ETSI EN 303 146-2 V1.2.1 (2016-06)

Reconfigurable Radio Systems (RRS);
Mobile Device (MD) information models and protocols;
Part 2: Reconfigurable Radio Frequency Interface (RRFI)

Reference
REN/RRS-0246

Keywords
interface, mobile, SDR

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

This European Standard (EN) has been produced by ETSI Technical Committee Reconfigurable Radio Systems (RRS).

The present document is part 2 of a multi-part deliverable covering the Mobile Device (MD) information models and protocols, as identified below:

ETSI EN 303 146-1: "Multiradio Interface (MURI)";

ETSI EN 303 146-2: "Reconfigurable Radio Frequency Interface (RRFI)";

ETSI EN 303 146-3: "Unified Radio Application Interface (URAI)";

ETSI TS 103 146-4: "Radio Programming Interface (RPI)".

National transposition dates	
Date of adoption of this EN:	30 May 2016
Date of latest announcement of this EN (doa):	31 August 2016
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	28 February 2017
Date of withdrawal of any conflicting National Standard (dow):	28 February 2017

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1 Scope

The present document defines an information model and protocol for reconfigurable radio frequency interface for reconfigurable MDs. The work is based on the Use Cases defined in ETSI TR 102 944 [i.1], on the system requirements defined in ETSI EN 302 969 [1] and on the radio reconfiguration related architecture for mobile devices defined in ETSI EN 303 095 [i.8].

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] ETSI EN 302 969 (V1.2.1): "Reconfigurable Radio Systems (RRS); Radio Reconfiguration related Requirements for Mobile Devices".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TR 102 944: "Reconfigurable Radio Systems (RRS); Use Cases for Baseband Interfaces for Unified Radio Applications of Mobile Device".

[i.2] Recommendation ITU-T Q.1290: "Glossary of Terms used in the Definition of Intelligent Networks".

[i.3] ETSI TR 102 839: "Reconfigurable Radio Systems (RRS); Multiradio Interface for Software Defined Radio (SDR) Mobile Device Architecture and Services".

[i.4] IEEE 1900.4-2009™: "IEEE Standard for Architectural Building Blocks Enabling Network-Device Distributed Decision Making for Optimized Radio Resource Usage in Heterogeneous Wireless Access Networks".

[i.5] ETSI EN 303 146-1: "Reconfigurable Radio Systems (RRS); Mobile Device Information Models and Protocols; Part 1: Multiradio Interface (MURI)".

[i.6] DigRF^{SM} Working Group: "MIPI® Alliance Specification for DigRF^{SM} v4".

[i.7] Recommendation ITU-T X.680: "Information technology - Abstract Syntax Notation One (ASN.1): Specification of basic notation".

[i.8] ETSI EN 303 095 (V1.2.1): "Reconfigurable Radio Systems (RRS); Radio Reconfiguration related Architecture for Mobile Devices".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

Application Processor (AP): part of mobile device hardware working under OS control and on which User Applications, among others, are executed

channel: designated part of the information transfer capability having specified characteristics, provided at the user network interface

NOTE: It is the over-the-air wireless propagation channel which is used to convey an information signal from transmitter to receiver. This definition is specified in Recommendation ITU-T Q.1290 [i.2].

Communication Services Layer (CSL): layer related to communication services supporting generic applications

NOTE: A communication services layer supports generic applications like Internet access. In the present document, it consists of Administrator, Mobility Policy Manager (MPM), Networking stack and Monitor.

link: connection from one location to another through a given Radio Access Technology for the purpose of transmitting and receiving digital information

NOTE: Each Link is conveyed over a given Channel.

Radio Application (RA): software which enforces the generation of the transmit RF signals or the decoding of the receive RF signals

NOTE 1: The software is executed on a particular radio platform or an RVM as part of the radio platform.

NOTE 2: RAs might have different forms of representation. They are represented as:

- source codes including Radio Library calls of Radio Library native implementation and Radio HAL calls;
- IRs including Radio Library calls of Radio Library native implementation and radio HAL calls;
- executable codes for a particular radio platform.

Radio Computer (RC): part of mobile device hardware working under ROS control and on which RAs are executed

NOTE: A Radio Computer typically includes programmable processors, hardware accelerators, peripherals, etc. RF part is considered to be part of peripherals.

Radio Control Framework (RCF): control framework which, as a part of the OS, extends OS capabilities in terms of radio resource management

NOTE: RCF is a control framework which consists of Configuration Manager (CM), Radio Connection Manager (RCM), Flow Controller (FC), Multiradio Controller (MRC) and Resource Manager (RM) which is typically part of OS.

Radio Frequency (RF) transceiver: part of radio platform converting, for transmission, baseband signals into radio signals, and, for reception, radio signals into baseband signals

Radio Operating System (ROS): any appropriate OS empowered by RCF

NOTE: ROS provides RCF capabilities as well as traditional management capabilities related to management of RP such as resource management, file system support, unified access to hardware resources, etc.

radio platform: part of mobile device hardware which relates to radio processing capability, including programmable components, hardware accelerators, RF transceiver, and antenna(s)

NOTE: A Radio Platform is a piece of hardware capable of generating RF signals or receiving RF signals. By nature, it is heterogeneous hardware including different processing elements such as fixed accelerators, e.g. Application-Specific Integrated Circuit (ASIC), or reconfigurable accelerators, e.g. FPGAs, etc.

Radio Virtual Machine (RVM): abstract machine which supports reactive and concurrent executions

NOTE: An RVM may be implemented as a controlled execution environment which allows the selection of a trade-off between flexibility of base band code development and required (re-)certification efforts.

reconfigurable Mobile Device (MD): Mobile Device with radio communication capabilities providing support for radio reconfiguration

NOTE: Reconfigurable Mobile Devices include but are not limited to: smartphones, feature phones, tablets, and laptops.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ACK	ACKnowledgement
ACKM	ACKnowledgement with Modification
AP	Application Processor
ASIC	Application-Specific Integrated Circuit
ASN.1	Abstract Syntax Notation One
BBIC	Base-Band Integrated Circuit
BLER	Block Error Rate
CSL	Communication Services Layer
EU	European Union
MD	Mobile Device
MDRC	Mobile Device Reconfiguration Class
MIMO	Multiple Input Multiple Output
MPM	Mobility Policy Manager
MURI	MUltiRadio Interface
NACK	Negative ACKnowledgement
OOB	Out Of Band
OS	Operating System
RA	Radio Application
RAN	Radio Access Network
RAP	Radio Application Package
RAT	Radio Access Technology
RC	Radio Computer
RCF	Radio Control Framework
RF	Radio Frequency
RFIC	Radio Frequency Integrated Circuit
ROS	Radio Operating System
RPI	Radio Programming Interface
RRFI	Reconfigurable Radio Frequency Interface
RVM	Radio Virtual Machine
RX	Reception
SINR	Signal to Interference plus Noise Ratio
TR	Technical Report
UML	Unified Modeling Language
URA	Unified Radio Applications
URAI	Unified Radio Applications Interface

4 Introduction

A reconfigurable MD is capable of running multiple radios simultaneously and of changing the set of radios by loading new Radio Application Package (RAP). All Radio Applications (RAs) are called Unified Radio Applications (URAs) when they exhibit a common behaviour from the reconfigurable MD's point of view [1]. In order to run multiple URAs, the reconfigurable MD will include Communication Services Layer (CSL), Radio Control Framework (RCF), Radio Platform and 4 sets of interfaces for their interconnection.

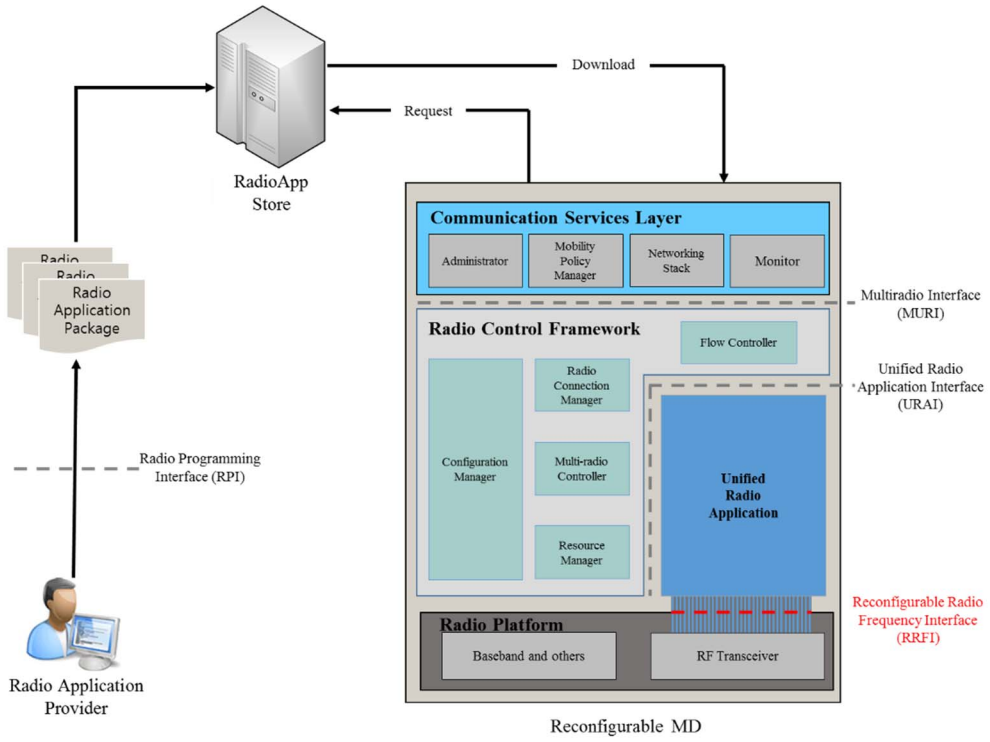

Figure 4.1: Four sets of interfaces for reconfigurable MD

Figure 4.1 illustrates the reconfigurable MD architecture with the 4 sets of interfaces, i.e.:

- MURI for interfacing CSL and RCF [i.5].
- RRFI for interfacing URA and RF Transceiver, which is the scope of the present document.
- URAI for interfacing URA and RCF [i.3].
- RPI for allowing an independent and uniform production of RAs [i.3].

The present document defines RRFI.

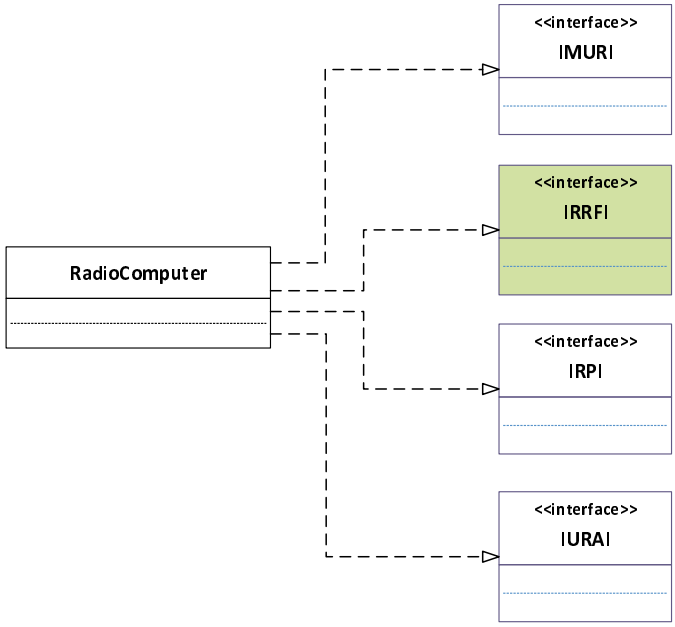

Figure 4.2: UML class diagram for RC interfaces

Figure 4.2 illustrates UML class diagram for RC interfaces. The reconfigurable MD may be seen as a RC where individual URAs are engineered as software entities [i.8].

The present document is organized as follows:

- clause 5 describes the system identification;
- clause 6 describes the notational tool for defining both information model classes and interface classes;
- clause 7 describes the information model for RC; and
- clause 8 describes the interface definition.

While UML is used for defining the information model and protocol related to RRFI, other modelling languages could be used as well.

5 System Identification

5.1 Radio Computer Structure

Figure 5.1 illustrates how URA and RF Transceiver interacts with each other using RRFI.

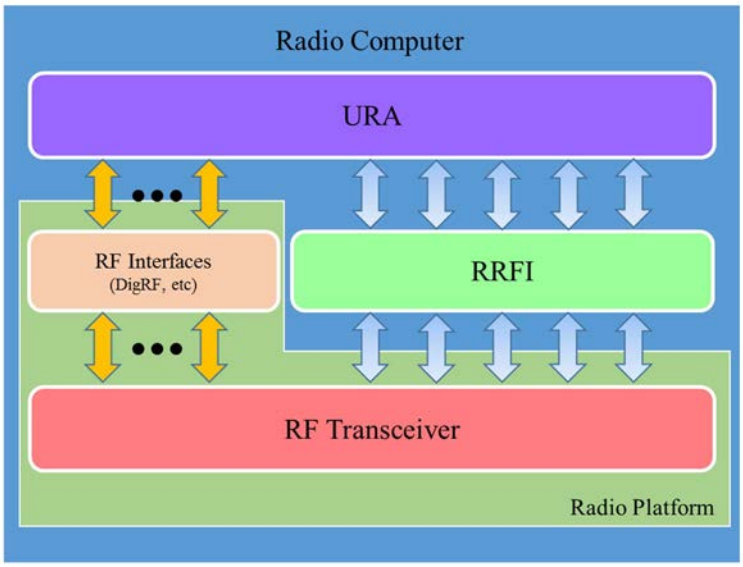

Figure 5.1: Interconnection between URA and RF Transceiver using RRFI for reconfigurable MD

As shown in figure 5.1, RRFI can support up to 5 kinds of services depending on the applicable MDRC [1].

A Reconfigurable MD shall support all the services as required by the corresponding MDRC as shown in table 5.1 and fully detailed in clause 8 of the present document. In case that a reconfigurable MD supports multiple MDRCs, the concerned reconfigurable MD shall support all the services as defined in table 5.1.

Table 5.1: Required services of RRFI according to each MDRC

Mobile Device Reconfiguration Class	Spectrum Control services	Power Control services	Antenna Management services	Tx/Rx Chain Control services	RVM Protection services
MDRC-0	No	No	No	No	No
MDRC-1	Yes	Yes	No	No	Yes
MDRC-2, MDRC-5	Yes	Yes	Yes	Yes (see note)	Yes
MDRC-3, MDRC-6	Yes	Yes	Yes	Yes	Yes
MDRC-4, MDRC-7	Yes	Yes	Yes	Yes	Yes
NOTE: Among the various Tx/Rx Chain Control services, only the service related with Tx/Rx timing is required in this case.					

A corresponding summary of the services is given below.

- **Spectrum Control services**

  These services are used to set up spectrum-related parameters such as carrier frequency, bandwidth, sampling frequency, etc. that will be determined according to the URAs they are related to.

- **Power Control services**

  These services are used to set up RF power-related parameters such as maximum transmit (Tx) power level, Tx power level per antenna, receive (Rx) gain, etc. Specific power schemes which have to be controlled according to the communication circumstance around the reconfigurable MD are also included in the Power Control services.

- **Antenna Management services**

  These services are used to determine the antenna configuration. Antenna radiation pattern, antenna gain, antenna direction, sector configuration, polarization, frequency range, etc. are some factors to be considered in the Antenna Management services.

NOTE: Antenna Management services depend on the configurability of the antenna.

- **Tx/Rx Chain Control services**

  These services are used to provide parameters related to real-time control of the RF transceiver chain. Parameters to be controlled using the Tx/Rx Chain Control services include (but are not limited to) Tx start/stop time, Rx start/stop time, spectrum- and/or power-related values.

- **RVM Protection services**

  These services are used to provide parameters related to the selection of RVM protection class. Parameters to be controlled using the RVM Protection services include (but are not limited to) selection and/or request of RF protection class as well as, RF Front-end indication of input data signals modification.

The clauses 5.2 to 5.4 describe the components/entities shown in figure 5.1.

5.2 URA

RAs need to be subject to a common reconfiguration, multiradio execution and resource sharing strategy framework (depending on the concerned MDRC). Since all RAs exhibit a common behaviour from the reconfigurable MD perspective, those RAs are called URAs [i.8].

5.3 RF Transceiver

RF Transceiver, which includes transceiver chain(s), is part of the radio platform in RC that transforms, in Tx mode, the baseband signal to radio signal, and in Rx mode, the radio signal to baseband signal.

5.4 RF Interfaces

The RF Interfaces depicted in figure 5.1 denote digital interfaces which define the physical interconnections between base-band and RFIC (Radio Frequency Integrated Circuit), for example, the DigRF^{SM} specification defining the interface between an RFIC and a BBIC (Base-Band Integrated Circuit) in a mobile device. RRFI defined in the present document complements such RF interfaces by defining services which are required for reconfigurable MDs.

5.5 Radio Computer RF System Requirement Mapping

The Radio Computer components above described shall support the RF system requirements shown in table 5.2 and described in clause 6.5 of ETSI EN 302 969 [1].

NOTE: The transceiver requirements defined in clauses 6.5.5, 6.5.6 and 6.5.8 of ETSI EN 302 969 [1] are not related to the RF Interface defined in the present document and therefore do not appear in table 5.2.

Table 5.2: Mapping of RC Components to the system requirements described in ETSI EN 302 969 [1]

Entity/Component/Unit	System Requirements [1]	Comments
Unified Radio Applications	R-FUNC-RFT-02	Radio Application selects a suitable number of antenna inputs/outputs. The requirement is described in clause 6.5.2 of ETSI EN 302 969 [1].
RF Transceiver	R-FUNC-RFT-03	The reconfigurable MD supports multiple Radio Applications using distinct frequency bands. The requirement is described in clause 6.5.3 of ETSI EN 302 969 [1].
	R-FUNC-RFT-04	RF transceiver manages input/output signals from/to one or several Radio Applications. The requirement is described in clause 6.5.4 of ETSI EN 302 969 [1].
Reconfigurable RF Interface	R-FUNC-RFT-01, R-FUNC-RFT-07	The RRFI provides a suitable interface for RF transceiver configuration. The requirement is described in clauses 6.5.1 and 6.5.7 of ETSI EN 302 969 [1].
	R-FUNC-RFT-09	The RRFI supports a suitable selection of an RF protection class. The requirement is described in clause 6.5.9 of ETSI EN 302 969 [1].

6 Notational Tools

6.1 Notational Tool for Information Model Classes

Table 6.1 shows a template for defining information model classes [i.4]. Each information model class is defined in clause 7.2 in accordance with the template shown in table 6.1.

NOTE: ASN.1 is used throughout the present document for abstract type definitions; however, alternative ways are possible and are not excluded.

Table 6.1: Template for defining Information Model Classes

Class<Class name>*[(abstract class)]*			
<Description of the class>			
DERIVED FROM	<List of super-classes>		
ATTRIBUTES			
<Attribute name> *[<optional>]*	*Value type:* <Attribute value type>	*Possible access:* <Attribute access qualifier>	*Default value:* <Default value>
<Description of the attribute>			
CONTAINED IN	<List of classes, whose instances may contain an instance of this class. If this class is an abstract class, that is, it is used for further refinement only and will never be instantiated, then this list is empty.>		
CONTAINS	<List of classes, whose instances may be contained in an instance of this class. Constraints used are: • [*] - zero or more instances, • [+] - one or more instances, • [<n>] - exactly n instances, • [<m> - <n>] - not less than m and not more than n instances.>		
SUPPORTED EVENTS	<List of event names that are detected by this class and lead potentially to a corresponding event report>.		

Further details on the template in table 6.1 are given below.

- <Class name> is the name of the Class as it appears in the corresponding model. Additional information is also included in case the class in question has been specified as an abstract one.
- DERIVED FROM field identifies the super class of the class in case of sub-classing.
- ATTRIBUTES field describes the attributes that have been defined in the class. More specifically:
  - <Attribute name> identifies the name of an attribute, as it is included in the class definition.
  - <Attribute value type> holds the type of the attribute specified in Abstract Syntax Notation One (ASN.1). Details related to the ASN.1 module are specified in annex A of the present document.
  - <Attribute access qualifier> provides information about the level of accessibility of the attribute. This may include: 'Read', 'Write', 'Read-Write', 'Add-Remove' (for list-type attributes), 'Read-Add-Remove', and 'None' (for internal access only).
- CONTAINED IN field includes a list of classes whose instances may contain an instance of this class; containment is a strong aggregation relationship, that is, a contained instance is for its lifetime bound to its container object and it is contained only in this one container.
- CONTAINS field provides a list of classes whose instances may be contained in an instance of the class in question.
- SUPPORTED EVENTS field includes a list of event names that are detected by this class and lead potentially to a corresponding event report.

6.2 Notational Tool for Interface Classes

Table 6.2 shows a template for defining interface classes for RRFI. Each interface class for RRFI will be defined in clause 8.7 in accordance with the template shown in table 6.2.

Table 6.2: Template for defining Interface Classes

Class<Class name*>[(abstract class)]*		
<Description of the class>		
OPERATIONS		
<Operation name>	*Return type:* <Operation return type>	*Value type:* <Operation value type>
<Description of the operation>		

The template fields in table 6.2 are described below.

- <Class name> is the name of the Class as it appears in the corresponding model. Additional information is also included in case the class in question has been specified as an abstract one.
- OPERATIONS field describes the operations that have been defined in the class. More specifically:
  - <Operation name> identifies the name of an operation, as it is included in the class definition.
  - <Return type> identifies the type of return value at the corresponding operation. Details related to the ASN.1 module are specified in annex B of the present document.
  - <Value type> identifies the access levels for member functions: public, private, protected.

7 Information Model for Radio Computer

7.1 Radio Computer

Figure 7.1 shows the UML class diagram for RC classes related to RRFI which are required to support Software Reconfiguration.

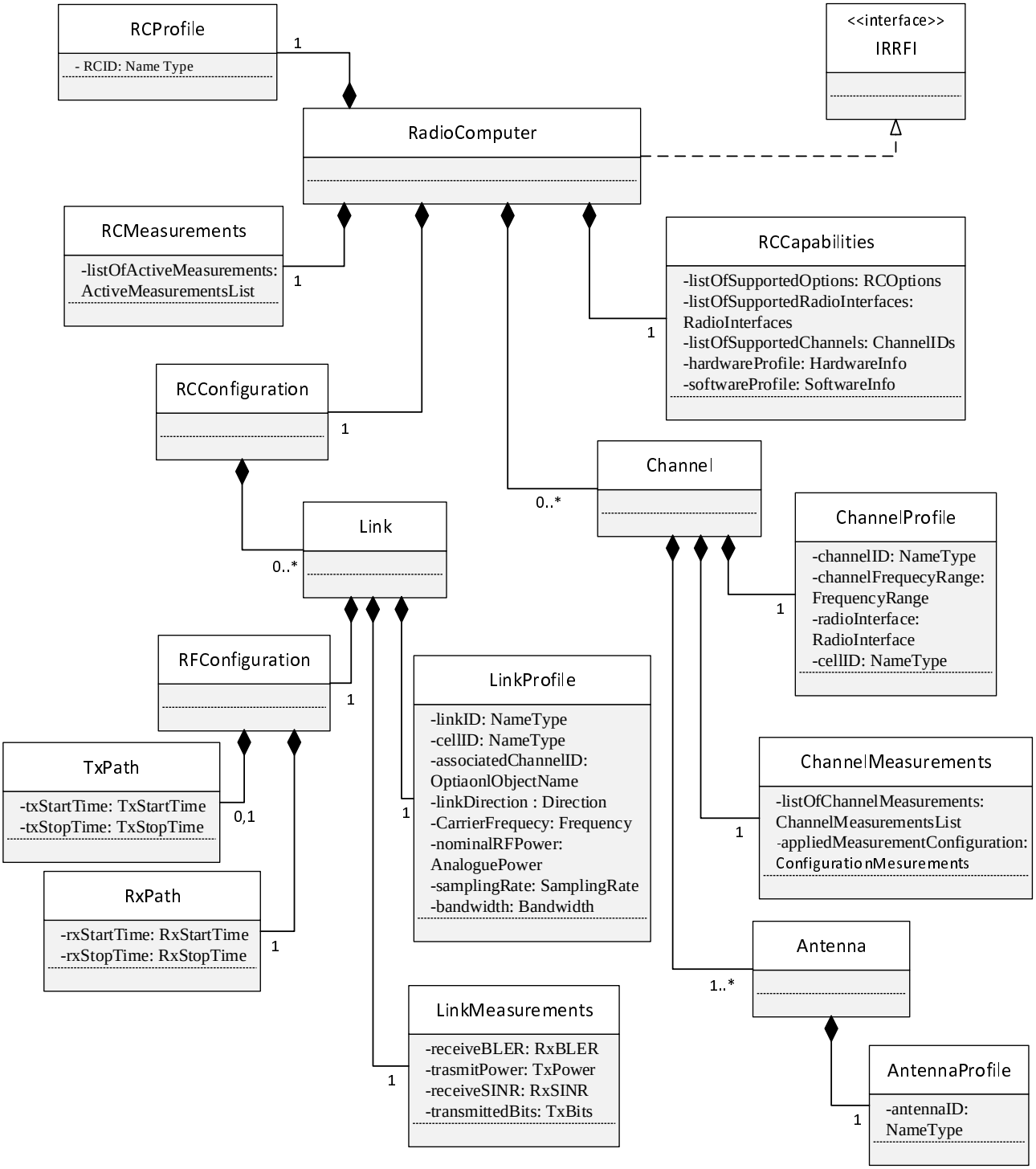

Figure 7.1: UML class diagram for RC classes related to RRFI

The RC classes related to RRFI are defined as follows:

- **RadioComputer**

  This class contains all URA(s) related information about resources and interactions related to hardware and software of a reconfigurable MD, for example, computational/spectral resource usage, collection of context information, channel measurement results, etc.

- **RCCapabilities**

  This class contains information about RC capabilities including hardware, software, transmission and measurement capabilities such as supported RATs and maximum transmission power. Each instance of RadioComputer class shall have only one instance of RCCapabilities class as a member.

- **Channel**

  This class contains one radio channel that may or may not be used by an active radio link. Each instance of RadioComputer class can have zero, one or several instances of Channel class as members (0..*). In case of an active radio link, at least one Channel class is available.

- **ChannelProfile**

  This class contains general information about the radio channel such as channel ID, centre frequency, bandwidth, and used RAT. Each instance of Channel class shall have only one instance of Channel Profile class as a member.

- **ChannelMeasurements**

  This class contains current measurements (instantaneous measurement data and related metadata) and the applied measurement configuration related to this radio channel such as interference and load measurements. Each instance of Channel class shall have only one instance of ChannelMeasurements class as a member.

- **Antenna**

  This class contains information about antenna selection. Each instance of Link class shall have at least one instance of Antenna class as a member (1..*).

- **AntennaProfile**

  This class contains general information about this antenna, such as antenna port, applicable frequency range and antenna gain. Each instance of Antenna class shall have only one instance of AntennaProfile class as a member.

- **RCConfiguration**

  This class contains information about the current configuration of RC. Each instance of RadioComputer class shall have only one instance of RCConfiguration class as a member.

- **Link**

  This class contains information about one active URA and the corresponding connection between the reconfigurable MD and the Radio Access Network (RAN). Each instance of RCConfiguration class has zero, one or several instances of Link class as members (0..*). Each instance of Link class is associated with one instance of Channel class.

- **LinkProfile**

  This class contains general information about this active connection, for example, link Identification (ID), serving cell ID, channel used, etc. Each instance of Link class shall have only one instance of LinkProfile class as a member.

- **LinkMeasurements**

  This class contains current measurements (instantaneous measurement data and related metadata) related to this active connection, such as Block Error Rate (BLER), power, and Signal to Interference plus Noise Ratio (SINR) measurements. Each instance of Link class shall have only one instance of LinkMeasurements class as a member.

- **RFConfiguration**

  This class contains information about the configuration of the RF transceiver. Each instance of Link class shall have only one instance of RFConfiguration class as a member.

- **TxPath**

  This class contains information about one transmit path. Each instance of RFConfiguration class has zero or one instance of TxPath class as a member (0,1).

- **RxPath**

  This class contains information about one receive path. Each instance of RFConfiguration class shall have only one instance of RxPath class as a member.

- **RCMeasurements**

  This class contains current measurements (instantaneous measurement data and related metadata) related to reconfigurable MD such as battery capacity, user mobility, MD location determination, and connection history information. Each instance of RadioComputer class shall have only one instance of RCMeasurements class as a member.

- **RCProfile**

  This class contains general information about the Radio Computer, for example, terminal Identification (ID). Each instance of a "RadioComputer" class can have only one instance of RCProfile class as a member.

NOTE: The Channel Class is separate from the Link Class, but the Channel Measurements may be based on any MD configuration which may or may not be used for the final Link Configuration.

7.2 Class Definitions for Information Model

Each class of RC can be defined using the template presented in clause 6.1 and in accordance with the UML diagram of figure 7.1 which specifies the relations among all the classes of RC. RC classes defined in this way are shown in tables 7.1 to 7.16.

Table 7.1: RadioComputer Class

Class **RadioComputer**	
This class contains all URA related information about resources and interactions related to hardware and software of a reconfigurable MD.	
DERIVED FROM	
ATTRIBUTES	
CONTAINED IN	
CONTAINS	**RCCapabilities [1]**, **RCConfiguration [1], RCMeasurements [1], Channel [0..*]**
SUPPORTED EVENTS	

Table 7.2: RCCapabilities Class

Class **RCCapabilities**			
This class contains information about RC capabilities including hardware, software, transmission and measurement capabilities.			
DERIVED FROM			
ATTRIBUTES			
listOfSupportedOptions	*Value type:* RCOptionsList	*Possible access:* Read-Write	*Default value:* Not specified
This attribute describes a list of supported options.			
listOfSupportedRadioInterfaces	*Value type:* RadioInterfacesList	*Possible access:* Read-Write	*Default value:* Not specified
This attribute describes radio interfaces supported by this RC.			
listOfSupportedChannels	*Value type:* ChannelIDsList	*Possible access:* Read-Write	*Default value:* Not specified
This attributes describes frequency channels supported by this RC.			
hardwareProfile	*Value type:* HardwareInfo	*Possible access:* Read-Write	*Default value:* Not specified
This attributes describes hardware capabilities of this RC.			
softwareProfile	*Value type:* SoftwareInfo	*Possible access:* Read-Write	*Default value:* Not specified
This attributes describes software capabilities of this RC.			
CONTAINED IN	**RadioComputer**		
CONTAINS			
SUPPORTED EVENTS			

Table 7.3: Channel Class

Class **Channel**	
This class describes one frequency channel that may or may not have active connections on it.	
DERIVED FROM	
ATTRIBUTES	
CONTAINED IN	**RadioComputer**
CONTAINS	**ChannelProfile [1], ChannelMeasurements [1], Antenna [1..*]**
SUPPORTED EVENTS	

Table 7.4: ChannelProfile Class

Class **ChannelProfile**			
This class contains general information about this frequency channel.			
DERIVED FROM			
ATTRIBUTES			
channelID	*Value type:* NameType	*Possible access:* Read	*Default value:* Not specified
This attribute describes ID of channel.			
channelFrequencyRange	*Value type:* FrequencyRange	*Possible access:* Read	*Default value:* Not specified
This attribute describes a value of channel frequency range.			
radioInterface	*Value type:* RadioInterface	*Possible access:* Read	*Default value:* Not specified
This attribute describes a radio interface.			
cellID	*Value type:* NameType	*Possible access:* Read	*Default value:* Not specified
This attribute describes ID of connected cell.			
CONTAINED IN	**Channel**		
CONTAINS			
SUPPORTED EVENTS			

Table 7.5: ChannelMeasurements Class

Class **ChannelMeasurements**			
This class contains current measurements related to this frequency channel.			
DERIVED FROM			
ATTRIBUTES			
listOfChannelMeasurements	*Value type:* ChannelMeasurementsList	*Possible access:* Read	*Default value:* Not specified
This attribute describes a list of channel measurements.			
appliedMeasurementsConfiguration	*Value type:* ConfigurationMeasurements	*Possible access:* Read	*Default value:* Not specified
This attribute describes configuration option of the MD, e.g. which Antenna(s) have been used, which RF front-end(s) have been used, etc.			
CONTAINED IN	**Channel**		
CONTAINS			
SUPPORTED EVENTS			

Table 7.6: Antenna Class

Class **Antenna**	
This class contains information about antenna selection.	
DERIVED FROM	
ATTRIBUTES	
CONTAINED IN	**Channel**
CONTAINS	**AntennaProfile [1]**
SUPPORTED EVENTS	

Table 7.7: AntennaProfileClass

Class **AntennaProfile**			
This class contains general information about this antenna.			
DERIVED FROM			
ATTRIBUTES			
antennaID	*Value type:* NameType	*Possible access:* Read	*Default value:* Not specified
This attribute describes ID of antenna.			
CONTAINED IN	**Antenna**		
CONTAINS			
SUPPORTED EVENTS			

Table 7.8: RCConfigurationClass

Class **RCConfiguration**	
This class contains information about the current configuration of RC.	
DERIVED FROM	
ATTRIBUTES	
CONTAINED IN	**RadioComputer**
CONTAINS	**Link [0..*]**
SUPPORTED EVENTS	

Table 7.9: LinkClass

Class **Link**	
This class contains information about one active Radio Application and corresponding connection between Reconfigurable Radio terminal and RANs.	
DERIVED FROM	
ATTRIBUTES	
CONTAINED IN	**RCConfiguration**
CONTAINS	**LinkProfile [1], LinkMeasurements [1], RFConfiguration [1]**
SUPPORTED EVENTS	

Table 7.10: LinkProfileClass

Class **LinkProfile**			
This class contains general information about this active connection.			
DERIVED FROM			
ATTRIBUTES			
linkID	*Value type:* NameType	*Possible access:* Read	*Default value:* Not specified
This attribute describes ID of link about activated connection.			
cellID	*Value type:* NameType	*Possible access:* Read-Write	*Default value:* Not specified
This attribute describes ID connected cell.			
associatedChannelID	*Value type:* OptionalObjectName	*Possible access:* Read-Add-Remove	*Default value:* Not specified
This attribute describes ID of associated channel.			
linkDirection	*Value type:* Direction	*Possible access:* Read	*Default value:* Not specified
This attribute describes a direction of link.			
carrierFrequency	*Value type:* FrequencyRange	*Possible access:* Read-Write	*Default value:* Not specified
This attribute describes a value of carrier frequency.			
nominalRFPower	*Value type:* AnaloguePower	*Possible access:* Read	*Default value:* Not specified
This attribute describes a value of nominal power.			
samplingRate	*Value type:* SamplingRate	*Possible access:* Read-Write	*Default value:* Not specified
This attribute describes a value of sampling rate.			
bandwidth	*Value type:* Bandwidth	*Possible access:* Read-Write	*Default value:* Not specified
This attribute describes a value of bandwidth.			
CONTAINED IN	**Link**		
CONTAINS			
SUPPORTED EVENTS			

Table 7.11: LinkMeasurementsClass

Class **LinkMeasurements**			
This class contains current measurements related to this active connection.			
DERIVED FROM			
ATTRIBUTES			
receiveBLER	*Value type:* RxBLER	*Possible access:* Read-Write	*Default value:* Not specified
This attribute describes a value of BLER for received data.			
transmitPower	*Value type:* TxPower	*Possible access:* Read-Write	*Default value:* Not specified
This attribute describes a power of transmit signal.			
receiveSINR	*Value type:* RxSINR	*Possible access:* Read-Write	*Default value:* Not specified
This attribute describes a value of SINR for received data.			
transmittedBits	*Value type:* TxBits	*Possible access:* Read-Write	*Default value:* Not specified
This attribute describes transmitted bits.			
CONTAINED IN	**Link**		
CONTAINS			
SUPPORTED EVENTS			

Table 7.12: RFConfigurationClass

Class **RFConfiguration**	
This class contains information about the configuration of RF transceiver.	
DERIVED FROM	
ATTRIBUTES	
CONTAINED IN	**Link**
CONTAINS	**TxPath [0,1], RxPath [1]**
SUPPORTED EVENTS	

Table 7.13: TxPathClass

Class **TxPath**			
This class describes one transmit path.			
DERIVED FROM	DERIVED FROM		
ATTRIBUTES			
txStartTime	*Value type:* TxStartTime	*Possible access:* Read-Write	*Default value:* Not specified
This attribute defines the time when the transceiver start transmission.			
txStopTime	*Value type:* TxStopTime	*Possible access:* Read-Write	*Default value:* Not specified
This attribute defines the time when the transceiver stop transmission.			
CONTAINED IN	**RFConfiguration**		
CONTAINS			
SUPPORTED EVENTS			

Table 7.14: RxPathClass

Class **RxPath**			
This class describes one receive path.			
DERIVED FROM	DERIVED FROM		
ATTRIBUTES			
rxStartTime	*Value type:* RxStartTime	*Possible access:* Read-Write	*Default value:* Not specified
This attribute defines the time when the transceiver start reception.			
rxStopTime	*Value type:* RxStopTime	*Possible access:* Read-Write	*Default value:* Not specified
This attribute defines the time when the transceiver stop reception.			
CONTAINED IN	**RFConfiguration**		
CONTAINS			
SUPPORTED EVENTS			

Table 7.15: RCMeasurementsClass

Class **RCMeasurements**			
This class contains current measurements related to Reconfigurable Radio terminal.			
DERIVED FROM			
ATTRIBUTES			
listOfActiveMeasurements	*Value type:* ActiveMeasurementsList	*Possible access:* Read-Add-Remove	*Default value:* Not specified
This attribute describes a list of active measurements.			
CONTAINED IN	**RadioComputer**		
CONTAINS			
SUPPORTED EVENTS			

Table 7.16: RCProfile Class

Class **RCProfile**			
This class contains general information about the Radio Computer.			
DERIVED FROM			
ATTRIBUTES			
RCID	*Value type:* NameType	*Possible access:* Read	*Default value:* Not specified
This attribute describes ID of radio computer.			
CONTAINED IN	**RadioComputer**		
CONTAINS			
SUPPORTED EVENTS			

8 Interface Definition

8.1 Interface Overview

The RRFI is complementary to other RF Interfaces, such as DigRF [i.6] which defines the data flow (mechanisms) between Base Band and RF components. In this context, the RRFI Interface proposes additions to those existing interfaces. Those additions are in particular addressing software reconfiguration requirements, such as the appropriate selection of protection classes.

As illustrated in figure 8.1 for MDRC-1-7 (supporting RVM), the Base-Band Processing is comprised of:

i) a hard-wired (ASIC type) Base Band implementation; and

ii) a Radio Virtual Machine (RVM). The RRFI based message exchanges are triggered by a Radio Virtual Machine software component in order to handle software reconfiguration interactions with the RF Front-End/RF Transceiver chain.

As illustrated in figure 8.2 for MDRC-0 (not supporting RVM), no Radio Virtual Machine is present and thus no interaction with the RF Front-End on Software Reconfiguration related features is available.

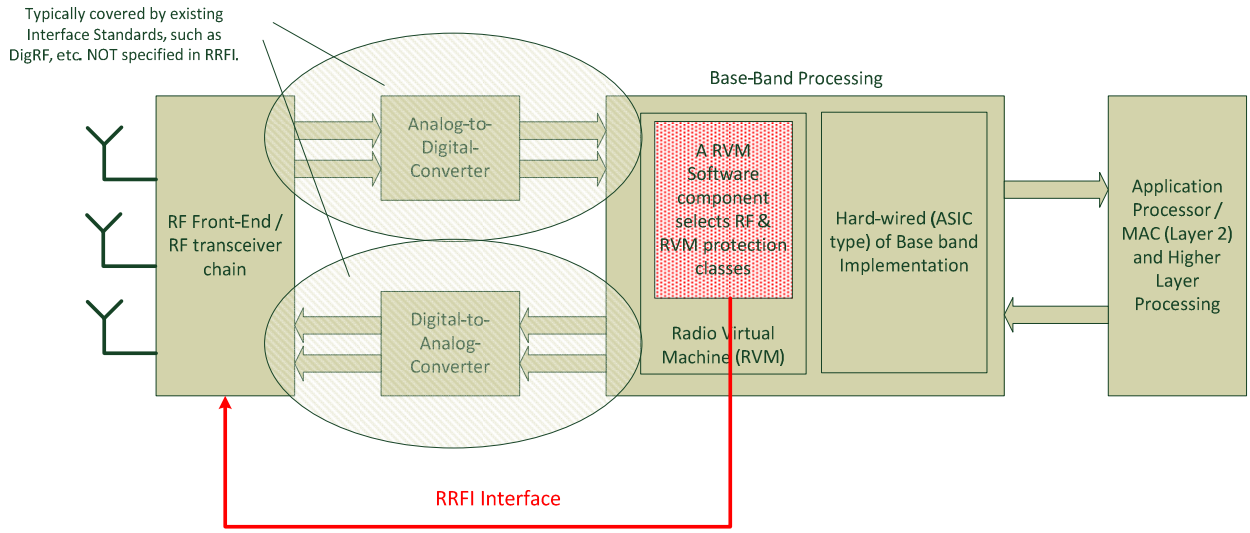

Figure 8.1: A typical radio equipment architecture for MDRC-1-7 (supporting RVM) comprising an RVM Software Component selecting RF and/or RVM protection class(es) and the RRFI

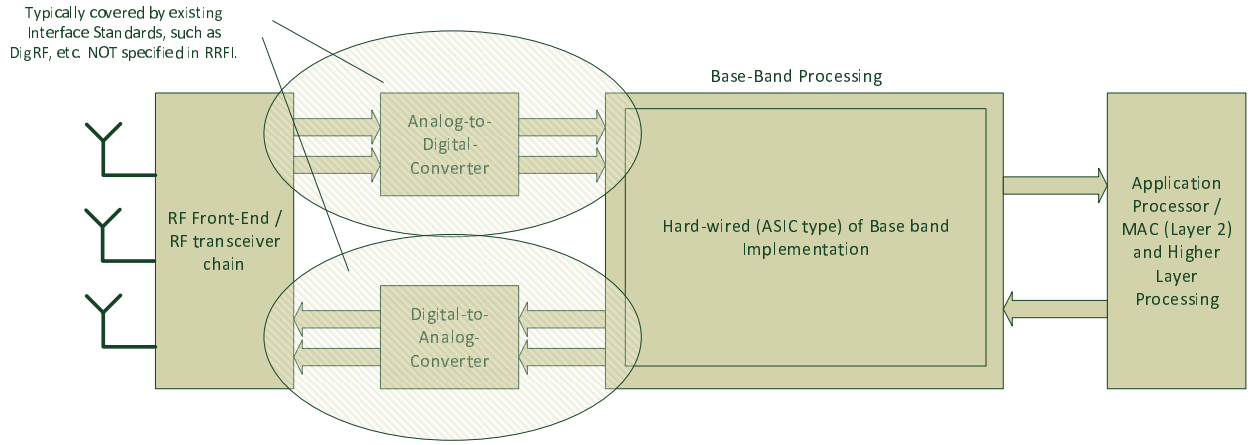

Figure 8.2: A typical radio equipment architecture for MDRC-0 (not supporting RVM)

Figure 8.3 shows the UML diagram for RRFI.

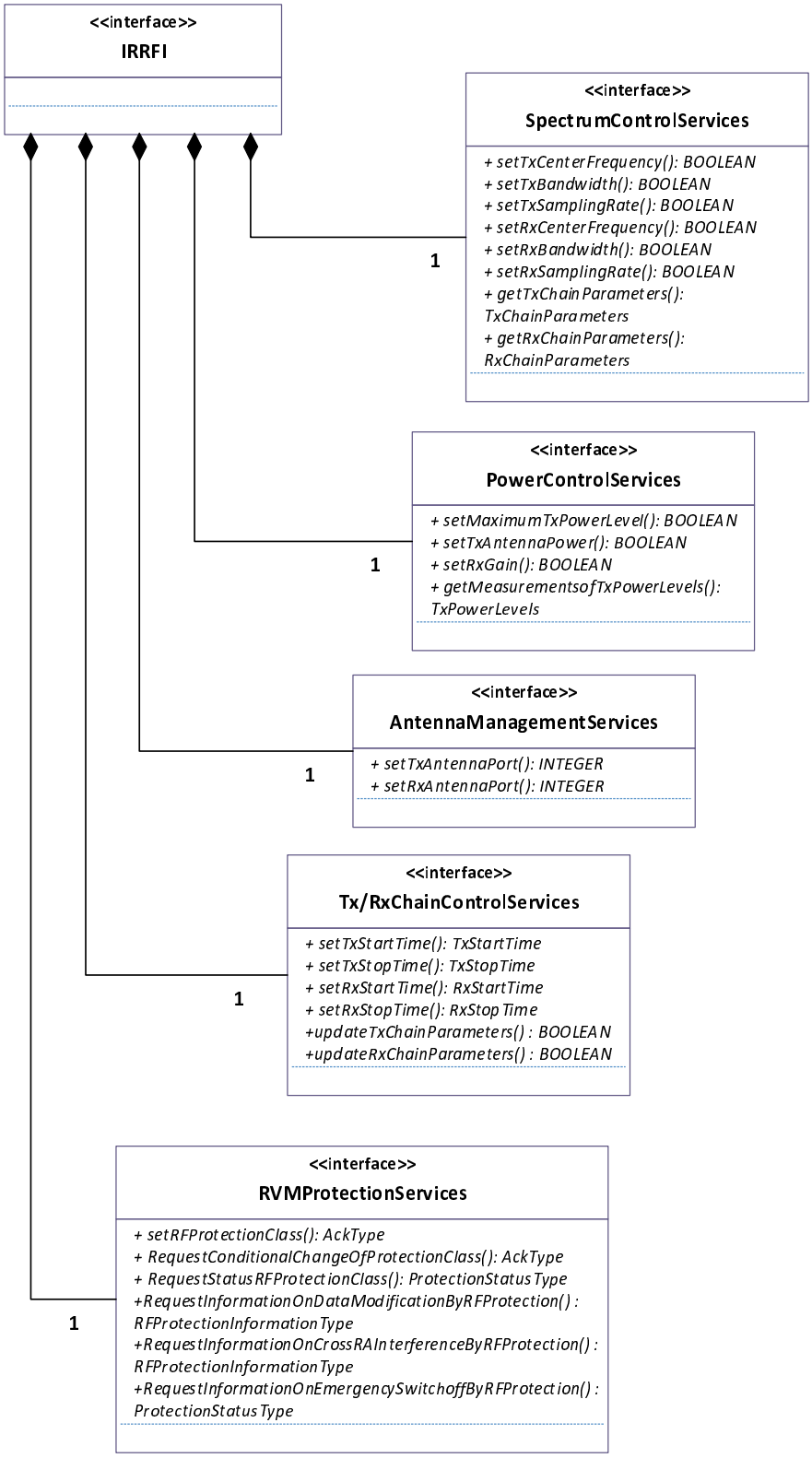

Figure 8.3: UML diagram for RRFI

The clauses 8.2 to 8.6 describe in detail the elements of the RRFI as shown in the UML diagram of figure 8.3.

8.2 Spectrum Control Services

8.2.1 Overview on Spectrum Control Services

Table 8.1 describes the services associated with the Spectrum Control. Class definition and related operations are described in clause 8.7.

Table 8.1: Overview on Spectrum Control Services

Spectrum Control Services	Explanation
Setting of Centre Frequency	Since the RF band to be used by a given RAT may have to be changed depending on user environments, the spectrum control service provides setting of the centre carrier frequency in the RF band of the given RAT.
Setting of Bandwidth	Since the RF band to be used by a given RAT may have to be changed depending on user environments, the spectrum control service provides setting of the bandwidth of the channel to be used by a given RAT. With this service, the bandwidth can adaptively be controlled depending on user environments.
Setting of Sampling Rate	Depending on a given RAT, spectrum control service provides setting of the sampling rate.
Request of Chain Parameters	Since not only URA but also the other components like MPM may request information about chain parameters such as centre frequency, bandwidth, sampling rate, etc. of a given RAT, spectrum control service provides those information.

8.2.2 Messages for Spectrum Control Services

The interfaces for Spectrum Control Services are used to transmit the following messages:

- From URA to RF transceiver:
  - Request of centre frequency set up.
  - Request of bandwidth set up.
  - Request of sampling rate set up.
  - Request of getting Tx chain parameters.
  - Request of getting Rx chain parameters.
- From RF transceiver to URA:
  - Confirmation of centre frequency set up.
  - Confirmation of bandwidth set up.
  - Confirmation of sampling rate set up.
  - Confirmation of getting Tx chain parameters.
  - Confirmation of getting Rx chain parameters.
  - Failure of centre frequency set up.
  - Failure of bandwidth set up.
  - Failure of sampling rate set up.
  - Failure of getting Tx chain parameters.
  - Failure of getting Rx chain parameters.

8.3 Power Control Services

8.3.1 Overview on Power Control Services

Table 8.2 describes the services associated with the Power Control. Class definition and related operations are described in clause 8.7.

Table 8.2: Overview on Power Control Services

Power Control Services	Explanation
Setting of Maximum Transmit Power	Since each RAT might be associated with its own maximum power level, power control service provides setting of the maximum transmit power for each URA. The maximum transmit power level might be dynamically controlled depending on user environments.
Setting of Antenna Power	Multiple antenna technologies such as Multiple Input Multiple Output (MIMO), Beamforming, etc. might require different transmit power at each antenna. Therefore, power control service provides setting of transmit power for each antenna. The algorithm of the antenna power allocation might be determined depending on the Radio Application code provided by 3rd party.
Setting of Rx Gain	Since the required power level of the RX signal might be different for each RAT, power control service provides setting of Rx gain in order to cope with the signal environment of too low or too high Rx signal power level.

8.3.2 Messages for Power Control Services

The interfaces for Power Control Services are used to transmit the following messages:

- From URA to RF transceiver:
  - Request of maximum power level set up for Tx chain.
  - Request of Tx power set up per Tx antenna.
  - Request of Rx gain set up for Rx chain.
- From RF transceiver to URA:
  - Confirmation of maximum power level set up for Tx chain.
  - Confirmation of Tx power set up per Tx antenna.
  - Confirmation of Rx gain set up for Rx chain.
  - Failure of maximum power level set up for Tx chain.
  - Failure of Tx power set up per Tx antenna.
  - Failure of Rx gain set up for Rx chain.

8.4 Antenna Management Services

8.4.1 Overview on Antenna Management Services

Table 8.3 describes the services associated with the Antenna Management. Class definition and related operations are described in clause 8.7.

Table 8.3: Overview on Antenna Management Services

Antenna Management Services	Explanation
Selection of Antenna Port	In the case of multiple antennas, each of which might be associated with a different Rx/Tx characteristics, any subset of the multiple antennas have to be available. Therefore, antenna management service provides selection of antenna ports for each URA. Depending on user environments, the same URA might use a different subset of antennas.

8.4.2 Messages for Antenna Management Services

The interfaces for Antenna Management Services are used to transmit the following messages:

- From URA to RF transceiver:
  - Request of Tx antenna port selection.
  - Request of Rx antenna port selection.
- From RF transceiver to URA:
  - Confirmation of Tx antenna port selection.
  - Confirmation of Rx antenna port selection.
  - Failure of Tx antenna port selection.
  - Failure of Rx antenna port selection.

8.5 Tx/Rx Chain Control Services

8.5.1 Overview on Tx/Rx Chain Control Services

Table 8.4 describes the services associated with the Chain Control. Class definition and related operations are described in clause 8.7.

Table 8.4: Overview on Tx/Rx Chain Control Services

Tx/Rx Chain Control Services	Explanation
Setting of start/stop Time for Transmission	Since Tx of data stream is active for a given duration, Tx/Rx chain control service provides setting of start/stop time of the corresponding Tx chain.
Setting of start/stop Time for Reception	Since Rx of data stream is active for a given duration, Tx/Rx chain control service provides setting of start/stop time of the corresponding Rx chain.
Request for Updating Chain Parameters	Considering a case that a specific set of parameters in the presently running URA might be changed, Tx/Rx chain control service provides request for real-time updating of chain parameters such as centre frequency, bandwidth, etc. of the presently running URA instead of resetting the current URA and setting up another URA.

8.5.2 Messages for Tx/Rx Chain Control Services

The interfaces for Tx/Rx Chain Control Services are used to transmit the following messages:

- From URA to RF transceiver:
  - Request of Tx start time set up.
  - Request of Tx stop time set up.
  - Request of Rx start time set up.

- Request of Rx stop time set up.
- Request of Tx/Rx chain parameter(s) update.

- From RF transceiver to URA:
  - Confirmation of Tx start time set up.
  - Confirmation of Tx stop time set up.
  - Confirmation of Rx start time set up.
  - Confirmation of Rx stop time set up.
  - Confirmation of Tx/Rx chain parameter(s) update.
  - Failure of Tx start time set up.
  - Failure of Tx stop time set up.
  - Failure of Rx start time set up.
  - Failure of Rx stop time set up.
  - Failure of Tx/Rx chain parameter(s) update.

8.6 RVM Protection Services

8.6.1 Overview on RVM Protection Services

Table 8.5 describes the services associated with the Radio Virtual Machine protection. Class definition and related operations are described in clause 8.7.

Table 8.5: Overview on RVM Protection Services

RVM Protection Services	Explanation
Selection of RF Protection Class	In the context of software reconfiguration, the RF front-end typically allows the selection of RF protection classes. The suitable protection class is typically provided with the software component and influences the level of required re-certification (leading to the final declaration of conformity within the EU context) of the concerned Mobile Device. The selection request for a specific RF Protection class is typically followed by an acknowledgement message (ACK) issued by the RF Front-End in case of successful operation, in case of unsuccessful operation a NACK (not acknowledgement) message is issued. In case that the RF front-end is not providing support for a specific requested protection class then the next higher protection class is selected which comprises the requested protection features plus possibly further ones. This is followed by the issuance of an ACKM (acknowledgement with Modification) message. Possibly, details on the modified protection class selection are given (possibly this information is provided on request). If the request for a protection class specifically indicates that no higher class may be selected (the more restrictive protection mechanisms may prevent the software components from operating correctly), then the next lower class is selected in case that the specific requested protection class is not available. This, however, possibly requires a more detailed re-certification process since the lower protection class may lead to a less protected front-end and thus poses a higher risk to other users.
Request of RF Protection Class status	Other components (in particular Base Band and/or Application Processor components) may request information on the RF protection class status. Then, the RF front-end provides information on which protection class mechanisms are activates, e.g. additional filters for limiting OOB emissions and/or spurious emissions, limitation of maximum output power levels, etc.

RVM Protection Services	Explanation
Request for (temporary/conditional) change of RF Protection Classes (including(de-)activation of RF Protection)	RF Protection may be changed depending on the currently active Radio Access Technologies, e.g. when hard-wired WiFi is used then no RF Protection Classes are required and they are deactivated. On the other hand, when a reconfigurable RAT is used, then a specific RF protection class is required (for example in order to reduce the required level of re-certification. The change of the protection class can occur based on a specific external trigger to the RF front-end or it can be automated, i.e. the RF-front end is programmed such that RF protection classes are (re-)configured as required, typically depending the input waveform/RAT data.
RF Front-end indication of modification of input data signals	In case that the RF Front-End protection mechanisms (selected by one of the upper processes) need to alter the request for data transmission (e.g. reduction of output power levels, cutting of out-band signal components, etc.), this message is providing a corresponding information to the outputs of the RF Front-End. It is typically processed by the Base Band and/or Application Processors.
RF Front-end emergency switch off	In case that the RF Front-End protection mechanisms detect massive violations of the emission limitations (e.g. massive OOB/spurious emissions, etc.) then the RF Front-End may decide to switch off the concerned transmission (while other (simultaneous) transmissions may still continue to operate in case they meet the limitations).
Information on Cross-RAT Interference	When multiple RATs are transmitted (received) simultaneously, it is possibly that the various RATs interfere with each other. If such a case is detected in the RF front-end, the RF front-end is providing corresponding information via the RRFI.

8.6.2 Messages for RVM Protection Services

The interfaces for RVM Protection Services are used to transmit the following messages:

- From URA to RF transceiver:
  - Request of RF protection class selection.
  - Request of change of RF protection class.
  - Request of RF protection class Status.
  - Request of information on data modification by RF protection.
  - Request of information on cross RAT interference by RF protection.
  - Request of emergency switch off of RF front-end.
- From RF transceiver to URA:
  - Confirmation of RF protection class selection.
  - Confirmation of change of RF protection class.
  - Confirmation of emergency switch off of RF front-end.
  - Failure of RF protection class selection.
  - Failure of change of RF protection class.
  - RF protection class Status.
  - Information on data modification by RF protection.
  - Information on cross RAT interference by RF protection.

8.7 Class Definitions for Interface

Each interface class related to RRFI can be defined using the template presented in clause 6.2 and in accordance with the UML diagram of figure 8.3 which specifies the interface classes related to RRFI. Tables 8.6 to 8.10 specify all the operations related to the five interface classes above described.

Table 8.6: SpectrumControlServices Class

Class **SpectrumControlServices**		
This class describes interfaces supporting Spectrum Control Services.		
OPERATIONS		
setTxCenterFrequency	*Return type:* BOOLEAN	*Value type:* public
This operation is needed for setting centre frequency of Tx chain.		
setTxBandwidth	*Return type:* BOOLEAN	*Value type:* public
This operation is needed for setting bandwidth of Tx chain.		
setTxSamplingRate	*Return type:* BOOLEAN	*Value type:* public
This operation is needed for setting sampling rate of Tx chain.		
setRxCenterFrequency	*Return type:* BOOLEAN	*Value type:* public
This operation is needed for setting centre frequency of Rx chain.		
setRxBandwidth	*Return type:* BOOLEAN	*Value type:* public
This operation is needed for setting bandwidth of Rx chain.		
setRxSamplingRate	*Return type:* BOOLEAN	*Value type:* public
This operation is needed for setting sampling rate of Rx chain.		
getTxChainParameters	*Return type:* TxChainParameters	*Value type:* public
This operation is needed for getting parameters of Tx chain.		
getRxChainParameters	*Return type:* RxChainParameters	*Value type:* public
This operation is needed for getting parameters of Rx chain.		

Table 8.7: PowerControlServices Class

Class **PowerControlServices**		
This class describes interfaces supporting Power Control Services.		
OPERATIONS		
setMaximumTxPowerLevel	*Return type:* BOOLEAN	*Value type:* public
This operation is needed for setting maximum power level of Tx chain.		
setTxAntennaPower	*Return type:* BOOLEAN	*Value type:* public
This operation is needed for setting antenna power of Tx chain.		
setRxGain	*Return type:* BOOLEAN	*Value type:* public
This operation is needed for setting antenna gain of Rx chain.		

Table 8.8: AntennaManagementServices Class

Class **AntennaManagementServices**		
This class describes interfaces supporting Antenna Management Services.		
OPERATIONS		
setTxAntennaPort	*Return type:* INTEGER	*Value type:* public
This operation is needed for setting antenna port of Tx chain.		
setRxAntennaPort	*Return type:* INTEGER	*Value type:* public
This operation is needed for setting antenna port of Rx chain.		

Table 8.9: Tx/RxChainControlServices Class

Class **Tx/RxChainControlServices**		
This class describes interfaces supporting Tx/Rx Chain Control Services.		
OPERATIONS		
setTxStartTime	*Return type:* TxStartTime	*Value type:* public
This operation is needed for setting start time of Tx chain.		
setTxStopTime	*Return type:* TxStopTime	*Value type:* public
This operation is needed for setting stop time of Tx chain.		
setRxStartTime	*Return type:* RxStartTime	*Value type:* public
This operation is needed for setting start time of Rx chain.		
setRxStoptime	*Return type:* RxStopTime	*Value type:* public
This operation is needed for setting stop time of Rx chain.		
updateTxChainParameters	*Return type:* BOOLEAN	*Value type:* public
This operation is needed for updating parameters of Tx chain.		
updateRxChainParameters	*Return type:* BOOLEAN	*Value type:* public
This operation is needed for updating parameters of Rx chain.		

Table 8.10: RVMProtectionServices Class

Class **RVMProtectionServices**		
This class describes interfaces supporting RF Protection Classes and related other components requesting RF protection related information.		
OPERATIONS		
SelectRFProtectionClass	*Return type:* AckType (typically ACK, NACK, ACKM)	*Value type:* public
This operation is related to the selection of an RF Protection Class.		
RequestConditionalChangeOfProtectionClass	*Return type:* AckType (typically ACK, NACK, ACKM)	*Value type:* public
This operation is related to the (temporary/conditional) change of an RF Protection Class.		
RequestStatusRFProtectionClass	*Return type:* ProtectionStatusType	*Value type:* public
This operation is related to requesting/delivering information on the current status RF Protection Class (i.e. which protection mechanisms are currently activated for which configuration (e.g. for which RAT type, etc.).		
RequestInformationOnDataModificationByRFProtection	*Return type:* RFProtectionInformationType	*Value type:* public
This operation is related to requesting/delivering information on how a RF Protection Class has modified incoming data prior to transmission in order to meet protection requirements.		
RequestInformationOnCrossRATInterferenceByRFProtection	*Return type:* RFProtectionInformationType	*Value type:* public
This operation is related to requesting/delivering information on how (how much) there is interference among (simultaneously transmitted/received) RATs due to operations of the currently active RF Protection Class.		
ProvideInformationOnEmergencySwitchoffByRFProtection	*Return type:* ProtectionStatusType	*Value type:* public
This operation is related to requesting/delivering information on an eventual emergency switch off of the RF Front-End due to massive violation of protection requirements.		

Annex A (informative): Abstract Data Definitions

The following ASN.1 [i.7] module contains all necessary abstract data definitions used in the attribute definitions in clause 7.2 and clause 8.5.

```
ETSI-TS-103-146-2-Type-Definitions DEFINITIONS ::= BEGIN
            ----------------------------------------------------------------
            ----------------------------------------------------------------
            -- START Common Data Types

            ----------------------------------------------------------------
            -- START Name Related Data Types

            NameType    ::= CHOICE      {
                    number      INTEGER,
                    string      PrintableString
            }

            ObjectName      ::= SEQUENCE OF NameType


            OptionalObjectName      ::= CHOICE  {
                id          ObjectName,
                void        NULL
                }

            ObjectNameList  ::= SEQUENCE OF ObjectName


            -- END Name Related Data Types
            ----------------------------------------------------------------

            ----------------------------------------------------------------
            -- START Version Related Data Types

            Version     ::= CHOICE  {
                intVersion          INTEGER,
                stringVersion       PrintableString
            }

            -- END Version Related Data Types
            ----------------------------------------------------------------

            -- END Common Data Types
            ----------------------------------------------------------------
            ----------------------------------------------------------------


            ----------------------------------------------------------------
            ----------------------------------------------------------------
            -- START Radio Computer Related Data Types

            RadioApplicationIDList      ::= SEQUENCE OF OptionalObjectName


            RCOptionID      ::= ENUMERATED      {
                mdrc-0, mdrc-1, mdrc-2, maximumTxPower, ...
            }

            RCOptionsList       ::= SEQUENCE OF SEQUENCE        {
                rCOptionName        RCOptionID,
                rCOptionValue       ANY
            }


            RadioInterfaceID        ::= ENUMERATED      {
                umts, hsdpa, wimax, lte, wifi, gsm, ...
            }

            RadioInterface      ::= CHOICE  {
                id          RadioInterfaceID,
                void        NULL
            }
```

```
RadioInterfacesList     ::= SEQUENCE OF RadioInterfaceID


ChannelIDsList      ::= SEQUENCE OF OptionalObjectName


HardwareInfo        ::= ENUMERATED      {
    fixedPipeline, programmablePipeline, hybridPipeline, ...
}

SoftwareInfo        ::= ENUMERATED      {
    rOSVersion, compiler, ...
}


Direction       ::= ENUMERATED      {
    downlink, uplink
}


RxBLER      ::= SEQUENCE    {
    accBLER     REAL,
    period      REAL OPTIONAL,
    instBLER    REAL OPTIONAL
}


TxPower     ::=     SEQUENCE    {
    power       REAL,
    unit        CHARACTER
}


RxSINR      ::= SEQUENCE    {
    accSINR     REAL,
    period      REAL OPTIONAL,
    instSINR    REAL OPTIONAL
}


TxBits      ::= SEQUENCE    {
    transmittedBit      REAL,
    unit                CHARACTER
}


ActiveMeasurementID ::= ENUMERATED      {
    transmitPower, transportLoad, processingLoad, ...
}

ActiveMeasurementIDs        ::= SEQUENCE OF {
    activeMeasurementID
}

ActiveMeasurementsList      ::=     SEQUENCE OF SEQUENCE    {
    activeMeasurementName       ActiveMeasurementID,
    activeMeasurementValue      ANY
}


FrequencyRange      ::= SEQUENCE    {
    centralFrequency    REAL,
    frequencyBand       REAL
}

AnaloguePower       ::=     SEQUENCE    {
    power       REAL,
    unit        CHARACTER
}

SamplingRate        ::=     SEQUENCE    {
    samplingRate        REAL,
    unit        CHARACTER
}

Bandwidth       ::=     SEQUENCE    {
    bandWidth       REAL,
    unit        CHARACTERs
```

```
}

TxStartTime         ::=         CHOICE  {
    absoluteTime    GeneralizedTime,
    relativeTime    INTEGER
}

TxStopTime          ::=         CHOICE  {
    Undefined       NULL,
    absoluteTime    GeneralizedTime,
    relativeTime    INTEGER
}


RxStartTime         ::=         CHOICE  {
    absoluteTime    GeneralizedTime,
    relativeTime    INTEGER
}


RxStopTime          ::=         CHOICE  {
    Undefined       NULL,
    absoluteTime    GeneralizedTime,
    relativeTime    INTEGER
}


ChannelMeasurementID        ::= ENUMERATED  {
    channelInterference, channelLoad, ...
}

ChannelMeasurementsList     ::= SEQUENCE OF SEQUENCE    {
    channelMeasurementName      ChannelMeasurementID,
    channelMeasurementValue     ANY
}
ConfigurationMeasurements::=    ENUMERATED  {
    antennaProt, RFfrontend, ...
}


-- END Radio Computer Related Data Types
--------------------------------------------------------------------
--------------------------------------------------------------------


--------------------------------------------------------------------
--------------------------------------------------------------------
-- START Reconfigurable Radio Frequency Interface Related Data Types

ChainParameterID    ::= ENUMERATED {
    A, b, c, ...
}

TxChainParameters       ::= SEQUENCE OF SEQUENCE    {
    txChainParameterName    ChainParameterID,
    txChainParameterValue   ANY
}

RxChainParameters       ::= SEQUENCE OF SEQUENCE    {
    rxChainParameterName    ChainParameterID,
    rxChainParameterValue   ANY
}
AckType     ::= ENUMERATED      {
    ACK, NACK, ACKM
}
ProtectionStatusType    ::= ENUMERATED      {
    protection mechanisms, configuration, ...
}
RFProtectionInformationType ::= ENUMERATED      {
    Modifieddata, interface-among-RATs, ...
}



-- END Reconfigurable Radio Frequency Interface Related Data Types
--------------------------------------------------------------------
--------------------------------------------------------------------
```

Annex B (informative): RRFI Qualification Methods for Validation

The RRFI requirements are basis for qualification methods to validate that the requirements can be met. A feature list exposing RRFI capabilities is created. Qualification methods correspond to the feature list and they qualify features of a particular RRFI implementation against the feature list.

The following qualification methods might be typically applied:

- Demonstration - The operation of interfacing entities that rely on observable functional operation.
- Test - The operation of interfacing entities using specialist test equipment to collect data for analysis.
- Analysis - The processing of data obtained from methods, such as reduction, interpretation, or extrapolation of test results.
- Inspection - The visual examination of interfacing entities, documentation, etc.
- Special qualification methods - Methods for the interfacing entities, such as specialist tools, techniques, procedures, facilities, etc.

History

Document history		
V1.1.1	May 2015	Publication as ETSI TS 103 146-2
V1.1.5	March 2016	EN Approval Procedure AP 20160530: 2016-03-01 to 2016-05-30
V1.2.1	June 2016	Publication