the ring topology change will be performed. The parameter carrying this delay is called MRP_Interval. When this time has expired, all MRCs shall clear their Filtering Database (FDB) information for their ring ports.

Each MRC shall send the configured delay in MRP_Interval to the MRM in the MRP_LinkUp and MRP_LinkDown frames to tell the MRM after which time the MRC will change its port state from BLOCKED to FORWARDING (MRP_LinkUp frame) or from FORWARDING to BLOCKED (MRP_LinkDown frame).

Measures shall be included to prevent the MRM from remaining stuck in the closed state in case of node failure.

610 The MRM shall forward MRP_InLinkChange frames, MRP_InLinkStatusPoll frames and
611 MRP_InTopologyChange frames between its ring ports, if it supports to be operated in rings
612 where an LC-mode MRP Interconnection is applied (LC-mode awareness) and both of its ring
613 ports are in state FORWARDING.

614 The MRM shall forward MRP_InTest frames, MRP_InLinkChange frames, and
615 MRP_InTopologyChange frames between its ring ports, if it supports to be operated in rings
616 where an RC-mode MRP Interconnection is applied (RC-mode awareness) and both of its ring
617 ports are in state FORWARDING.

618 The MRM may support LC-mode awareness or RC-mode awareness or both.

619 The MRM shall not forward MRP_InTest frames, MRP_InLinkChange frames,
620 MRP_InLinkStatusPoll frames and MRP_InTopologyChange frames between its ring ports, if
621 one of its ring port is in the port state BLOCKED.

622 The MRM shall process MRP_InTopologyChange frames. It shall clear its FDB if requested by
623 an MRP_InTopologyChange frame in a given time interval MRP_Interval. It shall send an
624 MRP_TopologyChange frame if requested by the MRP_InTopologyChange frame, in order to
625 ensure that all MRC, MIM and MIC in the ring domain clear their FDB at the same time.

626 **5.4 Media Redundancy Client (MRC)**

627 Each MRC shall forward MRP_Test frames received on one ring port to the other ring port and
628 vice versa.

629 If the MRC detects a failure or recovery of a ring port link, the MRC may optionally notify the
630 change by sending MRP_LinkChange frames through both of its ring ports. Each MRC shall
631 forward MRP_LinkChange frames received on one ring port to the other ring port and vice versa.

632 Each MRC shall forward MRP_TopologyChange frames received on one ring port to the other
633 ring port and vice versa. Each MRC shall process these frames. It shall clear its FDB if
634 requested by an MRP_TopologyChange frame in a given time interval MRP_Interval.

635 Each MRC shall forward MRP_InLinkChange frames, MRP_InTopologyChange frames and
636 MRP_InLinkStatusPoll frames between its ring ports, if it supports to be operated in rings where
637 an LC-mode MRP Interconnection is applied (LC-mode awareness).

638 Each MRC shall forward MRP_InTest frames, MRP_InLinkChange frames,
639 MRP_InTopologyChange frames between its ring ports, if it supports to be operated in rings
640 where an RC-mode MRP Interconnection is applied (RC-mode awareness).

641 The MRC may support LC-mode awareness or RC-mode awareness or both.

642 **5.5 Redundancy domain**

643 The redundancy domain represents a ring. By default, all MRM and MRCs belong to the default
644 domain. A unique domain ID can be allocated to all ring nodes of one ring as a key attribute.
645 This is especially essential to distinguish frames if a device is member of multiple rings by
646 implementing multiple instances of MRMs or MRCs. A node shall assign exactly two unique ring
647 ports per redundancy domain.

648 NOTE A device can have other ports than the two assigned to MRP. These other ports are not influenced by MRP.

649 **5.6 Media Link Check**

650 To enhance the quality of the link detection of certain ring or interconnection ports, a media link
651 check protocol may be used. It shall be used for LC-mode.

The Continuity Check protocol, defined in the Connectivity Fault Management (CFM) protocol suite within IEEE 802.1Q-2018 and further specified in this document under the name Connectivity Fault Management for MRP (CFM-MRP), shall be supported as media link check protocol.

CFM-MRP shall be used at the interconnection ports of the MIM and MICs when operating the ring interconnection in LC-mode. CFM-MRP may be used at the interconnection ports if operating the ring interconnection in RC-mode.

CFM-MRP may also be used at the ring ports of MRP devices.

5.7 Application of the Continuity Check protocol

5.7.1 General

When applying the CFM-MRP protocol according to the specification of the Continuity Check protocol as defined in IEEE 802.1Q-2018 to check the links between ring- or interconnection ports, then the ring- and interconnection ports represent Maintenance End Points (MEP) belonging to a Maintenance Domain (MD) and a Maintenance Association (MA) in the sense of IEEE 802.1Q-2018.

An MRP device, applying the CFM-MRP protocol on its interconnection ports or ring ports, shall internally produce a MAUTypeChangeInd event when the Continuity Check receiver instance on its MRP port has detected a remote Maintenance End Point (MEP) error by detecting a lifetime violation of the Continuity Check messages (CCM) from the linked remote MRP devices MEP CFM-MRP initiator.

5.7.2 Continuity Check Message Interval

The CCM Interval to be used shall be either 3,33 ms or 10 ms. It may be slower in accordance with IEEE 802.1Q-2018 for the redundant passive link or a single active link.

5.7.3 Maintenance Domain Level

The Maintenance Domain Level (MD Level) to be used between two ring- or interconnection ports of two MRP devices shall be level 0 for lowest level physical connections. Thereby also the fixed CCM Multicast MAC Address 01-80-C2-00-00-30 is assigned according to IEEE 802.1Q-2018.

5.7.4 Maintenance Association ID (MAID)

The Maintenance Association ID (MAID) according to IEEE 802.1Q-2018 to be used may be as specified in Table 2

683

Table 2 – Coding of the Maintenance Association ID (MAID)

Subfield	Value
Maintenance Domain Name Format (Character String)	4
Maintenance Domain Name Length	20
Maintenance Domain Name	Character string containing: "CFM CCM <MAC ADDRESS>" The substitution <MAC ADDRESS> shall represent the port MAC address converted to a string without any blanks or hyphens. E.g. the port MAC address 08-00-06-08-47-11 would result in the string "CFM CCM 080006084711". Two ports exchanging CFM CCM frames shall negotiate the final common Maintenance Domain Name of that Maintenance connection to be the string of the port with the lower MAC address, i.e. the port with the higher MAC address value changes the Maintenance Domain Name to be the name of the port with the lower MAC address value.
Short MA Name Format (2-octet integer)	3
Short MA Name Length	2
Short MA Name	two Octets containing the value: 0x0001

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686 5.7.5 Maintenance Association End Point ID (MEPID)

687 A Maintenance End Point (MEP) shall start sending CFM CCM frames with the MEPID value of "1". If it
 688 receives CFM CCM frames from a remote MEP with a Maintenance Domain Name containing a lower
 689 port MAC Address than its own, it shall change its MEP ID to the value "2" together with changing its
 690 Maintenance Domain Name to the remote MEPs Maintenance Domain Name. If the remote MEPs
 691 Maintenance Domain Name contains a higher MAC Address than its own, it shall neither change its
 692 MEPID nor Maintenance Domain Name.

693 5.7.6 Sender ID TLV

694 The use of the Sender ID TLV according to IEEE 802.1Q is optional for MRP.

695 5.7.7 Port Status TLV

696 The use of the Port Status TLV according to IEEE 802.1Q is optional for MRP.

697 5.7.8 Interface Status TLV

698 The use of the Interface Status TLV according to IEEE 802.1Q is optional for MRP.

699 5.8 Usage with diagnosis and alarms

700 If the attribute Check Media Redundancy has the value TRUE, media redundancy events shall
 701 cause diagnosis events and alarm notifications.

702 5.9 Ring diagnosis

703 In a redundancy domain the following diagnosis events handling shall be implemented by each
 704 MRM:

- If a device is configured as MRM, but not operating in the manager role, it shall signal a “MANAGER_ROLE_FAIL” diagnosis event and suspend reporting of all other media redundancy diagnosis events while not in the manager role.
- If a device is operating in manager role and this device detects another active MRM, it shall signal the “MULTIPLE_MANAGERS” event. This event can occur concurrently with the ring state event “RING_OPEN”.
- If a device is operating in manager role and detects an open ring, it shall signal the “RING_OPEN” event.

These events shall be signaled by using the State Change service (see 7.3).

NOTE The presence of MRP Test frames enables the checking of the existence of an MRM.

5.10 Multiple MRM in a single ring: Manager voting option

5.10.1 General

There shall be only one active MRM in the ring even if several nodes have this ability.

NOTE 1 Multiple active MRMs cause the ring to divide itself into several segments.

As an alternative to manual MRP-role configuration, in case of more than one node having the ability to become an MRM in the ring, an enhanced manager voting option, specified in this International Standard, may be used to decide which of these nodes shall finally become the MRM, while the other nodes take over the MRC role as shown in Figure 5 and Figure 6. To this effect, the nodes with the MRM ability have different priorities that shall be conveyed in the MRP Prio field of the MRP Test frame.

If an option for multiple MRM in a single ring is used, then all MRM in the ring shall support the same manager voting option, as defined in this document.

MRM supporting the manager voting option are named Media Redundancy Automanager or MRA.

Figure 5 shows an MRP ring at network startup with two devices in the administrative MRA role.

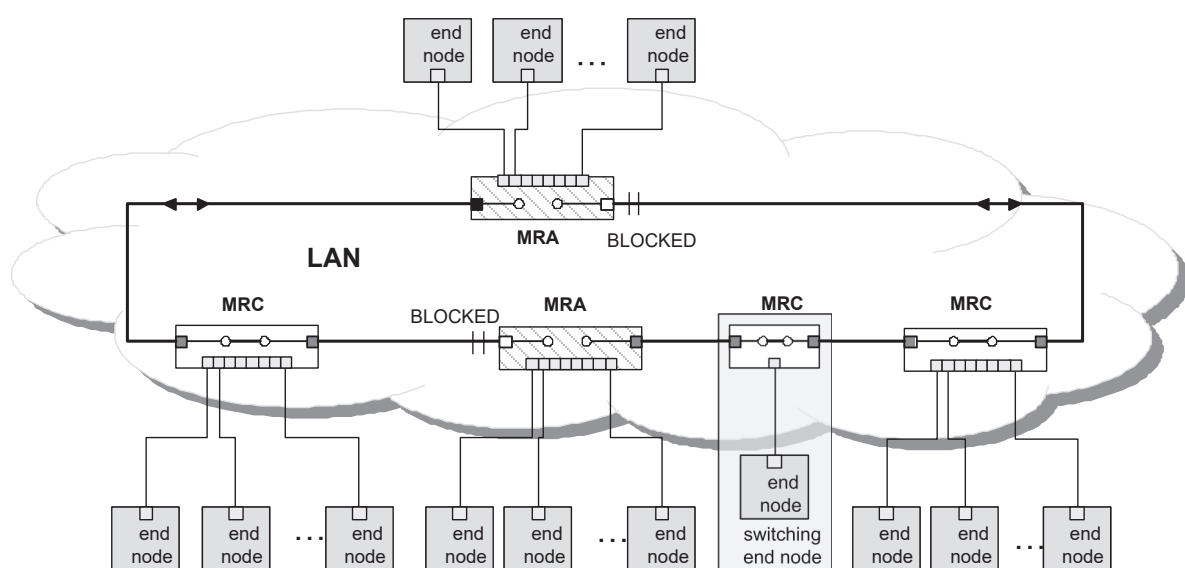


Figure 5 – MRP ring with MRA at network startup

732 The MRA role is an MRP role which comprises both the MRP roles MRM and MRC. Additionally
733 the MRA has the capability to transition at any point in time, by virtue of the voting protocol,
734 from its initial operational role manager (MRA) to the operational role client (MRC), and back
735 again, in coordination with possible other MRAs in the ring.

736 NOTE 2 To emphasize the principle, the following explanations use the expression MRM for the remaining MRA
737 managing the ring, although the device continues to be MRA, always capable to vote again.

738 Figure 6 shows the same network ring after the manager voting process has taken place. The
739 MRA transitioned to the MRP roles MRM and MRC.

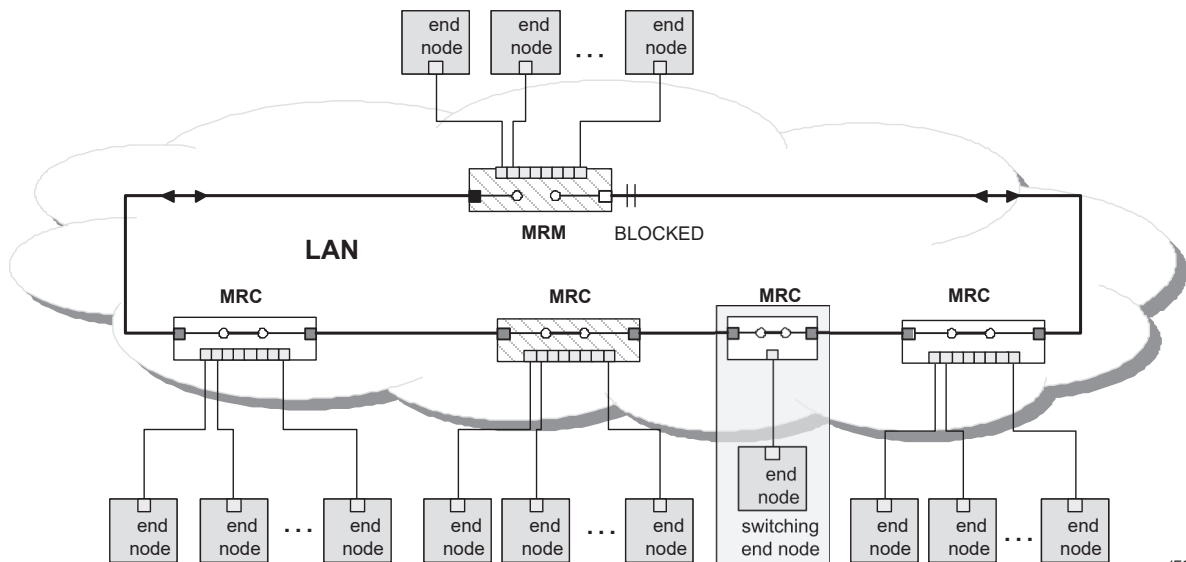


Figure 6 – MRP ring after the manager voting process

5.10.2 Basic principle of the manager voting process

The manager voting is an optional process only for devices which are capable of taking over the MRM role within MRP.

The manager voting phase of MRP shall take place right after device startup, and before the device starts to take one of the possible MRP-roles MRM or MRC.

The basic functionality of the manager voting process shall be as follows:

- Each network node of the ring with MRM-capability and manager voting option support, thereby being a so-called “Manager (Auto)” or short “MRA”, may be set to the MRP-role “Manager (Auto)” by factory-default.
- Each MRA shall have assigned a priority (MRP_Prio) value. This MRP_Prio-value, combined with the MAC address, results in a finally unique priority. A lower MRP_Prio-value means a higher priority. If devices have identical MRP_Prio values, then the value of the device MAC address decides. A lower MAC address means a higher priority.
- At startup, each MRA network node shall start up with the manager voting process and shall send MRP_Test frames.
- Other MRA shall receive the MRP_Test frames and shall compare their own priority with the priority of the next MRA. If they do have the higher priority, they shall cause the remote manager that is sending the MRP_Test frame to withdraw from the MRA-role into the MRC-role by sending a negative test manager acknowledgement.
- The MRA or MRM with the highest priority shall become the one and only MRM of the ring and shall now start to manage the ring according to MRP.

- If the MRM, which has been elected via the manager voting option, is taken out of the ring or fails to operate, the voting process shall start again and the next priority MRA shall become the managing MRM.
- If an additional MRA is inserted into a ring containing an already elected MRM, then the already elected MRM and the newly inserted MRA will exchange MRP_Test frames and will thereby vote the new remaining MRM among each other.
- For the manager voting option to work correctly, all devices in the ring supporting the manager role shall be set to MRP-role “Manager (Auto)” or shall remain in the MRP-role “Client”. At least one device of a ring shall be set to either the MRP-role “Manager (Auto)” or “Manager” though.
- If an MRM without MRA capability is part of the network ring, regardless whether the ring is open or closed, all MRA shall be configured to the MRC role.

NOTE Configuring MRA to the MRC role is not performed automatically by the automanager voting process but is done by the user.

5.10.3 The manager voting process

The manager voting process shall be as follows:

- At power on, all MRA shall start with the manager voting process.
- Each MRA shall start to send MRP_Test frames on both ring-ports. The MRP_Test frame shall contain the MRAs priority value MRP_Prio.
- Received MRP_Test frames shall be forwarded to the local host only.
- The remote managers priority values contained in the received MRP_Test frames shall be compared with their own priority, as described in 5.10.2. If their own priority is higher than the received priority, a negative test manager acknowledgement (“MRP_TestMgrNAck”) frame, with the remote managers MAC address as additional information, shall be sent.
- If a negative test manager acknowledgement (“MRP_TestMgrNAck”) with their own MAC address is received, the receiving MRA shall initiate the transition into client (MRC) role by:
 - recording the MAC address and priority of the higher priority manager;
 - entering the client role and propagating the role change and the higher priority manager information via a “MRP_TestPropagate” frame sent on both ring-ports.
- On reaching the MRP client role it shall forward MRP_Test frames between ring ports like a standard MRC. Additionally, it shall also forward MRP_Test frames to the host CPU.
- From now on, the MRA in client role shall monitor whether the recorded higher priority manager is still alive, i. e. whether it still receives MRP_Test frames from that manager.
- The MRP_TestPropagate frame shall be used to inform other MRA devices in client role about the role change and the new higher priority manager. The clients receiving this frame shall update their higher priority manager information accordingly. This ensures that clients stay in client role in case of a role change of the monitored higher priority manager.
- The frames MRP_TestMgrNAck and MRP_TestPropagate shall be sent using the destination multicast address MC_TEST.
- If the MRA in client role recognises (via MRP_Test frame reception monitoring timeout) that the higher priority manager has failed, it shall fall back into automanager role and shall thereby start a new manager voting process with the other MRA, which have fallen back into automanager role in the same way and for the same reason.

Figure 7 shows the frame exchanges over the time during the manager voting phase:

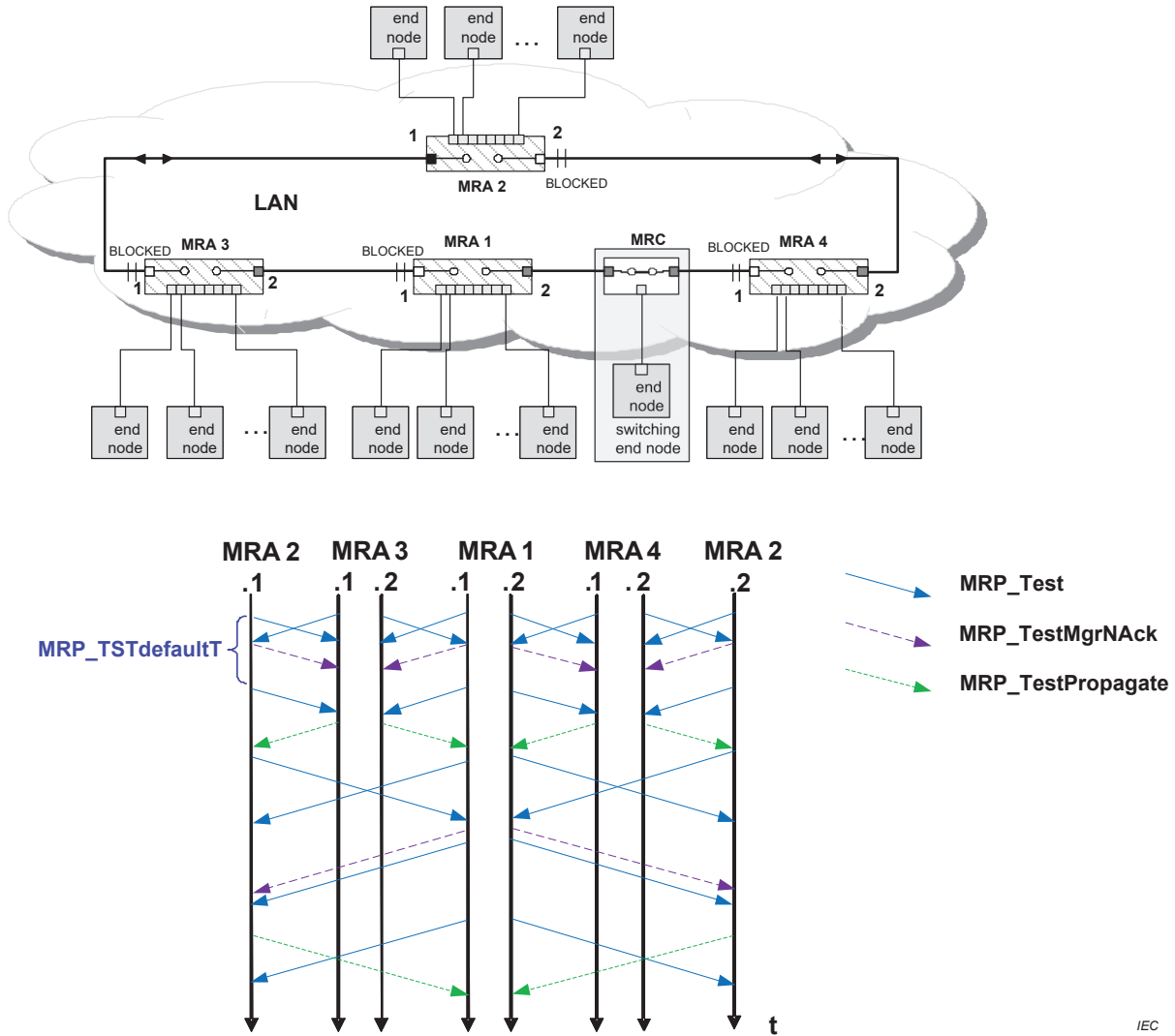
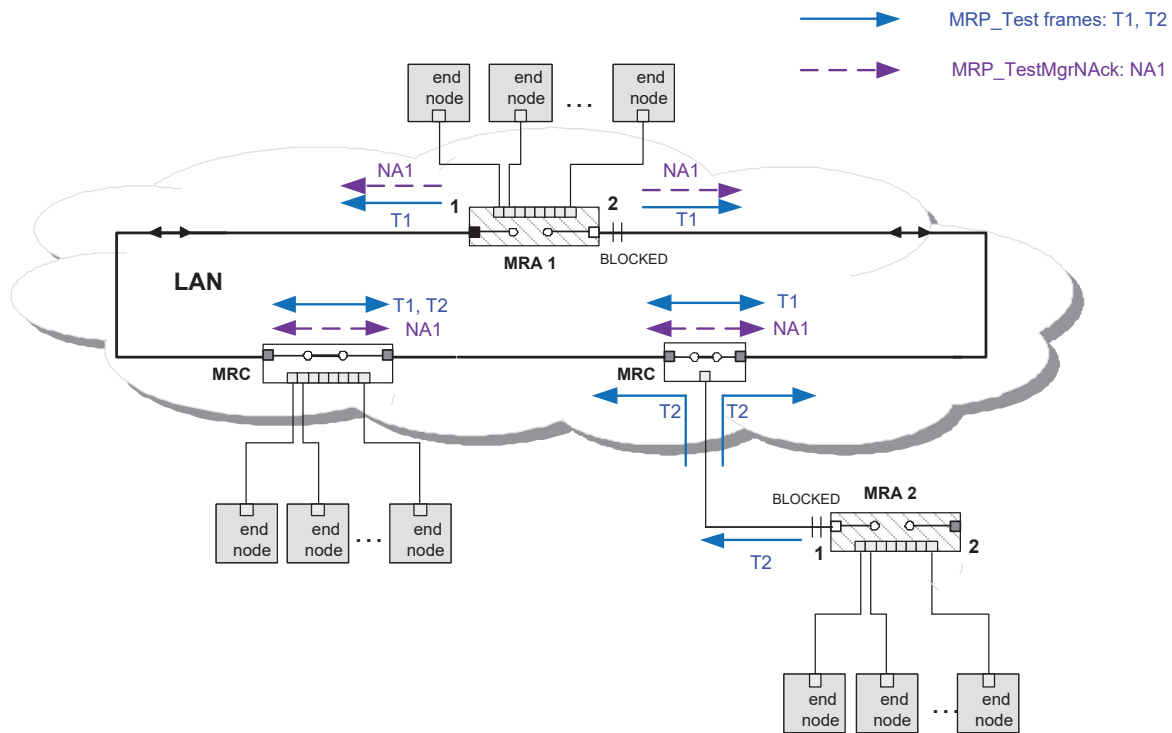


Figure 7 – Manager voting process

A handshake (negative test acknowledgement) is required to ensure the higher priority manager is located in the ring. This is necessary, as due to the switch frame forwarding rules, which allow MRP_Test frames from a manager device located outside the ring, connected via its ring-port to a non-ring port of an MRP device being part of the ring, are also forwarded into the ring, if a switch without “inbound” filtering capability (“ingress filtering”) is used.

Figure 8 shows an MRP ring with one MRA (MRA2) located outside the ring. MRA2 is connected via one of its ring ports to a non-ring port of a device which is part of the ring. The frames follow the forwarding rules as defined in 5.2.

While lower priority manager MRA1 receives test frames from higher priority manager MRA2, MRA2 does not receive test frames from lower priority manager MRA1 as these are not forwarded to non-ring ports, which excludes it from the voting process. Therefore MRA2 does not send negative test acknowledgements and MRA1 will stay in the MRM role. If MRA1 would have a higher priority as MRA2, MRA1 would send negative test acknowledgements but these would not reach MRA2 as these are not forwarded to non-ring ports either.



IEC

Figure 8 – MRA located outside the MRP ring

5.11 BLOCKED not supported (Option)

If an MRC is not able to support the BLOCKED port state at its ring ports, the MRC shall report it in the corresponding parameter of the MRP_LinkChange frames.

If an MRC does not support the BLOCKED state in a ring, then an MRM shall support additional functionalities (see Table 41 and Table 42, MRP_BLOCKED_SUPPORTED).

5.12 Interconnection port

The MIM and the MIC shall have one interconnection port.

The MIM and the MIC shall be able to detect the failure or recovery of a link on the interconnection port as follows:

- by using link detection mechanisms based on ISO/IEC/IEEE 8802-3 (IEEE 802.3)

In addition by applying one or both of the following mechanisms:

- a media link check protocol between interconnection ports. The media link check protocol shall be used at the MIM and MICs interconnection port if the MIM is configured to link check mode (LC-mode) and may be used if the MIM is configured to ring check mode (RC-mode).
- a periodic MRP_InTest frame which shall be sent and received by the MIM on its ring ports and interconnection port and shall be forwarded by the MICs on their ring ports and interconnection port. This mechanism shall be used for RC-mode and shall not be used for LC-mode.

The MIM and the MIC shall not forward MRP_InTest frames, MRP_InTopologyChange frames, MRP_InLinkStatusPoll frames and MRP_InLinkChange frames to ports other than ring ports and other than the interconnection port.

847 The interconnection port shall take one of the following port states:

848 – DISABLED

849 All frames shall be dropped.

850 – BLOCKED

851 All frames shall be dropped except the following:

- 852 • MRP_InTest frames;
- 853 • MRP_InLinkChange frames and MRP_InTopologyChange frames;
- 854 • MRP_InLinkStatusPoll frames;
- 855 • Media link check frames CFM-MRP according to IEEE 802.1Q-2018;
- 856 • Frames specified in IEEE 802.1D-2004, Table 7-10 to pass ports in “Discarding” state (e.g. LLDP, IEEE 1588-2008 PTP peer to peer frames);
- 857 • Frames only produced or consumed by the higher layer entities of this node and never forwarded.

860 – FORWARDING

861 All frames shall be passed through according to the forwarding behavior of IEEE 802.1D.

862 NOTE IEEE 802.1D refers to the port state corresponding to BLOCKED as “Discarding”.

863 5.13 Media redundancy Interconnection Manager (MIM)

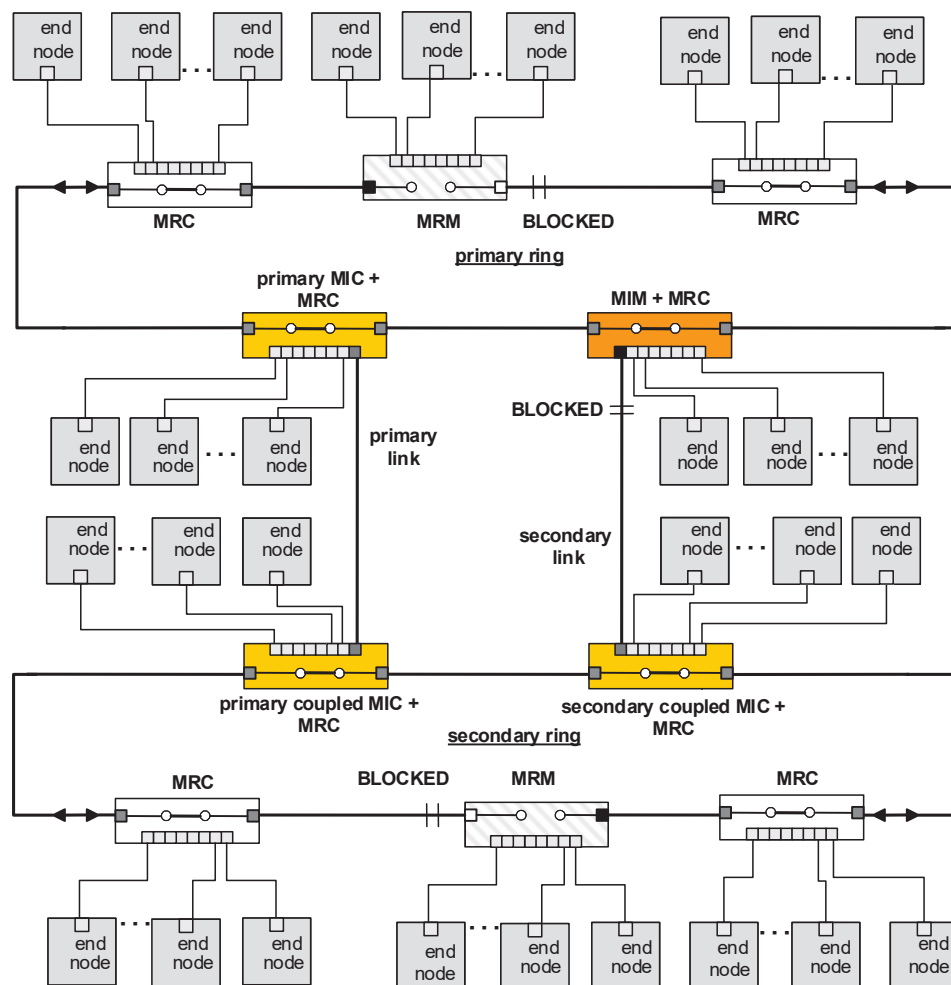


Figure 9 – MRP Interconnection topology

The interconnection port of the MIM in the primary ring shall be connected to the interconnection port of the secondary coupled MIC in the secondary MRP ring, and the interconnection port of the primary MIC in the same primary ring shall be connected to the interconnection port of the primary coupled MIC in the secondary MRP ring, thereby forming an MRP interconnection topology as shown in Figure 9.

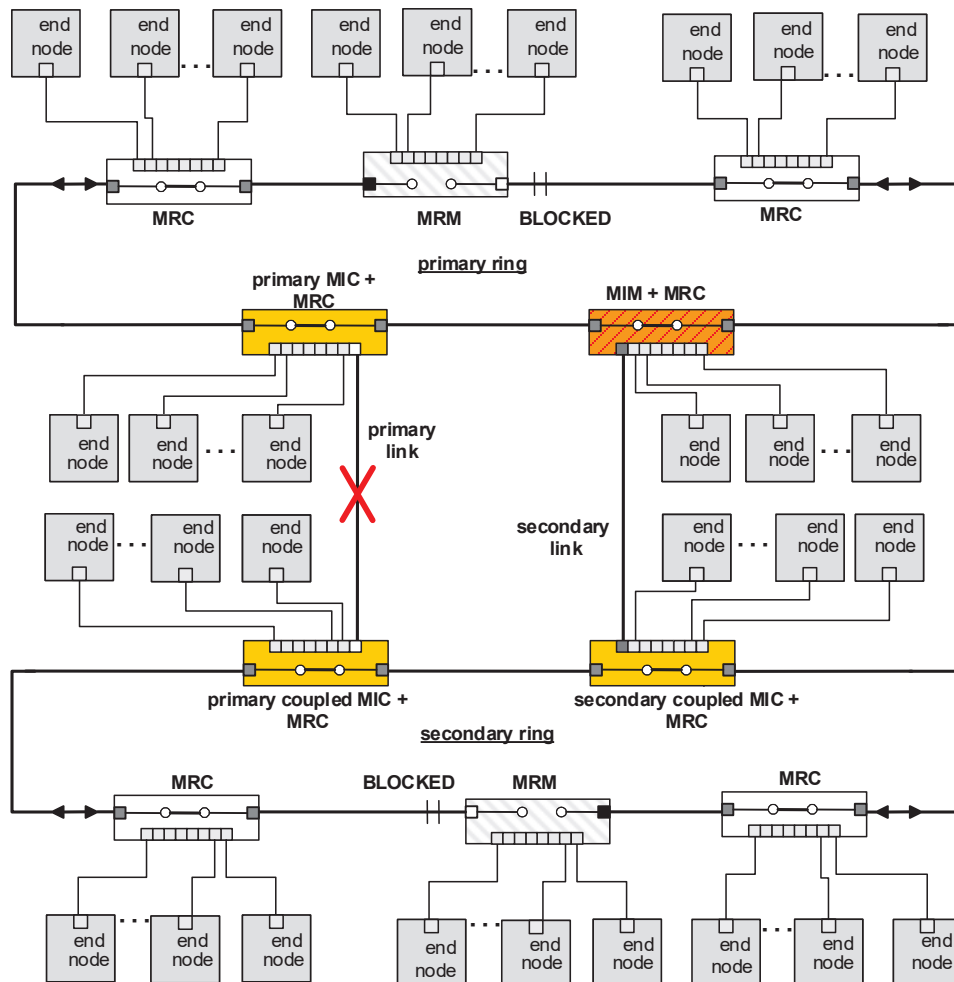


Figure 10 – MRP ring interconnection open

The MIM shall control its interconnection port state as follows:

- by directly reacting only on interconnection port link change notifications from the MICs and from its own interconnection port (link check mode: LC-mode);
- or optionally by reacting on MRP_InTest frames (ring check mode: RC-mode);
- setting its interconnection port in BLOCKED state if:
 - it is in LC-mode and receives interconnection port link up notifications from its own interconnection port and from the MICs of the primary interlink connection (this means that the interconnection topology is closed, see Figure 9);
 - it is in RC-mode and receives its own MRP_InTest frames (this means that the interconnection topology is closed, see Figure 9).
- setting the interconnection port in FORWARDING state if:
 - it is in LC-mode and receives an interconnection port link down notification from at least one of the MICs of the primary interlink connection (this means that the interconnection topology is open, see Figure 10.)

887 • it is in RC-mode and does not receive its own MRP_InTest frames within a configured
888 time according to MRP_IN_TSTdefaultT and MRP_IN_TSTNRmax in Table 60 (this
889 means that the interconnection topology is open, see Figure 10).

890 The following mechanism supports synchronization between MIM and MIC at interconnection
891 topology changes.

892 The MIM shall indicate changes in the interconnection topology state to the MICs, and to the
893 MRMs in the connected MRP rings, by means of MRP_InTopologyChange frames.

894 When it is in LC-mode, the MIM shall, after startup and after recognition of a link up at its
895 interconnection port, issue a MRP_InLinkStatusPoll frame at its ring ports, to poll the status of
896 the redundant interlink connection from the MICs.

897 When it is in RC-mode, the MIM shall, after startup and after recognition of a link up at its
898 interconnection port, cyclically send and receive MRP_InTest frames at its ring ports and at its
899 interconnection port, to detect the status of the interconnection topology.

900 When a transition to open or closed interconnection topology is detected, then the MIM shall
901 send the MRP_InTopologyChange frames through both ring ports and through its
902 interconnection port to the MICs and to the MRMs, to initiate the interconnection topology
903 change.

904 If the MIC receives an MRP_InTopologyChange frame, then the MIC shall, after recognition of
905 a link up at its interconnection port, change the port state of its interconnection port to
906 FORWARDING.

907 If the MRMs receive a MRP_InTopologyChange frame, then the MRMs shall send
908 MRP_TopologyChange frames at both ring ports, with the delay, after which all MRCs and MICs
909 in the connected MRP rings will clear their Filtering Database (FDB).

910 The MIM shall not forward its own MRP_InTest frames between the ring ports and its
911 interconnection port.

912 The MIM shall forward MRP_InLinkChange frames, MRP_InLinkStatusPoll frames and
913 MRP_InTopologyChange frames received on one ring port to the other ring port and vice versa.
914 The MIM shall process MRP_InLinkChange frames and MRP_InTopologyChange frames. The
915 MIM shall not forward MRP_InLinkChange frames, MRP_InLinkStatusPoll frames and
916 MRP_InTopologyChange frames, if the MIM received these frames at its interconnection port.

917 Each MIC shall send the configured delay in MRP_Interval to the MIM in the MRP_InLinkUp
918 and MRP_InLinkDown frames to tell the MIM after which time the MIC will change its
919 interconnection port state from BLOCKED to FORWARDING (MRP_InLinkUp frame) or from
920 FORWARDING to BLOCKED (MRP_InLinkDown frame).

921 Each MIM shall support BLOCKED port state at the interconnection port.

922 **5.14 Media redundancy Interconnection Client (MIC)**

923 The interconnection port of the secondary coupled MIC shall be connected to the
924 interconnection port of a MIM in a primary MRP ring, and the interconnection port of the primary
925 coupled MIC in the same secondary ring shall be connected to the interconnection port of the
926 primary MIC in this other primary MRP ring, thereby forming a MRP interconnection topology
927 as shown in Figure 9.

928 Each MIC in RC-mode or with RC-mode awareness shall forward MRP_InTest frames received
929 on one ring port to the other ring port. Each MIC in RC-mode shall forward MRP_InTest frames
930 to the interconnection port. Each MIC in RC-mode shall forward MRP_InTest frames to the

on the interconnection port to both ring ports. If the MIC detects a failure or recovery of the interconnection port link, the MIC shall notify the change by sending MRP_InLinkChange frames through both of its ring ports. Each MIC shall forward MRP_InLinkChange frames received on one ring port to the other ring port and vice versa. Each secondary coupled MIC shall forward MRP_InLinkChange frames received on one of the ring ports to the interconnection port.

Each MIC shall forward MRP_InTopologyChange frames received on one ring port to the other ring port and vice versa. Each MIC shall process MRP_InTopologyChange frames. It shall, after recognition of a link up at its interconnection port, change the port state of its interconnection port to FORWARDING.

After receiving a MRP_InLinkStatusPoll frame from the MIM, each MIC in LC-mode shall respond with a MRP_InLinkChange status frame informing about its current interconnection port link status.

Each MIC shall support BLOCKED port state at the interconnection port.

5.15 Interconnection domain

The interconnection domain represents an interconnection topology. The MIM and the MICs of one interconnection topology belong to the same interconnection domain. A unique interconnection ID shall be allocated as a key attribute, especially if MIM and MICs are member of rings with multiple interconnections. A node shall assign exactly one unique interconnection port per interconnection domain.

Each interconnection topology in the network shall have a unique interconnection ID.

There shall be only one active MIM in an interconnection domain.

NOTE Interconnection ports are expected to behave as if STP, RSTP or MSTP is disabled.

5.16 Interconnection diagnosis

In an interconnection domain the following diagnosis events handling shall be implemented by each MIM.

- If a device is configured as MIM, but not operating in this role, it shall signal a “MRP_INTERCONNECTION_MANAGER_ROLE_FAIL” diagnosis event and suspend reporting of all other media redundancy interconnection protocol diagnosis events while not in the manager role.
- If a device is operating in MRP interconnection manager role (MIM) and detects or is informed about an open interconnection topology, it shall signal the “INTERCONNECTION_OPEN” event.

These events shall be signaled by using the State Change service (see 7.10).

6 MRP Class specification

6.1 General

The MRP Application Service Element (ASE) defines two object types.

6.2 Template

6.2.1 Media redundancy template

An MRP object is described by the following template:

ASE: Media redundancy ASE

CLASS: Media redundancy

CLASS ID: not used

PARENT CLASS: IEEE 802.3, IEEE 802.1D

ATTRIBUTES:

1.	(m)	Key Attribute:	Domain ID
2.	(m)	Attribute:	Domain Name
3.	(m)	Attribute:	Ring Port 1 ID
4.	(m)	Attribute:	Ring Port 2 ID
5.	(o)	Attribute:	VLAN ID
6.	(m)	Attribute:	Expected Role (MANAGER (AUTO), MANAGER, CLIENT)
7.	(c)	Constraint:	Expected Role = MANAGER
7.1	(m)	Attribute:	Manager Priority
7.2	(m)	Attribute:	Topology Change Interval
7.3	(m)	Attribute:	Topology Change Repeat Count
7.4	(m)	Attribute:	Short Test Interval
7.5	(m)	Attribute:	Default Test Interval
7.6	(m)	Attribute:	Test Monitoring Count
7.7	(m)	Attribute:	Non-blocking MRC supported (TRUE, FALSE)
7.8	(c)	Constraint:	Non-blocking MRC supported = TRUE
7.8.1	(m)	Attribute:	Test Monitoring Extended Count
7.9	(o)	Attribute:	React On Link Change (TRUE, FALSE)
7.10	(m)	Attribute:	Check Media Redundancy (TRUE, FALSE)
7.10.1	(c)	Constraint:	Check Media Redundancy = TRUE
7.10.1.1	(m)	Attribute:	Real Role State
7.10.1.2	(m)	Attribute:	Real Ring State
7.10.1.3	(o)	Attribute:	Ring Port 1 Port State
7.10.1.4	(o)	Attribute:	Ring Port 2 Port State
8.	(c)	Constraint:	Expected Role = CLIENT
8.1	(m)	Attribute:	Link Down Interval
8.2	(m)	Attribute:	Link Up Interval
8.3	(m)	Attribute:	Link Change Count
8.4	(o)	Attribute:	Ring Port 1 Port State
8.5	(o)	Attribute:	Ring Port 2 Port State
8.6	(m)	Attribute:	BLOCKED state supported (TRUE, FALSE)

SERVICES:

1	(m)	OpsService:	Start MRM
2	(m)	OpsService:	Stop MRM
3	(o)	OpsService:	State Change
4	(m)	OpsService:	Start MRC
5	(m)	OpsService:	Stop MRC
6	(o)	OpsService:	Read MRM
7	(o)	OpsService:	Read MRC

6.2.2 Media redundancy Interconnection template

An MRP Interconnection object is described by the following template:

ASE: Media redundancy interconnection ASE

CLASS: Media redundancy interconnection

CLASS ID: not used

PARENT CLASS: IEEE 802.3, IEEE 802.1D

ATTRIBUTES:

1.	(m)	Key Attribute:	Interconnection ID
2.	(m)	Attribute:	Interconnection Name
3.	(m)	Attribute:	Interconnection Port ID
4.	(o)	Attribute:	Interconnection Port State
5.	(o)	Attribute:	Interconnection VLAN ID
6.	(o)	Attribute:	Interconnection Mode
7.	(m)	Attribute:	Interconnection Role (MANAGER, CLIENT)
8.	(c)	Constraint:	Interconnection Role = MANAGER
8.1	(m)	Attribute:	Interconnection Topology Change Interval
8.2	(m)	Attribute:	Interconnection Topology Change Repeat Count
8.3	(o)	Attribute:	Interconnection Default Test Interval
8.4	(o)	Attribute:	Interconnection Test Monitoring Count
8.5	(o)	Attribute:	Interconnection Link Status Poll Interval
8.6	(o)	Attribute:	Interconnection Link Status Poll Repeat Count
8.7	(m)	Attribute:	Interconnection Topology State
9.	(c)	Constraint:	Interconnection Role = CLIENT
9.1	(m)	Attribute:	Interconnection Link Down Interval
9.2	(m)	Attribute:	Interconnection Link Up Interval
9.3	(m)	Attribute:	Interconnection Link Change Count
9.4	(m)	Attribute:	Interconnection Link Information

SERVICES:

1	(m)	OpsService:	Start MIM
2	(m)	OpsService:	Stop MIM
3	(o)	OpsService:	Interconnection State Change
4	(m)	OpsService:	Start MIC
5	(m)	OpsService:	Stop MIC
5	(o)	OpsService:	Read MIM
6	(o)	OpsService:	Read MIC

6.3 Attributes

Domain ID

This key attribute defines the redundancy domain representing the ring the MRP object belongs to. It is set to default Domain ID or provided as unique ID by engineering.

Attribute Type: UUID

Domain Name

This attribute defines the redundancy domain representing the ring the Media redundancy object belongs to. It is set to default Domain Name or provided as unique ID by engineering.

Attribute Type: VisibleString[240]

Ring Port 1 ID

This attribute specifies one port of a switch which is assigned as ring port 1 in the redundancy domain referenced by the value of the attribute Domain ID.

Attribute Type: Unsigned16

Ring Port 2 ID

This attribute specifies another port of a switch different from Ring Port 1 ID which is assigned as ring port 2 in the redundancy domain referenced by the value of the attribute Domain ID.

Attribute Type: Unsigned16

1008 **VLAN ID**

1009 This optional attribute may be used by the MRP object and specifies its VLAN identifier in
1010 the redundancy domain.

1011 Attribute Type: Unsigned16

1012 **Expected Role**

1013 This attribute specifies the role of the MRP object in the redundancy domain.

1014 Attribute Type: Unsigned16

1015 Allowed values: MANAGER (Auto), MANAGER, CLIENT

1016 **Manager Priority**

1017 This attribute shall contain the priority of the MRM. A lower value indicates a higher priority,
1018 0x0000 (highest priority) to 0xFFFF (lowest priority) in increments of 0x0001.

1019 Attribute Type: Unsigned16

1020 **Topology Change Interval**

1021 This attribute specifies the interval for sending MRP_TopologyChange frames.

1022 Attribute Type: Unsigned16

1023 **Topology Change Repeat Count**

1024 This attribute specifies the interval count which controls repeated transmissions of
1025 MRP_TopologyChange frames.

1026 Attribute Type: Unsigned16

1027 **Short Test Interval**

1028 This attribute specifies the short interval for sending MRP_Test frames on ring ports after
1029 link changes in the ring.

1030 Attribute Type: Unsigned16

1031 **Default Test Interval**

1032 This attribute specifies the default interval for sending MRP_Test frames on ring ports.

1033 Attribute Type: Unsigned16

1034 **Test Monitoring Count**

1035 This attribute specifies the interval count for monitoring the reception of MRP_Test frames.

1036 Attribute Type: Unsigned16

1037 **Non-blocking MRC supported**

1038 This attribute specifies the ability of the MRM to support MRCs without BLOCKED port state
1039 support in the ring.

1040 Attribute Type: Boolean

1041 **Test Monitoring Extended Count**

1042 This attribute specifies the extended interval count for monitoring the reception of MRP_Test
1043 frames.

1044 Attribute Type: Unsigned16

1045 **React On Link Change**

1046 This optional attribute specifies whether the MRM reacts immediately on MRP_LinkChange
1047 frames or not.

1048 Attribute Type: Boolean

1049 **Check Media Redundancy**

1050 This attribute specifies whether monitoring of MRM state is enabled (TRUE) or disabled
1051 (FALSE) in the redundancy domain.

1052 Attribute Type: Boolean

1053 **Real Role State**

1054 This attribute specifies the actual role of the MRP object in the redundancy domain.

1055 Attribute Type: Unsigned16

1056 Allowed values: MANAGER (Auto), MANAGER, CLIENT, UNDEFINED

Real Ring State

This attribute specifies the actual ring state of the MRP object in the redundancy domain.
The Ring State shall have one of the following values:

OPEN: Ring is open due to link or MRC failure in ring.

CLOSED: Ring is closed (normal operation, no error).

UNDEFINED: Shall be set if the attribute Real Role State contains the value CLIENT
(i.e. MRP object was reconfigured to client role).

Attribute Type: Unsigned16

Allowed values: OPEN, CLOSED, UNDEFINED

Ring Port 1 Port State

This optional attribute specifies the actual port state of Ring Port 1. The Ring Port 1 state shall be specified according to Ring port states in 5.2.

Attribute Type: Unsigned16

Allowed values: DISABLED, BLOCKED, FORWARDING

Ring Port 2 Port State

This optional attribute specifies the actual port state of Ring Port 2. The Ring Port 2 state shall be specified according to Ring port states in 5.2.

Attribute Type: Unsigned16

Allowed values: DISABLED, BLOCKED, FORWARDING

Link Down Interval

This attribute specifies the interval for sending MRP_LinkDown frames on ring ports.

Attribute Type: Unsigned16

Link Up Interval

This attribute specifies the interval for sending MRP_LinkUp frames on ring ports.

Attribute Type: Unsigned16

Link Change Count

This attribute specifies the MRP_LinkChange frame count which controls repeated transmission of MRP_LinkChange frames.

Attribute Type: Unsigned16

BLOCKED state supported

This attribute specifies whether the MRC supports BLOCKED state at its ring ports or not.

Attribute Type: Boolean

Interconnection ID

This key attribute defines the interconnection domain representing the interconnection topology the MRP interconnection object belongs to. It is provided as unique ID by engineering..

Attribute Type: Unsigned16

Interconnection Name

This attribute specifies the name of the interconnection domain referenced by the value of the attribute Interconnection ID. It is set to a default Interconnection Name or provided as Interconnection Name by engineering.

Attribute Type: VisibleString[240]

Interconnection Port ID

This attribute specifies one port of a switch which is assigned as interconnection port in the interconnection domain referenced by the value of the attribute Interconnection ID.

Attribute Type: Unsigned16

Interconnection Port State

This optional attribute specifies the actual port state of the interconnection port. The Interconnection Port state shall be specified according to Interconnection port states in 5.2.

Attribute Type: Unsigned16

1107 Allowed values: DISABLED, BLOCKED, FORWARDING

1108 **Interconnection VLAN ID**

1109 This optional attribute may be used by the MRP interconnection object and specifies its
1110 VLAN identifier in the interconnection domain.

1111 Attribute Type: Unsigned16

1112 **Interconnection Mode**

1113 This attribute specifies the mode of the MRP interconnection object in the interconnection
1114 domain.

1115 LC_MODE: Link check mode. The MIM analyses the ring interconnection state by using
1116 the link change notifications of the MICs. MRP_InTest frames are disabled.

1117 RC_MODE: Ring check mode. The MIM analyses the ring interconnection state by
1118 sending and receiving MRP_InTest frames. Link change notifications of the MICs
1119 may be used in addition to optimize the recovery timing.

1120 Attribute Type: Unsigned16

1121 Allowed values: UNDEFINED, LC_MODE, RC_MODE

1122 **Interconnection Role**

1123 This attribute specifies the role of the MRP interconnection object in the interconnection
1124 domain.

1125 Attribute Type: Unsigned16

1126 Allowed values: MANAGER, CLIENT

1127 **Interconnection Topology Change Interval**

1128 This attribute specifies the interval for sending MRP_InTopologyChange frames.

1129 Attribute Type: Unsigned16

1130 **Interconnection Topology Change Repeat Count**

1131 This attribute specifies the interval count which controls repeated transmissions of
1132 MRP_InTopologyChange frames.

1133 Attribute Type: Unsigned16

1134 **Interconnection Default Test Interval**

1135 This attribute specifies the default interval for sending MRP_InTest frames on ring ports and
1136 on the interconnection port.

1137 Attribute Type: Unsigned16

1138 **Interconnection Test Monitoring Count**

1139 This attribute specifies the interval count for monitoring the reception of MRP_InTest frames.

1140 Attribute Type: Unsigned16

1141 **Interconnection Link Status Poll Interval**

1142 This attribute specifies the interval for sending MRP_InLinkStatusPoll frames.

1143 Attribute Type: Unsigned16

1144 **Interconnection Link Status Poll Repeat Count**

1145 This attribute specifies the interval count which controls repeated transmissions of
1146 MRP_InLinkStatusPoll frames.

1147 Attribute Type: Unsigned16

1148 **Interconnection Topology State**

1149 This attribute specifies the actual interconnection topology state of the MRP interconnection
1150 object in the interconnection domain. The Interconnection Topology State shall have one of
1151 the following values:

1152 UNDEFINED: Device has no information (yet) about the Interconnection topology;

1153 OPEN: Interconnection topology is open due to link or MIC failure in the interconnection
1154 topology;

1155 CLOSED: Interconnection topology is closed (normal operation, no error).

1156 Attribute Type: Unsigned16

1157 Allowed values: UNDEFINED, OPEN, CLOSED

1158 **Interconnection Link Down Interval**

1159 This attribute specifies the interval for sending MRP_InLinkDown frames on ring ports.

1160 Attribute Type: Unsigned16

1161 **Interconnection Link Up Interval**

1162 This attribute specifies the interval for sending MRP_InLinkUp frames on ring ports.

1163 Attribute Type: Unsigned16

1164 **Interconnection Link Change Count**

1165 This attribute specifies the MRP_InLinkChange frame count which controls repeated
1166 transmission of MRP_InLinkChange frames.

1167 Attribute Type: Unsigned16

1168 **Interconnection Link Information**

1169 This attribute specifies the MRP_InLinkChange frame additional information such as
1170 whether issued by the primary or secondary link and the reason for the state change.

1171 Attribute Type: Unsigned16

1172

1173

1174 7 MRP Service specification

1175 7.1 Start MRM

1176 The Start MRM service creates a local instance of the MRM protocol machine.

1177 Table 3 shows the parameters of the service.

1178 **Table 3 – MRP Start MRM**

Parameter name	Req	Cnf
Argument	M	
Domain ID	M	
Ring Port 1 ID	M	
Ring Port 2 ID	M	
VLAN ID	U	
Manager Priority	U	
Topology Change Interval	U	
Topology Change Repeat Count	U	
Short Test Interval	U	
Default Test Interval	U	
Test Monitoring Count	U	
Non-blocking MRC supported	U	
Test Monitoring Extended Count	U	
React On Link Change	U	
Check Media Redundancy	U	
Result(+)		S
Domain ID		M
Result(-)		S
Domain ID		M
Error Code		M
The meaning of Req, Cnf, M, U and S is specified in ISO/IEC 10164-1.		

1179 **Argument**

1180 The argument shall convey the service specific parameters of the service request.

1182 **Domain ID**

1183 This is the key attribute to identify the instance of the protocol machine.

1184 **Ring Port 1 ID**

1185 This parameter contains the ID of the port which serves as first ring port.

1186 **Ring Port 2 ID**

1187 This parameter contains the ID of the port which serves as second ring port.

1188 **VLAN ID**

1189 This optional parameter contains the value for the VLAN identifier.

1190 **Manager Priority**

1191 This parameter contains the value for the manager priority.

- 1192 **Topology Change Interval**
 1193 This parameter contains the value of the interval for sending MRP_TopologyChange
 1194 frames.
- 1195 **Topology Change Repeat Count**
 1196 This parameter contains the value of the interval count which controls repeated
 1197 transmissions of MRP_TopologyChange frames.
- 1198 **Short Test Interval**
 1199 This parameter contains the value of the short interval for sending MRP_Test frames on
 1200 ring ports after link changes in the ring.
- 1201 **Default Test Interval**
 1202 This parameter contains the value of the default interval for sending MRP_Test frames
 1203 on ring ports.
- 1204 **Test Monitoring Count**
 1205 This parameter contains the value of the interval count for monitoring the reception of
 1206 MRP_Test frames.
- 1207 **Non-blocking MRC supported**
 1208 This parameter specifies the ability of the MRM to support MRCs without BLOCKED port
 1209 state support in the ring.
- 1210 **Test Monitoring Extended Count**
 1211 This optional parameter contains the value of the extended interval count for monitoring
 1212 the reception of MRP_Test frames.
- 1213 **React On Link Change**
 1214 This optional parameter specifies whether the MRM reacts on MRP_LinkChange frames
 1215 or not.
- 1216 **Check Media Redundancy**
 1217 This parameter selects whether monitoring of MRM state is enabled or disabled.
- 1218 **Result(+)**
 1219 This parameter indicates that the service request succeeded.
- 1220 **Domain ID**
 1221 This is the key attribute to identify the instance of the protocol machine.
- 1222 **Result(-)**
 1223 This parameter indicates that the service request failed.
- 1224 **Domain ID**
 1225 This is the key attribute to identify the instance of the protocol machine.
- 1226 **Error Code**
 1227 The parameter Result contains the error code of the specific error.
 1228 Type: Unsigned16
 1229 Allowed values: DOMAIN_ID_MISMATCH, ROLE_NOT_SUPPORTED,
 1230 INVALID_RINGPORT
- 1231 **7.2 Stop MRM**
 1232 This service shall be used to stop the MRM protocol machine. Ring port states and switch
 1233 functionality remain.
- 1234 Table 4 shows the parameters of the service.

1235

Table 4 – MRP Stop MRM

Parameter name	Req	Cnf
Argument	M	
Domain ID	M	
Result(+)		S
Domain ID		M
Result(-)		S
Domain ID		M
Error Code		M
The meaning of Req, Cnf, M and S is specified in ISO/IEC 10164-1.		

1236

Argument

1237

The argument shall convey the service specific parameters of the service request.

1238

1239

Domain ID

1240

This is the key attribute to identify the instance of the protocol machine.

1241

Result(+)

1242

This parameter indicates that the service request succeeded.

1243

Domain ID

1244

This is the key attribute to identify the instance of the protocol machine.

1245

Result(-)

1246

This parameter indicates that the service request failed.

1247

Domain ID

1248

This is the key attribute to identify the instance of the protocol machine.

1249

Error Code

1250

The parameter Result contains the error code of the specific error.

1251

Type: Unsigned16

1252

Allowed values: DOMAIN_ID_MISMATCH

1253

7.3 State Change

1254

This service shall be used to indicate a change of the MRP domain state.

1255

Table 5 shows the parameters of the service.

1256

Table 5 – MRP Change State

Parameter name	Ind
Argument	M
Domain ID	M
Error Type List	M
The meaning of Ind and M is specified in ISO/IEC 10164-1.	

1257

Argument

1258

The argument shall convey the service specific parameters of the service request.

1259

1260

Domain ID

1261

This is the key attribute to identify the instance of the protocol machine.

Error Type List

This attribute consists of the following elements:

Error Type

This attribute identifies a media redundancy error.

Attribute Type: Unsigned16

Allowed values: MANAGER_ROLE_FAIL, RING_OPEN, MULTIPLE_MANAGERS

Appear

This attribute identifies whether the error appears or disappears.

Attribute Type: Boolean

Allowed values: TRUE, FALSE

7.4 Start MRC

The Start MRC service creates an instance of the MRC protocol machine.

Table 6 shows the parameters of the service.

Table 6 – MRP Start MRC

Parameter name	Req	Cnf
Argument	M	
Domain ID	M	
Ring Port 1 ID	M	
Ring Port 2 ID	M	
VLAN ID	U	
Link Down Interval	U	
Link Up Interval	U	
Link Change Count	U	
BLOCKED state supported	U	
Result(+)		S
Domain ID		M
Result(-)		S
Domain ID		M
Error Code		M
The meaning of Req, Cnf, M, U and S is specified in ISO/IEC 10164-1.		

Argument

The argument shall convey the service specific parameters of the service request.

Domain ID

This is the key attribute to identify the instance of the protocol machine.

Ring Port 1 ID

This parameter contains the ID of the port which serves as first ring port.

Ring Port 2 ID

This parameter contains the ID of the port which serves as second ring port.

VLAN ID

This optional parameter contains the value for the VLAN identifier.

1287 **Link Down Interval**
 1288 This parameter contains the value of the interval for sending MRP_LinkDown frames on
 1289 ring ports.

1290 **Link Up Interval**
 1291 This parameter contains the value of the interval for sending MRP_LinkUp frames on ring
 1292 ports.

1293 **Link Change Count**
 1294 This parameter contains the value of the MRP_LinkChange frame count which controls
 1295 repeated transmissions of MRP_LinkUp or MRP_LinkDown frames.

1296 **BLOCKED state supported**
 1297 This parameter specifies whether the MRC supports BLOCKED state at its ring ports or not.

1298 **Result(+)**
 1299 This parameter indicates that the service request succeeded.

1300 **Domain ID**
 1301 This is the key attribute to identify the instance of the protocol machine.

1302 **Result(-)**
 1303 This parameter indicates that the service request failed.

1304 **Domain ID**
 1305 This is the key attribute to identify the instance of the protocol machine.

1306 **Error Code**
 1307 The parameter Result contains the error code of the specific error.
 1308 Type: Unsigned16
 1309 Allowed values: DOMAIN_ID_MISMATCH, ROLE_NOT_SUPPORTED,
 1310 INVALID_RINGPORT

1311 7.5 Stop MRC

1312 This service shall be used to stop the MRC protocol machine. Ring port states and switch
 1313 functionality remain. Table 7 shows the parameters of the service.

1314 **Table 7 – MRP Stop MRC**

Parameter name	Req	Cnf
Argument	M	
Domain ID	M	
Result(+)		S
Domain ID		M
Result(-)		S
Domain ID		M
Error Code		M
The meaning of Req, Cnf, M and S is specified in ISO/IEC 10164-1.		

1315 **Argument**
 1316 The argument shall convey the service specific parameters of the service request.
 1317

1318 **Domain ID**
 1319 This is the key attribute to identify the instance of the protocol machine.

1320 **Result(+)**
 1321 This parameter indicates that the service request succeeded.

1322 **Domain ID**
1323 This is the key attribute to identify the instance of the protocol machine.

1324 **Result(-)**
1325 This parameter indicates that the service request failed.

1326 **Domain ID**
1327 This is the key attribute to identify the instance of the protocol machine.

1328 **Error Code**
1329 The parameter Result contains the error code of the specific error.
1330 Type: Unsigned16
1331 Allowed values: DOMAIN_ID_MISMATCH

1332 7.6 Read MRM

1333 The optional Read MRM service reads the actual state of the MRM protocol machine.

1334 Table 8 shows the parameters of the service.

Table 8 – MRP Read MRM

Parameter name	Req	Rsp
Argument	M	
Domain ID	M	
Result(+)		S
Domain ID		M
Ring Port 1 ID		M
Ring Port 2 ID		M
VLAN ID		U
Manager Priority		M
Check Media Redundancy		M
Real Role State		M
Real Ring State		M
Ring Port 1 Port State		U
Ring Port 2 Port State		U
Topology Change Interval		U
Topology Change Repeat Count		U
Short Test Interval		U
Default Test Interval		U
Test Monitoring Count		U
Non-blocking MRC supported		U
Test Monitoring Extended Count		U
React On Link Change		U
Result(-)		S
Domain ID		M
Error Code		M
The meaning of Req, Rsp, M, U and S is specified in ISO/IEC 10164-1.		

1336

- 1337 **Argument**
1338 The argument shall convey the service specific parameters of the service request.
- 1339 **Domain ID**
1340 This is the key attribute to identify the instance of the protocol machine.
- 1341 **Result(+)**
1342 This parameter indicates that the service request succeeded.
- 1343 **Domain ID**
1344 This is the key attribute to identify the instance of the protocol machine.
- 1345 **Ring Port 1 ID**
1346 This parameter contains the ID of the port which serves as first ring port.
- 1347 **Ring Port 2 ID**
1348 This parameter contains the ID of the port which serves as second ring port.
- 1349 **VLAN ID**
1350 This optional parameter contains the value for the VLAN identifier.
- 1351 **Manager Priority**
1352 This parameter contains the value for the manager priority.
- 1353 **Check Media Redundancy**
1354 This parameter indicates whether monitoring of MRM is enabled or disabled
- 1355 **Topology Change Interval**
1356 This parameter contains the value of the interval for sending MRP_TopologyChange frames.
- 1357 **Topology Change Repeat Count**
1358 This parameter contains the value of the interval count which controls repeated transmission
1359 of MRP_TopologyChange frames.
- 1360 **Short Test Interval**
1361 This parameter contains the value of the short interval for sending MRP_Test frames on ring
1362 ports after link changes in the ring.
- 1363 **Default Test Interval**
1364 This parameter contains the value of the default interval for sending MRP_Test frames on
1365 ring ports.
- 1366 **Test Monitoring Count**
1367 This parameter contains the value of the interval count for monitoring the reception of
1368 MRP_Test frames.
- 1369 **Non-blocking MRC supported**
1370 This parameter contains the ability of the MRM to support MRC without BLOCKED port state
1371 support in the ring.
- 1372 **Test Monitoring Extended Count**
1373 This optional parameter contains the value of the extended interval count for monitoring the
1374 reception of MRP_Test frames.
- 1375 **Real Role State**
1376 This attribute contains the actual role of the MRP object in the redundancy domain.
- 1377 **Real Ring State**
1378 This attribute contains the actual ring state of the MRP object in the redundancy domain.
- 1379 **Ring Port 1 Port State**
1380 This optional attribute contains the actual port state of Ring Port 1.
- 1381 **Ring Port 2 Port State**
1382 This optional attribute contains the actual port state of Ring Port 2.
- 1383 **React On Link Change**
1384 This optional parameter contains whether the MRM reacts on MRP_LinkChange frames or
1385 not.
- 1386 **Result(-)**
1387 This parameter indicates that the service request failed.