



AMRA STANDARD

AMRA-271:2022(en)

Edition: 2
2023-09-27

Mobile Robots - Common Communication Protocols

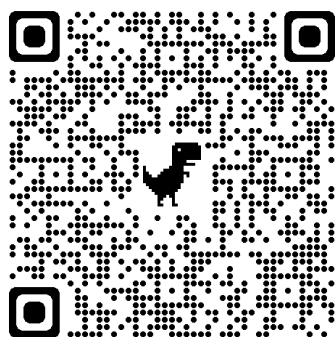
NOTICE

This document is copyright protected.
© AMRA Autonomous Mobile Robot Alliance 2023

All rights reserved. Inquiries and comments relative to the contents of this document should be addressed to AMRA. Without prior written permission, no part of this document may be reproduced or utilized in any form, including posting on the internet or an intranet. AMRA retains the copyright on the material. By downloading this file, the individual agrees not to charge for or resell the resulting material.

For more information, contact:
Autonomous Mobile Robot Alliance (AMRA)
contact@amr-alliance.org
<https://www.amr-alliance.org/>

For standard improvement, submit comments:
<https://forms.gle/9gNNiQXAhFuA4kP8>



INTRODUCTION

This standard defined the communication message structure in an AMR system. In this edition of the standard, the communication between a mobile robot and a management system is defined at the presentation network layer. The content covered the communication related to common movement, mission, status report, elevator, and auto door commands. The purpose of this standard was to foster a thriving AMR industry ecosystem where various mobile robots, systems, and devices can be integrated together with ease. This standard was developed by the experts in AMRA working group #3 (WG3) based on consensus. The final standard was reviewed by the technical committee (TC) and approved by the board. The participants in the following list, sorted alphabetically, have made valuable contributions to this standard.

With comments about editorial issues from members after publication, ED2 of this standard was updated by the secretariat (SEC) and approved by the board.

Board

Approved AMRA-271:2022(en)-ED2 on 2023-09-25

ASUS	CiLS	eYs3D Microelectronics
AU Optronics	DEKRA iST Reliability Services	ITRI [Chair]
CASTEC International Corp.	Delta Electronics	Wistron Corporation

Technical Committee

Reviewed AMRA-271:2022(en) on 2022-10-31

ASUSTeK Computer	Intel	Neousys Technology
AU Optronics	ITRI [Chair]	Pepperl+Fuchs Taiwan
Delta Electronics	Kaneka Taiwan	UniRing Tech

Working Group #3 Experts

Formed the draft of AMRA-271:2022(en)

Akito Yang	Henry Tsai	Nelson Chang [Chair]	Tom Tsui
Castaly Wang	Jack Lee	Olivia Chen	Wade Jen
Chao-Wen Yang	Jennifer Chang	Ray Yeh	Yi-Hong Chen
Chia-Hung Hsu	Jimmy Chow	Richard Chen	Yi-Jun Lin
Crystal Tseng	Joseph Yao-Cheng Chen	Roy Xu	Yu-Kai Chen
Henry Li	Josh Chang		

Contents

1. SCOPE	11
2. NORMATIVE REFERENCES	11
3. TERMS AND DEFINITIONS	12
3.1 Peripheral	12
3.2 Mobile robot internal module	12
3.3 MR management system (MS)	12
3.4 Mission	12
3.5 Action	12
3.6 Path	12
3.7 Waypoint	12
3.8 Zone	12
3.9 Monitor	12
3.10 Request	13
3.11 Response	13
3.12 Heartbeat	13
3.13 Reservation	13
3.14 Auto door	13
4. COMMUNICATION IN MOBILE ROBOT SYSTEM	14
4.1 Interactions between mobile robots and MR management system	15
4.2 Interaction between mobile robots and MR management system for peripherals	15
4.3 Interaction between mobile robots and peripherals	15
4.4 Interaction between mobile robots	15
5. COMMUNICATION PROTOCOL	16
6. THE COMMUNICATION BETWEEN MOBILE ROBOTS AND A MR MANAGEMENT SYSTEM	18
6.1 Movement and mission related messages	18
6.1.1 MSMoveToPoint	18
6.1.1.1 Description	18
6.1.1.2 Message structure of the data section	18
6.1.2 MSExecuteMissionByPoseID	20
6.1.2.1 Description	20
6.1.2.2 Message structure of the data section	20
6.1.3 MSExecuteMissionByXYTheta	22
6.1.3.1 Description	22
6.1.3.2 Message structure of the data section	22
6.1.4 MSCancelMission	25
6.1.4.1 Description	25
6.1.4.2 Message structure of the data section	25
6.1.5 MSAbortMission	27

6.1.5.1 Description	27
6.1.5.2 Message structure of the data section	27
6.1.6 MSPauseMission	29
6.1.6.1 Description	29
6.1.6.2 Message structure of the data section	29
6.1.7 MSResumeMission	31
6.1.7.1 Description	31
6.1.7.2 Message structure of the data section	31
6.1.8 MSNotifyEmergency	33
6.1.8.1 Description	33
6.1.8.2 Message structure of the data section	33
6.2 Status information related messages	35
6.2.1 MSReportMRStatus	35
6.2.1.1 Description	35
6.2.1.2 Message structure of the data section	35
6.2.2 MSReportMROptionalStatus	40
6.2.2.1 Description	40
6.2.2.2 Message structure of the data section	40
6.2.2.3 Optional information examples	42
6.2.3 MSQueryMROptionalStatusInfoKeys	43
6.2.3.1 Description	43
6.2.3.2 Message structure of the data section	43
6.2.4 MRHeartBeat	45
6.2.4.1 Description	45
6.2.4.2 Message structure of the data section	45
6.2.5 MSSetHeartbeatPeriod	47
6.2.5.1 Description	47
6.2.5.2 Message structure of the data section	47
6.2.6 MRActiveStatusNotification	49
6.2.6.1 Description	49
6.2.6.2 Message structure of the data section	49
7. THE COMMUNICATION BETWEEN MOBILE ROBOTS AND A MR MANAGEMENT SYSTEM ON PERIPHERALS	51
7.1 Elevator related messages	51
7.1.1 MRRequestElevator	51
7.1.1.1 Description	51
7.1.1.2 Message structure of the data section	51
7.1.2 MRCancelElevator	54
7.1.2.1 Description	54
7.1.2.2 Message structure of the data section	55
7.1.3 MSElevatorReady	56

7.1.3.1 Description	56
7.1.3.2 Message structure of the data section	56
7.1.4 MRRequestElevatorStatus	58
7.1.4.1 Description	58
7.1.4.2 Message structure of the data section	58
7.1.5 MRInsideElevator	61
7.1.5.1 Description	61
7.1.5.2 Message structure of the data section	61
7.1.6 MRExitedElevator	63
7.1.6.1 Description	63
7.1.6.2 Message structure of the data section	63
7.1.7 MSActiveElevatorStatusNotification	65
7.1.7.1 Description	65
7.1.7.2 Message structure of the data section	65
7.2 Auto door related messages	69
7.2.1 MRRequestDoor	69
7.2.1.1 Description	69
7.2.1.2 Message structure of the data section	70
7.2.2 MRCancelDoor	72
7.2.2.1 Description	72
7.2.2.2 Message structure of the data section	72
7.2.3 MSDoorReady	74
7.2.3.1 Description	74
7.2.3.2 Message structure of the data section	75
7.2.4 MRRequestDoorStatus	76
7.2.4.1 Description	76
7.2.4.2 Message structure of the data section	77
7.2.5 MSActiveDoorStatusNotification	79
7.2.5.1 Description	79
7.2.5.2 Message structure of the data section	80
ANNEX A. (INFORMATIVE) CHANGES BETWEEN VERSIONS	83
ANNEX B. (INFORMATIVE) MESSAGE FORMAT EXAMPLES	84
B.1 Movement and mission related messages	84
B.1.1 MSMoveToPoint	84
B.1.2 MSExecuteMissionByPoseID	85
B.1.3 MSExecuteMissionByXYTheta	86
B.1.4 MSCancelMission	88
B.1.5 MSAbortMission	89
B.1.6 MSPauseMission	90
B.1.7 MSResumeMission	91
B.1.8 MSNotifyEmergency	92

B.2 Status report related messages	93
B.2.1 MSReportMRStatus	93
B.2.2 MSReportMROptionalStatus	94
B.2.3 MSQueryMROptionalStatusInfoKeys	96
B.2.4 MRHeartBeat	97
B.2.5 MSSetHeartbeatPeriod	98
B.2.6 MRActiveStatusNotification	99
B.3 Elevator related messages	100
B.3.1 MRRequestElevator	100
B.3.2 MRCancelElevator	101
B.3.3 MSElevatorReady	102
B.3.4 MRRequestElevatorStatus	103
B.3.5 MRInsideElevator	104
B.3.6 MRExitedElevator	105
B.3.7 MSActiveElevatorStatusNotification	106
B.4 Door related messages	107
B.4.1 MRRequestDoor	107
B.4.2 MRCancelDoor	108
B.4.3 MSDoorReady	109
B.4.4 MRRequestDoorStatus	110
B.4.5 MSActiveDoorStatusNotification	111
ANNEX C. (INFORMATIVE) MISSION AND ACTION STATE DESCRIPTION AND TRANSITION EXAMPLE	112

TABLES

Table 1 Message structure of the head section	17
Table 2 The data section of MSMoveToPoint request message	18
Table 3 The data section of MSMoveToPoint response message	19
Table 4 The data section of MSExecuteMissionByPoselD request message	20
Table 5 The data section of MSExecuteMissionByPoselD response message	21
Table 6 The data section of MSExecuteMissionByXYTheta request message	22
Table 7 The data section of MSExecuteMissionByXYTheta response message	23
Table 8 The data section of MSCancelMission request message	25
Table 9 The data section of MSCancelMission response message	25
Table 10 The data section of MSAbortMission request message	27
Table 11 The data section of MSAbortMission response message	27
Table 12 The data section of MSPauseMission request message	29
Table 13 The data section of MSPauseMission response message	29
Table 14 The data section of MSResumeMission request message	31
Table 15 The data section of MSResumeMission response message	31
Table 16 The data section of MSNotifyEmergency request message	33
Table 17 The data section of MSNotifyEmergency response message	33
Table 18 The data section of MSReportMRStatus request message	35
Table 19 The data section of MSReportMRStatus response message	35
Table 20 Message structure of the essential status of a mobile robot	36
Table 21 The data section of MSReportMROptionalStatus request message	40
Table 22 The data section of MSReportMROptionalStatus response message	40
Table 23 Example message structure of the optional status information of a motor	42
Table 24 Example message structure of the optional status information of a camera	42
Table 25 The data section of MSQueryMROptionalStatusInfoKeys request message	43
Table 26 The data section of MSQueryMROptionalStatusInfoKeys response message	43
Table 27 The data section of MRHeartBeat request message	45
Table 28 The data section of MRHeartBeat response message	45
Table 29 The data section of MSSetHeartbeatPeriod request message	47
Table 30 The data section of MSSetHeartbeatPeriod response message	47
Table 31 The data section of MRActiveStatusNotification request message	49
Table 32 The data section of MRActiveStatusNotification response message	50
Table 33 The data section of MRRequestElevator request message	51
Table 34 The data section of MRRequestElevator response message	52
Table 35 The data section of MRCancelElevator request message	55
Table 36 The data section of MRCancelElevator response message	55
Table 37 The data section of MSElevatorReady request message	56
Table 38 The data section of MSElevatorReady response message	57
Table 39 The data section of MRRequestElevatorStatus request message	58
Table 40 The data section of MRRequestElevatorStatus response message	59

Table 41 The data section of MRInsideElevator request message	61
Table 42 The data section of MRInsideElevator response message	62
Table 43 The data section of MRExitedElevator request message	63
Table 44 The data section of MRExitedElevator response message	64
Table 45 The data section of MSActiveElevatorStatusNotification request message	65
Table 46 The data section of MSActiveElevatorStatusNotification response message	67
Table 47 The data section of MRRequestDoor request message	70
Table 48 The data section of MRRequestDoor response message	70
Table 49 The data section of MRCancelDoor request message	72
Table 50 The data section of MRCancelDoor response message	72
Table 51 The data section of MSDoorReady request message	75
Table 52 The data section of MSDoorReady response message	75
Table 53 The data section of MRRequestDoorStatus request message	77
Table 54 The data section of MRRequestDoorStatus response message	77
Table 55 The data section of MSActiveDoorStatusNotification request message	80
Table 56 The data section of MSActiveDoorStatusNotification response message	81

FIGURES

Figure 1 Interaction among MR management system, mobile robots and Peripherals	14
Figure 2 An example of request-response communication between a mobile robot and a MR management system	16
Figure 3 Message structure of request and response	17
Figure 4 A request-response example of MSMoveToPoint	18
Figure 5 A request-response example of MSExecuteMissionByPoseID	20
Figure 6 A request-response example of MSExecuteMissionByXYTheta	22
Figure 7 A request-response example of MSCancelMission	25
Figure 8 A request-response example of MSAbortMission	27
Figure 9 A request-response example of MSPauseMission	29
Figure 10 A request-response example of MSResumeMission	31
Figure 11 A request-response example of MSNotifyEmergency	33
Figure 12 A request-response example of MSReportMRStatus	35
Figure 13 A request-response example of MSReportMROptionalStatus	40
Figure 14 A request-response example of MSQueryMROptionalStatusInfoKeys	43
Figure 15 A request-response example of MRHeartBeat	45
Figure 16 A request-response example of MSSetHeartbeatPeriod	47
Figure 17 A request-response example of MRActiveStatusNotification	49
Figure 18 A request-response example of MRRequestElevator during an elevator operation	51
Figure 19 A request-response example of MRCancelElevator before the reservation was being granted	54
Figure 20 A request-response example of MRCancelElevator after the reservation was being granted	54
Figure 21 A request-response example of MSElevatorReady during an elevator operation	56
Figure 22 A request-response example of MRRequestElevatorStatus during an elevator operation	58
Figure 23 A request-response example of MRInsideElevator during an elevator operation	61
Figure 24 A request-response example of MRExitedElevator during an elevator operation	63
Figure 25 A request-response example of MSActiveElevatorStatusNotification during an elevator operation	65
Figure 26 A request-response example of MRRequestDoor during an auto door operation	69
Figure 27 A request-response example of MRCancelDoor during an auto door operation	72
Figure 28 A request-response example of MRDoorReady during an auto door operation	74
Figure 29 A request-response example of MRRequestDoorStatus during an auto door operation	76
Figure 30 A request-response example of MSActiveDoorStatusNotification during an auto door operation	79
Figure C.1 State transition graph of a mission	113
Figure C.2 Transition graph of an action state	114