

Technical Committee

mioty® Generic Sensor End to End profiles V1.0.0

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mioty alliance e.V.

Frauenweiherstr. 15
91058 Erlangen
Germany

Registered association listed at
Amtsgericht Nürnberg: VR 202493
Germany

mioty® Generic Sensor End to End profiles

This document is authored by the technical committee of the mioty alliance and prepared by the task force “New Frequency Bands”.

Technical Committee Chair: Josef Bernhard

Task Force “E2E” Chair: Thomas Kauppert

Editor: Benoit Ponsard

Contributors (in alphabetical order): Josef Bernhard, Thomas C. Blank, Thomas W. Blank, Stefan Ereth, Thomas Kauppert, Gerd Kilian, Béla Márkus, Benoit Ponsard, Achim Rech, Markus Völker

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1 Introduction

1.1 Scope of the document

The present document specifies profiles for end-to-end (E2E) solutions connecting a generic sensor to an external server over a mioty® radio network. At time of issuing, the notion of generic sensor includes three E2E solutions:

- the basic sensor E2E solution (a.k.a. blueprint sensor), where the sensor behaviour is ruled by the mioty® application specifications (see ref. [4]),
- the IO-Link E2E solution, where sensor behaviour is ruled by the IO-Link over mioty specifications (see ref. [9]),
- the mioty4OMS E2E solution, where sensor is an OMS end device with a mioty radio interface (see ref. [8], [11], and [12]).

As such, the present document is a superset specification, that encompasses three levels of already existing technical specifications (see Figure 1-1). In this superset, each sub-section, addressing a given use case, contains the minimum requirements, to get operational interoperability between all elements of the communication chain for this E2E solution.

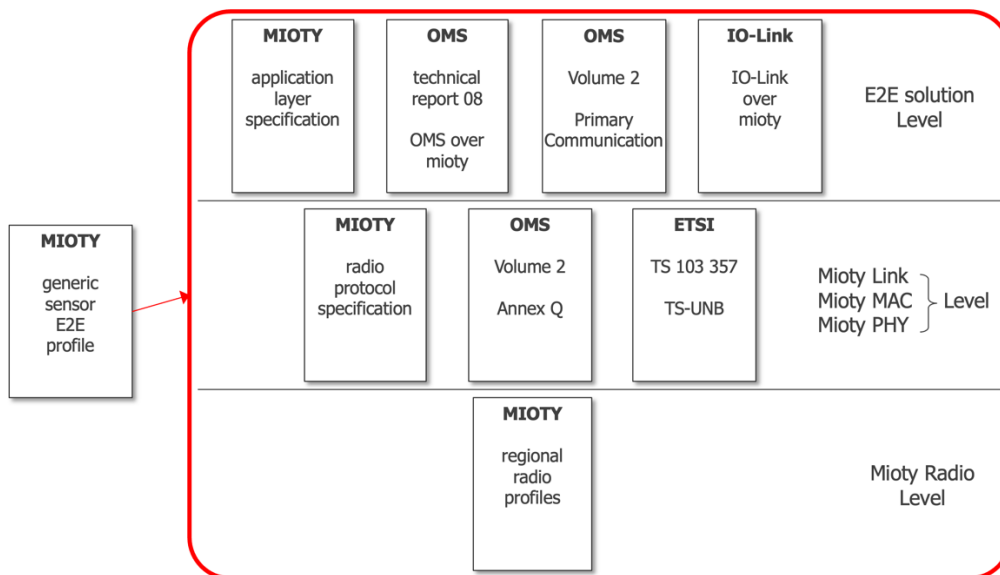


Figure 1-1: A three-level superset of specifications

1.2 Document structure

The present document is organised, as follows:

- Section 2 is about conventions used in the present document, including the E2E reference model,
- Section 3 specifies the basic sensor (i.e. the blue-print sensor) E2E solution,
- Section 4 specifies the IO-Link sensor E2E solution,
- Section 5 specifies the mioty4OMS E2E solution, with two sub-profiles: the OMS LPWAN Splitting Mode, and the OMS over mioty mode.

NOTE: the present specifications refer to the first release of the ETSI specifications [1]. New TS-UNB functionalities such as higher symbol rates, DLB/DLC transmission modes, and timing flexibility, that are in the second release of ETSI specifications [10], are referenced here as OMS features.

2 Conventions

2.1 E2E reference model

In all E2E solutions, the communication chain is built with functional blocks, organised according to an E2E reference model (see Figure 2-1).



Figure 2-1: E2E solution reference model

The E2E reference model contains functional blocks, as follows:

- end-point: all functions and parameters of the generic sensor that are directly related to the mioty® communication protocol (radio, PHY, MAC, and Link levels), or that specify the sensor behaviour at solution level,
- base station: the counter part of the end-point for the mioty® radio-communication,
- Service Centre (SC): all central functions and parameters that are directly related to the mioty® communication protocol (radio, PHY, MAC, and Link levels), and the corresponding network management functions,
- Application Centre (AC): functions and parameters that tailor a mioty® radio-communication infrastructure to a specific solution,
- External Server: a third-party server, external to the mioty® communication infrastructure, that processes data at E2E solution level.

In the E2E reference model, the service centre functional block and the application centre functional block are hosted in a single entity, named service centre/application centre (SC/AC) (see Figure 2-2). It is also possible to have them hosted in two separate entities (see Figure 2-3). In this case, the communication link between the SC functional block and the AC functional block shall implement the SCACI protocol [6].



Figure 2-2: Service centre and application centre implemented in one entity



Figure 2-3: Service centre and application centre implemented in separated entities

2.2 Requirements on functionalities and/or parameter values

The present specifications put requirements on functionalities and/or parameters values to achieve operational interoperability between blocks of an end-to-end solution. When listed in tables, these requirements are stated in a “support” column, that shall be understood as follows:

- mandatory: the generic sensor specifications contain a requirement on the functionality availability in the device or on a specific value for this functionality. This requirement is checked with a dedicated test in the generic sensor approval process,
- conditional: the functionality is mandatory (see above) only when the corresponding functionality (detailed in the table) is implemented. Otherwise, the functionality is optional (see below),
- optional: the functionality is not tested in the generic sensor approval process,
- not allowed: the generic sensor specifications contain a requirement that this functionality shall not be used. The fulfillment of this requirement is under the manufacturer’s declaration.

2.3 Acronyms

AC	Application Centre
BS	Base Station
BSSCI	Base Station to Service Centre Interface
DL	Down-Link
DLA	end-point triggered downlink transmission mode (class A)
DLB	scheduled downlink transmission mode (class B)
DLC	event triggered downlink transmission mode (class C)
DLRX	Downlink Receive (status)
E2E	End to End
EP	End-Point
ETSI	European Telecommunications Standards Institute
LPWAN	Low Power Wide Area Network
MAC	Medium Access Control (i.e. a protocol level)
MPF	MAC Payload Format
N/A	Not Applicable
OLSM	OMS LPWAN Splitting Mode
OMS	Open Metering System
OOM	OMS over mioty
OTA	Over The Air
PHY	PHYSical (i.e. a protocol level)
RRP	Regional Radio Profile
SBR	Single Burst Rate (i.e. a symbol rate)
SC	Service Centre
SCACI	Service Centre to Application Centre Interface
TSMA	Telegram Splitting Multiple Access
TS-UNB	Telegram Splitting Ultra Narrow Band
UL	Up-Link
ULP	Ultra Low Power (i.e. a symbol rate)
UPG3	Uplink (TSMA) Pattern Group 3

2.4 Verbal forms for the expression of provisions

In the present specifications, the verbal forms “SHALL”, “SHALL NOT”, “SHOULD”, “SHOULD NOT”, “MAY”, “NEED NOT”, “WILL”, “WILL NOT”, “CAN” and “CAN NOT” are to be interpreted as in ref. [3].

3 The basic sensor end-to-end solution

3.1 Foreword

The basic sensor E2E solution, also known as “blueprint sensor” E2E solution, assumes that:

- end-points are unidirectional by default: they are one-way devices, transmitting in uplink only (i.e. with no receiving capability),
- all other functional blocks of the mioty communication chain (i.e. base station, service centre and application centre) are bidirectional by default: they implement both uplink and downlink communication.

Bidirectional end-points that may exist in basic sensor E2E solution, implement specific functionalities, that are indicated hereunder as “class A”.

Unidirectional base stations, that might be produced and deployed in the field, are not covered by the present specifications of basic sensor E2E solution.

3.2 End-point requirements

In a basic sensor E2E solution, the end-point functional block shall implement an air interface compliant with the following specifications:

- at solution level: the mioty® application layer specifications [4],
- at PHY, MAC, and Link levels: the TS-UNB protocol specified in ETSI specifications [1], and the mioty® radio protocol specifications [2],
- at radio level: at least, one of the profiles specified in the mioty® regional radio profiles [7].

Table 3-1, Table 3-2, Table 3-3, and Table 3-4 summarize implementation and use of key functionalities of the end-point air interface, in case of basic sensor E2E solution.

Table 3-1: Solution level key functionalities for EP

Functionality	Support	Comment
Blueprint compliant format	mandatory	See ref. [4]
Application level cryptography	optional	See ref. [4]

Table 3-2: Link level key functionalities for EP

Functionality (control segment)	Direction	Support in class Z EPs	Support in class A EPs	Comment
Attach Request (*)	UL	N/A	optional	Unidirectional EPs use pre-attachment

Attach Request IPv6	UL	N/A	optional	
Attach Accept (*)	DL	N/A	conditional	(**) in response to Attach Request
Detach Request (*)	UL	N/A	optional	EP-triggered detach
Detach Accept (*)	DL	N/A	conditional	(**) in response to Detach Request UL
Detach Request (*)	DL	N/A	conditional	BS-triggered detach
Detach Accept (*)	UL	N/A	conditional	(**) in response to Detach Request DL
DLRX-Status Query	DL	N/A	optional	
DLRX-Status Response	UL	N/A	conditional	(**) in response to DLRX Status Query
Link Adaptation Request	DL	N/A	optional	
Link Adaptation Confirm	UL	N/A	conditional	(**) in response to Link Adaptation Request
User specific control segments	UL	optional	optional	
User specific control segments	DL	N/A	optional	
(*) : If over-the-air attachment procedure is used, all these control segments shall be implemented. (**): mandatory when corresponding request is implemented.				

Table 3-3: MAC level key functionalities for EP

Functionality	Support	Comment
Fixed MAC Mode	mandatory	
Variable MAC Mode	not allowed	variable MAC mode is not used by basic sensors
Uplink MPF Flag (in MAC header)	0 or 1	0: MPF field not transmitted in UL (*) 1: MPF field present
Downlink MPF Flag (in MAC header)	0 or 1	0: MPF field not transmitted in DL (*) 1: MPF field present
MPF field (in UL and DL)	conditional (values as per table 6-17 in [1])	Condition on MPF Flag=1 Only custom values (0xC0 to 0xFF) are possible for basic sensor

Response Flag (in DL MAC header)	mandatory for class A EPs	flag set by BS, when an UL response is expected after the DL message
Response Priority Flag (in downlink MAC header)	mandatory for class A EPs	flag set by BS, when UL response is expected within priority time window
Short address	optional	
(*): a not-transmitted MPF field (i.e. MPF flag=0) is assumed to be 0x00 by the receiving party		

Table 3-4: PHY level key functionalities for EP

Functionality	Support	Comment
Transmission mode in UL	mandatory	
Transmission mode in DL	mandatory for class A EPs	N/A in Class Z end-points
Symbol rate in UL	ULP mandatory	ER symbol rate not used by basic sensor
Modulation in UL	GMSK with BT=1 mandatory	MSK in UL not allowed in basic sensor
Modulation in DL (implemented in BS)	MSK mandatory	N/A for Class Z end-points
Symbol rate in DL	ULP mandatory	SBR symbol rate not allowed in basic sensor
ΔT_{TSI} in DLA transmission	512 symbols mandatory	Other values are optional
ΔT_{DN} in DLA transmission	512 symbols mandatory	Other values are optional
ΔT_{UD}	16 384 symbols mandatory	N/A for Class Z end-points
Low latency in UL	UPG3 optional	Off by default in ref. [2]
Sync Burst	mandatory when in RRP	See ref. [7]
Repetition in UL	not allowed	

3.3 Base station requirements

In a basic sensor E2E solution, the base station shall implement an air interface compliant with the following specifications:

- at PHY, MAC, and Link levels: the TS-UNB protocol specified in ETSI specifications [1], and in the mioty® radio protocol specifications [2],
- at radio level: at least, one of the profiles specified in the mioty® regional radio profiles [7].

In a basic sensor E2E solution, the base station interface to the SC functional block shall be compliant with the BSSCI specifications [5].

Table 3-5, Table 3-6, and Table 3-7 summarize implementation and use of key functionalities of the base station air interface, in case of basic sensor E2E solution.

Table 3-5: Link level key functionalities for BS

Functionality (control segment)	Direction	Support	Comment
Attach Request	UL	mandatory	Handled by Base Station in conjunction with Service Centre
Attach Request IPv6	UL	optional	
Attach Accept	DL	mandatory	
Detach Request	UL	mandatory	
Detach Accept	DL	mandatory	
Detach Request	DL	mandatory	
Detach Accept	UL	mandatory	
DLRX-Status Query	DL	N/A	Transparently forwarded by Base Station to Service Centre
DLRX-Status Response	UL	N/A	
Link Adaptation Request	DL	N/A	
Link Adaptation Confirm	UL	N/A	
User specific control segments	UL	N/A	
User specific control segments (DL)	DL	N/A	

Table 3-6: MAC level key functionalities for BS

Functionality	Support	Comment
Fixed MAC Mode	mandatory	Use depends on EP choice
Variable MAC Mode	optional	Variable MAC mode is not used in basic sensor solution
Uplink MPF Flag (in MAC header)	0 or 1	0: MPF field not transmitted in UL (*) 1: MPF field present
Downlink MPF Flag (in MAC header)	0 or 1	0: MPF field not transmitted in DL (*) 1/ MPF field present
MPF field (in UL and DL)	conditional (as per table 6-17 in [1])	Condition is on MPF Flag=1 Only custom values (0xC0 to 0xFF) are possible for basic sensor
Response Flag (in downlink MAC header)	mandatory	Flag set when an UL response is expected after the DL message
Response Priority Flag (in downlink MAC header)	mandatory	Flag set when UL response is expected within priority time window

Short address	conditional	Condition is on Addressing Mode=0 in UL MAC header format.
(*): when MPF flag is 0, MPF field is not transmitted, and assumed to be 0x00 by the receiving end		

Table 3-7: PHY level key functionalities for BS

Functionality	Support	Comment
Transmission mode in UL	mandatory	
Transmission mode in DL	mandatory	
Symbol rate in UL	ULP mandatory	ER symbol rate not used by basic sensor
Modulation in UL	GMSK with BT=1 mandatory	Only GMSK is allowed in UL for basic sensor
Modulation in DL	MSK mandatory	Only MSK is allowed in DL for basic sensor
Symbol rate in DL	ULP mandatory	SBR symbol rate not allowed in basic sensor
ΔT_{TSI} in DLA transmission	512 symbols mandatory	Other values are optional
ΔT_{DN} in DLA transmission	512 symbols mandatory	Other values are optional
ΔT_{UD}	16 384 symbols mandatory	Class A end-points
Low latency in UL	UPG3 mandatory	
Sync Burst	mandatory when in RRP	See ref. [7]
Repetition in UL	optional	

3.4 Service Centre requirements

In a basic sensor E2E solution, the service centre functional block shall:

- implement an interface with one or several base stations, as specified in the BSSCI specifications [5],
- support network-level cryptographic functions, as specified in ETSI specifications [1],
- support pre-registration of uplink-only basic sensors (class Z end-points),
- support over-the-air (OTA) registration for bidirectional basic sensor (class A end-points).

The service centre functional block may implement functionalities such as a human-machine interface, a network manager, or an end-point manager; their specifications are not in the scope of the present document.

3.5 Application Centre requirements

In a basic sensor E2E solution, the application centre functional block shall implement:

- a blueprint converter, compliant with mioty® application layer specifications [4],
- an application layer cryptography compliant with mioty® application layer specifications [4].

In a basic sensor E2E solution, the application centre functional block shall implement an IP-based interface to one or several external servers. The communication protocol over this IP-based interface may run various protocols, which specification is out-of-scope of the present document.

4 The IO-Link E2E solution

This section on IO-Link end-to-end solution is reserved for a future revision of the present specification.

5 The mioty4OMS end-to-end solution

5.1 Overview

The mioty4OMS end-to-end solution covers two sub-profiles as shown in Figure 5-1.

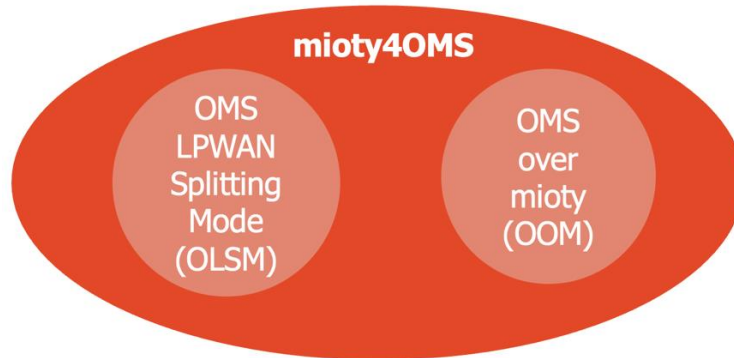


Figure 5-1: mioty4OMS sub-profiles

A mioty4OMS end-point shall support one of these two sub-profiles. All other components of the end-to-end solution shall support the requirements for both sub-profiles.

5.2 End-point requirements

5.2.1 OMS LPWAN Splitting Mode

An OMS LPWAN Splitting Mode (OLSM) end-point shall implement an air interface compliant with the following specifications:

- at solution level: the OMS primary specification [11],
- at PHY, MAC, and Link levels: the OMS LPWAN specification, Annex Q [12],
- at radio level: the mioty® regional radio profiles [7].

Table 5-1, Table 5-2, Table 5-3, and

Table 5-4 summarize implementation and use of key functionalities of the end-point in case of an OMS LPWAN Splitting Mode sub-profile.

Table 5-1: Solution level key functionalities for OLSM end-points

Functionality	Support	Comment
Installation/Deinstallation procedure	optional	According to ref. [11], clause 4.3.2.4
Solution level cryptography	mandatory	According to ref. [11], clause 9 and 9.3
OMS application coding	mandatory	According to ref. [11], clause 8.4.4
OMS application security	optional	According to ref. [11], clause 9.4

Table 5-2: Link level key functionalities for OLSM end-points

Functionality	Support	Comment
Logical Link Control layer	mandatory	According to ref. [12], clause Q.4

Table 5-3: MAC level key functionalities for OLSM end-points

Functionality	Support	Comment
Variable MAC Mode	mandatory	According to ref. [12], clause Q.2.5.4.1.6
MAC Type	mandatory	According to ref. [12], clause Q.2.5.4.3
MAC Layer	mandatory	According to ref. [12], clause Q.3
MAC Security	conditional	Mandatory when MAC services are provided (see ref. [12], clause Q.3.4)
MAC Services	optional	According to ref. [12], clause Q.3.7

Table 5-4: PHY level key functionalities for OLSM end-points

Functionality	Support in class Z EPs	Support in class A EPs	Comment
Splitting Mode	mandatory	mandatory	According to ref. [12], clause Q.2.5
Transmission mode in uplink	UL-S1 (***) mandatory	UL-S1 (***) mandatory	According to ref. [12], clause Q.2.3
Transmission mode in uplink	UL-S2, UL-S3 (***) optional	UL-S2, UL-S3 (***) optional	According to ref. [12], clause Q.2.3
Transmission mode in downlink	N/A	DL-S1 (***) mandatory	According to ref. [12], clause Q.2.3
Transmission mode in downlink	N/A	DL-S2 to DL-S4 (***) optional	According to ref. [12], clause Q.2.3
Flexible Timing Mode	N/A	mandatory	According to ref. [12], clause Q.2.5.4.2.8 (**)
Access options	N/A	access option #3 mandatory (*)	According to ref. [12], clause Q.2.5.6.1 and clause Q.3.5.2.1.2 (**)
Synchronous transmission	mandatory	mandatory	According to ref. [12], clause Q.2.5.6.3
Sync Burst	not allowed	not allowed	
Repetition in UL	not allowed	not allowed	
(*): other access options optional. (**): new topics of OMS Annex Q PHY Layer relates on a future ETSI V2 specification. (***): Transmission modes in Annex Q specify frequencies and symbol rates. Other RRP, than EU868 (ref. [7]), are possible.			

NOTE:

Table 5-4 may list parameters or functionalities that are not yet in the ETSI specifications [1]. In the present document, these parameters and functionalities are referenced with OMS specifications. They will be referenced with future revision of ETSI specifications, once available.

5.2.2 OMS over mioty

An OMS over mioty (OOM) end-point shall implement an air interface compliant with the following specifications:

- at solution level: the OMS over mioty specification (see ref. [8]),
- at PHY, MAC, and Link levels: the TS-UNB protocol specified in ETSI specifications [1], and the mioty® radio protocol specifications [2],
- at radio level: the mioty® regional radio profiles [7].

Table 5-5, Table 5-6, Table 5-7, and Table 5-8 summarize implementation and use of key functionalities of the end-point in case of an OMS over mioty sub-profile.

Table 5-5: Solution level key functionalities for OOM end-points

Functionality	Support	Comment
Installation/Deinstallation procedure	mandatory	According to possible options of ref. [8], clause 6.3
M-Bus adaptation layer	mandatory	See ref. [8], clause 6.2
OMS application coding	mandatory	According to ref. [8], clause 6.4.5
Solution level cryptography	mandatory	According to ref. [8], clause 6.5.3

Table 5-6: Link level key functionalities for OOM end-points

Functionality	Support	Comment
See Table 3-2: Link level key functionalities for EP		

Table 5-7: MAC level key functionalities for OOM end-points

Functionality	Support	Comment
Fixed MAC Mode	mandatory	
Uplink MPF Flag (in MAC header)	MPF=1 mandatory	Introduces MPF field
Downlink MPF Flag (in MAC header)	MPF=1 mandatory	Introduces MPF field
Response Flag (in DL MAC header)	optional	Flag set when an UL response is expected after the DL message
Response Priority Flag (in downlink MAC header)	optional	Flag set when UL response is expected within priority time window

MPF Field	value 0x83 mandatory	According to ref. [8], clause 4.3
Short Address	conditional	Condition is on Addressing Mode=0 set by EP

Table 5-8: PHY level key functionalities for OOM end-points

Functionality	Support	Comment
See Table 3-4: PHY level key functionalities for EP		

5.3 Base station requirements

In a mioty4OMS E2E solution, the base station shall implement an air interface compliant with the following specifications:

- at PHY, MAC, and Link levels: the TS-UNB protocol specified in ETSI specifications [1], the mioty® radio protocol specifications [2], and the OMS LPWAN specification, Annex Q [12],
- at radio level: the mioty® regional radio profiles [7].

In a mioty4OMS E2E solution, a base station shall support both sub-profiles: OMS LPWAN Splitting Mode (OLSM) and OMS over mioty (OOM).

Table 5-9 summarize implementation and use of key functionalities of the base station in a mioty4OMS E2E solution.

Table 5-9: Base station key functionalities in mioty4OMS E2E solution

Functionality	Support	Comment
BSSCI Interface	mandatory	According to [5]
Radio interface	mandatory	According to [1] and [2]
Fixed MAC	mandatory	According to [1] and [2]
ETSI MAC and Link Layer	mandatory	According to [1] and [2]
Variable MAC	mandatory	Activated by Service Centre in case of OLSM end-points

5.4 Service Centre requirements

In a mioty4OMS E2E solution, the service centre functional block shall:

- implement an interface with one or several base stations, as specified in the BSSCI specifications [5],
- support both sub-profiles: OMS LPWAN Splitting Mode and OMS over mioty.

Table 5-10 summarizes implementation and use of key functionalities of the service centre of a mioty4OMS E2E solution.

Table 5-10: Service centre key functionalities in mioty4OMS E2E solution

Functionality	Support	Comment
Network-level cryptography	mandatory	Activated in case of OOM end-points
Pre-registration	mandatory	Activated in case of OOM class Z end-points
Over-the-air registration	mandatory	Activated in case of OOM class A end-points
MAC Type 0x02 support	mandatory	Activated in case of OLSM end-points
OMS MAC Layer	mandatory	Activated in case of OLSM end-points
OMS Link Layer	mandatory	Activated in case of OLSM end-points
MAC Security	mandatory	Activated in case of OLSM end-points
MAC Services	mandatory	Activated in case of OLSM end-points

5.5 Application Centre requirements

In a mioty4OMS E2E solution, the application centre functional block shall implement the key functionalities as defined in Table 5-11.

In a mioty4OMS E2E solution, the application centre shall support both sub-profiles: OMS LPWAN Splitting Mode and OMS over mioty.

Table 5-11: Application centre key functionalities in mioty4OMS E2E solution

Functionality	Support	Comment
Address mapping	mandatory	According to ref. [8]
OMS communication security	mandatory	According to ref. [11], clause 9.3
OMS application coding	optional (*)	According to ref. [11], clause 8.4.4
OMS application security	optional (*)	According to ref. [11], clause 9.4
IP-based interface to application servers	N/A	Protocol specification not in scope of this document
(*) : If this function is not implemented in the Application Centre it shall be provided by the External Server (see Figure 2-1)		

6 Bibliography references

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