

ETSI TS 123 437 V19.3.0 (2026-01)



**LTE;
5G Service Enabler Architecture Layer for Verticals (SEAL);
Spatial map and Spatial anchors;
(3GPP TS 23.437 version 19.3.0 Release 19)**



Reference

DTS/TSGS-0623437vj30

Keywords

5G,LTE

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 - APE 7112B
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° w061004871

Important notice

The present document can be downloaded from the
[ETSI Search & Browse Standards application](#).

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the prevailing version of an ETSI deliverable is the one made publicly available in PDF format on [ETSI deliver repository](#).

Users should be aware that the present document may be revised or have its status changed,
this information is available in the [Milestones listing](#).

If you find errors in the present document, please send your comments to
the relevant service listed under [Committee Support Staff](#).

If you find a security vulnerability in the present document, please report it through our
[Coordinated Vulnerability Disclosure \(CVD\)](#) program.

Notice of disclaimer & limitation of liability

The information provided in the present deliverable is directed solely to professionals who have the appropriate degree of experience to understand and interpret its content in accordance with generally accepted engineering or other professional standard and applicable regulations.

No recommendation as to products and services or vendors is made or should be implied.

No representation or warranty is made that this deliverable is technically accurate or sufficient or conforms to any law and/or governmental rule and/or regulation and further, no representation or warranty is made of merchantability or fitness for any particular purpose or against infringement of intellectual property rights.

In no event shall ETSI be held liable for loss of profits or any other incidental or consequential damages.

Any software contained in this deliverable is provided "AS IS" with no warranties, express or implied, including but not limited to, the warranties of merchantability, fitness for a particular purpose and non-infringement of intellectual property rights and ETSI shall not be held liable in any event for any damages whatsoever (including, without limitation, damages for loss of profits, business interruption, loss of information, or any other pecuniary loss) arising out of or related to the use of or inability to use the software.

Copyright Notification

No part may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm except as authorized by written permission of ETSI.

The content of the PDF version shall not be modified without the written authorization of ETSI.

The copyright and the foregoing restriction extend to reproduction in all media.

© ETSI 2026.
All rights reserved.

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The declarations pertaining to these essential IPRs, if any, are 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 IPR online database](#).

Pursuant to the ETSI Directives including the ETSI IPR Policy, no investigation regarding the essentiality of IPRs, 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.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members. **3GPP™**, **LTE™** and **5G™** logo are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners. **oneM2M™** logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners. **GSM®** and the GSM logo are trademarks registered and owned by the GSM Association.

Legal Notice

This Technical Specification (TS) has been produced by ETSI 3rd Generation Partnership Project (3GPP).

The present document may refer to technical specifications or reports using their 3GPP identities. These shall be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between 3GPP and ETSI identities can be found at [3GPP to ETSI numbering cross-referencing](#).

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.

Contents

Intellectual Property Rights	2
Legal Notice	2
Modal verbs terminology.....	2
Foreword.....	8
Introduction	9
1 Scope	10
2 References	10
3 Definitions of terms, symbols and abbreviations	10
3.1 Terms.....	10
3.2 Symbols.....	11
3.3 Abbreviations	11
4 Architectural requirements	11
4.1 General	11
4.2 Spatial anchors management	11
4.3 Spatial map management.....	11
5 Involved business relationships.....	12
6 Functional model deployment options	12
6.1 General	12
7 Identities and commonly used values.....	12
7.1 General	12
7.2 Identities	12
7.2.1 General.....	12
7.2.2 Identities related to spatial anchors.....	12
7.2.2.1 Spatial anchor ID	12
7.2.3 Identities related to spatial map	12
7.2.3.1 Spatial map ID	12
7.2.3.2 Spatial map layer ID.....	13
7.3 Common values.....	13
7.3.1 General.....	13
7.3.2 Common values related to spatial anchors.....	13
7.3.2.1 Spatial anchor profile	13
7.3.3 Common values related to spatial map	13
7.3.3.1 Spatial map information	13
7.3.3.2 SM data source profile	14
8 Spatial Anchors (SAn) Service.....	15
8.1 General	15
8.2 Functional model for spatial anchors service	15
8.2.1 General.....	15
8.2.2 On-network functional model description	15
8.2.2.1 Functional Elements.....	16
8.2.2.1.1 Spatial anchors (SAn) server	16
8.2.2.1.2 Spatial anchors (SAn) client	16
8.2.2.1.3 VAL server	16
8.2.2.1.4 VAL client.....	16
8.2.2.2 Reference Points	16
8.2.2.2.1 SAn-UU.....	16
8.2.2.2.2 SAn-S	16
8.2.2.2.3 SAn-C.....	16
8.2.2.2.4 SEAL-X (AnM) (between the SAn server and the SM server)	16
8.2.3 Service based architecture	17
8.3 Spatial anchors management procedures.....	17

8.3.1	Spatial anchor creation.....	17
8.3.1.1	General	17
8.3.1.2	Procedure	17
8.3.1.3	Information flows.....	18
8.3.1.3.1	Spatial anchor create request	18
8.3.1.3.2	Spatial anchor create response.....	19
8.3.2	Spatial anchor update.....	19
8.3.2.1	General	19
8.3.2.2	Procedure	20
8.3.2.3	Information flows.....	20
8.3.2.3.1	Spatial anchor update request	20
8.3.2.3.2	Spatial anchor update response.....	21
8.3.3	Spatial anchor deletion.....	21
8.3.3.1	General	21
8.3.3.2	Procedure	21
8.3.3.3	Information flows.....	22
8.3.3.3.1	Spatial anchor delete request	22
8.3.3.3.2	Spatial anchor delete response.....	22
8.3.4	Spatial anchor discovery	23
8.3.4.1	General	23
8.3.4.2	Procedure	23
8.3.4.3	Information flows.....	24
8.3.4.3.1	Spatial anchor discovery request	24
8.3.4.3.2	Spatial anchor discovery response.....	24
8.3.5	Spatial anchor subscription	25
8.3.5.1	General	25
8.3.5.2	Procedures.....	25
8.3.5.2.1	Subscribe	25
8.3.5.2.2	Notify	26
8.3.5.2.3	Subscription update	27
8.3.5.2.4	Unsubscribe	28
8.3.5.3	Information flows.....	28
8.3.5.3.1	Spatial anchor subscribe request.....	28
8.3.5.3.2	Spatial anchor subscribe response	29
8.3.5.3.3	Spatial anchor notification.....	30
8.3.5.3.4	Spatial anchor subscription update request.....	30
8.3.5.3.5	Spatial anchor subscription update response	31
8.3.5.3.6	Spatial anchor unsubscribe request.....	31
8.3.5.3.7	Spatial anchor unsubscribe response	31
8.3.6	Spatial anchor retrieve	32
8.3.6.1	General	32
8.3.6.2	Procedure	32
8.3.6.3	Information flows.....	33
8.3.6.3.1	Spatial anchor retrieve request	33
8.3.6.3.2	Spatial anchor retrieve response	33
8.4	Spatial anchor usage information	33
8.4.1	General.....	33
8.4.2	Spatial anchor usage information (Sub-Notify)	33
8.4.2.1	General	33
8.4.2.2	Procedure	33
8.4.2.3	Information flows.....	34
8.4.2.3.1	Spatial anchor usage information subscription request	34
8.4.2.3.2	Spatial anchor usage information subscription response	35
8.4.2.3.3	Spatial anchor usage information notification	35
8.4.3	Spatial anchor usage information (Request-Response).....	36
8.4.3.1	General	36
8.4.3.2	Procedure	36
8.4.3.3	Information flows.....	36
8.4.3.3.1	Spatial anchor usage information request.....	36
8.4.3.3.2	Spatial anchor usage information response	36
8.4.4	Spatial anchor usage reporting.....	37
8.4.4.1	General	37

8.4.4.2	Procedure	37
8.4.4.3	Information flows.....	38
8.4.4.3.1	Spatial anchor usage report request	38
8.4.4.3.2	Spatial anchor usage report response.....	38
8.5	SEAL APIs for spatial anchor management.....	38
8.5.1	General.....	38
8.5.2	SS_SAnManagement API.....	39
8.5.2.1	General	39
8.5.2.2	Create operation	39
8.5.2.3	Update operation	39
8.5.2.4	Delete operation	39
8.5.2.5	Retrieve operation	40
8.5.2.6	Subscribe operation.....	40
8.5.2.7	Notify operation	40
8.5.2.8	UpdateSubscription operation.....	40
8.5.2.9	Unsubscribe operation.....	40
8.5.3	SS_SAnDiscovery API	41
8.5.3.1	General	41
8.5.3.2	Request operation.....	41
8.5.4	SS_SAnUsageInfo API.....	41
8.5.4.1	General	41
8.5.4.2	Request operation.....	41
8.5.4.3	Subscribe operation.....	41
8.5.4.4	Notify operation	41
8.5.5	SS_SAnUsageReport API.....	42
8.5.5.1	General	42
8.5.5.2	Request operation.....	42
9	Spatial Map (SM) management.....	42
9.1	General	42
9.2	Functional model for spatial map management.....	42
9.2.1	General.....	42
9.2.2	On-network functional model description	42
9.2.2.1	Functional Elements.....	43
9.2.2.1.1	Spatial map (SM) server	43
9.2.2.1.2	Spatial map (SM) client.....	43
9.2.2.1.3	VAL server	43
9.2.2.1.4	VAL client.....	44
9.2.2.2	Reference Points	44
9.2.2.2.1	SM-UU	44
9.2.2.2.2	SM-S.....	44
9.2.2.2.3	SM-C	44
9.2.3	Service based architecture	44
9.3	Spatial map management procedures	44
9.3.1	Create spatial map.....	44
9.3.1.1	General	44
9.3.1.2	Procedure	45
9.3.1.3	Information flows.....	46
9.3.1.3.1	Create spatial map request.....	46
9.3.1.3.2	Create spatial map response	46
9.3.2	Discover spatial map.....	47
9.3.2.1	General	47
9.3.2.2	Procedure	47
9.3.2.3	Information flows.....	47
9.3.2.3.1	Discover spatial map request	47
9.3.2.3.2	Discover spatial map response	48
9.3.3	Get spatial map information.....	48
9.3.3.1	General	48
9.3.3.2	Procedure	48
9.3.3.3	Information flows.....	49
9.3.3.3.1	Get spatial map information request.....	49
9.3.3.3.2	Get spatial map information response	49

9.3.4	Update spatial map.....	50
9.3.4.1	General	50
9.3.4.2	Procedure	50
9.3.4.3	Information flows.....	51
9.3.4.3.1	Update spatial map request.....	51
9.3.4.3.2	Update spatial map response	51
9.3.5	Delete spatial map.....	51
9.3.5.1	General	51
9.3.5.2	Procedure	51
9.3.5.3	Information flows.....	52
9.3.5.3.1	Delete spatial map request.....	52
9.3.5.3.2	Delete spatial map response	52
9.3.6	Spatial map subscription.....	52
9.3.6.1	General	52
9.3.6.2	Procedures.....	53
9.3.6.2.1	Subscribe spatial map event	53
9.3.6.2.2	Notify spatial map event.....	53
9.3.6.2.3	Unsubscribe spatial map.....	54
9.3.6.3	Information flows.....	55
9.3.6.3.1	Subscribe spatial map request.....	55
9.3.6.3.2	Subscribe spatial map response	55
9.3.6.3.3	Notify spatial map event.....	56
9.3.6.3.4	Unsubscribe spatial map request	56
9.3.6.3.5	Unsubscribe spatial map response	56
9.4	Spatial localization services	57
9.4.1	General.....	57
9.4.2	Procedure	57
9.4.3	Information flows	57
9.4.3.1	Spatial localization service request	57
9.4.3.2	Spatial localization service response	58
9.5	SM data source	58
9.5.1	General.....	58
9.5.2	SM data source registration	58
9.5.2.1	General	58
9.5.2.2	Procedure	58
9.5.2.3	Information flows.....	59
9.5.2.3.1	SM data source registration request.....	59
9.5.2.3.2	SM data source registration response	59
9.5.3	SM data source registration update.....	60
9.5.3.1	General	60
9.5.3.2	Procedure	60
9.5.3.3	Information flows.....	61
9.5.3.3.1	SM data source registration update request	61
9.5.3.3.2	SM data source registration update response.....	61
9.5.4	SM data source deregistration.....	61
9.5.4.1	General	61
9.5.4.2	Procedure	61
9.5.4.3	Information flows.....	62
9.5.4.3.1	SM data source deregistration request.....	62
9.5.4.3.2	SM data source deregistration response	62
9.5.5	SM data source discovery	63
9.5.5.1	General	63
9.5.5.2	Procedure	63
9.5.5.3	Information flows.....	64
9.5.5.3.1	SM data source discovery request	64
9.5.5.3.2	SM data source discovery response.....	64
9.5.5.3.3	SM data source notification.....	64
9.6	SM service capable application server (SMAS).....	65
9.6.1	General.....	65
9.6.2	SMAS registration	65
9.6.2.1	General	65
9.6.2.2	Procedure	65

9.6.2.3	Information flows.....	66
9.6.2.3.1	SMAS registration request.....	66
9.6.2.3.2	SMAS registration response	67
9.6.3	SMAS registration update.....	67
9.6.3.1	General	67
9.6.3.2	Procedure	67
9.6.3.3	Information flows.....	68
9.6.3.3.1	SMAS registration update request	68
9.6.3.3.2	SMAS registration update response.....	68
9.6.4	SMAS deregistration.....	69
9.6.4.1	General	69
9.6.4.2	Procedure	69
9.6.4.3	Information flows.....	70
9.6.4.3.1	SMAS deregistration request.....	70
9.6.4.3.2	SMAS deregistration request.....	70
9.6.5	SMAS discovery	70
9.7	SEAL APIs for spatial map management.....	70
9.7.1	General.....	70
9.7.2	SS_SmManagement API	71
9.7.2.1	General	71
9.7.2.2	Create operation	71
9.7.2.3	Get operation.....	71
9.7.2.4	Update operation	72
9.7.2.5	Delete operation	72
9.7.2.6	Subscribe operation.....	72
9.7.2.7	Notify operation	72
9.7.2.8	Unsubscribe operation.....	72
9.7.3	SS_SmDiscovery API.....	73
9.7.3.1	General	73
9.7.3.2	Request operation.....	73
9.7.4	SS_SmLocalization API	73
9.7.4.1	General	73
9.7.4.2	Request operation.....	73
9.7.5	SS_SmDataSourceRegistration API	73
9.7.5.1	General	73
9.7.5.2	Request operation.....	73
9.7.5.3	Update operation	74
9.7.5.4	Deregister operation	74
9.7.6	SS_SmDataSourceDiscovery API	74
9.7.6.1	General	74
9.7.6.2	Request operation.....	74
9.7.6.3	Notify operation	74
9.7.7	SS_SmSmasRegistration API	75
9.7.7.1	General	75
9.7.7.2	Request operation.....	75
9.7.7.3	Update operation	75
9.7.7.4	Deregister operation	75
Annex A (informative): Change history		76
History		77

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

- x the first digit:
 - 1 presented to TSG for information;
 - 2 presented to TSG for approval;
 - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

- shall** indicates a mandatory requirement to do something
- shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

- should** indicates a recommendation to do something
- should not** indicates a recommendation not to do something
- may** indicates permission to do something
- need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

- can** indicates that something is possible
- cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

- will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document
- will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document
- might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

might not indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

is (or any other verb in the indicative mood) indicates a statement of fact

is not (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

Introduction

The term "metaverse" has been used in various ways to refer to the broader implications of AR and VR. It is used to refer to a persistent, shared, perceived set of interactive perceived spaces. "Metaverse" in diverse sectors evokes a number of possible new experiences, products and services that emerges in virtual reality and augmented reality services.

Localized mobile metaverse services are immersive and integrated into a user's ordinary experiences. Such service experiences are location-related and can include presentation of AR, MR media. Localized mobile metaverse services can be associated with specific places (3D locations in the physical world). The association between these places and service information is termed a spatial anchor. Spatial anchors enable mobile metaverse services to be discovered and accessed, if the user is authorized. Users' localization is important in order to discover spatial anchors.

The spatial map is created using processed sensor data. Creation of a spatial map for a location makes localization there possible, as well as assignment of spatial anchors in that location.

This technical specification provides application layer architecture and related procedures for enabling spatial anchors management and spatial mapping management.

1 Scope

The present document specifies the application layer architecture, procedures and information flows necessary for spatial anchors management and spatial mapping management to support mobile metaverse services. It includes architectural requirements, application layer architecture fulfilling the architecture requirements and procedures to manage spatial anchors and spatial maps.

The normative work in the present document is based on the requirements as defined in 3GPP TS 22.156 [2] and related use cases in 3GPP TR 22.856 [3].

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] 3GPP TS 22.156: "Mobile Metaverse Services; Stage 1".
- [3] 3GPP TR 22.856: "Feasibility Study on Localized Mobile Metaverse Services".
- [4] 3GPP TS 23.434: "Service Enabler Architecture Layer for Verticals (SEAL); Functional architecture and information flows".
- [5] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".
- [6] 3GPP TS 23.273: "5G System (5GS) Location Services (LCS); Stage 2".
- [7] 3GPP TS 23.222: "Functional architecture and information flows to support Common API Framework for 3GPP Northbound APIs; Stage 2".

3 Definitions of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

For the purposes of the present document, the following terms given in 3GPP TS 22.156 [2] apply:

localization

pose

Spatial anchor

Spatial map

spatial mapping service

spatial localization service

3.2 Symbols

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

<symbol>	<Explanation>
----------	---------------

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

<ABBREVIATION>	<Expansion>
ID	identifier
SAn	Spatial Anchor
SM	Spatial Map

4 Architectural requirements

4.1 General

This clause provides architectural requirements to consider for Spatial anchors service and Spatial map service.

4.2 Spatial anchors management

[AR-4.2-a] The spatial anchors management service shall provide mechanisms to manage (e.g. create, get, update, delete) , discover and subscribe spatial anchors.

[AR-5.2-b] The spatial anchors management service shall provide spatial anchor usage information to the authorized consumers.

4.3 Spatial map management

[AR-4.3-a] The spatial map management service shall provide mechanisms to produce, get, update, delete and subscribe spatial maps.

[AR-4.3-b] The spatial map management service shall provide mechanisms to expose spatial map information to the authorized third parties.

[AR-4.3-c] The spatial map management service shall allow multiple spatial maps in a given three-dimensional space for different vertical applications and consumer's usage.

[AR-4.3-d] The spatial map management service shall be able to interact with other SEAL servers and 5GS to support vertical applications.

[AR-4.3-e] The spatial map management service shall provide mechanisms to register, update and deregister spatial map data source and allow discovery of spatial map data source by authorized consumers.

[AR-4.3-f] The spatial map management service shall provide mechanisms to register, update and deregister VAL servers with spatial map capabilities and allow discovery of VAL servers with spatial map capabilities by authorized consumers.

[AR-4.3-g] The spatial map management service shall provide mechanisms to localize a VAL UE.

[AR-4.3-h] The spatial map management service shall provide mechanisms for authorized consumers to augment information associated with a spatial map.

5 Involved business relationships

The business relationship as specified in clause 5 of 3GPP TS 23.434 [4] is applicable for this specification, where VAL user is metaverse service user, VAL service provider is metaverse service provider and further, VAL service provider and SEAL service provider can be same organization.

6 Functional model deployment options

6.1 General

The deployment model as specified in clause 8 of 3GPP TS 23.434 [4] is applicable for this specification. The SEAL server(s) as specified in clause 8.2.1 of 3GPP TS 23.434 [4] can be one or more SEAL services (e.g. Spatial anchors service, Spatial map service), providing enablement services to the metaverse application servers. The SEAL-S interface provides multiple service APIs towards Metaverse application server.

7 Identities and commonly used values

7.1 General

This clause specifies details about the identifiers and common values used for spatial anchors and spatial map services.

7.2 Identities

7.2.1 General

Following identifies as defined in clause 7 of 3GPP TS 23.434 [4] are applicable for this specification too.

User ID

VAL user ID

VAL UE ID

VAL service ID

7.2.2 Identities related to spatial anchors

7.2.2.1 Spatial anchor ID

A unique identifier to identify spatial anchor. It is assigned by SEAL SAn server. The identity is unique within service provider's domain.

7.2.3 Identities related to spatial map

7.2.3.1 Spatial map ID

A unique identifier to identify spatial map. It is assigned by SEAL SM server. The identity is unique within service provider's domain.

7.2.3.2 Spatial map layer ID

A unique identifier to identify a layer within a spatial map. It is assigned by SEAL SM server. The identity is unique within a spatial map.

7.3 Common values

7.3.1 General

This clause specifies common values used in this specification.

7.3.2 Common values related to spatial anchors

7.3.2.1 Spatial anchor profile

Table 7.3.2.1-1 describes information elements for the spatial anchor profile stored in the SAn server.

Table 7.3.2.1-1: Spatial anchor profile

Information element	Status	Description
Spatial anchor ID	M	Identifier of the discovered spatial anchor.
Position (NOTE)	O	The 3D geographic position of the spatial anchor in space (x, y and z coordinates).
Spatial map position (NOTE)	O	Position information based on spatial map. It includes the identifier of the Spatial map and the corresponding localization information.
Application specific Spatial anchor information	O	A container to contain application specific information.
VAL service information	M	Information about the application service associated with the spatial anchor.
> VAL Service ID	M	The identifier of the application service.
> Service endpoint	M	Endpoint information (e.g., URI, FQDN, IP address) used to communicate with the application service.
> Service connection information	O	The connection information (e.g., DNN, DNAI(s)) for establishing connectivity to the application service.
Service area	O	The service area where the spatial anchor is accessible.
Allowed entities list	O	Identity of entities (e.g. VAL client, VAL server or VAL service identity) which are permitted to discover the spatial anchor.
NOTE: One of the IEs shall be present.		

7.3.3 Common values related to spatial map

7.3.3.1 Spatial map information

Table 7.3.3.1-1 describes information elements for the spatial map information stored in the SM server.

Table 7.3.3.1-1: Spatial map information

Information element	Status	Description
Spatial map ID	M	The identifier of the spatial map
Spatial map coverage	M	The three-dimensional space coordinates information of the spatial map
Allowed entities list	O	Identity of entities (e.g. VAL client, VAL server or VAL service identity) which are permitted to discover and access the spatial map
List of spatial map layers	M	The list of spatial map layer information. At least one or more spatial map layers should be included. Each element includes the information described below.
> Spatial map layer ID	M	The identifier of the corresponding spatial map layer.
> Spatial map layer information	O	A container to carry the corresponding spatial map layer specific information
>> area	O	The area covered by this layer. This area can be the same or a subset of the Spatial map coverage space.
>> associated spatial map	O	The details about a spatial map associated with this layer. For example, if the layer is for a particular floor of the building, the detailed spatial map of that particular floor can be associated with this layer.
> List of objects	O	List of object information. Each element includes the information below.
>> Object ID	M	The identifier of the corresponding object
>> Object type	M	The type of object
>> Object position	O	The 3D position of the object in the layer
>> Object specific information	O	Object specific attribute information

NOTE: For the current release, the object specific information is implementation specific and out of scope.

7.3.3.2 SM data source profile

Table 7.3.3.2-1 describes information elements in the SM data source profile.

Table 7.3.3.2-1: SM data source profile

Information element	Status	Description
SM data source ID	M	The identifier of the SM data source
SM information details	M	The SM information details available at the SM data source; each element includes the information described below.
> SM data identifier	M	The identifier of SM information
> SM data type (NOTE)	M	The type of SM information (e.g., LiDAR camera, RGB-D camera, high-resolution cameras, etc.) that is provided by the application layer.
> SM data format	O	The format of a SM information (e.g., raw, processed, etc.)
> SM data area	M	The spatial coverage area of the SM data.
> Position information	O	Indicates the Three dimensional area of interest or location information of the SM data source
> Availability State information	O	Indicates the time period availability information of the SM data source.
> Data source update interval information	O	Indicates the rate at which data source updates or generates the data. It describes how often the new data is captured or collected. e.g., every x milliseconds generates data.

NOTE: The definition of SM data types is application specific (e.g., VAL client) for the current release.

8 Spatial Anchors (SAn) Service

8.1 General

Spatial anchors service is a SEAL service that offers spatial anchors related capabilities to one or more vertical applications.

8.2 Functional model for spatial anchors service

8.2.1 General

This clause provides architecture for spatial anchors (SAn) service. The on-network functional model is specified in clause 8.2.2, and service based architecture is specified in clause 8.2.3.

8.2.2 On-network functional model description

Figure 8.2.2-1 illustrates an on-network functional model for Spatial Anchors (SAn) service.

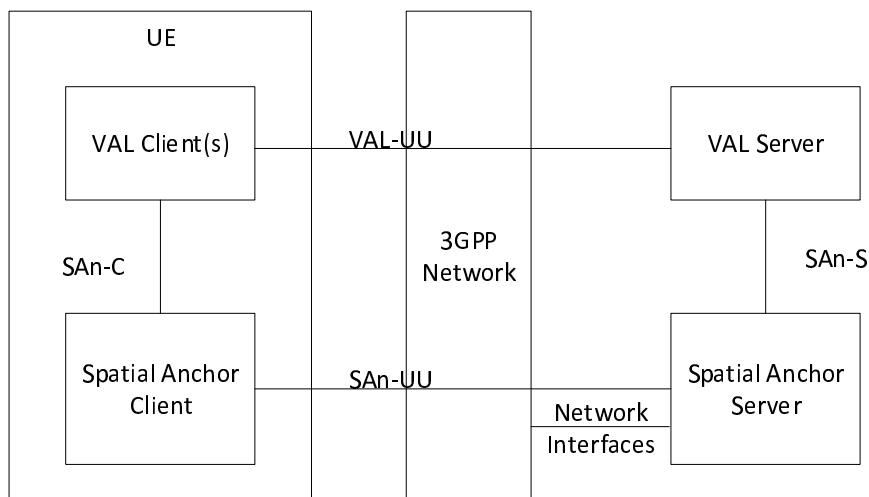


Figure 8.2.2-1: On-network Spatial Anchors service functional model

The Spatial Anchors service functional entities are grouped into the vertical application layer and the Service Enabler Architecture Layer (SEAL) layer. The Spatial Anchors service offers the capabilities to manage spatial anchors to the vertical application layer. The Spatial Anchors service functional model is based on SEAL layer as specified in 3GPP TS 23.434 [4].

The spatial anchors service functional entities on the UE and in the network are respectively the spatial anchors (SAn) client and spatial anchors (SAn) server. The VAL client and VAL server are application client and server respectively to provide an application service to the user. The SAn client and SAn server provides client and server side functionalities respectively for managing spatial anchors for the application. The SAn client is a SEAL client providing spatial anchors service to VAL client. The SAn server is a SEAL server providing spatial anchors service to VAL server and UE. The interface between SAn Client and SAn Server is SAn-UU. The SAn client interacts with the VAL client using a SAn-C interface. The SAn server interacts with the VAL server using a SAn-S. The SAn server communicates with the underlying 3GPP network system (either directly or via NEF) using network interfaces specified by the 3GPP network system (e.g. T8, N33). When SAn server is deployed by PLMN operator, the SAn server communicates with 3GPP network system by directly invoking the APIs from exposed by 3GPP core network functions.

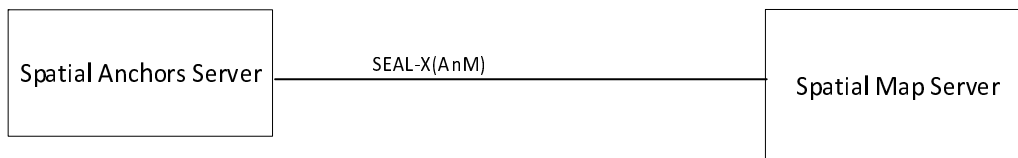


Figure 8.2.2-2: Spatial Anchors server interaction with Spatial Map Server

Figure 8.2.2-2 illustrates the functional model for interconnection between SAn server and Spatial Map server.

8.2.2.1 Functional Elements

8.2.2.1.1 Spatial anchors (SAn) server

The SAn server acts as a SEAL client and it is used to provide services to create/update/delete/discover spatial anchors for the VAL application (i.e. metaverse application). It can communicate with other SAn server in the distributed SEAL deployments.

8.2.2.1.2 Spatial anchors (SAn) client

The SAn client acts as a SEAL client for spatial anchors server. It supports client side functionalities for creating/updating/deleting/discovering/retrieving spatial anchors for VAL application (i.e. metaverse application). The SAn client receives the request from VAL client to perform specific functionality.

8.2.2.1.3 VAL server

The VAL server is specified in clause 6.4.2.3 of 3GPP TS 23.434 [4]. The VAL server provides the server side functionalities corresponding to the vertical applications (i.e. metaverse applications) to the client of a VAL user based on a service contract.

8.2.2.1.4 VAL client

The VAL client is specified in clause 6.4.2.2 of 3GPP TS 23.434 [4]. The VAL client provides a metaverse services to the user. It uses the SAn client to manage spatial anchors for the application.

8.2.2.2 Reference Points

8.2.2.2.1 SAn-UU

SAn-UU reference point enables interactions between a SAn client and SAn server. It is used to create/update/delete/discover/retrieve spatial anchors for the VAL applications (i.e. metaverse applications).

8.2.2.2.2 SAn-S

SAn-S reference point enables interactions between a SAn server and VAL servers (i.e. metaverse application servers). It can be used to create/update/delete/get/retrieve spatial anchors for the VAL applications (i.e. metaverse applications).

8.2.2.2.3 SAn-C

SAn-C reference point enables interactions between a SAn client and VAL clients (i.e. metaverse application clients). It is used by the VAL client to share information regarding spatial anchors related information to the SAn client and also to get spatial anchors related information from the SAn client.

8.2.2.2.4 SEAL-X (AnM) (between the SAn server and the SM server)

The SEAL-X (AnM) reference point, which exists between the Spatial anchors server and the Spatial map server, provides a means for the both servers to exchange information related to anchors and maps to each other.

8.2.3 Service based architecture

Figure 8.2.3-1 illustrates the service-based SEAL architecture to support spatial anchors services.

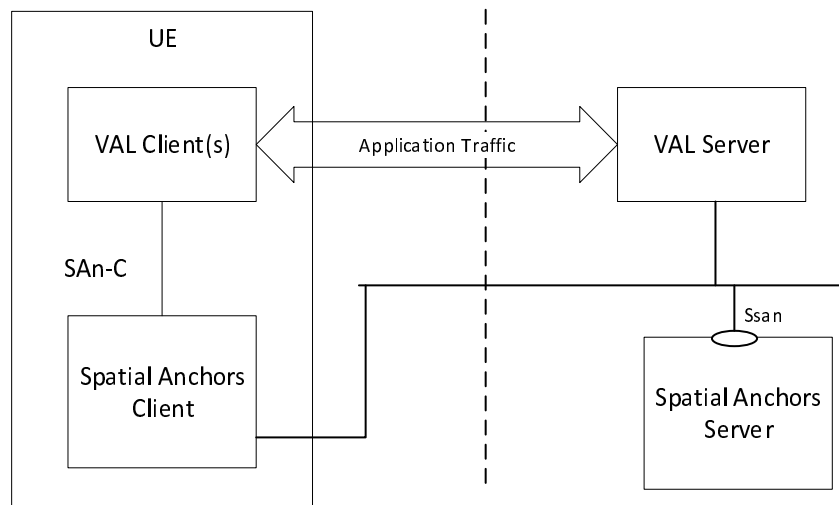


Figure 8.2.3-1: Service based architecture for spatial anchors service

The SAn server exposes the APIs over the SSAn interface to the VAL server and SAn client. The VAL servers consume the services by interacting on the SSAn interface of the SAn server. The CAPIF can be used by VAL functions to discover the services of the SAn server.

8.3 Spatial anchors management procedures

8.3.1 Spatial anchor creation

8.3.1.1 General

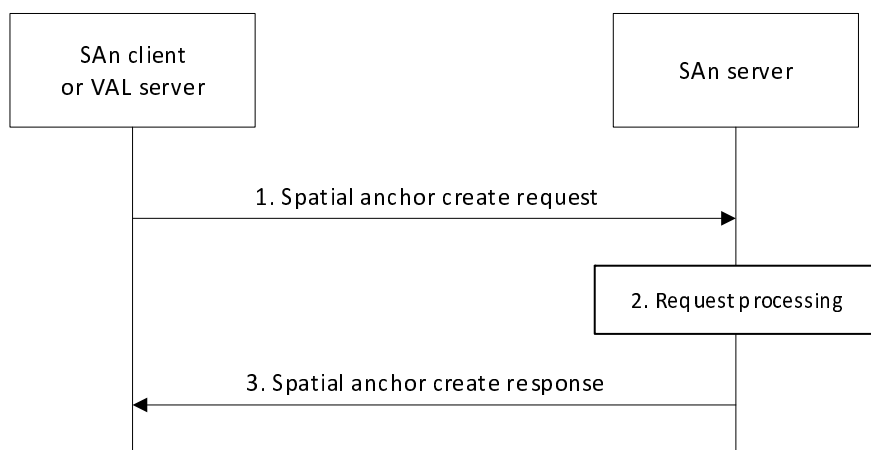
Spatial anchor creation enables a SAn client or VAL server to create spatial anchor(s) with the SAn server.

8.3.1.2 Procedure

Figure 8.3.1.2-1 illustrates the spatial anchor creation procedure.

Pre-conditions:

1. The SAn client or VAL server has received information (e.g. URI, IP address) related to the SAn server;
2. The SAn client or VAL server has received security credentials authorizing it to communicate with the SAn server.
3. For SAn client to trigger this procedure, the SAn client has received the required information from the VAL client over SAn-C interface.

**Figure 8.3.1.2-1: Spatial anchor creation**

1. The requestor (e.g., SAn client or VAL server) sends a spatial anchor create request to the SAn server. The request includes a requestor identifier, security credentials, and list of spatial anchors to be created as described in clause 8.3.1.3.1. The request includes a position, allowed entities list defining which entities are permitted to discover and access the spatial anchor, and discoverability information (e.g., indicating whether the spatial anchor is discoverable by any user). If the request includes application specific spatial anchor information, that information remains opaque to the SAn server and can be stored with the spatial anchor. The request can indicate to create multiple spatial anchors.

NOTE: The application specific spatial anchor information is out of scope of standardization. For example, the application specific spatial anchor information can contain specific service information like a name, a URL, a media data, a type, a manufacturing company, a date, an expiry date, a ratings, and customer premise information (e.g. a residence, office or shop), a service schedule defining times when the spatial anchor(s) are active and inactive, etc. Such information may be stored in key-value pair and is opaque to the SAn server.

2. Upon receiving the request, the SAn server validates if the requestor is authorized for the request. If the requestor is authorized, the SAn server creates the spatial anchor(s), assigns spatial anchor identifier to the newly created spatial anchor(s) and stores the spatial anchor information.
3. The SAn server sends a spatial anchor create response to the requestor. If the SAn server created spatial anchors, the response includes an indication of success and spatial anchor identifier(s) of newly created spatial anchor(s). Otherwise, the response includes an indication of failure and can include a reason for failure.

8.3.1.3 Information flows

8.3.1.3.1 Spatial anchor create request

Table 8.3.1.3.1-1 describes information elements for the spatial anchor create request from the SAn client or VAL server to the SAn server.

Table 8.3.1.3.1-1: Spatial anchor create request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL server or VAL UE and VAL user).
Security credentials	M	The security credentials of the requestor.
VAL service information	M	Information about the application service associated with the spatial anchor.
> Service ID	M	The identifier of the application service.
> Service endpoint	M	Endpoint information (e.g., URI, FQDN, IP address) used to communicate with the application service.
> Service connection information	O	The connection information (e.g., DNN, DNAI(s)) for establishing connectivity to the application service.
List of spatial anchors	M	List of spatial anchors to be created.
> Position information	M	Position information of the spatial anchor
>> Position (NOTE)	O	The 3D geographic position of the spatial anchor in space (x, y and z coordinates).
>> Spatial map position (NOTE)	O	Position information of the spatial anchor within the spatial map. It includes the identifier of the Spatial map, identifier of spatial map layer(s) and the corresponding localization information (The localization information is specific to spatial map format).
> Application specific Spatial anchor information	O	A container to contain application specific information.
> Service area	O	The service area where the spatial anchor is accessible.
> Allowed entities list	O	Identity of entities (e.g. VAL client, VAL server or VAL service identity) which are permitted to discover the spatial anchor.
> Spatial anchor resource identifier	M	The identifier to associate the resource information with the created spatial anchors.
NOTE: One of the IEs shall be present.		

8.3.1.3.2 Spatial anchor create response

Table 8.3.1.3.2-1 describes information elements for the spatial anchor create response from the SAn service.

Table 8.3.1.3.2-1: Spatial anchor create response

Information element	Status	Description
Successful response	O	Indicates that the spatial anchor create request was successful.
> List of spatial anchors	O	The list of created spatial anchors.
>> Spatial anchor ID	O	The identifier of the spatial anchor
>> Spatial anchor resource identifier	O	The identifier provided by the SAn client in order to associate the created spatial anchor with the resource information used for creating the spatial anchor.
Failure response	O	Indicates that the create spatial anchor request has failed.
> Cause	O	The cause for the request failure.

8.3.2 Spatial anchor update

8.3.2.1 General

Spatial anchor update enables a SAn client or VAL server to update spatial anchor(s) with the SAn server.

8.3.2.2 Procedure

Figure 8.3.2.2-1 illustrates the spatial anchor update procedure.

Pre-conditions:

- 1. The SAn client or VAL server has received information (e.g. URI, IP address) related to the SAn server; and
- 2. The SAn client or VAL server has received security credentials authorizing it to communicate with the SAn server.
- 3. For SAn client to trigger this procedure, the SAn client has received the required information from the VAL client over SAn-C interface.

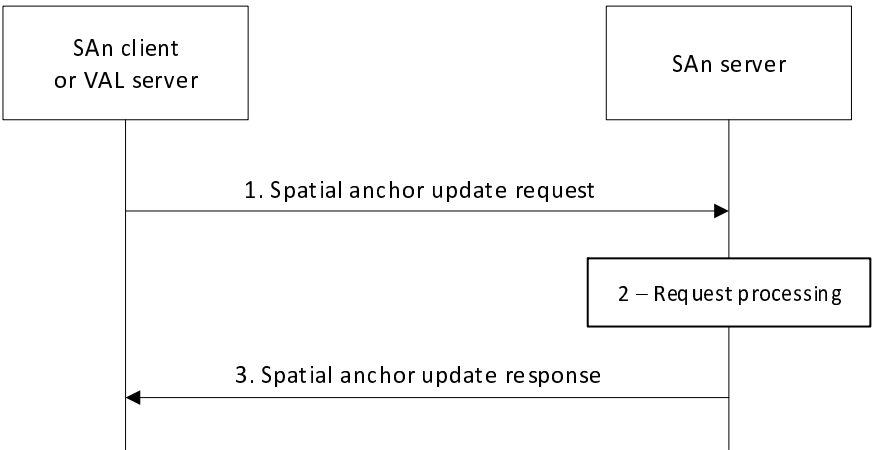


Figure 8.3.2.2-1: Spatial anchor update

- 1. The requestor (e.g., SAn client or VAL server) sends a spatial anchor update request to the SAn server. The request includes a requestor identifier, security credentials, the identifier of spatial anchors, and spatial anchor information to update as described in clause 8.3.2.3.1. The request may include information to update multiple spatial anchors.
- 2. Upon receiving the request, the SAn server validates if the requestor is authorized for the request. If the requestor is authorized and the spatial anchor identifier provided in the request is found, the SAn server updates the spatial anchor information based on information provided in the request.
- 3. The SAn server sends a spatial anchor update response to the requestor. If the SAn server updated the spatial anchor, the response includes an indication of success and the identifier of updated spatial anchor(s). Otherwise, the response includes an indication of failure and may include a reason for failure.

8.3.2.3 Information flows

8.3.2.3.1 Spatial anchor update request

Table 8.3.2.3.1-1 describes information elements for the spatial anchor update request from the SAn client or VAL server to the SAn server.

Table 8.3.2.3.1-1: Spatial anchor update request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL server or VAL UE and VAL user).
Security credentials	M	The security credentials of the requestor.
> VAL service information	O	Information about the application service associated with the spatial anchor.
>> Service ID	O	The identifier of the application service.
>> Service endpoint	O	Endpoint information (e.g., URI, FQDN, IP address) used to communicate with the application service.
>> Service connection information	O	The connection information (e.g., DNN, DNAI(s)) for establishing connectivity to the application service.
List of spatial anchors	M	List of spatial anchors to be updated.
> Spatial anchor ID	M	Identifier of the spatial anchor to be updated.
> Position information	O	Position information of the spatial anchor
>> Position (NOTE)	O	The 3D geographic position of the spatial anchor in space (x, y and z coordinates).
>> Spatial map position (NOTE)	O	Position information of the spatial anchor within the spatial map. It includes the identifier of the Spatial map, identifier of spatial map layer(s) and the corresponding localization information (The localization information is specific to spatial map format).
> Application specific Spatial anchor information	O	A container to contain application specific information.
> Service area	O	The service area where the spatial anchor is accessible.
> Allowed entities list	O	Identity of entities (e.g. VAL client, VAL server or VAL service identity) which are permitted to discover the spatial anchor.
NOTE: If Position information is included, at least one of the IEs shall be present.		

8.3.2.3.2 Spatial anchor update response

Table 8.3.2.3.2-1 describes information elements for the spatial anchor update response from the SAn server.

Table 8.3.2.3.2-1: Spatial anchor update response

Information element	Status	Description
Successful response	O	Indicates that the update spatial anchor request was successful.
> List of spatial anchor ID	O	List of identifiers of the updated spatial anchors.
Failure response	O	Indicates that the update spatial anchor request has failed.
> Cause	O	The cause for the request failure.

8.3.3 Spatial anchor deletion

8.3.3.1 General

Spatial anchor deletion enables a SAn client or VAL server to delete spatial anchor(s) with the SAn server.

8.3.3.2 Procedure

Figure 8.3.3.2-1 illustrates the spatial anchor deletion procedure.

Pre-conditions:

1. The SAn client or VAL server has received information (e.g. URI, IP address) related to the SAn server; and

2. The SAn client or VAL server has received security credentials authorizing it to communicate with the SAn server.
3. For SAn client to trigger this procedure, the SAn client has received the required information from the VAL client over SAn-C interface.

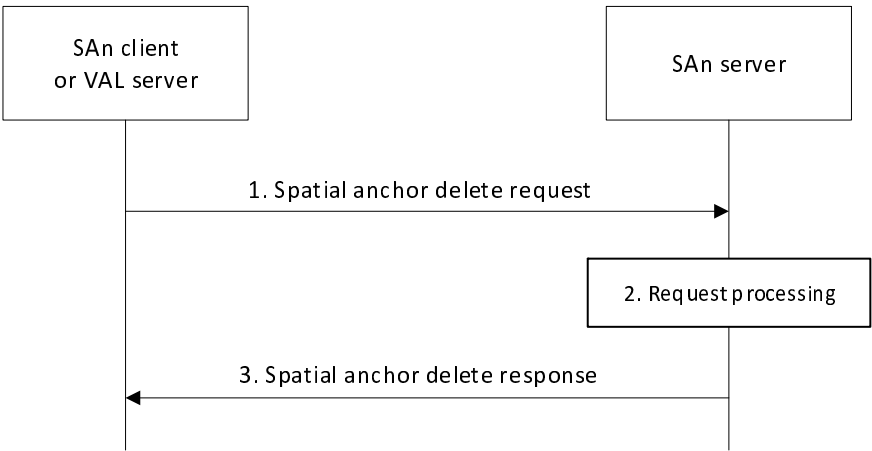


Figure 8.3.3.2-1: Spatial anchor deletion

1. The requestor (e.g., SAn client or VAL server) sends a spatial anchor delete request to the SAn server. The request includes a requestor identifier, security credentials, the identifier of spatial anchors to delete as described in clause 8.3.3.3.1. The request may include information to delete multiple spatial anchors.
2. Upon receiving the request, the SAn server validates if the requestor is authorized for the request. If the requestor is authorized and the spatial anchor identifier provided in the request is found, the SAn server deletes the spatial anchor information.
3. The SAn server sends a spatial anchor delete response to the requestor. If the SAn server deleted the spatial anchor(s), the response includes an indication of success and the identifier of deleted spatial anchor(s). Otherwise, the response includes an indication of failure and may include a reason for failure.

8.3.3.3 Information flows

8.3.3.3.1 Spatial anchor delete request

Table 8.3.3.3.1-1 describes information elements for the spatial anchor delete request from the SAn client or VAL server to the SAn server.

Table 8.3.3.3.1-1: Spatial anchor delete request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL server or VAL UE and VAL user).
Security credentials	M	The security credentials of the requestor.
List of spatial anchors ID	M	List of identifiers of the spatial anchors to be deleted.

8.3.3.3.2 Spatial anchor delete response

Table 8.3.3.3.2-1 describes information elements for the delete spatial anchor response from the SAn server to the SAn client or VAL server.

Table 8.3.3.3.2-1: Delete spatial anchor response

Information element	Status	Description
Successful response	O	Indicates that the delete spatial anchor request was successful.
> List of spatial anchor ID	O	List of identifiers of the deleted spatial anchors.
Failure response	O	Indicates that the delete spatial anchor request has failed.
> Cause	O	The cause for the request failure.

8.3.4 Spatial anchor discovery

8.3.4.1 General

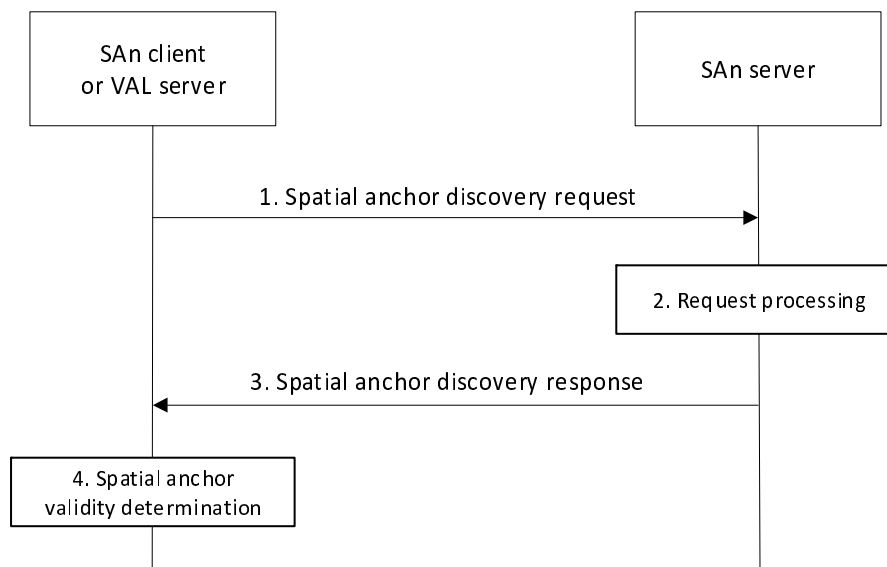
Spatial anchor discovery enables a SAn client or VAL server to discover spatial anchor(s) with the SAn server. The discovery of spatial anchor(s) is based on matching spatial anchor discovery filters provided in the request.

8.3.4.2 Procedure

Figure 8.3.4.2-1 illustrates the procedure for spatial anchor discovery following the request-response model.

Pre-conditions:

1. The SAn client or VAL server has received information (e.g. URI, IP address) related to the SAn server; and
2. The SAn client or VAL server has received security credentials authorizing it to communicate with the SAn server.
3. For SAn client to trigger this procedure, the SAn client has received the required information from the VAL client over SAn-C interface.

**Figure 8.3.4.2-1: Spatial anchor discovery**

1. The requestor (e.g., SAn client or VAL server) sends a spatial anchor discovery request message to the SAn server to obtain information about spatial anchors of interest. The request includes a requestor identifier, security credentials, and can include spatial anchor discovery filters as described in clause 8.3.4.3.1. If the discovery request was triggered by a VAL client on a UE, the spatial anchor discovery request can additionally include a VAL client identifier.
2. Upon receiving the request, the SAn server validates if the requestor is authorized for the request. If the requestor is authorized, the SAn server identifies spatial anchor(s) that satisfies the spatial anchor discovery filters.

NOTE 1: User preferences in the spatial anchor discovery filters can be compared with spatial anchor specific information.

For each matching spatial anchor, the SAn server checks whether the requestor is authorized to obtain the spatial anchor based on the identity and location of the requestor, and based on the allowed entities list. To determine the location of interest of the requestor, the SAn server may use location information provided in the request. If location information is not provided in the request, the SAn server may obtain location information by invoking the 3GPP Core Network Location Services as described in 3GPP TS 23.273 [6] and 3GPP TS 23.502 [5] directly or via the NEF, or by invoking the SEAL Location Management APIs as described in 3GPP TS 23.434 [4].

3. The SAn server sends a spatial anchor discovery response to the requestor. If the SAn server has identified spatial anchor(s), the response includes an indication of success and the identified spatial anchors and may include the recommended list of spatial anchors. Otherwise, the response includes an indication of failure and may include a reason for failure.

NOTE 2: The logic to generate a recommended list of spatial anchors is out of scope and implementation specific.

4. Upon receiving the spatial anchor discovery response, if the response indicates success, the requestor can store the spatial anchor information in a spatial anchor cache. The requestor evaluates the validity conditions associated with the discovered spatial anchors prior to using the spatial anchor. If the requestor is the SAn client, the SAn client can provide spatial anchor information to the VAL client(s). Upon receiving valid spatial anchor information, VAL client(s) can access the service(s) associated with each spatial anchor.

8.3.4.3 Information flows

8.3.4.3.1 Spatial anchor discovery request

Table 8.3.4.3.1-1 describes information elements for the spatial anchor discovery request from the SAn client or VAL server to the SAn server.

Table 8.3.4.3.1-1: Spatial anchor discovery request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL server or VAL UE and VAL user).
Security credentials	M	The security credentials of the requestor.
VAL client ID	O	The identifier of the VAL client when the requestor is a SAn client.
Discovery filters	O	The filters used for determining the spatial anchors.
> List of spatial anchor ID	O	The list of spatial anchor identifiers to discover.
> Area of interest	O	The area of interest (e.g., topological area and/or geographical area).
> Service ID	O	The identifier of a VAL service.
> Application specific Spatial anchor information	O	A container to contain application specific information.

8.3.4.3.2 Spatial anchor discovery response

Table 8.3.4.3.2-1 describes information elements for the spatial anchor discovery response from the SAn server.

Table 8.3.4.3.2-1: Spatial anchor discovery response

Information element	Status	Description
Successful response	O	Indicates that the spatial anchor discovery request was successful.
List of spatial anchors	O	List of discovered spatial anchors.
> Spatial anchor ID	M	Identifier of the discovered spatial anchor.
> Position	M	The 3D position of the spatial anchor in space (x, y and z coordinates).
> Application specific Spatial anchor information	O	A container to contain application specific information.
> VAL service information	M	Information about the application service associated with the spatial anchor.
>> Service ID	M	The identifier of the application service.
>> Service endpoint	M	Endpoint information (e.g., URI, FQDN, IP address) used to communicate with the application service.
>> Service connection information	O	The connection information (e.g., DNN, DNAI(s)) for establishing connectivity to the application service.
Failure response	O	Indicates that the spatial anchor discovery request has failed.
> Cause	O	The cause for the request failure.

8.3.5 Spatial anchor subscription

8.3.5.1 General

Spatial anchor subscription enables a SAn client or VAL server to subscribe with the SAn server to receive notifications related to spatial anchors.

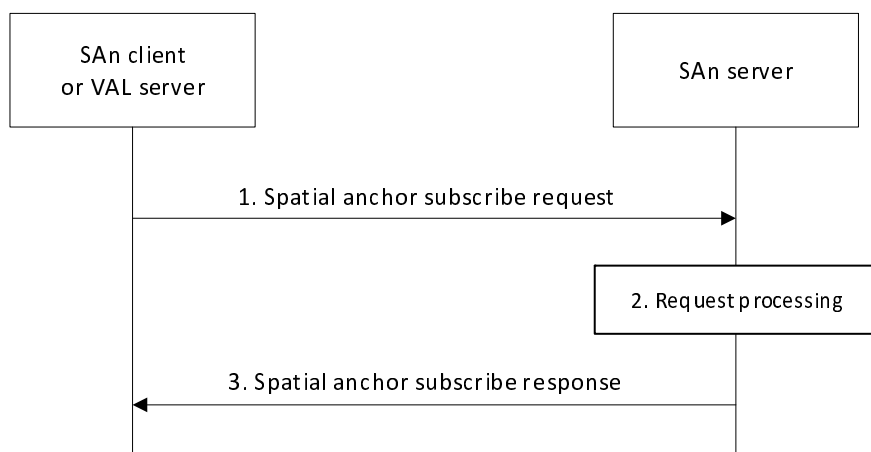
8.3.5.2 Procedures

8.3.5.2.1 Subscribe

Figure 8.3.5.2.1-1 illustrates the spatial anchor subscription procedure.

Pre-conditions:

1. The SAn client or VAL server has received information (e.g. URI, IP address) related to the SAn server; and
2. The SAn client or VAL server has received security credentials authorizing it to communicate with the SAn server.

**Figure 8.3.5.2.1-1: Spatial anchor subscription**

1. The requestor (e.g., SAn client or VAL server) sends a spatial anchor subscribe request to the SAn server. The request includes a requestor identifier, security credentials, a notification endpoint, and event information for which the requestor is subscribing. The request may include an expiration time.
 - a. The requestor may include the "discovery" event type to indicate the SAn server to notify the requestor when the SAn server detects events related to the management of spatial anchors (e.g., creation, update, deletion) according to discovery event filters and spatial anchor filters provided in the request. If the requestor is a SAn client, the request includes a VAL client identifier.
 - b. The VAL server may include the "UE with spatial anchor interest" event type to indicate the SAn server to notify the VAL server when the SAn server detects UE(s) with interest in specific spatial anchors according to the spatial anchor of interest event filters and spatial anchor filters provided in the request.
 - c. The requestor may include the "spatial anchor in range" event type to indicate the SAn server to notify the requestor when the SAn server detects that spatial anchors become in range or out of range of the subscriber according to range event filters provided in the request. Range event filters can include a range for detecting spatial anchors, an indication to enable persistent search, the pose of the subscriber. If the requestor is a SAn client, the spatial anchor subscribe request includes a VAL client identifier.
2. Upon receiving the request from the requestor, the SAn server validates if the requestor is authorized for the request. If the requestor is authorized, the SAn server creates the subscription and stores the subscription information.
 - a. If the subscribed event is for "discovery", the SAn server starts monitoring spatial anchors management events according to the discovery event filters and spatial anchor filters.
 - b. If the subscribed event is for "UE with spatial anchor interest", the SAn server starts monitoring spatial anchors of interest according to the UE with spatial anchor interest event filters and spatial anchor filters. If the spatial anchors of interest have been discovered by a UE, the SAn server can obtain the UE location information from the 5GS or the SEAL Location Management service. Additionally, the SAn server can consider data analytics, such as UE mobility prediction. The SAn server may monitor the distance between UEs and the spatial anchor of interest to determine whether the UEs enters, exits or is within range of the spatial anchors of interest.
 - c. If the subscribed event is for "spatial anchor in range" and the requestor is a SAn client, the SAn server starts monitoring the corresponding UE location and direction corresponding to the pose information according to the range event filters and spatial anchor filters. The UE location information can be obtained by using capabilities of the 5GS or the SEAL Location Management service. Additionally, the SAn server can consider data analytics, such as UE mobility prediction. The SAn server monitors the distance between UEs and the spatial anchor of interest to determine whether the spatial anchors becomes in-range or out-of-range of the UE. If persistent search is enabled, the SAn server monitors location of the user (or UE) and pose of the user, along with a direction of movement, and discovers a list of spatial anchors which becomes in-range or out of range of the user device based on the location of the user device, the pose of the user and in the user's field of view.
3. The SAn server sends a spatial anchor subscribe response to the requestor. If the SAn server has created the subscription, the response includes an indication of success, the subscription identifier and may include an expiration time; to maintain the subscription, the requestor shall send a subscription update request before the expiration time, otherwise the spatial anchor subscription expires. If the SAn server has not created the subscription, the response includes an indication of failure and may include a reason for failure.

8.3.5.2.2 Notify

Figure 8.3.5.2.2-1 illustrates the spatial anchor notify operation between the SAn server and a SAn client or VAL server.

Pre-conditions:

1. The SAn client or VAL server has subscribed for spatial anchor notifications with the SAn server;

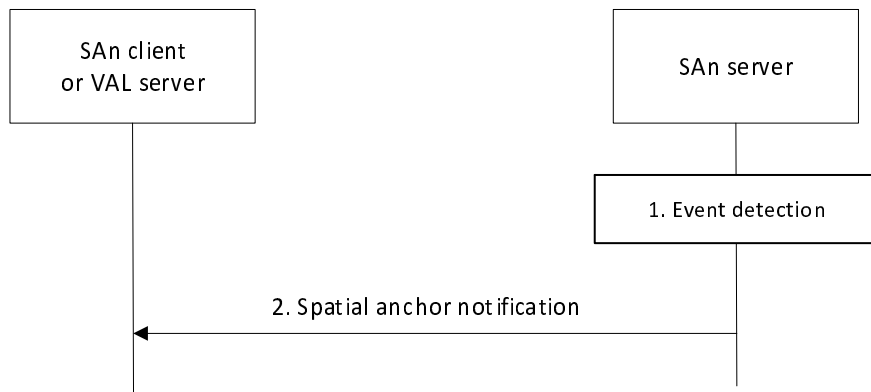


Figure 8.3.5.2.2-1: Spatial anchor notification

1. An event occurs at the SAn server that satisfies trigger conditions for notifying a subscriber (e.g., SAn client or VAL server) according to subscribed events and discovery filters provided for the events.
2. The SAn server sends a spatial anchor notification to the requestor indicating the event. The notification includes a subscription identity and includes event-specific information.
 - a. If the subscribed event is for "discovery", the notification includes the list of determined spatial anchors
 - b. If the subscribed event is for "UE with spatial anchor interest", the notification includes information about UE with spatial anchor interest (e.g., UE identifier, spatial anchor identifier(s), range from the spatial anchor(s), entering or exiting the range, etc.).
 - c. If the subscribed event is for "spatial anchor in range", the notification includes the list of determined spatial anchors that become in range, out of range of the subscriber.

8.3.5.2.3 Subscription update

Figure 8.3.5.2.3-1 illustrates the procedure for a SAn client or VAL server to update a subscription with the SAn server.

Pre-conditions:

1. The SAn client or VAL server has subscribed for spatial anchor notifications with the SAn server;

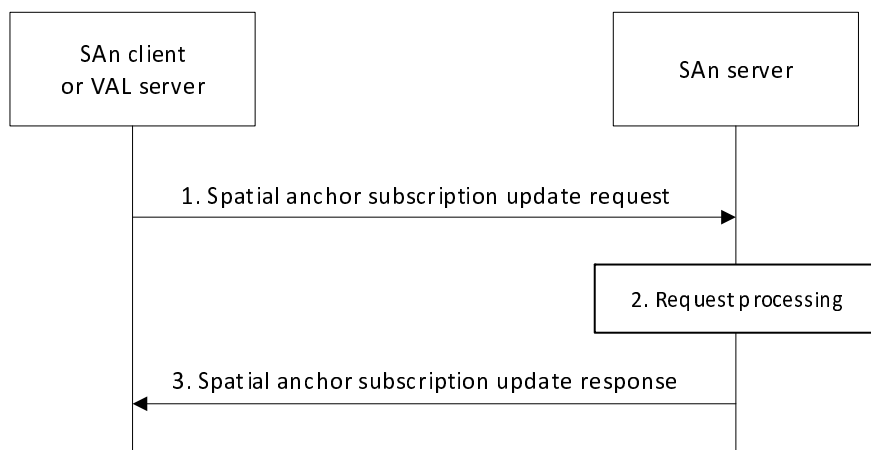


Figure 8.3.5.2.3-1: Spatial anchor subscription update

1. The requestor (e.g., SAn client or VAL server) sends a spatial anchor subscription update request to the SAn server. The request includes the requestor identifier, security credentials and the subscription identifier and may include subscribed event information and expiration time.
2. Upon receiving the request from the requestor, the SAn server validates if the requestor is authorized for the request. If the requestor is authorized, the SAn server updates the subscription information.

3. The SAn server sends a spatial anchor subscription update response to the requestor. If the SAn server has updated the subscription, the response includes an indication of success and may include an expiration time. To maintain the subscription, the requestor shall send a subscription update request before the expiration time, otherwise the spatial anchor subscription expires. If the SAn server has not updated the subscription, the response includes an indication of failure and may include a reason for failure.

8.3.5.2.4 Unsubscribe

Figure 8.3.5.2.4-1 illustrates the procedure for a SAn client or VAL server to unsubscribe with the SAn server.

Pre-conditions:

1. The SAn client or VAL server has subscribed for spatial anchor notifications with the SAn server;

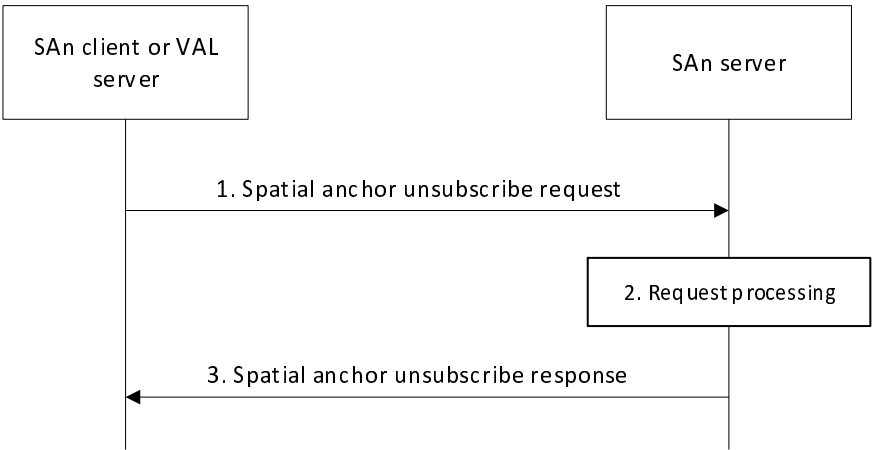


Figure 8.3.5.2.4-1: Spatial anchor unsubscribe

1. The requestor (e.g., SAn client or VAL server) sends a spatial anchor unsubscribe request to the SAn server. The request includes the requestor identifier, security credentials and the subscription identifier.
2. Upon receiving the request from the requestor, the SAn server validates if the requestor is authorized for the request. If the requestor is authorized, the SAn server cancels the subscription associated with the subscription identifier.
3. The SAn server sends a spatial anchor unsubscribe response to the requestor. If the SAn server has canceled the subscription, the response includes an indication of success. If the SAn server has not canceled the subscription, the response includes an indication of failure and may include a reason for failure.

8.3.5.3 Information flows

8.3.5.3.1 Spatial anchor subscribe request

Table 8.3.5.3.1-1 describes information elements for the spatial anchor subscribe request from the SAn client or VAL server to the SAn server.

Table 8.3.5.3.1-1: Spatial anchor subscribe request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL server or VAL UE and VAL user).
Security credentials	M	The security credentials of the requestor.
VAL client ID	O	The identifier of the VAL client when the requestor is a SAn client.
Notification Target Address	M	Notification target address (e.g. URL) where the notifications should be sent.
Proposed expiration time	O	Proposed expiration time for the subscription.
Event type	M	The type of event for which the requestor is subscribing. Supported event types include: - "discovery" - "UE with spatial anchor interest" - "spatial anchor in range"
Persistent Search (NOTE)	O	Indicates to enable persistent search.
Event detection filters	O	Event type specific detection filters.
> Discovery event filters	O	Event filters applicable to the "discovery" event type. The event filter is considered by the SAn server for triggering the notification and can include management events (e.g., creation, update, deletion).
> UE with spatial anchor interest event filters	O	Event filters applicable to "UE with spatial anchor interest" event type. The event filter is considered by the SAn server for triggering the notification and can include an indication for detecting UEs that have discovered spatial anchors, that are within range or become out of range of spatial anchors, or that enter or leave the range of a spatial anchor, and a value for the range.
> Range event filters	O	Event filters applicable to "spatial anchor in range" event type. The event filter is considered by the SAn server for triggering the notification and can include an indication for spatial anchors becoming in range of the UE, out of range of the UE, or both and a value for the range.
>> current location	O	Current location of the user and direction.
>> pose	O	Current pose of the user
>> application specific range	M	Specifies range within which the spatial anchors are monitored to be in range or out of range of the subscriber's field of view.
Spatial anchor filters	O	The characteristics of spatial anchors that the SAn server considers for triggering a notification.
> Spatial anchor ID list	O	Identifiers of the spatial anchors of interest.
> Service ID list	O	Identifiers of the associated application services of interest.
> Area of interest	O	The area of interest (e.g., topological and/or geographical).
NOTE: This IE can be included with "spatial anchor in range" event.		

8.3.5.3.2 Spatial anchor subscribe response

Table 8.3.5.3.2-1 describes information elements for the spatial anchor subscribe response sent by the SAn server.

Table 8.3.5.3.2-1: Spatial anchor subscribe response

Information element	Status	Description
Successful response	O	Indicates that the subscription request was successful.
> Subscription ID	M	Subscription identifier corresponding to the subscription.
> Expiration time	O	Indicates the expiration time of the subscription. To maintain an active subscription, a subscription update is required before the expiration time.
Failure response	O	Indicates that the subscription request failed.
> Cause	O	Indicates the cause of subscription request failure

8.3.5.3.3 Spatial anchor notification

Table 8.3.5.3.3-1 describes information elements for the spatial anchor notification sent by the SAn server.

Table 8.3.5.3.3-1: Spatial anchor notification

Information element	Status	Description
Subscription ID	M	Subscription identifier corresponding to the subscription.
Event type	M	The type of event notification. Supported event types include: - "discovery" - "UE with spatial anchor interest" - "spatial anchor in range"
Detected event	O	Identifier of the event that was detected and that triggered the server to send a notification (e.g., spatial anchors becoming in range of the UE or out of range of the UE; or, UE entering the range of a spatial anchor or leaving the range of a spatial anchor).
Spatial anchor list	O	List of discovered spatial anchors (as detailed in spatial anchor discovery response). Applicable for "discovery" and "spatial anchor in range" events.
UE with spatial anchor interest list	O	List of UE with spatial anchor interest. Applicable for "UE with spatial anchor interest" and "spatial anchor in range" events.
> UE ID	O	Identifier of the UE with spatial anchor interest.
> Spatial anchor ID	O	Identifier of the spatial anchor of interest.
> Spatial anchor range	O	The spatial anchor range.

8.3.5.3.4 Spatial anchor subscription update request

Table 8.3.5.3.4-1 describes information elements for the spatial anchor subscription update request from the SAn client or VAL server to the SAn server.

Table 8.3.5.3.4-1: Spatial anchor subscription update request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL server or VAL UE and VAL user).
Security credentials	M	Security credentials of the requestor.
Subscription ID	M	Subscription identifier corresponding to the subscription to be updated.
Notification Target Address	O	Notification target address (e.g. URL) where the notifications should be sent.
Proposed expiration time	O	Proposed expiration time for the subscription.
Event detection filters	O	Event type specific detection filters that the SAn server considers for triggering a notification, as detailed in Table 8.3.5.3.1-1.
Spatial anchor filters	O	The characteristics of spatial anchors that the SAn server considers for triggering a notification, as detailed in Table 8.3.5.3.1-1.

8.3.5.3.5 Spatial anchor subscription update response

Table 8.3.5.3.5-1 describes information elements for the spatial anchor subscription update response sent by the SAn server.

Table 8.3.5.3.5-1: Spatial anchor subscription update response

Information element	Status	Description
Successful response	O	Indicates that the subscription update request was successful.
> Expiration time	O	Indicates the expiration time of the updated subscription. To maintain an active subscription, a subscription update is required before the expiration time.
Failure response	O	Indicates that the subscription update request failed.
> Cause	O	Indicates the cause of subscription update request failure

8.3.5.3.6 Spatial anchor unsubscribe request

Table 8.3.5.3.6-1 describes information elements for the spatial anchor unsubscribe request from the SAn client or VAL server to the SAn server.

Table 8.3.5.3.6-1: Spatial anchor unsubscribe request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL server or VAL UE and VAL user).
Security credentials	M	Security credentials of the EEC
Subscription ID	M	Subscription identifier corresponding to the subscription to be unsubscribed

8.3.5.3.7 Spatial anchor unsubscribe response

Table 8.3.5.3.7-1 describes information elements for the spatial anchor unsubscribe response sent by the SAn server.

Table 8.3.5.3.7-1: Spatial anchor unsubscribe response

Information element	Status	Description
Successful response	O	Indicates that the unsubscribe request was successful.
Failure response	O	Indicates that the unsubscribe request failed.
> Cause	O	Indicates the cause of unsubscribe request failure

8.3.6 Spatial anchor retrieve

8.3.6.1 General

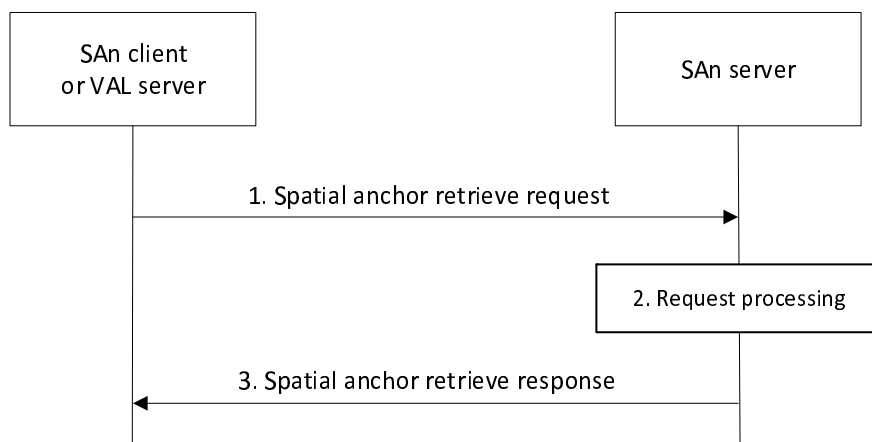
Spatial anchor get operation enables a SAn client or VAL server to get details about the specific spatial anchor from the SAn server.

8.3.6.2 Procedure

Figure 8.3.6.2-1 illustrates the procedure for spatial anchor retrieve operation following the request-response model.

Pre-conditions:

1. The SAn client or VAL server has received information (e.g. URI, IP address) related to the SAn server;
2. The SAn client or VAL server has received security credentials authorizing it to communicate with the SAn server;
3. The SAn client or VAL server has discovered the list of spatial anchors as per the procedure defined in clause 8.3.4.

**Figure 8.3.6.2-1: Spatial anchor retrieve**

1. The requestor (e.g., SAn client or VAL server) sends a spatial anchor retrieve request message to the SAn server to get information about specific spatial anchors of interest. The request includes a requestor identifier, security credentials, identity of the spatial anchor.
2. Upon receiving the request, the SAn server validates if the requestor is authorized for the request. If the requestor is authorized, the SAn server identifies whether spatial anchor exists or not based on identity of the spatial anchor.
3. The SAn server sends a spatial anchor retrieve response to the requestor. If the SAn server has identified spatial anchor, the response includes an indication of success and the details about the spatial anchor. Otherwise, the response includes an indication of failure and may include a reason for failure.

8.3.6.3 Information flows

8.3.6.3.1 Spatial anchor retrieve request

Table 8.3.6.3.1-1 describes information elements for the spatial anchor retrieve request from the SAn client or VAL server to the SAn server.

Table 8.3.6.3.1-1: Spatial anchor retrieve request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL server or VAL UE and VAL user).
Security credentials	M	The security credentials of the requestor.
> Spatial anchor ID	M	Identifier of the spatial anchor.

8.3.6.3.2 Spatial anchor retrieve response

Table 8.3.6.3.2-1 describes information elements for the spatial anchor retrieve response from the SAn server.

Table 8.3.6.3.2-1: Spatial anchor retrieve response

Information element	Status	Description
Successful response	O	Indicates that the spatial anchor retrieve request was successful.
> Spatial anchor profile	M	Spatial anchor profile as specified in Table 7.3.2.1-1
Failure response	O	Indicates that the spatial anchor retrieve request has failed.
> Cause	O	The cause for the request failure.

8.4 Spatial anchor usage information

8.4.1 General

The spatial anchor usage information procedure allows consumer (i.e. VAL server) to get usage information about the spatial anchor. The spatial anchor usage information procedure enables the VAL server to request or subscribe with the SAn server to receive spatial anchor usage information.

8.4.2 Spatial anchor usage information (Sub-Notify)

8.4.2.1 General

This clause enables VAL server to subscribe spatial anchor usage information from the SEAL SAn server.

8.4.2.2 Procedure

Figure 8.4.2.2-1 depicts the procedure for subscribing to receive information related to spatial anchor usage for metaverse applications. The service is provided by SAn server.

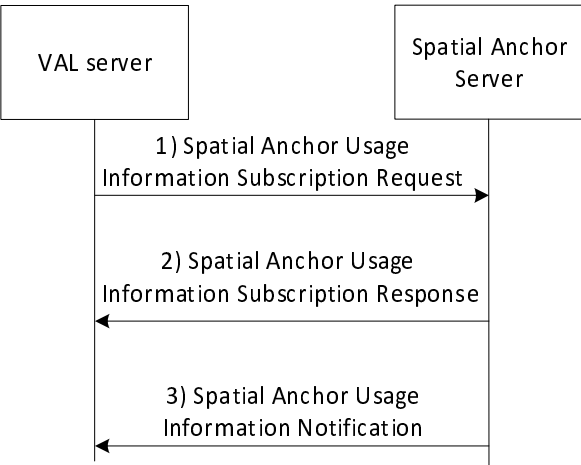


Figure 8.4.2.2-1: Spatial anchor usage information subscription

1. A consumer (e.g. VAL server) sends a spatial anchor usage information subscription request to the SAn server). The request can include the VAL server identifier, security credentials, a notification endpoint (e.g., IP address, FQDN, URI), and spatial anchor filters like spatial anchor identifiers, spatial anchor location information, position of the user, proximity distance, and application service identifier. It may also include the periodicity for reporting notification and sampling interval.
2. Upon receiving the request, the SAn server authorizes the VAL server subscription request and sends a spatial anchor usage subscription response to the consumer.
3. The SAn server samples the information related to spatial anchor usage based on the obtained data and the stored spatial anchor data as per the sampling interval. It provides notification to the consumer as per the reporting interval. The notification message includes spatial anchor ID, number of times spatial anchor discovered and accessed, spatial anchor density per location, user density per spatial anchor, spatial anchor services accessed information.

8.4.2.3 Information flows

8.4.2.3.1 Spatial anchor usage information subscription request

Table 8.4.2.3.1-1 describes information elements for the spatial anchor usage information subscription request from the consumer to the SAn server.

Table 8.4.2.3.1-1: Spatial anchor usage information subscription request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL server).
Security credentials	M	The security credentials of the requestor.
Spatial anchor filters	M	Indicates the spatial anchor filter for the information
> Spatial anchor identifiers	O	Indicates the spatial anchor identities
> Spatial anchor location information	O	Indicates the spatial anchor location information
> Area information	O	Indicates the area information (e.g., location information)
> Application service information	O	Indicates the application service information (e.g., application identifier)
Sampling interval	O	Indicates the interval to sample the spatial anchor(s) related information
Reporting interval	O	Indicates the periodic reporting interval of information
notification endpoint	O	Indicates the endpoint (e.g., IP address, FQDN, URI) to send the information notification
NOTE: Spatial anchor filters IE must include at least one optional IE.		

8.4.2.3.2 Spatial anchor usage information subscription response

Table 8.4.2.3.2-1 describes information elements for the spatial anchor usage information subscription response from the SAn server to the consumer.

Table 8.4.2.3.2-1: Spatial anchor usage information subscription response

Information element	Status	Description
Successful response	O	Indicates that the subscription request was successful.
> Spatial anchor usage information subscription ID	M	Identity for the spatial anchor usage information subscription
Failure response	O	Indicates that the subscription request has failed.
> Cause	O	The cause for the request failure.

8.4.2.3.3 Spatial anchor usage information notification

Table 8.4.2.3.3-1 describes information elements for the spatial anchor usage information notification from the SAn server to the consumer.

Table 8.4.2.3.3-1: Spatial anchor usage information notification

Information element	Status	Description
Spatial anchor usage information subscription ID	M	Identity for the spatial anchor usage information subscription
Spatial anchor identifiers	M	Indicates the spatial anchor identities
> Spatial anchor usage information	M	Indicates spatial anchor usage information. It includes number of times spatial anchor discovered and accessed, spatial anchor services accessed information.
> Spatial anchor density per location	M	Indicates the density of the spatial anchor in the given area.
> User density per spatial anchor	M	Indicates the density of users within proximity to a specific spatial anchor.

8.4.3 Spatial anchor usage information (Request-Response)

8.4.3.1 General

This clause enables VAL server to request spatial anchor usage information from the SEAL SAn server.

8.4.3.2 Procedure

Figure 8.4.3.2-1 depicts the procedure to receive information related to spatial anchor usage for metaverse applications. The service is provided by SAn server.

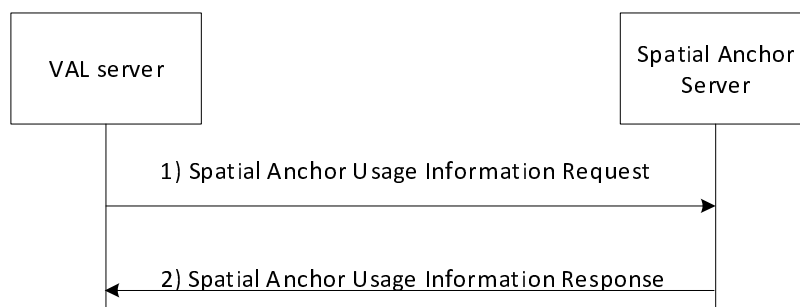


Figure 8.4.3.2-1 Spatial anchor usage information

- 1) The consumer (e.g. VAL server) sends a request message to the SAn server to get the spatial anchor usage information as per Table 8.4.3.3.1-1.
- 2) The SAn server authorizes the consumer. If the requestor is authorized, then the SAn server provides the spatial anchor usage information. The response message includes spatial anchor ID, number of times spatial anchor discovered and accessed, spatial anchor density per location, user density per spatial anchor, spatial anchor services accessed information.

8.4.3.3 Information flows

8.4.3.3.1 Spatial anchor usage information request

Table 8.4.3.3.1-1 describes information elements for the spatial anchor usage information request from the consumer to the SAn server.

Table 8.4.3.3.1-1: Spatial anchor usage information request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL server).
Security credentials	M	The security credentials of the requestor.
Spatial anchor filters	M	Indicates the spatial anchor filter for the information
> Spatial anchor identifiers	O	Indicates the spatial anchor identities
> Spatial anchor location information	O	Indicates the spatial anchor location information
> Area information	O	Indicates the area information (e.g., location information)
> Application service information	O	Indicates the application service information (e.g., application identifier)
NOTE: Spatial anchor filters IE must include at least one optional IE.		

8.4.3.3.2 Spatial anchor usage information response

Table 8.4.3.3.2-1 describes information elements for the spatial anchor usage information response from the SAn server to the consumer.

Table 8.4.3.3.2-1: Spatial anchor usage information response

Information element	Status	Description
Successful response	O	Indicates that the request was successful.
> Spatial anchor identifiers	M	Indicates the spatial anchor identities
> Spatial anchor usage information	M	Indicates spatial anchor usage information. It includes number of times spatial anchor discovered and accessed, spatial anchor services accessed information.
> Spatial anchor density per location	M	Indicates the density of the spatial anchor in the given area.
> User density per spatial anchor	M	Indicates the density of users within proximity to a specific spatial anchor.
Failure response	O	Indicates that the request has failed.
> Cause	O	The cause for the request failure.

8.4.4 Spatial anchor usage reporting

8.4.4.1 General

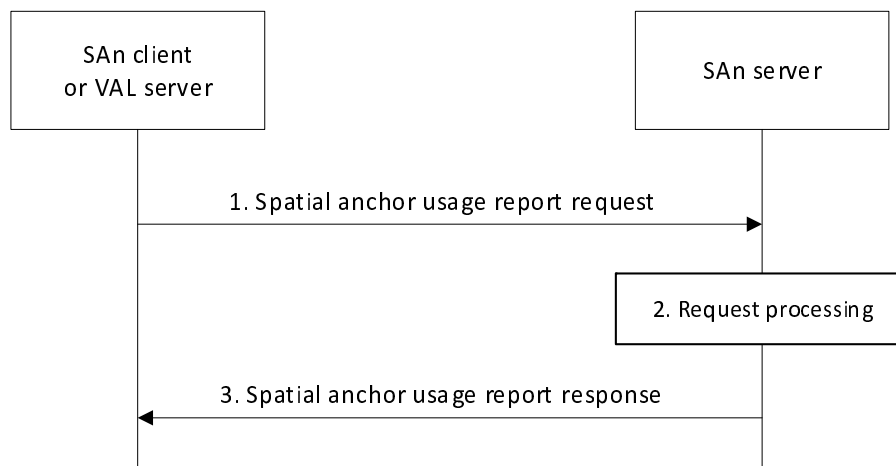
Spatial anchor usage reporting enables a spatial anchor consumer (e.g., SAn client or VAL server) to report spatial anchor usage to the SAn server.

8.4.4.2 Procedure

Figure 8.4.4.2-1 illustrates the spatial anchor usage reporting procedure.

Pre-conditions:

1. The SAn client or VAL server has received information (e.g. URI, IP address) related to the SAn server;
2. The SAn client or VAL server has received security credentials authorizing it to communicate with the SAn server.

**Figure 8.4.4.2-1: Spatial anchor usage reporting**

1. The requestor (e.g., SAn client or VAL server) sends a spatial anchor usage report request to the SAn server. The request includes a requestor identifier, security credentials, and spatial anchor usage information as described in clause 8.4.4.3.1.
2. Upon receiving the request, the SAn server validates if the requestor is authorized for the request. If the requestor is authorized, the SAn server updates the spatial anchor usage information. The SAn server uses the spatial anchor usage information when notifying subscribers(s) as specified in clause 8.4.2.2.

3. The SAn server sends a spatial anchor usage report response to the requestor. If the SAn server successfully stored the spatial anchor usage information, the response includes an indication of success. Otherwise, the response includes an indication of failure and can include a reason for failure.

8.4.4.3 Information flows

8.4.4.3.1 Spatial anchor usage report request

Table 8.4.4.3.1-1 describes information elements for the spatial anchor usage report request from the SAn client or VAL server to the SAn server.

Table 8.4.4.3.1-1: Spatial anchor usage report request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL server or VAL UE and VAL user).
Security credentials	M	The security credentials of the requestor.
List of spatial anchor usage information	M	List of usage information for spatial anchors.
> Spatial anchor ID	M	Identifier of the spatial anchor.
> Number of access	M	The number of times the spatial anchor was accessed.
> Report period	O	The time period for which the number of access applies. If omitted, the number of access is the number of access since the last spatial anchor usage report request.

8.4.4.3.2 Spatial anchor usage report response

Table 8.4.4.3.2-1 describes information elements for the spatial anchor usage report response from the SAn server to the SAn client or VAL server.

Table 8.4.4.3.2-1: Spatial anchor usage report response

Information element	Status	Description
Successful response	O	Indicates that the spatial anchor usage report request was successful.
Failure response	O	Indicates that the spatial anchor usage report request has failed.
> Cause	O	The cause for the request failure.

8.5 SEAL APIs for spatial anchor management

8.5.1 General

Table 8.5.1-1 illustrates the SEAL APIs for spatial anchor management.

Table 8.5.1-1: List of SEAL APIs for spatial anchor management

API Name	API Operations	Known Consumer(s)	Communication Type
SS_SAnManagement	Create	VAL server, SAn client	Request/Response
	Update	VAL server, SAn client	
	Delete	VAL server, SAn client	
	Get	VAL server, SAn client	
	Subscribe	VAL server, SAn client	Subscribe/Notify
	Notify	VAL server, SAn client	
	UpdateSubscription	VAL server, SAn client	
	Unsubscribe	VAL server, SAn client	
SS_SAnDiscovery	Request	SAn client, VAL server	Request/Response
SS_SAnUsageInfo	Request	VAL server	Request/Response
	Subscribe	VAL server	Subscribe/Notify
	Notify	VAL server	
SS_SAnUsageReport	Request	VAL server, SAn client	Request/Response

8.5.2 SS_SAnManagement API

8.5.2.1 General

Service description: This API enables a VAL server (or SAn client) to manage spatial anchors on SEAL SAn server.

8.5.2.2 Create operation

API operation name: SS_SAnManagement_Create

Description: The consumer requests to create spatial anchors.

Known Consumers: VAL server, SAn client.

Inputs: See Table 8.3.1.3.1-1.

Outputs: See Table 8.3.1.3.2-1.

See clause 8.3.1 for details of usage of this operation.

8.5.2.3 Update operation

API operation name: SS_SAMnagement_Update

Description: The consumer requests to update spatial anchors.

Known Consumers: VAL server, SAn client.

Inputs: See Table 8.3.2.3.1-1.

Outputs: See Table 8.3.2.3.2-1.

See clause 8.3.2 for details of usage of this operation.

8.5.2.4 Delete operation

API operation name: SS_SAnManagement_Delete

Description: The consumer requests to delete spatial anchors.

Known Consumers: VAL server, SAn client.

Inputs: See Table 8.3.3.3.1-1.

Outputs: See Table 8.3.3.3.2-1.

See clause 8.3.3 for details of usage of this operation.

8.5.2.5 Retrieve operation

API operation name: SS_SAnManagement_Retrieve

Description: The consumer requests to get spatial anchor profile.

Known Consumers: VAL server, SAn client.

Inputs: See Table 8.3.6.3.1-1.

Outputs: See Table 8.3.6.3.2-1.

See clause 8.3.6 for details of usage of this operation.

8.5.2.6 Subscribe operation

API operation name: SS_SAnManagement_Subscribe

Description: The consumer subscribes for spatial anchors information.

Inputs: See clause 8.3.5.3.1.

Outputs: See clause 8.3.5.3.2.

See clause 8.3.5.2.1 for details of usage of this operation.

8.5.2.7 Notify operation

API operation name: SS_SAnManagement_Notify

Description: The consumer is notified with spatial anchors information.

Inputs: See clause 8.3.5.3.3.

Outputs: None.

See clause 8.3.5.2.2 for details of usage of this operation.

8.5.2.8 UpdateSubscription operation

API operation name: SS_SAnManagement_UpdateSubscription

Description: The consumer updates an existing subscription for spatial anchors information.

Inputs: See clause 8.3.5.3.4.

Outputs: See clause 8.3.5.3.5.

See clause 8.3.5.2.3 for details of usage of this operation.

8.5.2.9 Unsubscribe operation

API operation name: SS_SAnManagement_Unsubscribe

Description: The consumer cancels an existing subscription for spatial anchors information.

Inputs: See clause 8.3.5.3.6.

Outputs: See clause 8.3.5.3.7.

See clause 8.3.5.2.4 for details of usage of this operation.

8.5.3 SS_SAnDiscovery API

8.5.3.1 General

Service description: This API enables a VAL server or SAn client to discover spatial anchors from SEAL SAn server.

8.5.3.2 Request operation

API operation name: SS_SAnDiscovery_Request

Description: The consumer requests to discover spatial anchors.

Known Consumers: VAL server, SAn client.

Inputs: See Table 8.3.4.3.1-1.

Outputs: See Table 8.3.4.3.2-1.

See clause 8.3.4 for details of usage of this operation.

8.5.4 SS_SAnUsageInfo API

8.5.4.1 General

Service description: This API enables a VAL server to get spatial anchor usage information from the SEAL SAn server.

8.5.4.2 Request operation

API operation name: SS_SAnUsageInfo_Request

Description: The consumer requests for spatial anchors usage information.

Inputs: See clause 8.4.3.3.1.

Outputs: See clause 8.4.3.3.2.

See clause 8.4.3 for details of usage of this operation.

8.5.4.3 Subscribe operation

API operation name: SS_SAnUsageInfo_Subscribe

Description: The consumer subscribes for spatial anchors usage information.

Inputs: See clause 8.4.2.3.1.

Outputs: See clause 8.4.2.3.2.

See clause 8.4.2.2 for details of usage of this operation.

8.5.4.4 Notify operation

API operation name: SS_SAnUsageInfo_Notify

Description: The consumer is notified with spatial anchors usage information.

Inputs: See clause 8.4.2.3.3.

Outputs: None.

See clause 8.4.2.2 for details of usage of this operation.

8.5.5 SS_SAnUsageReport API

8.5.5.1 General

Service description: This API enables a VAL server or SAn client to report spatial anchor usage information to the SEAL SAn server.

8.5.5.2 Request operation

API operation name: SS_SAnUsageReport_Request

Description: The consumer provides spatial anchors usage information.

Inputs: See clause 8.4.4.3.1.

Outputs: See clause 8.4.4.3.2.

See clause 8.4.4 for details of usage of this operation.

9 Spatial Map (SM) management

9.1 General

The Spatial Map (SM) management is a SEAL service that offers the spatial map related capabilities to vertical application(s).

9.2 Functional model for spatial map management

9.2.1 General

The functional model for the spatial map server is based on the generic functional model specified in clause 6 of 3GPP TS 23.434 [4]. It is organized into functional entities to describe a functional architecture which addresses the support for spatial map aspects for vertical applications. This clause provides architecture for spatial map (SM) service. The on-network functional model is specified in clause 9.2.2, and service based architecture is specified in clause 9.2.3.

9.2.2 On-network functional model description

Figure 9.2.2-1 illustrates an on-network functional model for spatial map (SM) service.

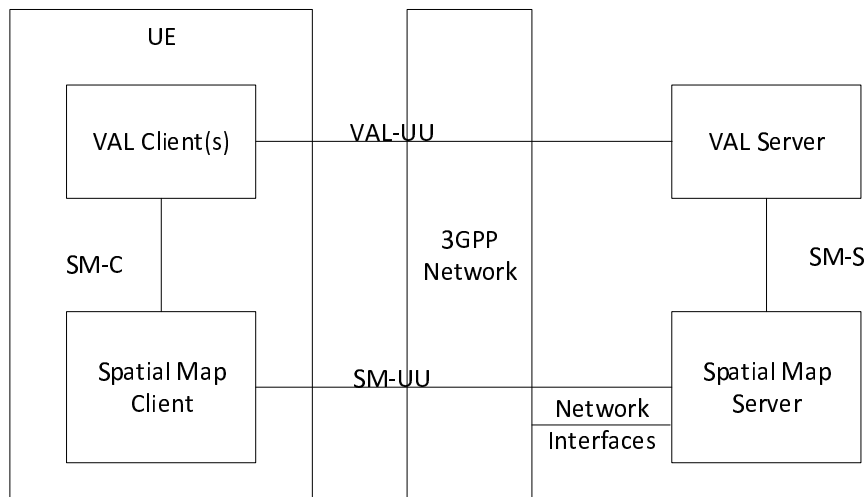


Figure 9.2.2-1: On-network spatial map functional model

The Spatial map management functional entities are grouped into the vertical application layer and the Service Enabler Architecture Layer (SEAL) layer. The Spatial map management offers the capabilities to manage spatial map to the vertical application layer. The Spatial map management functional model is based on SEAL layer as specified in 3GPP TS 23.434 [4].

The Spatial map functional entities on the UE and in the network are respectively the spatial map (SM) client and spatial map (SM) server. The VAL client and VAL server are application client and server respectively to provide an application service to the user. The SM client and SM server provides client and server side functionalities respectively for managing spatial map for the application. The SM client is a SEAL client providing spatial map service to VAL client. The SM server is a SEAL server providing spatial map service to VAL server and UE. The interface between SM Client and SM Server is SM-UU. The SM client interacts with the VAL client using a SM-C interface. The SM server interacts with the VAL server using a SM-S. The SM server communicates with the underlying 3GPP network system (either directly or via NEF) using 3GPP interfaces specified by the 3GPP network system (e.g. T8, N33). When SM server is deployed by PLMN operator, the SM server communicates with 3GPP network system by directly invoking the APIs from exposed by 3GPP core network functions.

The SM server interacts with SAn server over SEAL-X (AnM) reference point as specified in clause 8.2.2.

9.2.2.1 Functional Elements

9.2.2.1.1 Spatial map (SM) server

The SM server acts as a SEAL server and it is used to provide services to create/update/delete/discover spatial map for the VAL application (i.e. metaverse application) and also provides spatial localization service. It can communicate with other SM server in the distributed SEAL deployments.

9.2.2.1.2 Spatial map (SM) client

The SM client acts as a SEAL client for spatial map function. It supports client side functionalities for creating/updating/deleting/discovering/retrieving spatial map for VAL application (i.e. metaverse application) and also provides spatial localization service. The SM client receives the request from VAL client to perform specific functionality.

9.2.2.1.3 VAL server

The VAL server is specified in clause 6.4.2.3 of 3GPP TS 23.434 [4]. The VAL server provides the server side functionalities corresponding to the vertical applications (i.e. metaverse applications) to the client of a VAL user based on a service contract.

9.2.2.1.4 VAL client

The VAL client is specified in clause 6.4.2.2 of 3GPP TS 23.434 [4]. The VAL client provides a metaverse services to the user. It uses the SM client to manage spatial maps for the application.

9.2.2.2 Reference Points

9.2.2.2.1 SM-UU

SM-UU reference point enables interactions between a SM client and SM server. It is used to create/update/delete/discover/retrieve spatial map for the VAL applications (i.e. metaverse applications).

9.2.2.2.2 SM-S

SM-S reference point enables interactions between a SM server and VAL servers (i.e. metaverse application servers). It can be used to create/update/delete/get/retrieve spatial map for the VAL applications (i.e. metaverse applications).

9.2.2.2.3 SM-C

SM-C reference point enables interactions between a SM client and VAL clients (i.e. metaverse application clients). It is used by the VAL client to share information regarding spatial maps related information to the SM client and also to get spatial maps related information from the SM client.

9.2.3 Service based architecture

Figure 9.2.3-1 illustrates the service-based SEAL architecture to support spatial map services.

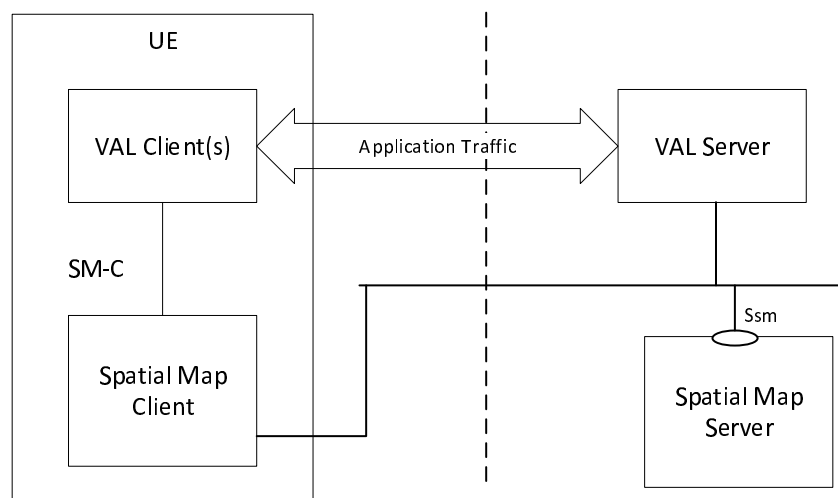


Figure 9.2.3-1: Service based architecture for spatial map

The SM server exposes the APIs over the Ssm interface to the VAL server and SM client. The VAL servers consume the services by interacting on the Ssm interface of the SM server. The CAPIF can be used by VAL functions to discover the services of the SM server.

9.3 Spatial map management procedures

9.3.1 Create spatial map

9.3.1.1 General

The create spatial map procedure enables the consumers to request the SEAL SM Server to create spatial map of the area of interest.

9.3.1.2 Procedure

Figure 9.3.1.2-1 depicts the procedure for creating a spatial map. For the request from VAL server or SEAL SM client, as a spatial map consumer, SEAL SM server creates a spatial map. A spatial map can be structured in layers where each layer signifies a specific aspect of the spatial information (e.g. three dimensional space of area of interest, objects).

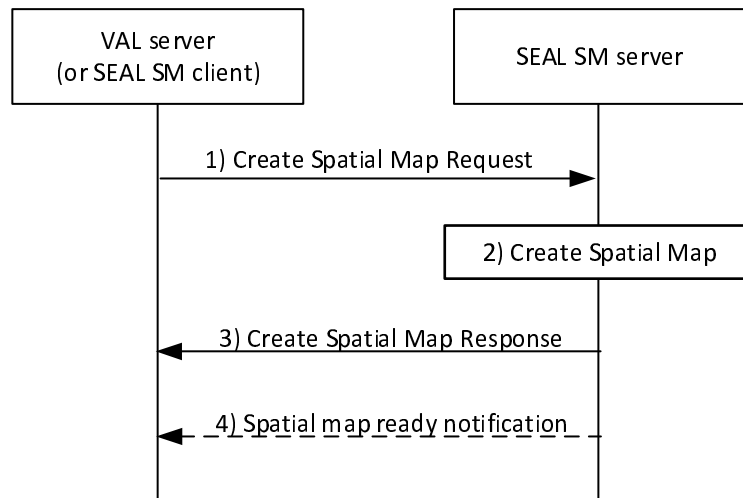


Figure 9.3.1.2-1: Create spatial map procedure

- 1) The requestor (e.g., VAL server or SEAL SM client) sends a request message to the SEAL SM server to create a spatial map. The request includes requestor ID, security credentials, three-dimensional area of interest, information to be included in the spatial map such as allowed entities list defining which entities are permitted to discover and access the spatial map. The request may include spatial map layering information parameters and may also include augmented layer information that can be requested with the spatial map.

NOTE: SEAL SM server can obtain augmented layer information and can provide the obtained augmented layer information to the requestor in the response message.

- 2) The SEAL SM server authorizes the requestor, and validates the request. The SEAL SM server produces a requested spatial map using layering information and processed sensor data.
 - a) If the augmented layer information indicates to include VAL UE information, the SEAL SM server fetches the list of VAL UEs in the area of interest from LM server using clause 9.3.10 of 3GPP TS 23.434 [4] and/or from NEF as specified in 3GPP TS 23.502 [5].
 - b) If the augmented layer information indicates to include spatial anchors information within area of interest, the SEAL SM server fetches the list of spatial anchors in the area of interest as specified in clause 8.3.4.

NOTE: For the current release, the processed sensor data is stored at VAL layer (e.g., in database at VAL layer) and the SEAL SM server gets access to such database to create a spatial map via application specific way which is out of scope.

- 3) The SEAL SM server sends response message to the requestor with a indication of success, in-progress or fail. If the requested spatial map has been created successfully, the response message includes assigned spatial map ID and information which includes three-dimensional space defined by the spatial map and can include a list of spatial map layers with their corresponding layer ID, objects belong to the layer, etc.. If the response indicates "in-progress", an assigned spatial map ID is included in the message. Further, if the response indicates "in-progress" and the requestor has not provided a notification target address, then the requestor subscribes for spatial map event to receive notification when the spatial map is created. Otherwise, the response includes an indication of failure and may include a reason for the failure.
- 4) If the response indicates "in-progress", the SM server detects when the SEAL SM server has sufficient information to map all the objects related to area of interest and the spatial map is ready to provide service (e.g. employed for localization). If the requestor has provided a notification target address in the request or has subscribed for spatial map events, the SEAL SM server notifies the requestor with the spatial map ready notification message. The notification includes parameters as specified in Table 9.3.6.3.3-1.

9.3.1.3 Information flows

9.3.1.3.1 Create spatial map request

Table 9.3.1.3.1-1 describes the information elements from VAL server (or SEAL SM client) to SM server for create spatial map request.

Table 9.3.1.3.1-1: Create spatial map request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL server or VAL User or VAL UE)
Security credentials	M	The security credentials of the requestor.
Application service ID	M	ID of the requesting VAL application service
Area of interest	M	Three-dimensional area information to produce the spatial map
Notification Target Address	O	Notification target address (e.g. URL, URI, IP) where the notifications should be sent.
Information to include	O	Information to be included in the spatial map
> Allowed entities list	O	Identity of entities (e.g. VAL client, VAL server or VAL service identity) which are permitted to discover and access the spatial map
> List of spatial map layers	O	List of spatial map layer information. Each element includes the information described below.
>> Spatial map layer information	O	Information to specify the corresponding spatial map layer specific information
> Augmented layer information	O	List of required augmented layer information. This IE can contain multiple values. Possible values are: - VAL_USERS; - SPATIAL_ANCHORS.

NOTE 1: For the current release, the spatial map layer information is implementation specific and out of scope.

9.3.1.3.2 Create spatial map response

Table 9.3.1.3.2-1 describes the information elements for create spatial map response from SM server to VAL server or SM client.

Table 9.3.1.3.2-1: Create spatial map response

Information element	Status	Description
Application service ID	O	ID of the requesting VAL application service
Success response	O (NOTE)	Information on the created spatial map. It contains information as specified in Table 7.3.3.1-1.
> Spatial map information	M	The information about the created spatial map as described in Table 7.3.3.1-1.
> Augmented layer information	O	Augmented layer information provided by SM server
In-progress response	O (NOTE)	Indicates that creation of the requested spatial map is in-progress.
> Spatial map ID	O	Identifier of the spatial map which is in-progress state.
Failure response	O (NOTE)	Indicates failed create spatial map
> Cause	O	Cause of the failure
NOTE: One of the information elements shall be provided.		

9.3.2 Discover spatial map

9.3.2.1 General

The discover spatial map procedure enables the consumers to request the SEAL SM Server to discover either spatial maps or SMAS of the area of interest.

9.3.2.2 Procedure

Figure 9.3.2.2-1 depicts the procedure for an authorized spatial map consumer (VAL server or SEAL SM client) to discover either spatial map(s) or SMAS. The service is provided by SEAL SM server.

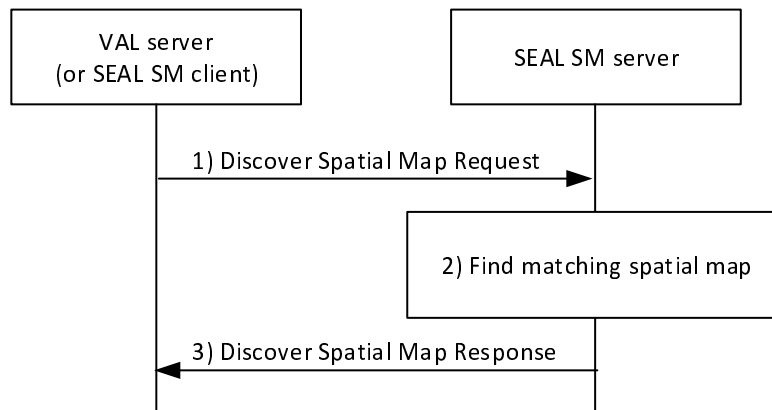


Figure 9.3.2.2-1: Discover spatial map procedure

- 1) The requestor (e.g., VAL server or SEAL SM client) sends a request message to the SEAL SM server to discover spatial map(s). The request includes requestor ID, security credentials, three-dimensional area of interest or localization information to discover spatial maps in the area, optional discovery filters, i.e., a set of characteristics (e.g., a list of specific spatial map layers) to search the matching spatial maps when multiple spatial maps are allowed in the area of interest.

NOTE 1: How the requestor identifies the three-dimensional area of interest is implementation specific.

- 2) The SEAL SM server authorizes the requestor, and validates the request. If the request is authorized, the SEAL SM server determines the spatial map(s) available with it according to the requested filtering criteria. If no spatial map determined for the requested area of interest, the SEAL SM server determines the SMAS registered with the SEAL SM server according to the requested filtering criteria.
- 3) The SEAL SM server sends the discover spatial map response message to the requestor. If the request was successful, the response includes an indication of success and the determined spatial map information or SMAS profile(s), otherwise the response includes an indication of failure and may include a failure reason.

NOTE 2: The requestor can discover APIs associated with SMAS(s) via CAPIF as specified in 3GPP TS 23.222 [7].

9.3.2.3 Information flows

9.3.2.3.1 Discover spatial map request

Table 9.3.2.3.1-1 describes the information elements from VAL server (or SEAL SM client) to SEAL SM server for discover spatial map request.

Table 9.3.2.3.1-1: Discover spatial map request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL server or VAL User or VAL UE)
Security credentials	M	The security credentials of the requestor.
Application service ID	M	ID of the requesting VAL application service
Filtering criteria	M	Criteria to get spatial map(s)
> Area of interest	O (NOTE)	Three-dimensional area information to discover spatial maps
> Location information	O (NOTE)	Location, orientation and pose information that is used to identify relevant spatial maps.
> Optional discovery filters	O	A set of characteristics to search the matching spatial maps
>> List of spatial map layers	O	The list of spatial map layers to discover spatial map(s) with matching layers. Each element includes the information described below.
>>> Spatial map layer information	O	Information to specify the corresponding spatial map layer specific information.
NOTE: At least one of the information elements shall be provided.		

9.3.2.3.2 Discover spatial map response

Table 9.3.2.3.2-1 describes the information elements for Discover spatial map response from SEAL SM server to VAL server or SEAL SM client.

Table 9.3.2.3.2-1: Discover spatial map response

Information element	Status	Description
Application service ID	O	ID of the requesting VAL application service
Success response	O (NOTE 1)	Indicates successful discovery
> List of discovered spatial maps	O (NOTE 2)	List of ID(s) of the discovered spatial map(s). Each element includes the information described below
>> Spatial map ID	M	ID of a spatial map discovered
> List of SMAS profiles	O (NOTE 2)	The list of SMAS profiles as described in Table 9.6.2.3.1-2.
Failure response	O (NOTE 1)	Indicates failed discovery
> Cause	O	Cause of the failure
NOTE 1: At least one of the information elements shall be provided.		
NOTE 2: At least one of the information elements shall be provided.		

9.3.3 Get spatial map information

9.3.3.1 General

The get spatial map procedure enables the consumers to request the SEAL SM Server to get all details about the specific spatial map.

9.3.3.2 Procedure

Figure 9.3.3.2-1 depicts the procedure for an authorized spatial map consumer (VAL server or SEAL SM client) to get the spatial map. The service is provided by SEAL SM server.

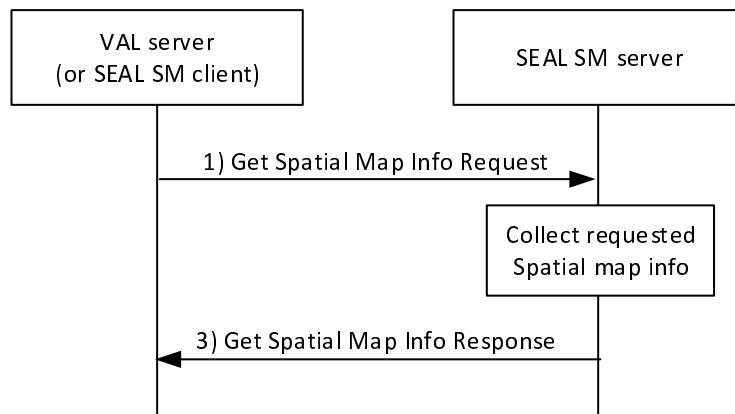


Figure 9.3.3.2-1: Get spatial map information procedure

- 1) The requestor (e.g., VAL server or SEAL SM client) sends a request message to the SEAL SM server to get the spatial map information. The request includes requestor ID, security credentials, spatial map ID and may include a list of requested spatial map layers and augmented layer information.
- 2) The SEAL SM server authorizes the requestor, and validates the request. If the request is authorized, the SEAL SM server determines information about the requested spatial map information.
- 3) The SEAL SM server sends the get spatial map information response message to the requestor. If the request is successful, the response includes spatial map information and may include augmented layer information, otherwise the response indicates a failure and may include a failure reason.

9.3.3.3 Information flows

9.3.3.3.1 Get spatial map information request

Table 9.3.3.3.1-1 describes the information elements for get spatial map request from the VAL server or SEAL SM client to the SEAL SM server.

Table 9.3.3.3.1-1: Get spatial map information request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL server or VAL User or VAL UE)
Security credentials	M	The security credentials of the requestor.
Application service ID	M	ID of the requesting VAL application service
Spatial map ID	M	ID of the spatial map to get information on it
> List of spatial map layers	O	A list of spatial map layers for which information is requested.
> Augmented layer information	O	List of requested augmented layer information. This IE can contain multiple values. Possible values are: - VAL_USERS; - SPATIAL_ANCHORS.

9.3.3.3.2 Get spatial map information response

Table 9.3.3.3.2-1 describes the information elements for get spatial map response from the SEAL SM server to the VAL server or SEAL SM client.

Table 9.3.3.2-1: Get spatial map information response

Information element	Status	Description
Spatial map ID	M	ID of the requested spatial map to get information
Application service ID	O	ID of the requesting VAL application service
Success response	O (NOTE)	Indicates successful get information
> Spatial map information	M	Information about the requested spatial map as specified in Table 7.3.3.1-1.
> Augmented layer information	O	Augmented layer information provided by SM server.
Failure response	O (NOTE)	Indicates failed get information
> Cause	O	Cause of the failure
NOTE: At least one of the information elements shall be provided.		

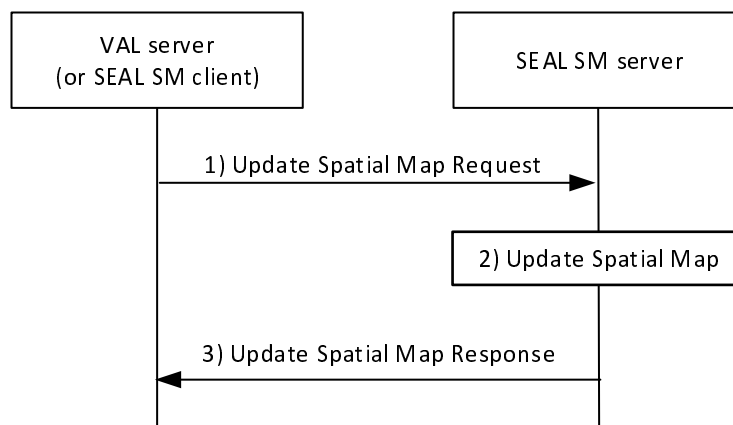
9.3.4 Update spatial map

9.3.4.1 General

The update spatial map procedure enables the consumers to request the SEAL SM Server to update a spatial map.

9.3.4.2 Procedure

Figure 9.3.4.2-1 depicts the procedure to update the spatial map. For the request from the spatial map consumer (VAL server or SEAL SM client), SEAL SM server updates the spatial map as requested.

**Figure 9.3.4.2-1: Update spatial map procedure**

- 1) The requestor (e.g., VAL server or SEAL SM client) sends a request message to the SEAL SM server to update a spatial map. The request includes requestor ID, security credentials, spatial map ID, information on what to update such as updated spatial map layering information and updated spatial map coverage area. As a part of update, the request may include augmented layer information (e.g., VAL users, spatial anchors).
- 2) The SEAL SM server authorizes the requestor and validates the request. The SEAL SM server updates the spatial map as requested.
- 3) The SEAL SM server sends response message to the requestor with result of the request and updated spatial map information with the spatial map ID. SEAL SM server may include the requested augmented layer information in the response message.

9.3.4.3 Information flows

9.3.4.3.1 Update spatial map request

Table 9.3.4.3.1-1 describes the information elements for update spatial map request from VAL server or SEAL SM client to SEAL SM server.

Table 9.3.4.3.1-1: Update spatial map request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL server or VAL User or VAL UE)
Security credentials	M	The security credentials of the requestor.
Application service ID	M	ID of the requesting VAL application service
Spatial map ID	M	ID of the spatial map to update
Spatial map update information	M	The spatial map Information to update as described in described in Table 7.3.3.1-1. Only IEs which need to be updated are included.
> Augmented layer information	O	List of required augmented layer information. This IE can contain multiple values. Possible values are: - VAL_UE; - SPATIAL_ANCHORS.
NOTE: At least one of the information elements shall be provided.		

9.3.4.3.2 Update spatial map response

Table 9.3.4.3.2-1 describes the information elements for update spatial map response from the SEAL SM server to the VAL server or SEAL SM client.

Table 9.3.4.3.2-1: Update spatial map response

Information element	Status	Description
Spatial map ID	M	ID of the requested spatial map to get information
Application service ID	O	ID of the requesting VAL application service
Success response	O (NOTE)	Indicates successful update
> Spatial map information	M	Updated spatial map information. It contains information as specified in Table 7.3.3.1-1.
> Augmented layer information	O	Augmented layer information
Failure response	O (NOTE)	Indicates failed update
> Cause	O	Cause of failure
NOTE: At least one of the information elements shall be provided.		

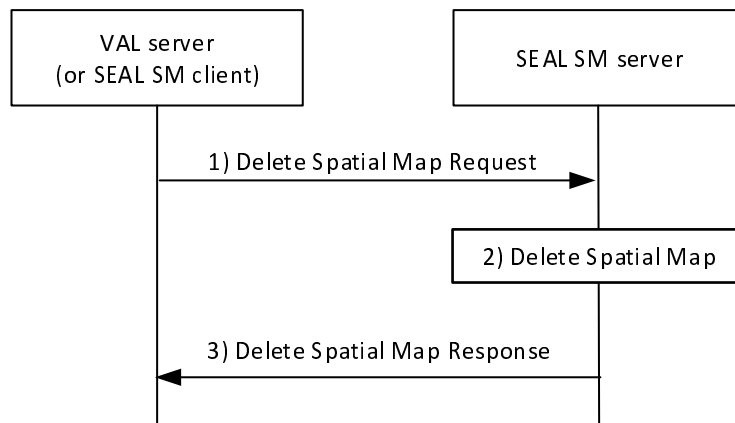
9.3.5 Delete spatial map

9.3.5.1 General

The delete spatial map procedure enables the consumers to request the SEAL SM Server to delete a spatial map.

9.3.5.2 Procedure

Figure 9.3.5.2-1 depicts the procedure to delete the spatial map. For the request from the spatial map consumer (VAL server or SEAL SM client), SEAL SM server deletes the spatial map as requested.

**Figure 9.3.5.2-1: Delete spatial map procedure**

- 1) The requestor (e.g., VAL server or SEAL SM client) sends a request message to the SEAL SM server to delete the spatial map. The request includes requestor ID, security credentials, a spatial map ID.
- 2) The SEAL SM server authorizes the requestor and validates the request. The SEAL SM server deletes the spatial map as requested.
- 3) The SEAL SM server sends response message to the requestor with the result of success or failure.

9.3.5.3 Information flows

9.3.5.3.1 Delete spatial map request

Table 9.3.5.3.1-1 describes the information elements for delete spatial map request from VAL server or SEAL SM client to SEAL SM server.

Table 9.3.5.3.1-1: Delete spatial map request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL server or VAL User or VAL UE)
Security credentials	M	The security credentials of the requestor.
Spatial map ID	M	Spatial map ID to delete

9.3.5.3.2 Delete spatial map response

Table 9.3.5.3.2-1 describes the information elements for delete spatial map response from SEAL SM server to VAL server or SEAL SM client.

Table 9.3.5.3.2-1: Delete spatial map response

Information element	Status	Description
Success response	O (NOTE)	Indicates successful delete
Failure response	O (NOTE)	Indicates failed delete
> Cause	O	Cause of failure
NOTE: At least one of the information elements shall be provided.		

9.3.6 Spatial map subscription

9.3.6.1 General

This clause provides subscription related procedures to spatial map specific events.

9.3.6.2 Procedures

9.3.6.2.1 Subscribe spatial map event

Figure 9.3.6.2.1-1 depicts the procedure for the authorized spatial map consumer (VAL server or SEAL SM client) to subscribe the spatial map event. The service is provided by SEAL SM server. Spatial map consumer can get notification information when the the SM server detects subscribed event.

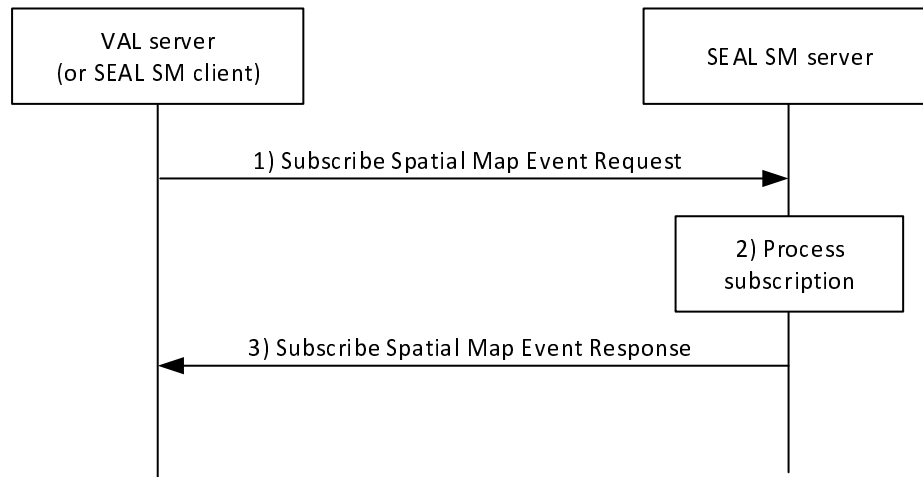


Figure 9.3.6.2.1-1: Subscribe spatial map event procedure

- 1) The VAL server (or SEAL SM client) sends a request message to the SEAL SM server to subscribe spatial map event. The request includes requestor ID, security credentials, a notification endpoint, target spatial map(s), event to subscribe which triggers the notification. The request message may also include a list of spatial map layers with its corresponding layer IDs to subscribe spatial map layering information related events. The requestor (VAL server or SEAL SM client) may subscribe to one or more of the following events:
 - a) "changes of objects" events to indicate the SM server to notify the requestor when changes of the objects are detected. The notification triggering criteria for "changes of objects" event may include added or removed objects, position or direction changes of the spatial map objects.
 - b) "layers modification" events to indicate the SM server to notify the requestor when any layer in the spatial map is added or updated or removed.
 - c) "spatial map ready" events to indicate the SM server to notify the requestor when the SEAL SM server has sufficient information to map all the objects related to area of interest the spatial map and the spatial map is ready to provide service (e.g. employed for localization). This event is used when the result IE in the Create spatial map response indicates "in-progress".

NOTE: In this release, objects are limited to UEs.

- 2) The SEAL SM server authorizes VAL server (or SEAL SM client), and validates the request. If authorized, the SEAL SM server determines the target spatial map(s) using spatial map ID(s), area of interest, and/or location information provided in the request. Then the SEAL SM server adds the requestor into the subscriber list of the event. The SEAL SM server starts monitoring for events.
- 3) The SEAL SM server sends response message with the result. For the successful subscribe request, a subscription ID is included in the message. Otherwise, the response message includes an indication of failure and may include a reason for failure.

9.3.6.2.2 Notify spatial map event

Figure 9.3.6.2.2-1 depicts the notify spatial map event operation between the authorized spatial map consumer (VAL server or SEAL LM client) and SEAL SM server.

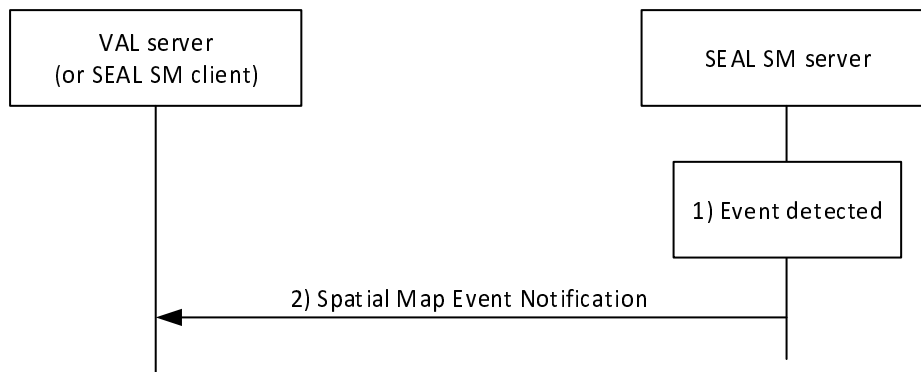


Figure 9.3.6.2.2-1: Notify spatial map event

- 1) The SEAL SM server detects an event that triggers the notification to the subscribers for the corresponding event.
 - a) If the subscribed event is "changes of objects", the SM server detects any changes of the spatial map objects.
 - b) If the subscribed event is "Layers modification", the SM server detects any changes of the spatial map layers information.
 - a) If the subscribed event is "spatial map ready", the SM server detects when the SEAL SM server has sufficient information to map all the objects related to area of interest the spatial map and the spatial map is ready to provide service (e.g. employed for localization).

SM server determines whether the detected event matches triggering criteria and notifies subscribers accordingly.

- 2) The SEAL SM server notifies the VAL servers (or SEAL SM clients) which subscribed the corresponding event. The notification includes a subscription ID and event-specific information. If the event is "changes of objects", spatial map notification message includes the information on the detected triggering event, e.g. added or removed objects, position or direction changes of the objects in the spatial map etc. If the event is "Layer modification", the notification message includes the list of all layers for the spatial map.

9.3.6.2.3 Unsubscribe spatial map

Figure 9.3.6.2.3-1 depicts the procedure for the authorized spatial map consumer (VAL server or SEAL CM client) to unsubscribe from the spatial map event. The service is provided by SEAL SM server.

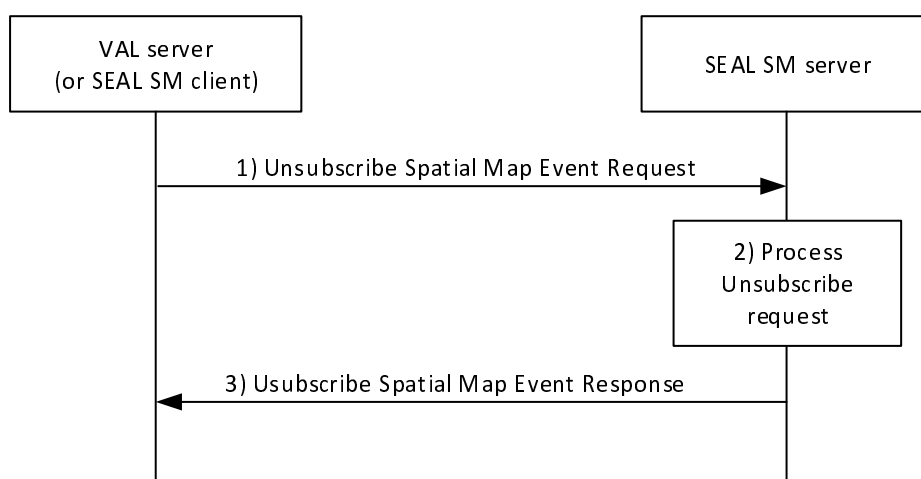


Figure 9.3.6.2.3-1: Unsubscribe spatial map procedure

- 1) The VAL server (or SEAL SM client) sends a request message to the SEAL SM server to unsubscribe from spatial map event. The request includes requestor ID, security credentials and the subscription ID for the event.

- 2) The SEAL SM server authorizes VAL server (or SEAL SM client), and validates the request. Then SM server removes the requestor's subscription ID from the subscriber list for the spatial map event.
- 3) The SEAL SM server sends unsubscribe spatial map event response message with the result. If successful, the response includes an indication of success. Otherwise, the response includes an indication of failure and may include a reason for failure.

9.3.6.3 Information flows

9.3.6.3.1 Subscribe spatial map request

Table 9.3.6.3.1-1 shows the subscribe spatial map event request sent by VAL server (or SEAL SM client) to SEAL SM server to subscribe for spatial map event(s).

Table 9.3.6.3.1-1: Subscribe spatial map event request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL server or VAL user)
Security credentials	M	The security credentials of the requestor.
Application service ID	M	ID of the requesting VAL application service
Expiry time	O	Proposed subscription expiry time
Notification endpoint	M	Indicates the address (e.g., IP address, FQDN, URI) where the notifications should be sent.
Target spatial map(s)	M	Spatial map(s) to subscribe
> List of spatial map IDs	O (NOTE 1)	ID(s) of the spatial map(s) to subscribe
> Area of interest	O (NOTE 1)	Three-dimensional area information to discover spatial map(s) to subscribe
> Location information	O (NOTE 1)	Location, orientation and pose information that is used to identify relevant spatial maps to subscribe.
List of events	M	Events to subscribe. Each element includes the information described below.
> Event type	O	List of events to subscribed. Possible values are: - Change of objects - Layers modification - spatial map ready
> specified objects	O	List of specified objects for "change of objects" event
> Triggering criteria	O	Specifies the condition to determine whether the event is occurred, e.g. Spatial map is employed and ready for localization service.
>> Changes in objects	O (NOTE 2)	Triggers notification if any or specified (or specified type of) objects are added, removed, etc.
>> Layer IDs	O (NOTE 2)	List of layers. Triggers notification if any or specified spatial map layer change is detected
> Notification intervals	O	Specifies when to notify the detected event, Possible values are: - Event based (e.g., promptly); Or - Periodically (with minimum time between consecutive notifications) - intervals (i.e. minimum time between consecutive notifications)
> interval time	O	Time between consecutive notifications (applicable only if notification intervals is set to intervals.
NOTE 1: At least one of the sub-elements shall be provided.		
NOTE 2: At least one of the sub-elements shall be provided.		

9.3.6.3.2 Subscribe spatial map response

Table 9.3.6.3.2-1 shows the subscribe spatial map event response sent by SEAL SM server to VAL server (or SEAL SM client) as the response to the subscribe spatial map event request.

Table 9.3.6.3.2-1: Subscribe spatial map event response

Information element	Status	Description
Result	M	Result of the subscribe spatial map event request
Subscription Id (NOTE)	O	Identity of the subscription
Expire time	O	Subscription expire time
Failure cause	O	Indicates reason for the failure.
NOTE: This IE is mandatory when Result IE indicates success.		

9.3.6.3.3 Notify spatial map event

Table 9.3.6.3.3-1 shows the spatial map notification sent by SEAL SM server to VAL server (or SEAL SM client) to notify about spatial map event(s).

Table 9.3.6.3.3-1: Spatial map event notification

Information element	Status	Description
Subscription ID	M	Subscription ID for the event
Notification information	M	Specifies what matches the triggering notification condition, including related information
> Spatial map ID	M	ID of the spatial map for which the event is detected
> Event type	M	Type of event detected. One of the event as specified in Table 9.3.6.3.1-1.
>> Changed object	O (NOTE)	Information on the object which triggered the notification
>>> Object ID	O	ID of the changed object
>>> Type of change	O	Specifies the detected type of change for the object (e.g., added, removed, or changed position or direction)
>>> Changed object information	O	A container to carry the changed object specific information
>> list of layers (NOTE 2)	O	Information about layers for the spatial map.
NOTE 1: This IE is applicable for "Change of objects" event type.		
NOTE 2: This IE is applicable for "Layer modification" event type.		

NOTE: For the current release, the object specific information is implementation specific and out of scope.

9.3.6.3.4 Unsubscribe spatial map request

Table 9.3.6.3.4-1 shows the unsubscribe spatial map event request sent by VAL server (or SEAL SM client) to SEAL SM server to subscribe for spatial map event(s).

Table 9.3.6.3.4-1: Unsubscribe spatial map event request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL server or VAL user)
Security credentials	M	The security credentials of the requestor.
Subscription ID	M	Subscription ID for the event

9.3.6.3.5 Unsubscribe spatial map response

Table 9.3.6.3.5-1 shows the unsubscribe spatial map event response sent by SEAL SM server to VAL server (or SEAL SM client) as the response to the unsubscribe spatial map event request.

Table 9.3.6.3.5-1: Unsubscribe spatial map event response

Information element	Status	Description
Result	M	Result of the subscribe spatial map event request
Failure cause	O	Indicates reason for the failure.

9.4 Spatial localization services

9.4.1 General

This spatial localization services enables consumer to request SEAL SM Server for localization of a VAL user or VAL UE.

9.4.2 Procedure

Figure 9.4.2-1 depicts the procedure for the authorized spatial map consumer (VAL server or SEAL SM client) to invoke spatial localization services. The service is provided by SEAL SM server.

Pre-condition:

- 1) Spatial map is created and the authorized consumer is aware of the spatial map identity.

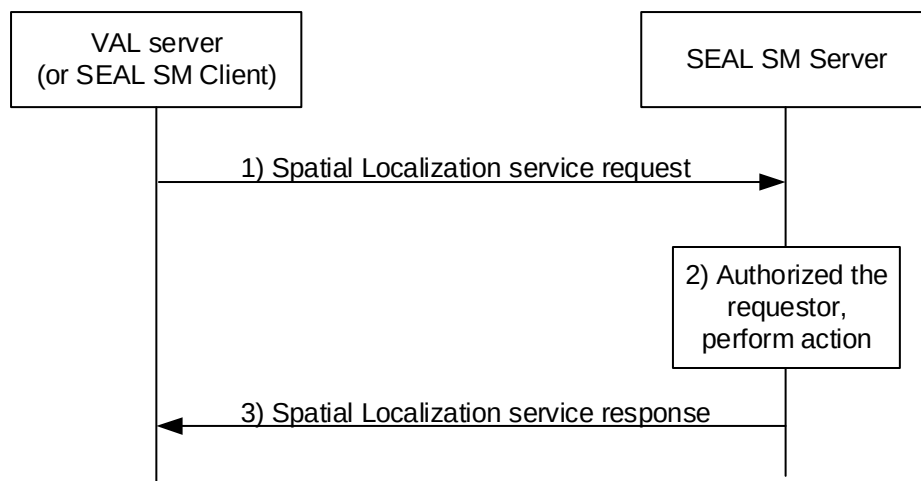


Figure 9.4.2-1: Spatial localization services

- 1) The VAL server (or SEAL SM client) sends request to perform localization service in the spatial map to the SEAL SM server. The request includes a requestor identifier, security credentials, and identity of the map on which the action is to be performed. The request may include list of users (or UEs) to localize.
- 2) The SEAL SM server authorizes the requestor (e.g. VAL server or SEAL SM client). If the requestor is not authorized then the SEAL SM server sends failure response. If the request is authorized: the SEAL SM server, identifies all users/UEs localization along with their three dimensional location and pose in the spatial map. If area of interest IE is present then the SEAL SM server identifies the target users/UEs within the area of interest only, otherwise, the SEAL SM server identifies the target users for whole map (according to the area associated with spatial map identifier).
- 3) The SEAL SM server sends response to the VAL server (or SEAL SM client). The response includes the object localization and identity.

NOTE: In this release, the localization of UE is considered. Localization of all objects will be considered in future release.

9.4.3 Information flows

9.4.3.1 Spatial localization service request

Table 9.4.3.1-1 describes information elements for the spatial localization service request from the SM client or VAL server to the SM server.

Table 9.4.3.1-1: Spatial localization service request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL User or VAL UE, VAL server)
Security credentials	M	The security credentials of the requestor.
Spatial Map Id	M	Identity of the spatial map
Area of interest	O	Contains three dimensional area within spatial map
Target identities	O	List of identity of the users or objects to localize

9.4.3.2 Spatial localization service response

Table 9.4.3.2-1 describes information elements for the spatial localization service response from the SM server to the SM client or VAL server.

Table 9.4.3.2-1: Spatial localization service response

Information element	Status	Description
Result	M	Indicates success or failure of the action
Object details (NOTE)	O	A list of objects or users
>> UE id	O	Identity of the UE
>> localization	O	3D position and pose of the VAL UE
NOTE: This IE should be added in case of successful response.		

9.5 SM data source

9.5.1 General

This clause provides registration related procedures for SM data source.

9.5.2 SM data source registration

9.5.2.1 General

The SM data source registration procedure registers the authorized SM information data source with SEAL SM server.

9.5.2.2 Procedure

Figure 9.5.2.2-1 depicts the procedure for an authorized VAL client, via a SEAL SM client, to register as a SM data source with the SEAL SM server.

Pre-conditions:

1. The SEAL SM client has received information (e.g. URI, IP address) related to the SEAL SM server;
2. The SEAL SM client has received security credentials authorizing it to communicate with the SEAL SM server.

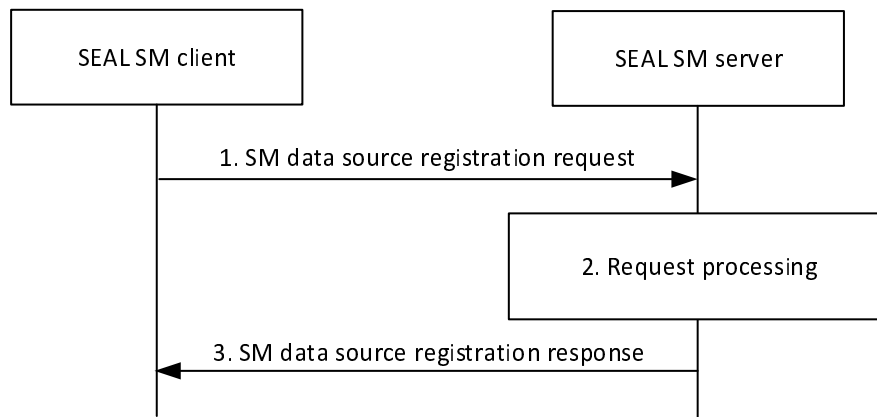


Figure 9.5.2.2-1: SM data source registration procedure

1. The SEAL SM client sends a SM data source registration request to the SEAL SM server. The request includes a requestor ID, security credentials, SEAL SM client notification endpoint and a SM data source profile including SM information details (e.g., provider identifier, type, position, state). The request may include UE identifier, VAL client identifier, Proposed expiration time. The SM data source profile may also include data source update interval information, to support the different needs for frequency of the data source. When real-time data is needed (such as autonomous driving, drones, etc.) a different update interval can be used than for the fixed cases (e.g., in industrial setting).
2. Upon receiving the request, the SEAL SM server validates if the requestor is authorized for the request. If the requestor is authorized, the SEAL SM server assigns a unique identifier for the registration and stores the SM data source profile provided in the request.
3. The SEAL SM server sends a SM data source registration response to the SEAL SM client. If the SEAL SM server successfully stored the SM data source profile, the response includes an indication of success, the registration identifier and may include an expiration time for the registration. Otherwise, the response includes an indication of failure and may include a reason for failure.

NOTE: In this release, SM specific data source procedures are used. If and when generic data source related procedures are available, usage of generic procedures will be considered.

9.5.2.3 Information flows

9.5.2.3.1 SM data source registration request

Table 9.5.2.3.1-1 describes information elements in the SM data source registration request from the SEAL SM client to the SEAL SM server.

Table 9.5.2.3.1-1: SM data source registration request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL User or VAL UE)
Security credentials	M	The security credentials of the requestor
Proposed expiration time	O	Proposed expiration time for the registration
UE ID	O	The identifier of the hosting UE (i.e., GPSI)
VAL client ID	O	The identifier of the VAL client
Notification endpoint	M	The endpoint for notifying the SM data source about a SM information request.
SM data source profile	M	The SM data source profile of the registering SM data source as described in Table 7.3.3.2-1.

9.5.2.3.2 SM data source registration response

Table 9.5.2.3.2-1 describes information elements in the SM data source registration response from the SEAL SM server to the SEAL SM client.

Table 9.5.2.3.2-1: SM data source registration response

Information element	Status	Description
Successful response	O	Indicates that the registration request was successful
> Registration ID	M	Identifier of the registration
> Expiration time	O	Indicates the expiration time of the registration. To maintain an active registration status, a registration update is required before the expiration time. If the Expiration time IE is not included, it indicates that the registration never expires.
Failure response	O	Indicates that the registration request failed
> Cause	O	Indicates the cause of registration request failure

9.5.3 SM data source registration update

9.5.3.1 General

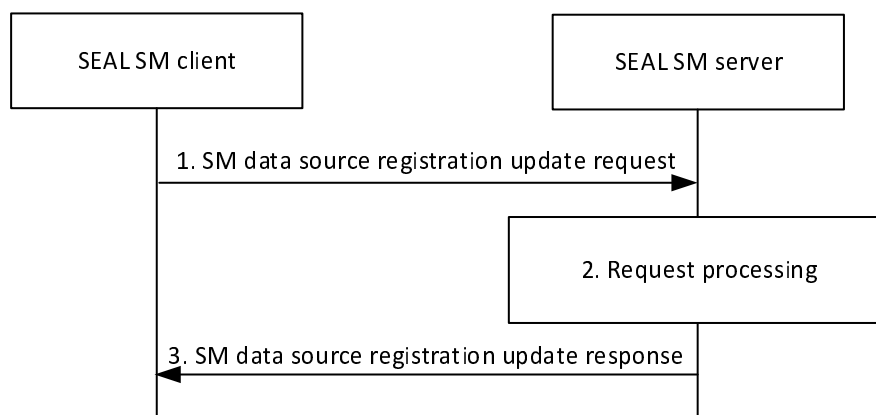
The SM data source registration update procedure updates registration status of the authorized SM information data source to the SEAL SM server.

9.5.3.2 Procedure

Figure 9.5.3.2-1 depicts the procedure for an authorized VAL client, via a SEAL SM client, to update a registered SM data source information.

Pre-conditions:

1. The SEAL SM client has successfully registered the SM data source with the SEAL SM server.

**Figure 9.5.3.2-1: SM data source registration update procedure**

1. The SEAL SM client sends a SM data source registration update request to the SEAL SM server. The request includes a requestor ID, security credentials, a registration ID, and may include an updated SM data source profile and a proposed expiration time for the updated registration.
2. Upon receiving the request, the SEAL SM server validates if the requestor is authorized for the request. If the requestor is authorized, the SEAL SM server updates the SM data source profile based on the request information.
3. The SEAL SM server sends the SM data source registration update response to the SEAL SM client. If the SEAL SM server successfully updated the SM data source profile, the response includes an indication of success. Otherwise, the response includes an indication of failure and may include a reason for failure.

NOTE: In this release, SM specific data source procedures are used. If and when generic data source related procedures are available, usage of generic procedures will be considered.

9.5.3.3 Information flows

9.5.3.3.1 SM data source registration update request

Table 9.5.3.3.1-1 describes information elements in the SM data source registration update request from the SEAL SM client to the SEAL SM server.

Table 9.5.3.3.1-1: SM data source registration update request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL User or VAL UE)
Security credentials	M	The security credentials of the requestor
Registration ID	M	Identifier of the registration
Proposed expiration time (NOTE)	O	Proposed expiration time for the registration
Updated SM data source profile (NOTE)	O	The SM data source profile, as described in Table 7.3.3.2-1, with updated SM information details. Included only if there is an update in SM information details.
NOTE: At least one of the IEs is included.		

9.5.3.3.2 SM data source registration update response

Table 9.5.3.3.2-1 describes information elements in the SM data source registration update response from the SEAL SM server to the SEAL SM client.

Table 9.5.3.3.2-1: SM data source registration update response

Information element	Status	Description
Successful response	O	Indicates that the registration update request was successful
> Expiration time	O	Indicates the expiration time of the updated registration. To maintain an active registration status, a registration update is required before the expiration time. If the Expiration time IE is not included, it indicates that the updated registration never expires.
Failure response	O	Indicates that the request failed
> Cause	O	Indicates the cause of the failure

9.5.4 SM data source deregistration

9.5.4.1 General

The SM data source deregistration procedure deregisters the authorized SM information data source from the SEAL SM server.

9.5.4.2 Procedure

Figure 9.5.4.2-1 depicts the procedure for an authorized SEAL SM client to deregister a SM data source.

Pre-conditions:

1. The SEAL SM client has already registered the SM data source with the SEAL SM server.

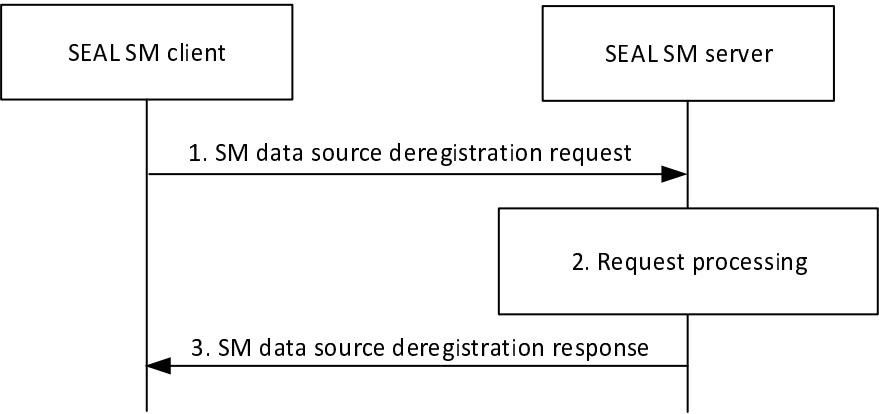


Figure 9.5.4.2-1: SM data source deregistration procedure

- 1. The SEAL SM client sends a SM data source deregistration request to the SEAL SM server. The request includes a requestor ID, security credentials, and a registration ID.
- 2. Upon receiving the request, the SEAL SM server validates if the requestor is authorized for the request. If the requestor is authorized, the SEAL SM server ends the SM data source registration and removes the stored SM data source profile.
- 3. The SEAL SM server sends the SM data source deregistration response to the SEAL SM client. If the SEAL SM server successfully deregistered the SEAL SM client, the response includes an indication of success. Otherwise, the response includes an indication of failure and may include a reason for failure.

NOTE: In this release, SM specific data source procedures are used. If and when generic data source related procedures are available, usage of generic procedures will be considered.

9.5.4.3 Information flows

9.5.4.3.1 SM data source deregistration request

Table 9.5.4.3.1-1 describes information elements in the SM data source deregistration request from the SEAL SM client to the SEAL SM server.

Table 9.5.4.3.1-1: SM data source deregistration request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL User or VAL UE)
Security credentials	M	The security credentials of the requestor
Registration ID	M	Identifier of the registration

9.5.4.3.2 SM data source deregistration response

Table 9.5.4.3.2-1 describes information elements in the SM data source deregistration response from the SEAL SM server to the SEAL SM client.

Table 9.5.4.3.2-1: SM data source deregistration response

Information element	Status	Description
Successful response	O	Indicates that the deregistration request was successful
Failure response	O	Indicates that the request failed
> Cause	O	Indicates the cause of the failure

9.5.5 SM data source discovery

9.5.5.1 General

The SM data source discovery procedure allows VAL server to discover the authorized SM information data sources from the SEAL SM server.

9.5.5.2 Procedure

Figure 9.5.5.2-1 depicts the procedure for an authorized VAL server to discover SM data source(s).

Pre-conditions:

1. The VAL server has received information (e.g. URI, IP address) related to the SEAL SM server;
2. The VAL server has received security credentials authorizing it to communicate with the SEAL SM server.

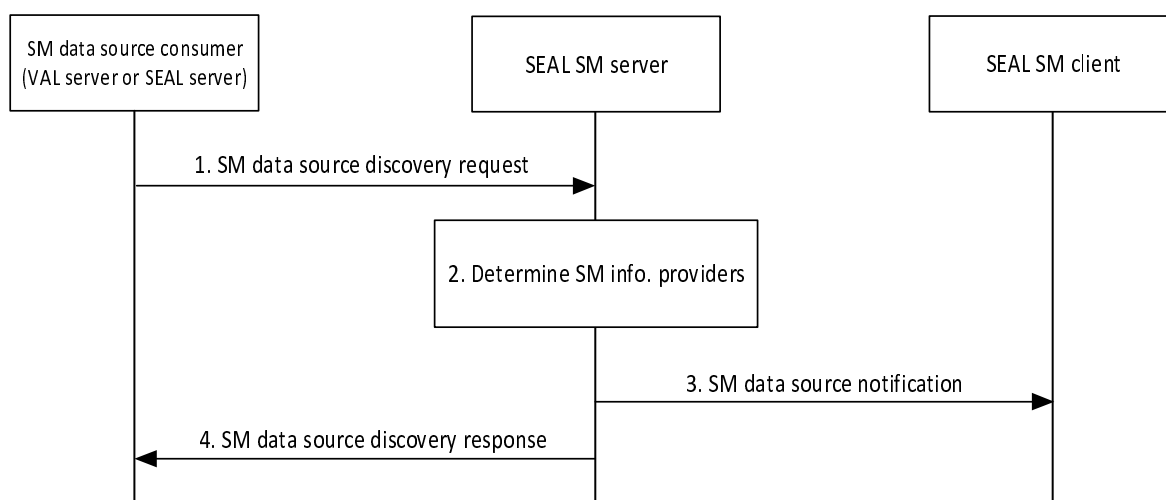


Figure 9.5.5.2-1: SM data source discovery procedure

1. The requestor (e.g. VAL server or SEAL server) sends a SM data source discovery request to the SEAL SM server. The request includes a requestor ID, security credentials, and may include discovery filters and endpoint information for receiving spatial mapping information from discovered SM data sources. Discovery filters include the area of interest (e.g., three-dimensional area, localization information) and requirements on spatial mapping information as defined in clause 9.5.5.3.1.

NOTE 1: How the requestor determines the requested area of interest is implementation specific.

2. The SEAL SM server authorizes the requestor and validates the request. If the request is authorized, the SEAL SM server determines one or more registered SM data source(s) according to the discovery filters.

The SEAL SM server evaluates if the SM data source location is in accordance with the area of interest included in the discovery request to determine the SM data source(s). The SEAL SM server can obtain UE location information from the 3GPP core network by invoking the 3GPP Core Network Location Services exposed by the NEF as described in 3GPP TS 23.273 [6] and 3GPP TS 23.502 [5], or by invoking the SEAL Location Management APIs as described in 3GPP TS 23.434 [4].

3. The SEAL SM server sends a SM data source notification to trigger the determined SEAL SM client(s) to send spatial mapping information. The notification includes details about the requested spatial mapping information and endpoint information for sending the spatial mapping information to the requestor. The SEAL SM client provides the information included in the notification to the VAL client that will send the spatial mapping information.
4. The SEAL SM server sends a SM data source discovery response to the requestor. The response includes information about SM data source(s) when at least one SM data source has been determined. If no SM information provided was determined, the SEAL SM server sends a failure indication with a reason for failure.

NOTE: In this release, SM specific data source procedures are used. If and when generic data source related procedures are available, usage of generic procedures will be considered.

9.5.5.3 Information flows

9.5.5.3.1 SM data source discovery request

Table 9.5.5.3.1-1 describes information elements in the SM data source discovery request from the VAL server to the SEAL SM server.

Table 9.5.5.3.1-1: SM data source discovery request

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., VAL server)
Security credentials	M	The security credentials of the requestor
SM data reporting endpoint	O	The endpoint information where the triggered spatial mapping data source sends the SM data.
Discovery filters	O	Set of characteristics to determine SM data source(s) in the area of interest
> Area of interest	O	Three-dimensional area of interest or localization information to discover SM data source(s) in the area
> SM information details	O	The SM information details to match
>> SM data identifier	O	The identifier of SM information
>> SM data type (NOTE)	O	The type of SM information (e.g., LiDAR camera, RGB-D camera, high-resolution cameras, etc.) that is provided by the application layer.
>> SM data format	O	The format of a SM information (e.g., raw, processed, etc.)
>> Position information	O	Indicates the Three dimensional area of interest or location information of the SM data source
>> Availability State information	O	Indicates the time period availability information of the SM data source.
>> Data source update interval information	O	Indicates the rate at which data source updates or generates the data. It describes how often the new data is captured or collected. e.g., every x milliseconds generates data.
NOTE: The definition of SM data types is application specific (e.g., VAL client) for the current release.		

9.5.5.3.2 SM data source discovery response

Table 9.5.5.3.2-1 describes information elements in the SM data source discovery response from the SEAL SM server to the SM data source consumer (e.g., VAL server or SEAL server).

Table 9.5.5.3.2-1: SM data source discovery response

Information element	Status	Description
Successful response	O	Indicates that the discovery request was successful
> SM data source profiles	O	The list of SM data source profiles as described in Table 7.3.3.2-1.
Failure response	O	Indicates that the request failed
> Cause	O	Indicates the cause of the failure

9.5.5.3.3 SM data source notification

Table 9.5.5.3.3-1 shows the notification sent by a SEAL SM server to a SEAL SM client for triggering a spatial mapping information session from a SM data source.

Table 9.5.5.3.3-1: SM data source notification

Information element	Status	Description
Requestor identifier	M	The identifier of the requestor (e.g., SEAL SM server, VAL server).
Security credentials	M	The security credentials of the requestor.
SM data source ID	M	The identifier of the SM data source.
SM information reporting session	M	The characteristics of SM information reporting session.
> SM data identifier	M	The identifier of spatial SM data to report.
> SM data type (NOTE)	O	The type of SM information data to report. (e.g., LiDAR camera, RGB-D camera, high-resolution cameras, etc.) that is provided by the application layer.
> SM data format	O	The format of a SM information data to report. (e.g., raw, processed, etc.).
> SM duration	O	The duration for which the SM data is reported.
> SM frequency	O	The frequency at which the SM data is reported.
> SM endpoint	M	The endpoint where to report the SM data.
NOTE: The definition of SM data types is application specific (e.g., VAL client) for the current release.		

9.6 SM service capable application server (SMAS)

9.6.1 General

This clause enables VAL server with SM capability to register with SEAL SM server in order to provide SM services.

9.6.2 SMAS registration

9.6.2.1 General

The SMAS registration procedure registers the authorized VAL server with SM capability with SEAL SM server.

9.6.2.2 Procedure

Figure 9.6.2.2-1 depicts the procedure for an authorized VAL server with SM capabilities to register a SMAS with the SEAL SM server.

Pre-conditions:

1. The VAL server has received information (e.g. URI, IP address) related to the SEAL SM server;
2. The VAL server has received security credentials authorizing it to communicate with the SEAL SM server.

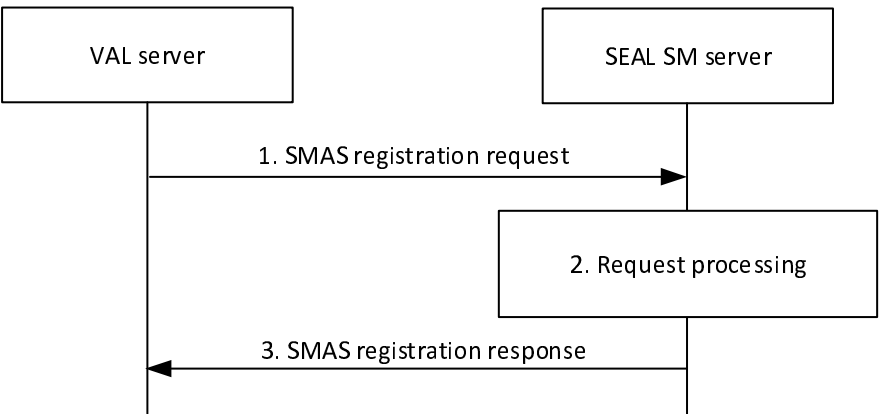


Figure 9.6.2.2-1: SMAS registration procedure

1. The VAL server sends a SMAS registration request to the SEAL SM server. The request includes a requestor ID, security credentials, and a SMAS profile including SM service information (e.g., endpoint, availability period, availability location) and spatial map information (e.g., identifier, coverage area, civic address, latest update time).
2. Upon receiving the request, the SEAL SM server validates if the requestor is authorized for the request. If the requestor is authorized, the SEAL SM server assigns a unique identifier for the registration and stores the SMAS profile that was provided in the request.
3. The SEAL SM server sends a SMAS registration response to the VAL server. If the SEAL SM server successfully stored the SMAS profile, the response includes an indication of success, the registration identifier and may include a proposed expiration time for the registration. Otherwise, the response includes an indication of failure and may include a reason for failure.

9.6.2.3 Information flows

9.6.2.3.1 SMAS registration request

Table 9.6.2.3.1-1 describes information elements in the SMAS registration request from the VAL server to the SEAL SM server.

Table 9.6.2.3.1-1: SMAS registration request

Information element	Status	Description
Requestor ID	M	The identifier of the requestor (e.g., VAL server)
Security credentials	M	The security credentials of the requestor
Proposed expiration time	O	Proposed expiration time for the registration
SMAS profile	O	The SMAS profile as described in Table 9.6.2.3.1-2.

Table 9.6.2.3.1-2 describes information elements in the SMAS profile.

Table 9.6.2.3.1-2: SMAS profile

Information element	Status	Description
SMAS information	M	The information about the SM service; each element includes the information described below.
> Endpoint	O	The endpoint information (e.g. URI, FQDN, IP address) used to communicate with the SM Service.
> Availability period	O	The time period when a service consumer can access the SM service.
> Availability location	O	The location where a service consumer can access the service from.
List of spatial map information	M	The information about spatial map(s) available at the SM service; each spatial map of the list includes the information described below.
> Identifier	M	The identifier of a spatial map
> Coverage area	M	The spatial coverage area of a spatial map

9.6.2.3.2 SMAS registration response

Table 9.6.2.3.2-1 describes information elements in the SMAS registration response from the SEAL SM server to the VAL server.

Table 9.6.2.3.2-1: SMAS registration response

Information element	Status	Description
Successful response	O	Indicates that the registration request was successful
> Registration ID	M	Identifier of the registration
> Expiration time	O	Indicates the expiration time of the registration. To maintain an active registration status, a registration update is required before the expiration time. If the Expiration time IE is not included, it indicates that the registration never expires.
Failure response	O	Indicates that the request failed
> Cause	O	Indicates the cause of the failure

9.6.3 SMAS registration update

9.6.3.1 General

The SMAS registration update procedure updates registration status of the authorized VAL server with SM capability to the SEAL SM server.

9.6.3.2 Procedure

Figure 9.6.3.2-1 depicts the procedure for an authorized VAL server to update SMAS information.

Pre-conditions:

1. The VAL server has already registered the SM service with the SEAL SM server.

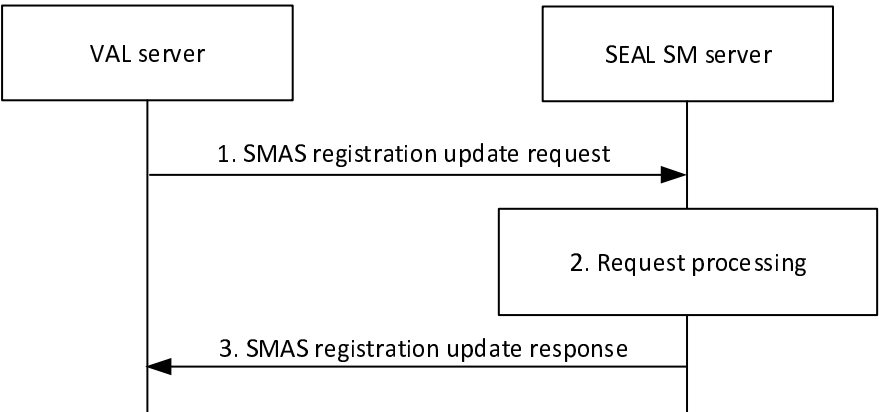


Figure 9.6.3.2-1: SMAS registration update procedure

1. The VAL server sends a SMAS registration update request to the SEAL SM server. The request includes a requestor ID, security credentials, a registration ID, and may include an updated SMAS profile and proposed expiration time for the updated registration.
2. Upon receiving the request, the SEAL SM server validates if the requestor is authorized for the request. If the requestor is authorized, the SEAL SM server updates the SMAS profile based on the request information.
3. The SEAL SM server sends the SMAS registration update response to the VAL server. If the SEAL SM server successfully updated the SMAS profile, the response includes an indication of success and may include a proposed expiration time for the registration. Otherwise, the response includes an indication of failure and may include a reason for failure.

9.6.3.3 Information flows

9.6.3.3.1 SMAS registration update request

Table 9.6.3.3.1-1 describes information elements in the SMAS registration update request from the VAL server to the SEAL SM server.

Table 9.6.3.3.1-1: SMAS registration update request

Information element	Status	Description
Requestor ID	M	The identifier of the requestor (e.g., VAL server)
Security credentials	M	The security credentials of the requestor
Registration ID	M	Identifier of the registration
Proposed expiration time (NOTE)	O	Proposed expiration time for the registration
SMAS profile (NOTE)	O	The SMAS profile as described in Table 9.6.2.3.1-2.
NOTE: At least one of the IEs is included.		

9.6.3.3.2 SMAS registration update response

Table 9.6.3.3.2-1 describes information elements in the SMAS registration update response from the SEAL SM server to the VAL server.

Table 9.6.3.3.2-1: SMAS registration update response

Information element	Status	Description
Successful response	O	Indicates that the registration update request was successful
> Expiration time	O	Indicates the expiration time of the updated registration. To maintain an active registration status, a registration update is required before the expiration time. If the Expiration time IE is not included, it indicates that the updated registration never expires.
Failure response	O	Indicates that the request failed
> Cause	O	Indicates the cause of the failure

9.6.4 SMAS deregistration

9.6.4.1 General

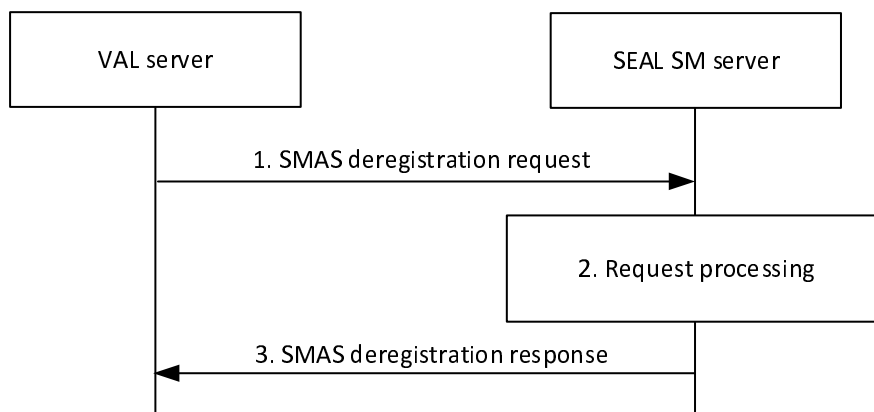
The SMAS deregistration procedure deregisters the authorized VAL server with SM capability from the SEAL SM server.

9.6.4.2 Procedure

Figure 9.6.4.2-1 depicts the procedure for an authorized VAL server to deregister a SMAS.

Pre-conditions:

1. The VAL server has already registered the SM service with the SEAL SM server.

**Figure 9.6.4.2-1: SMAS deregistration procedure**

1. The VAL server sends a SMAS deregistration request to the SEAL SM server. The request includes a requestor ID, security credentials, and a registration ID.
2. Upon receiving the request, the SEAL SM server validates if the requestor is authorized for the request. If the requestor is authorized, the SEAL SM server ends the SMAS registration and removes the stored SMAS profile.
3. The SEAL SM server sends the SMAS deregistration response to the VAL server. If the SEAL SM server successfully deregistered the SMAS, the response includes an indication of success. Otherwise, the response includes an indication of failure and may include a reason for failure.

9.6.4.3 Information flows

9.6.4.3.1 SMAS deregistration request

Table 9.6.4.3.1-1 describes information elements in the SMAS deregistration request from the VAL server to the SEAL SM server.

Table 9.6.4.3.1-1: SMAS deregistration request

Information element	Status	Description
Requestor ID	M	The identifier of the requestor (e.g., VAL server)
Requestor security credentials	M	The security credentials of the requestor
Registration ID	M	Identifier of the registration

9.6.4.3.2 SMAS deregistration response

Table 9.6.4.3.2-2 describes information elements in the SMAS deregistration response sent from the SEAL SM server to the VAL server.

Table 9.6.4.3.2-2: SMAS deregistration response

Information element	Status	Description
Successful response	O	Indicates that the deregistration request was successful
Failure response	O	Indicates that the request failed
> Cause	O	Indicates the cause of the failure

9.6.5 SMAS discovery

SMAS registered with a SEAL SM server are discovered via the spatial map discovery procedure described in clause 9.3.2.

9.7 SEAL APIs for spatial map management

9.7.1 General

Table 9.7.1-1 illustrates the SEAL APIs for spatial map management.

Table 9.7.1-1: List of SEAL APIs for spatial map management

API Name	API Operations	Known Consumer(s)	Communication Type
SS_SmManagement	Create	VAL server, SEAL SM client	Request/Response
	Get	VAL server, SEAL SM client	
	Update	VAL server, SEAL SM client	
	Delete	VAL server, SEAL SM client	Subscribe/Notify
	Subscribe	VAL server, SEAL SM client	
	Notify	VAL server, SEAL SM client	
	Unsubscribe	VAL server, SEAL SM client	
SS_SmDiscovery	Request	SEAL SM client, VAL server	Request/Response
SS_SmLocalization	Request	VAL server, SEAL SM client	Request/Response
SS_SmDataSourceRegistration	Request	SEAL SM client	Request/Response
	Update	SEAL SM client	
	Deregister	SEAL SM client	
SS_SmDataSourceDiscovery	Request	VAL server	Request/Response
	Notify	SEAL SM client	Notify
SS_SmSmasRegistration	Request	VAL server	Request/Response
	Update	VAL server	
	Deregister	VAL server	

9.7.2 SS_SmManagement API

9.7.2.1 General

Service description: This API enables the VAL server or SEAL SM client to manage spatial maps on SEAL SM server.

9.7.2.2 Create operation

API operation name: SS_SmManagement_Create

Description: Create a spatial map in the given three-dimensional area of interest.

Known Consumers: VAL server, SEAL SM client.

Inputs: Refer Table 9.3.1.3.1-1

Outputs: Refer Table 9.3.1.3.2-1

See clause 9.3.1 for the details of usage of this API operation.

9.7.2.3 Get operation

API operation name: SS_SmManagement_Get

Description: Provide requested spatial map information to the authorized consumers.

Known Consumers: VAL server, SEAL SM client.

Inputs: Refer Table 9.3.3.3.1-1

Outputs: Refer Table 9.3.3.3.2-1

See clause 9.3.3 for the details of usage of this API operation.

9.7.2.4 Update operation

API operation name: SS_SmManagement_Update

Description: Update the information on a spatial map as requested.

Known Consumers: VAL server, SEAL SM client.

Inputs: Refer Table 9.3.4.3.1-1

Outputs: Refer Table 9.3.4.3.2-1

See clause 9.3.4 for the details of usage of this API operation.

9.7.2.5 Delete operation

API operation name: SS_SmManagement_Delete

Description: Delete spatial map.

Known Consumers: VAL server, SEAL SM client.

Inputs: Refer Table 9.3.5.3.1-1

Outputs: Refer Table 9.3.5.3.2-1

See clause 9.3.5 for the details of usage of this API operation.

9.7.2.6 Subscribe operation

API operation name: SS_SmManagement_Subscribe

Description: Process the authorized consumer's subscription to the spatial map events.

Known Consumers: VAL server, SEAL SM client.

Inputs: Refer Table 9.3.6.3.1-1

Outputs: Refer Table 9.3.6.3.2-1

See clause 9.3.6.2.1 for the details of usage of this API operation.

9.7.2.7 Notify operation

API operation name: SS_SmManagement_Notify

Description: Notify the information on the detected triggering events to which the authorized consumers are subscribed.

Known Consumers: VAL server, SEAL SM client.

Inputs: None

Outputs: Refer Table 9.3.6.3.3-1

See clause 9.3.6.2.2 for the details of usage of this API operation.

9.7.2.8 Unsubscribe operation

API operation name: SS_SmManagement_Unsubscribe

Description: Revoke the authorized consumer's subscription to the spatial map events.

Known Consumers: VAL server, SEAL SM client.

Inputs: Refer Table 9.3.6.3.4-1

Outputs: Refer Table 9.3.6.3.5-1

See clause 9.3.6.2.3 for the details of usage of this API operation.

9.7.3 SS_SmDiscovery API

9.7.3.1 General

Service description: This API enables the VAL server or SEAL SM client to discover spatial maps and SMAS from the SEAL SM server.

9.7.3.2 Request operation

API operation name: SS_SmDiscovery_Request

Description: Discover spatial maps or SMAS in the given three-dimensional area of interest.

Known Consumers: VAL server, SEAL SM client.

Inputs: Refer Table 9.3.2.3.1-1

Outputs: Refer Table 9.3.2.3.2-1

See clause 9.3.2 for the details of usage of this API operation.

9.7.4 SS_SmLocalization API

9.7.4.1 General

Service description: This API enables the VAL server or SEAL SM client to get localization information from the spatial maps.

9.7.4.2 Request operation

API operation name: SS_SmLocalization_Request

Description: Get localization information of the requested object from the spatial map.

Known Consumers: VAL server, SEAL SM client.

Inputs: Refer Table 9.4.3.1-1

Outputs: Refer Table 9.4.3.2-1

See clause 9.4.2 for the details of usage of this API operation.

9.7.5 SS_SmDataSourceRegistration API

9.7.5.1 General

Service description: This API enables the SM data source to register, update register or deregister with SEAL SM server.

9.7.5.2 Request operation

API operation name: SS_SmDataSourceRegistration_Request

Description: registers the SM data source to the SEAL SM server.

Known Consumers: SEAL SM client.

Inputs: Refer Table 9.5.2.3.1-1

Outputs: Refer Table 9.5.2.3.2-1

See clause 9.5.2.2 for the details of usage of this API operation.

9.7.5.3 Update operation

API operation name: SS_SmDataSourceRegistration_Update

Description: Updates existing registration of the SM data source to the SEAL SM server.

Known Consumers: SEAL SM client.

Inputs: Refer Table 9.5.3.3.1-1

Outputs: Refer Table 9.5.3.3.2-1

See clause 9.5.3.2 for the details of usage of this API operation.

9.7.5.4 Deregister operation

API operation name: SS_SmDataSourceRegistration_Deregister

Description: Deregisters the existing registration of the SM data source to the SEAL SM server.

Known Consumers: SEAL SM client.

Inputs: Refer Table 9.5.4.3.1-1

Outputs: Refer Table 9.5.4.3.2-1

See clause 9.5.4.2 for the details of usage of this API operation.

9.7.6 SS_SmDataSourceDiscovery API

9.7.6.1 General

Service description: This API enables the VAL server to discover SM data sources from the SEAL SM server.

9.7.6.2 Request operation

API operation name: SS_SmDataSourceDiscovery_Request

Description: discovers the SM data sources from the SEAL SM server.

Known Consumers: VAL server.

Inputs: Refer Table 9.5.5.3.1-1

Outputs: Refer Table 9.5.5.3.2-1

See clause 9.5.5.2 for the details of usage of this API operation.

9.7.6.3 Notify operation

API operation name: SS_SmDataSourceDiscovery_Notify

Description: Notify a SM data source to trigger a spatial mapping information session.

Known Consumers: SEAL SM client.

Inputs: Refer Table 9.5.5.3.3-1

Outputs: None

See clause 9.5.5 for the details of usage of this API operation.

9.7.7 SS_SmSmasRegistration API

9.7.7.1 General

Service description: This API enables the VAL server with SM capabilities to register, update register or deregister with the SEAL SM server.

9.7.7.2 Request operation

API operation name: SS_SmSmasRegistration_Request

Description: registers the VAL server with SM capabilities to the SEAL SM server.

Known Consumers: VAL server.

Inputs: Refer Table 9.6.2.3.1-1

Outputs: Refer Table 9.6.2.3.2-1

See clause 9.6.2.2 for the details of usage of this API operation.

9.7.7.3 Update operation

API operation name: SS_SmSmasRegistration_Update

Description: Updates existing registration of the VAL server with SM capabilities to the SEAL SM server.

Known Consumers: VAL server.

Inputs: Refer Table 9.6.3.3.1-1

Outputs: Refer Table 9.6.3.3.2-1

See clause 9.6.3.2 for the details of usage of this API operation.

9.7.7.4 Deregister operation

API operation name: SS_SmSmasRegistration_Deregister

Description: Deregisters the existing registration of the VAL server with SM capabilities to the SEAL SM server.

Known Consumers: VAL server.

Inputs: Refer Table 9.6.4.3.1-1

Outputs: Refer Table 9.6.4.3.2-1

See clause 9.6.4.2 for the details of usage of this API operation.

Annex A (informative): Change history

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2024-07	SA6#62-AE	S6a240151				Skeleton	0.1.0
2024-08	SA6#62	S6-243614				Introduction and Scope of the TS	0.2.0
2024-08	SA6#62	S6-243661				Spatial Anchors Management Architecture	0.2.0
2024-08	SA6#62	S6-243669				Spatial Anchor Management and Discovery	0.2.0
2024-08	SA6#62	S6-243670				Spatial Anchor Subscription	0.2.0
2024-08	SA6#62	S6-243671				Spatial Map Management Architecture	0.2.0
2024-08	SA6#62	S6-243703				New text for clause 9 Spatial Map (SM) management	0.2.0
2024-10	SA6#63	S6-244187				Pseudo-CR on Terms and Abbreviations	0.3.0
2024-10	SA6#63	S6-244563				Pseudo-CR on business relation and functional model	0.3.0
2024-10	SA6#63	S6-244564				Spatial anchor update	0.3.0
2024-10	SA6#63	S6-244686				Spatial Anchor Analytics Information	0.3.0
2024-10	SA6#63	S6-244687				Pseudo-CR on enhancements to spatial anchor subscription procedure	0.3.0
2024-10	SA6#63	S6-244689				Pseudo-CR on enhancements to spatial map subscription procedures	0.3.0
2024-10	SA6#63	S6-244690				Pseudo-CR on Support for spatial mapping data sources	0.3.0
2024-10	SA6#63	S6-244700				Pseudo-CR on Support for spatial mapping service exposure	0.3.0
2024-10	SA6#63	S6-244711				Pseudo-CR on localization service	0.3.0
2024-10	SA6#63	S6-244712				Spatial map procedure updates and Information Flows	0.3.0
2024-11	SA6#64	S6-245517				TS clean up and restructuring	0.4.0
2024-11	SA6#64	S6-245518				Updates to Terms	0.4.0
2024-11	SA6#64	S6-245519				Pseudo-CR on Spatial map management requirements	0.4.0
2024-11	SA6#64	S6-245520				Pseudo-CR on architectural requirements	0.4.0
2024-11	SA6#64	S6-245676				Pseudo-CR on Identities and commonly used values	0.4.0
2024-11	SA6#64	S6-245114				Pseudo-CR on general clauses	0.4.0
2024-11	SA6#64	S6-245735				Pseudo-CR on spatial anchor usage information update	0.4.0
2024-11	SA6#64	S6-245523				Pseudo-CR on Spatial anchor usage analytics reporting	0.4.0
2024-11	SA6#64	S6-245636				Spatial Anchor Usage Analytics API clause	0.4.0
2024-11	SA6#64	S6-245699				Spatial Anchor association with Spatial Map	0.4.0
2024-11	SA6#64	S6-245120				Pseudo-CR on correction to SM service procedure	0.4.0
2024-11	SA6#64	S6-245700				Pseudo-CR on implicit subscription for spatial map ready event	0.4.0
2024-11	SA6#64	S6-245506				Pseudo-CR on APIs for Spatial anchors and Spatial map services	0.4.0
2024-12	SA#106	SP-241702				Submitted to SA#106 for information and approval	1.0.0
2024-12	SA#106	SP-241702				MCC Editorial update for publication after TSG SA approval (SA#106)	19.0.0
2025-03	SA#107	SP-250214	0001	1	F	Correction for clause 8.4	19.1.0
2025-03	SA#107	SP-250214	0005	1	B	Remove EN on access control rules	19.1.0
2025-03	SA#107	SP-250214	0006		B	Removing EN on additional events	19.1.0
2025-03	SA#107	SP-250214	0007	1	B	Removing EN on Get operation	19.1.0
2025-03	SA#107	SP-250214	0009	4	F	Update to requestor identity in information flows	19.1.0
2025-03	SA#107	SP-250214	0010	1	B	SMAS discovery procedure	19.1.0
2025-03	SA#107	SP-250214	0011	2	B	Spatial anchor usage reporting	19.1.0
2025-03	SA#107	SP-250214	0016	1	B	Enhancements to SM data source services	19.1.0
2025-06	SA#108	SP-250610	0017	2	F	Fix for spatial anchor usage information (Sub-Notify)	19.2.0
2025-06	SA#108	SP-250610	0023	1	F	Removing ENs in Spatial map subscription	19.2.0
2025-06	SA#108	SP-250610	0024	1	F	Enhancement to spatial localization services procedure text	19.2.0
2025-06	SA#108	SP-250610	0027	1	F	Corrections to Clause 8	19.2.0
2025-06	SA#108	SP-250610	0028	1	F	Updates to the spatial anchor profile	19.2.0
2025-06	SA#108	SP-250610	0030	1	F	Corrections to spatial anchor specific information	19.2.0
2025-06	SA#108	SP-250610	0031		F	Retrieving spatial map augmented layer information	19.2.0
2025-06	SA#108	SP-250610	0034	1	F	EN resolution on changed objects event	19.2.0
2025-06	SA#108	SP-250610	0041		F	Corrections to the Create spatial map response and Subscribe spatial map event request IEs	19.2.0
2025-06	SA#108	SP-250610	0042		F	Correction for spatial map subscription	19.2.0
2025-09	SA#109	SP-251061	0051		F	Fix for clause 9.3	19.3.0
2025-09	SA#109	SP-251061	0053		F	Fix for clause 9.4	19.3.0
2025-09	SA#109	SP-251061	0055		F	Fix for clause 9.5	19.3.0

History

Document history		
V19.3.0	January 2026	Publication