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## Contents

1	Scope of Document	5
2	Conventions to be used	6
2.1	Document Conventions	6
2.2	Requirements Guideline	7
2.2.1	Requirements quality	7
2.2.2	Requirements identification	7
3	Acronyms and abbreviations	8
3.1	Acronyms	8
3.2	Abbreviations	8
4	Requirements Specification	9
4.1	Functional Overview	9
4.1.1	Global data space	9
4.2	Functional Requirements	12
4.2.1	General	12
4.2.2	Security	15
4.2.3	Safety	15
4.2.4	DDS-DCPS Configuration	16
4.2.5	Requirements for unidirectional DDS communication	16
4.2.6	Requirements for DDSI-RTPS	17
4.3	Non-Functional Requirements	18
5	Requirements Tracing	19
6	References	20
A	Appendix	21
B	Change history of AUTOSAR traceable items	22
B.1	Traceable item history of this document according to AUTOSAR Release R24-11	22
B.1.1	Added Requirements in R24-11	22
B.1.2	Changed Requirements in R24-11	22
B.1.3	Deleted Requirements in R24-11	22
B.2	Traceable item history of this document according to AUTOSAR Release R23-11	23
B.2.1	Added Requirements in R23-11	23
B.2.2	Changed Requirements in R23-11	23
B.2.3	Deleted Requirements in R23-11	23
B.3	Traceable item history of this document according to AUTOSAR Release R22-11	24
B.3.1	Added Requirements in R22-11	24
B.3.2	Changed Requirements in R22-11	24

**B.3.3 Deleted Requirements in R22-11 . . . . . 24**

# 1 Scope of Document

This document specifies the requirements of the **Data Distribution Service (DDS)** [1], which shall be supported by AUTOSAR CP and AP.

DDS is a middleware protocol and API standard for data-centric connectivity standardized by the Object Management Group (OMG), so every requirement would be directly derived from the OMG standard.

A detailed list can be found on [4.2](#)

## 2 Conventions to be used

### 2.1 Document Conventions

The representation of requirements in AUTOSAR documents follows the table specified in [TPS\_STDT\_00078], see Standardization Template, chapter Support for Traceability ([2]).

The verbal forms for the expression of obligation specified in [TPS\_STDT\_00053] shall be used to indicate requirements, see Standardization Template, chapter Support for Traceability ([2]).

In requirements, the following specific semantics shall be used (based on the Internet Engineering Task Force IETF).

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as:

- **SHALL:** This word means that the definition is an absolute requirement of the specification.
- **SHALL NOT:** This phrase means that the definition is an absolute prohibition of the specification.
- **MUST:** This word means that the definition is an absolute requirement of the specification due to legal issues.
- **MUST NOT:** This phrase means that the definition is an absolute prohibition of the specification due to legal constraints.
- **SHOULD:** This word, or the adjective "RECOMMENDED", mean that there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course.
- **SHOULD NOT:** This phrase, or the phrase "NOT RECOMMENDED" mean that there may exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
- **MAY:** This word, or the adjective OPTIONAL, means that an item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because the vendor feels that it enhances the product while another vendor may omit the same item. An implementation, which does not include a particular option, MUST be prepared to interoperate with another implementation, which does include the option, though perhaps with reduced functionality. In the same vein an implementation, which does include a particular option, MUST be

prepared to interoperate with another implementation, which does not include the option (except, of course, for the feature the option provides.)

## 2.2 Requirements Guideline

The functional requirements defined in this document have been grouped on the basis of their functionality. The groups detailed in the next chapters are:

- **General:** [ 4.2.1] Different kind of requirements related to the DDS OMG standard and to the introduction on AUTOSAR CP and AP architectures.
- **Security:** [ 4.2.2] Requirements required to guarantee some degrees of Security.
- **Safety:** [ 4.2.3] Requirements required to guarantee some degrees of Safety according ISO-26262 [3].
- **DDS-DCPS Configuration:** [ 4.2.4]. Requirements stating the compliance with the Data-Centric Publisher/Subscriber communication paradigm.
- **Requirements for unidirectional DDS communication:** [ 4.2.5]. Requirement related to the used DDS transport protocol.
- **DDSI-RTPS:** [ 4.2.6]. Requirements stating the compliance with OMG DDSI-RTPS protocol [4]

### 2.2.1 Requirements quality

No content

### 2.2.2 Requirements identification

No content

## **3 Acronyms and abbreviations**

### **3.1 Acronyms**

For acronyms and abbreviations refer to [\[5, AUTOSAR glossary\]](#).

### **3.2 Abbreviations**

None



## 4 Requirements Specification

This chapter describes all requirements driving the work to define the RS DDS Specification.

### 4.1 Functional Overview

The **Data Distribution Service (DDS)** [1] is a middleware protocol and API standard from the Object Management Group (OMG). It integrates the components of a system together, providing low-latency data connectivity, extreme reliability, and a scalable architecture.

The DDS Middleware is a software layer that abstracts the Application from the details of the operating system, network transport, and low-level data formats. Low-level details like data wire format, discovery, connections, reliability, protocols, transport selection; QoS, security, etc. are managed by the middleware.

DDS provides QoS-controlled data sharing. Applications communicate by publishing and subscribing to Topics identified by their Topic name. Subscriptions can specify time and content filters and get only a subset of the data being published on the Topic. Different DDS Domains are completely independent from each other. There is no datasharing across DDS domains.

DDS is uniquely data centric. Data centrality ensures that all messages include the contextual information an application needs to understand the data it receives. The essence of data centrality is that DDS knows what data it stores and controls how to share that data. Programmers using traditional message-centric middleware must write code that sends messages. Programmers using data-centric middleware write code that specifies how and when to share data and then directly share data values. Rather than managing all this complexity in the application (user) code, DDS directly implements controlled, managed, secure data sharing for the user.

#### 4.1.1 Global data space

DDS relies on a Data model that is independent from the platform used. This model defines the global data space and specifies how Publishers and Subscribers refer to portions of this space. The data-model can be as simple as a set of unrelated data-structures, each identified by a topic and a type.

The topic provides an identifier that uniquely identifies some data items within the global data space. The type provides structural information needed to tell the middleware how to manipulate the data. The use of typed interfaces implies the need for a generation tool to translate type descriptions into appropriate interfaces and implementations that fill the gap between the typed interfaces and the generic middleware.

Following definitions maybe useful to better understand the meaning and the context off all the requirements.

**Entity:** The basic object of DDS, almost all the others are specializations of this one.

**Publisher:** This object is responsible for data distribution. It may publish data of different data types.

**DataWriter:** The application must use the DataWriter to communicate to a Publisher the existence and value of data-objects of a given type. When data-object values have been communicated to the Publisher through the appropriate data-writer, it is the Publisher's responsibility to perform the distribution (the Publisher will do this according to its own QoS, or the QoS attached to the corresponding data-writer).

**Subscriber:** The Subscriber is responsible for receiving published data and making it available (according to the Subscriber's QoS) to the receiving application. It may receive and dispatch data of different specified types.

**DataReader:** The Subscriber uses a DataReader to provide to the application the received data of a specific type.

**Domain:** A domain is a distributed concept that links all the applications able to communicate with each other. It represents a communication plane: only the publishers and the subscribers attached to the same domain may interact.

**Quality of Services (QoS):** QoS (Quality of Service) is a general concept that is used to specify the behavior of an entity. QoS is comprised of individual QoS policies (objects of type deriving from QoSPolicy). Specific values for one or more QoS policies affecting diverse entities may be grouped in QoS profiles.

**Topic:** A topic corresponds to a single data type. Topic objects conceptually fit between publications and subscriptions. Publications must be known in such a way that subscriptions can refer to them unambiguously. A Topic is meant to fulfill that purpose: it associates a name (unique in the domain), a data-type, and QoS related to the data itself. In addition to the topic QoS, the QoS of the DataWriter associated with that Topic and the QoS of the Publisher associated to the DataWriter control the behavior on the publisher's side, while the corresponding Topic, DataReader, and Subscriber QoS control the behavior on the subscriber's side.

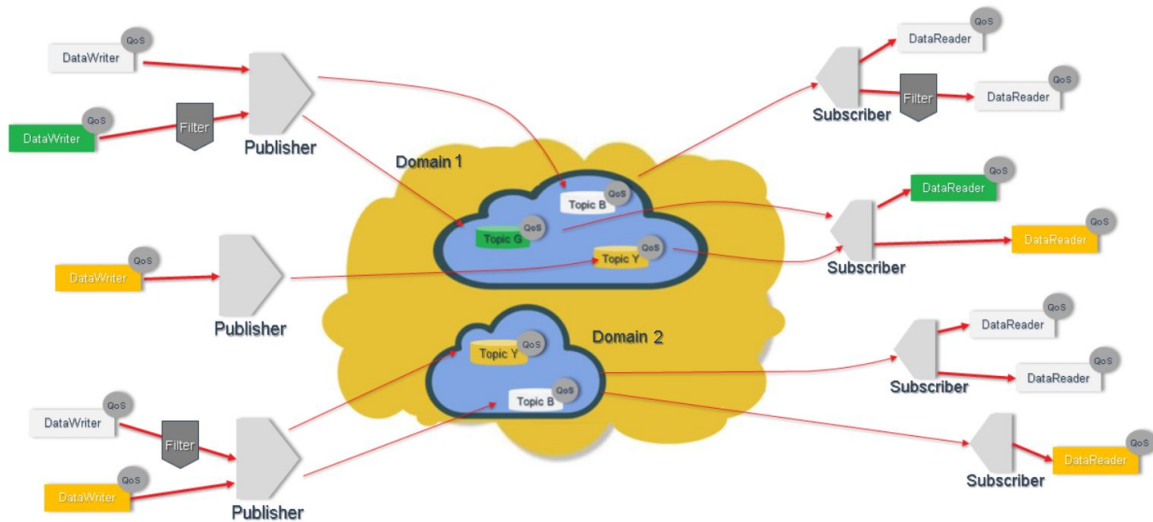


Figure 4.1: The DDS logical view

DDS is a **Data-Centric Publish Subscribe** [4] protocol. This protocol defines the functionality used by an application to publish and subscribe to the values of data objects. It allows:

- The publishing applications to identify the data objects they intend to publish, and then provide values for these objects (they use some Publishers/DataWriters defined in some DomainParticipant).
- The subscribing applications to identify which data objects they are interested in, and then access their data values (they use some Subscribers/DataReaders defined in the same DomainParticipants of the Publishers of which they want to receive the data on the various topics).
- The applications to define topics, to attach type information to the topics, to create publisher and subscriber entities, to attach QoS policies to all these entities and, in summary, to make all these entities operate.

## 4.2 Functional Requirements

### 4.2.1 General

#### [FO\_RS\_Dds\_00001] DDS Compliance

Upstream requirements: [RS\\_Main\\_00280](#)

[

<b>Description:</b>	The DDS components of AUTOSAR shall comply with the DDS Minimum Profile defined in [1], the DDS Wire Interoperability protocol (DDSI-RTPS) defined in [4], and the DDS-XTYPES Minimal Programming Interface and Network Interoperability Profiles defined in [6].
<b>Rationale:</b>	Interoperability with other nodes implementing DDS
<b>Dependencies:</b>	–
<b>Use Case:</b>	<ul style="list-style-type: none"> <li>• Intercommunications between different kinds of architectures (e.g: AP/CP communication compatibility)</li> <li>• Intercommunicate with simulators or ADAS systems based on DDS (e.g. based on ROS2)</li> </ul>
<b>AppliesTo:</b>	FO, CP
<b>Supporting Material:</b>	OMG Data Distribution Service protocol specification [1] OMG DDS Interoperability Wire Protocol [4] OMG Extensible and Dynamic Topic Types for DDS [6]

]

#### [FO\_RS\_Dds\_00002] DDS standard serialization rules

Upstream requirements: [RS\\_Main\\_00280](#)

[

<b>Description:</b>	Data packets to be sent to the network shall be compliant with the DDS Interoperability Wire Protocol (DDSI-RTPS) defined in [4]
<b>Rationale:</b>	Interoperability with other nodes implementing DDS
<b>Dependencies:</b>	–
<b>Use Case:</b>	<ul style="list-style-type: none"> <li>• Intercommunications between different kinds of architectures</li> <li>• Intercommunicate with simulators or ADAS systems based on DDS (e.g. based on ROS2)</li> </ul>
<b>Supporting Material:</b>	OMG DDS Interoperability Wire Protocol [4]
<b>AppliesTo:</b>	FO, CP

]

**[FO\_RS\_Dds\_00004] DDS payload serialization rules**

Upstream requirements: [RS\\_Main\\_00280](#)

[

<b>Description:</b>	The serialization of the payload shall be done according to the DDS standard serialization rules defined in [6]
<b>Rationale:</b>	Interoperability with other nodes implementing DDS
<b>Dependencies:</b>	–
<b>Use Case:</b>	<ul style="list-style-type: none"> <li>• Intercommunications between different kinds of architectures</li> <li>• Intercommunicate with simulators or ADAS systems based on DDS (e.g. based on ROS2)</li> </ul>
<b>Supporting Material:</b>	OMG Extensible and Dynamic Topic Types for DDS [6]
<b>AppliesTo:</b>	FO, CP

]

**[FO\_RS\_Dds\_00005] DDS Quality of Service**

Upstream requirements: [RS\\_Main\\_00280](#)

[

<b>Description:</b>	The DDS components of AUTOSAR shall support DDS QoS policies
<b>Rationale:</b>	Leverage QoS policy features
<b>Dependencies:</b>	–
<b>Use Case:</b>	<ul style="list-style-type: none"> <li>• Receive data at different rates</li> <li>• Time-sensitive Network Support</li> <li>• Support on Safety</li> <li>• Custom presentation order</li> </ul>
<b>Supporting Material:</b>	OMG Data Distribution Service protocol specification [1]
<b>AppliesTo:</b>	FO, CP

]

**[FO\_RS\_Dds\_00006] The DDS AUTOSAR components receive unserialized data**

Upstream requirements: [RS\\_Main\\_00280](#)

[

<b>Description:</b>	In order to better integrate data-centric capabilities of DDS, the DDS components of AUTOSAR shall receive and produce data in unserialized format.
---------------------	---

▽

△

<b>Rationale:</b>	To exploit all DDS functionalities, the DDS components shall work with untransformed data. The DDS middleware shall be aware of application data type it receives.
<b>Dependencies:</b>	–
<b>Use Case:</b>	–
<b>Supporting Material:</b>	OMG Data Distribution Service protocol specification [1]
<b>AppliesTo:</b>	FO, CP

]

### [FO\_RS\_Dds\_00007] Type Definition

Upstream requirements: [RS\\_Main\\_00280](#)

[

<b>Description:</b>	The DDS middleware shall define an unequivocal mapping of AUTOSAR and DDS types relevant in DDS communication, for each supported AUTOSAR platform.
<b>Rationale:</b>	Application Software Components will deal exclusively with AUTOSAR APIs and type system, thus an internal mapping supporting data format consistency is in order.
<b>Dependencies:</b>	–
<b>Use Case:</b>	–
<b>Supporting Material:</b>	OMG Extensible and Dynamic Topic Types for DDS [6]
<b>AppliesTo:</b>	FO, CP

]

### [FO\_RS\_Dds\_00008] Customization

Upstream requirements: [RS\\_Main\\_00280](#), [RS\\_Main\\_00080](#)

[

<b>Description:</b>	DDS shall allow customization of the DDS entities within the ECU.
<b>Rationale:</b>	Interoperate with other DDS-based systems, adapting to their data architecture and specific QoS policy.
<b>Dependencies:</b>	–
<b>Use Case:</b>	–
<b>Supporting Material:</b>	–
<b>AppliesTo:</b>	FO, CP

]

## 4.2.2 Security

### [FO\_RS\_Dds\_00009] Security mechanism

Upstream requirements: [RS\\_Main\\_00510](#), [RS\\_Main\\_00514](#)

[

<b>Description:</b>	The DDS middleware shall support and implement the DDSI-RTPS wire protocol extensions of DDS Security [7] in order to guarantee data integrity and data authentication.
<b>Rationale:</b>	Because external and hybrid communication will be provided, the communication must be secured
<b>Dependencies:</b>	–
<b>Use Case:</b>	<ul style="list-style-type: none"> <li>Secure interoperability with other platforms in the vehicle</li> </ul>
<b>Supporting Material:</b>	OMG DDS Security Specification [7]
<b>AppliesTo:</b>	FO, CP

]

## 4.2.3 Safety

### [FO\_RS\_Dds\_00010] Safety mechanism

Upstream requirements: [RS\\_Main\\_00010](#), [RS\\_Main\\_00030](#)

[

<b>Description:</b>	The DDS middleware shall support ISO26262-compliant E2E [8] safety mechanisms, without breaking DDS and DDSI-RTPS specification compliance
<b>Rationale:</b>	Because external and hybrid communication will be provided, the communication must incorporate safety mechanisms
<b>Dependencies:</b>	–
<b>Use Case:</b>	<ul style="list-style-type: none"> <li>Safe interoperability with other platforms in the vehicle</li> </ul>
<b>Supporting Material:</b>	ISO 26262 [3]
<b>AppliesTo:</b>	FO, CP

]

#### 4.2.4 DDS-DCPS Configuration

##### [FO\_RS\_Dds\_00015] Publish

Upstream requirements: [RS\\_Main\\_00280](#)

[

<b>Description:</b>	The DDS AUTOSAR component shall permit to publish data on specific topics
<b>Rationale:</b>	Send data
<b>Dependencies:</b>	–
<b>Use Case:</b>	Send typed data
<b>Supporting Material:</b>	OMG Data Distribution Service protocol specification [1]
<b>AppliesTo:</b>	FO, CP

]

##### [FO\_RS\_Dds\_00016] Subscribe

Upstream requirements: [RS\\_Main\\_00280](#)

[

<b>Description:</b>	The DDS AUTOSAR component shall permit to subscribe to specific topics
<b>Rationale:</b>	Receive typed data
<b>Dependencies:</b>	–
<b>Use Case:</b>	Receive specific data type
<b>Supporting Material:</b>	OMG Data Distribution Service protocol specification [1]
<b>AppliesTo:</b>	FO, CP

]

#### 4.2.5 Requirements for unidirectional DDS communication

##### [FO\_RS\_Dds\_00017] Transport protocol

Upstream requirements: [RS\\_Main\\_00230](#), [RS\\_Main\\_00280](#)

[

<b>Description:</b>	The AUTOSAR DDS component shall support different transport protocols underneath.
<b>Rationale:</b>	The AUTOSAR DDS component is unaware of the transport protocol.

▽



△

<b>Dependencies:</b>	–
<b>Use Case:</b>	<ul style="list-style-type: none"> <li>• DDS over UDP for time critical communications.</li> <li>• DDS over TCP for time-uncritical communication of large data.</li> <li>• Shared-memory for intra-ecu communications.</li> </ul>
<b>Supporting Material:</b>	DDS Interoperability Wire Protocol ([4], chapter 9)
<b>AppliesTo:</b>	FO, CP

]

#### 4.2.6 Requirements for DDSI-RTPS

##### [FO\_RS\_Dds\_00019] RTPS message encapsulation

Upstream requirements: [RS\\_Main\\_00280](#)

[

<b>Description:</b>	The DDS components of AUTOSAR shall encapsulate data into RTPS messages
<b>Rationale:</b>	DDS intercommunicate by using RTPS messages
<b>Dependencies:</b>	–
<b>Use Case:</b>	DDS intercommunication
<b>Supporting Material:</b>	–
<b>AppliesTo:</b>	FO, CP

]

##### [FO\_RS\_Dds\_00020] RTPS message decapsulation

Upstream requirements: [RS\\_Main\\_00280](#)

[

<b>Description:</b>	The DDS components of AUTOSAR shall decapsulate data from RTPS messages
<b>Rationale:</b>	DDS intercommunicate by using RTPS messages
<b>Dependencies:</b>	–
<b>Use Case:</b>	DDS intercommunication
<b>Supporting Material:</b>	–
<b>AppliesTo:</b>	FO, CP

]

### 4.3 Non-Functional Requirements

None.

## 5 Requirements Tracing

The following table references the features specified in [9] and links to the fulfillments of these.

Requirement	Description	Satisfied by
[RS_Main_00010]	Safety Mechanisms	[FO_RS_Dds_00010]
[RS_Main_00030]	Safety Related Process Support	[FO_RS_Dds_00010]
[RS_Main_00080]	Formal Description Language	[FO_RS_Dds_00008]
[RS_Main_00230]	Network Technology Support	[FO_RS_Dds_00017]
[RS_Main_00280]	Standardized Automotive Communication Protocols	[FO_RS_Dds_00001] [FO_RS_Dds_00002] [FO_RS_Dds_00004] [FO_RS_Dds_00005] [FO_RS_Dds_00006] [FO_RS_Dds_00007] [FO_RS_Dds_00008] [FO_RS_Dds_00015] [FO_RS_Dds_00016] [FO_RS_Dds_00017] [FO_RS_Dds_00019] [FO_RS_Dds_00020]
[RS_Main_00510]	Secure Onboard Communication	[FO_RS_Dds_00009]
[RS_Main_00514]	System Security Support	[FO_RS_Dds_00009]

**Table 5.1: Requirements Tracing**

## 6 References

- [1] Data Distribution Service (DDS), Version 1.4  
<http://www.omg.org/spec/DDS/1.4>
- [2] Standardization Template  
AUTOSAR\_FO\_TPS\_StandardizationTemplate
- [3] ISO 26262:2018 (all parts) – Road vehicles – Functional Safety  
<https://www.iso.org>
- [4] DDS Interoperability Wire Protocol, Version 2.2  
<http://www.omg.org/spec/DDSI-RTPS/2.2>
- [5] Glossary  
AUTOSAR\_FO\_TR\_Glossary
- [6] Extensible and Dynamic Topic Types for DDS, Version 1.2  
<https://www.omg.org/spec/DDS-XTypes/1.2>
- [7] DDS Security, Version 1.1  
<https://www.omg.org/spec/DDS-SECURITY/1.1>
- [8] Specification of SW-C End-to-End Communication Protection Library  
AUTOSAR\_CP\_SWS\_E2ELibrary
- [9] Requirements on AUTOSAR Features  
AUTOSAR\_CP\_RS\_Features

## **A Appendix**

No content

## B Change history of AUTOSAR traceable items

Please note that the lists in this chapter also include traceable items that have been removed from the specification in a later version. These items do not appear as hyperlinks in the document.

### B.1 Traceable item history of this document according to AUTOSAR Release R24-11

#### B.1.1 Added Requirements in R24-11

none

#### B.1.2 Changed Requirements in R24-11

Number	Heading
[FO_RS_Dds_00001]	DDS Compliance
[FO_RS_Dds_00002]	DDS standard serialization rules
[FO_RS_Dds_00004]	DDS payload serialization rules
[FO_RS_Dds_00005]	DDS Quality of Service
[FO_RS_Dds_00006]	The DDS AUTOSAR components receive unserialized data
[FO_RS_Dds_00007]	Type Definition
[FO_RS_Dds_00008]	Customization
[FO_RS_Dds_00009]	Security mechanism
[FO_RS_Dds_00010]	Safety mechanism
[FO_RS_Dds_00015]	Publish
[FO_RS_Dds_00016]	Subscribe
[FO_RS_Dds_00017]	Transport protocol
[FO_RS_Dds_00019]	RTPS message encapsulation
[FO_RS_Dds_00020]	RTPS message decapsulation

**Table B.1: Changed Requirements in R24-11**

#### B.1.3 Deleted Requirements in R24-11

none

## B.2 Traceable item history of this document according to AUTOSAR Release R23-11

### B.2.1 Added Requirements in R23-11

Number	Heading
[FO_RS_Dds_00001]	DDS Compliance
[FO_RS_Dds_00002]	DDS standard serialization rules
[FO_RS_Dds_00004]	DDS payload serialization rules
[FO_RS_Dds_00005]	DDS Quality of Service
[FO_RS_Dds_00006]	The DDS AUTOSAR components receive unserialized data
[FO_RS_Dds_00007]	Type Definition
[FO_RS_Dds_00008]	Customization
[FO_RS_Dds_00009]	Security mechanism
[FO_RS_Dds_00010]	Safety mechanism
[FO_RS_Dds_00015]	Publish
[FO_RS_Dds_00016]	Subscribe
[FO_RS_Dds_00017]	Transport protocol
[FO_RS_Dds_00019]	RTPS message encapsulation
[FO_RS_Dds_00020]	RTPS message decapsulation

**Table B.2: Added Requirements in R23-11**

### B.2.2 Changed Requirements in R23-11

none

### B.2.3 Deleted Requirements in R23-11

none

## B.3 Traceable item history of this document according to AUTOSAR Release R22-11

### B.3.1 Added Requirements in R22-11

Number	Heading
[FO_RS_Dds_00001]	DDS Compliance
[FO_RS_Dds_00002]	DDS standard serialization rules
[FO_RS_Dds_00004]	DDS payload serialization rules
[FO_RS_Dds_00005]	DDS Quality of Service
[FO_RS_Dds_00007]	Type Definition
[FO_RS_Dds_00008]	Customization
[FO_RS_Dds_00009]	Security mechanism
[FO_RS_Dds_00010]	Safety mechanism
[FO_RS_Dds_00015]	Publish
[FO_RS_Dds_00016]	Subscribe
[FO_RS_Dds_00017]	Transport protocol
[FO_RS_Dds_00019]	RTPS message encapsulation
[FO_RS_Dds_00020]	RTPS message decapsulation
[FO_RS_Dds_- CONSTR_00006]	The DDS AUTOSAR components receive unserialized data

**Table B.3: Added Requirements in R22-11**

### B.3.2 Changed Requirements in R22-11

none

### B.3.3 Deleted Requirements in R22-11

none