ETSI TS 103 652-2 V1.1.1 (2020-01)

Reconfigurable Radio Systems (RRS);
evolved Licensed Shared Access (eLSA);
Part 2: System architecture and high-level procedures

Reference
DTS/RRS-0151

Keywords
architecture, LSA spectrum resource, network, radio

ETSI

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

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

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

Important notice

The present document can be downloaded from:
http://www.etsi.org/standards-search

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 at www.etsi.org/deliver.

Users of the present document should be aware that the document may be subject to revision or change of status.
Information on the current status of this and other ETSI documents is available at
https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx

If you find errors in the present document, please send your comment to one of the following services:
https://portal.etsi.org/People/CommiteeSupportStaff.aspx

Copyright Notification

Contents

Intellectual Property Rights

Essential patents

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

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

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.

Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Reconfigurable Radio Systems (RRS).

The present document is part 2 of a multi-part deliverable. Full details of the entire series can be found in part 1 ETSI TS 103 652-1 [1].

Modal verbs terminology

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

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

1 Scope

The present document specifies the system architecture for the operation of an Evolved Licensed Shared Access (eLSA) System, enabling the provision of spectrum access to many local high-quality wireless networks in dedicated licensed and leasing scenarios.

The eLSA system architecture specification will include the identification and definition of the logical functional elements, interfaces, reference points, the mapping of functions to logical entities as well as the definition of the high-level procedures and information flows enabling assignment and handling of spectrum for the different scenarios considered.

The present document has been developed following, and in accordance with, the system requirements for eLSA captured in ETSI TS 103 652-1 [1] and the feasibility study on temporary spectrum access for local high-quality wireless networks as documented in ETSI TR 103 588 [i.1].

2 References

2.1 Normative references

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

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

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

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

[1] ETSI TS 103 652-1: "Reconfigurable Radio Systems (RRS); evolved Licensed Shared Access (eLSA); Part 1: System requirements".

2.2 Informative references

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

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

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

[i.1] ETSI TR 103 588: "Reconfigurable Radio Systems (RRS); Feasibility study on temporary spectrum access for local high-quality wireless networks".

[i.2] ETSI TS 103 235: "Reconfigurable Radio Systems (RRS); System architecture and high level procedures for operation of Licensed Shared Access (LSA) in the 2 300 MHz - 2 400 MHz band".

[i.3] ECC Recommendation (15)04: "Guidance for the implementation of a sharing framework between MFCN and PMSE within 2300-2400 MHz".

[i.4] CEPT Report 58: "Technical sharing solutions for the shared use of the 2300-2400 MHz band for WBB and PMSE".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

allowance zone: geographical area within which an eLSA Licensee is allowed to operate radio transmitters on its assigned spectrum resource

NOTE 1: An allowance zone is defined using specific measurement quantities and thresholds, e.g. a maximum field strength level expressed in dBµ V/m/MHz, along the border of its geographical area.

NOTE 2: An allowance zone is normally applicable for a defined frequency range and time period.

3.2 Symbols

Void.

3.3 Abbreviations

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

3GPP	Third Generation Public Private Partnership
AV	Audio-Visual
AV-VSP	Audio-Visual Vertical Sector Player
DOM	Detached Operation Mode
eLC	evolved eLSA Controller
eLR	evolved LSA Repository
eLSA	evolved Licensed Shared Access
eLSR	evolved LSA Spectrum Resource
eLSRAI	evolved LSA Spectrum Resource Availability Information
IEM	In Ear Monitoring
LC	LSA Controller
LR	LSA Repository
LSA	Licensed Shared Access
LSRAI	LSA Spectrum Resource Availability Information
MFCN	Mobile/Fixed Communication Network

NOTE: MFCN is used in the present document to refer to a local high-quality wireless network [i.1].

MNO	Mobile Network Operator
NRA	National Regulatory Authority
PMSE	Programme Making and Special Events
VSP	Vertical Sector Player

4 eLSA supported spectrum access schemes

4.1 Introduction

ETSI TR 103 588 [i.1] concept identified three spectrum access schemes for MFCN operated by vertical sector operators (aka *local high-quality wireless networks*):

- **Local area licensing:** NRA provides a license to a vertical sector player to operate in a given frequency allocation in a defined area and for a defined period of time. The vertical sector player (licensee) shall apply the required operational conditions and restrictions established by the NRA.

- **Local area Leasing:** Incumbents (including MNOs) can lease out part of their licensed spectrum to vertical sector players (lessees) to operate MFCNs in a defined area and for a defined period of time. An Incumbent (lessor) and a vertical sector player (lessee) agrees through a leasing arrangement, where the existing rules and operational conditions given in the incumbent's license is included (the incumbent is still responsible for the fulfilment of those rules/conditions to the NRA). The leasing arrangement can include additional operational conditions and restrictions for the use of the leased spectrum. An additional license for vertical sector players is not needed.

- **Network as a Service:** MFCNs of a vertical sector player are instantiated as local network service areas (e.g. network slices of a 3GPP network) within the incumbent (e.g. MNO) domain. The incumbent as license holder offers infrastructure, spectrum and coexistence management service to the MFCNs. An additional license for vertical sector players is not needed.

Figure 1 illustrates the relationships between the National Regulatory Administration (NRA), the vertical sector player, and the incumbent (e.g. MNO) for the different spectrum allocation and service provisioning schemes.

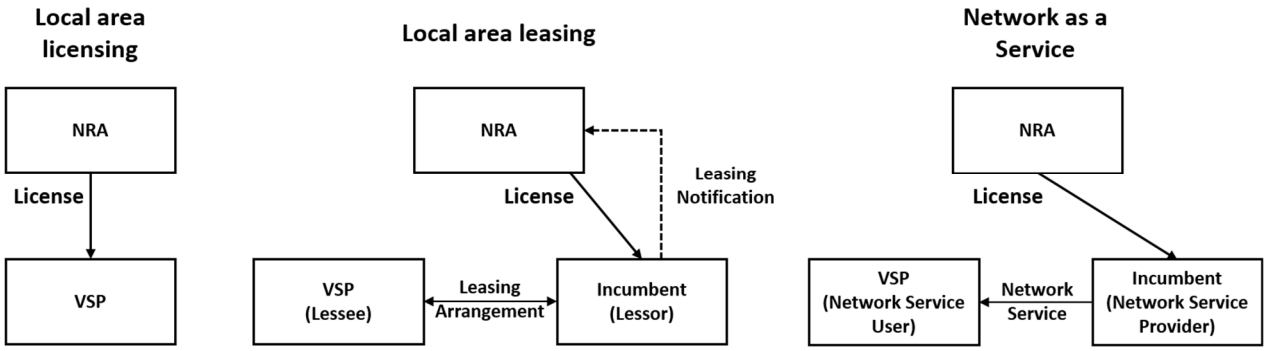

Figure 1: Relationship models for eLSA spectrum access schemes.

eLSA aims to evolve the LSA architecture [i.2] to satisfy the local area spectrum demands covering both short-term and long-term allocations of vertical sector players. In doing so, eLSA targets a system architecture as close as possible to LSA maximizing synergies at both implementation and regulatory levels.

Annex C provides for two of the spectrum access schemes identified in [i.1], local area licensing and local area leasing, an architectural instantiation of eLSA, the associated functionality and a list of the technical evolvements compared to the LSA reference architecture model [i.2]. The Network as a Service option will not be further specified in the present document as it is handled within the license holder domain.

4.2 eLSA Architecture Reference Model

4.2.0 introduction

The eLSA Architecture Reference model is shown in Figure 2. It is based on the architecture reference model for LSA defined in [i.2] and supports additionally the spectrum access schemes for local area licensing and the local area leasing. Reference points shown in dashed format indicate that the respective interfaces and corresponding interface functions will not be defined in the present document, although some guidance is provided.

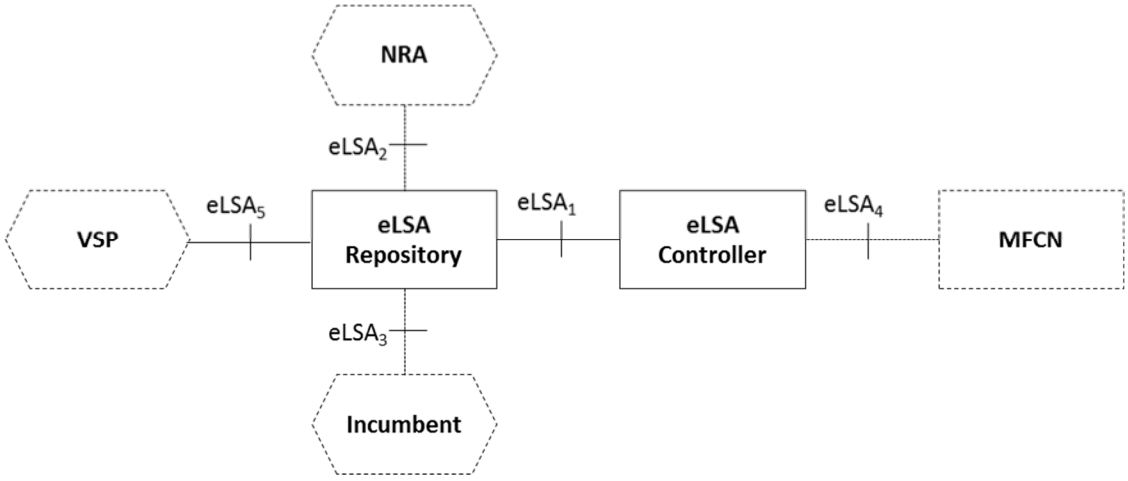

Figure 2: eLSA Architecture Reference Model

4.2.1 Logical Elements

eLSA Repository (eLR): The eLR supports the entry and storage of information describing the shared spectrum resources as well as Incumbent's and VSP's usage and protection requirements. It is able to convey spectrum resource information including related availability information to eLSA Controllers. The eLR also provides means for the NRA to monitor the operation of the eLSA System [see ETSI TS 103 652-1 [1]] and to provide the eLSA System with information on local area licensing and local area leasing. The eLR ensures that the eLSA system operates in conformance with the Sharing Framework and the licensing regime and may in addition realize any non-regulatory details of the Sharing Arrangement [1].

eLSA Controller (eLC): The eLC is associated with the VSP's domain. The eLC enables the VSP to obtain eLSA spectrum resource and availability information from the eLR. The eLC interacts with the VSP's MFCN in order to support the mapping of spectrum resource and availability information into appropriate radio transmitter configurations and receive the respective confirmation from the MFCN.

4.2.2 Reference Points

$eLSA_1$: Reference point between eLR and eLC.

$eLSA_2$: Reference point for Administration/NRA interaction with the eLR. Some of the functionality associated with this reference point is described in clause B.2.

$eLSA_3$: Reference point for Incumbent interaction with the eLR. Some of the functionality associated with this reference point is described in clause B.3.

$eLSA_4$: Reference point between eLC and MFCN.

$eLSA_5$: Reference point for VSP interaction with the eLR. Some of the functionality associated with this reference point is described in clause B.4.

4.3 High-Level Functions

4.3.0 introduction

This clause lists and describes the high-level functions performed by the eLSA System. The high-level functions cover the aspects of eLSA System operation in line with requirements of ETSI TS 103 652-1 [1].

4.3.1 Information Entry Function

The information entry function allows the entry and storage of information that is needed for the operation of the eLSA System, including the following:

- Sharing Framework information (set of sharing rules or sharing conditions for the band, information on spectrum that can be made available for shared use and the corresponding technical and operational conditions for its use, identification of incumbents).
- eLSA License and Leasing information (VSP identity and related information).
- Sharing Arrangement information for each Incumbent and VSP (set of practical details for sharing an eLSA spectrum resource, whereby eLSA spectrum resource may be used by Incumbent or VSP).
- Incumbent's eLSA spectrum resource usage and protection requirements.
- The function also supports the verification of inputs (consistency with Sharing Framework/Arrangement).

4.3.2 Information Processing Function

This function supports the derivation of eLSRAI for each VSP domain, to be provided to the Information Exchange function and the Reporting Function. The eLSRAI is derived based on the data collected by the Information Entry Function. The function further supports the processing of VSP domain acknowledgment information.

The above functionality also includes support for multiple Incumbents and multiple VSP domains, scheduled and on-demand modes of operation, and logging of processing information.

4.3.3 Information Mapping Function

The information mapping function receives eLSRAI, confirms reception and initiates respective operations in the MFCN. It also sends acknowledgements to the information exchange function (for forwarding to the information processing function) when changes in the MFCN are processed.

NOTE: The respective interaction with the MFCN is out of scope of the present document.

4.3.4 Reporting Function

The reporting function is responsible to create and provide reports regarding the eLSA System operation to Administration/NRA, Incumbent(s), and/or VSP(s) on an on-demand or scheduled basis, e.g. pre-checking of spectrum resource availability for a local area.

4.3.5 eLSA Information Exchange Function

The information exchange function supports communication mechanisms, internal to the eLSA System, to exchange spectrum resource and availability information, and related acknowledgement information.

4.3.6 System Support Functions Group

The system support functions comprise:

Security Support Function: support of authentication and authorization as well as services to support integrity and confidentiality of data.

Robustness and Reliability Function: support of mechanisms to maintain robustness and reliability against failures and malicious attacks.

Fault Management Function: support of:

- Failure detection in the eLSA System.
- Subsequent generation and delivery of respective failure notification(s) to VSP(s) and Incumbent(s).

- Initiation of respective operations in the eLSA System.

4.3.7 System Management Functions Group

This includes:

- Operation, administration and maintenance tasks in the eLSA System.
- Identity management (comprising user identity and authentication management, and user authorization profiles).

System management is separate for eLR and eLC since these logical entities belong to different operation domains. The supported functionality may also be different in the two entities. Identity management applies to the eLR only.

4.4 Mapping of High-Level Functions to Logical Elements

Figure 3 shows how the high-level functions and function groups are mapped to the logical entities eLR and eLC.

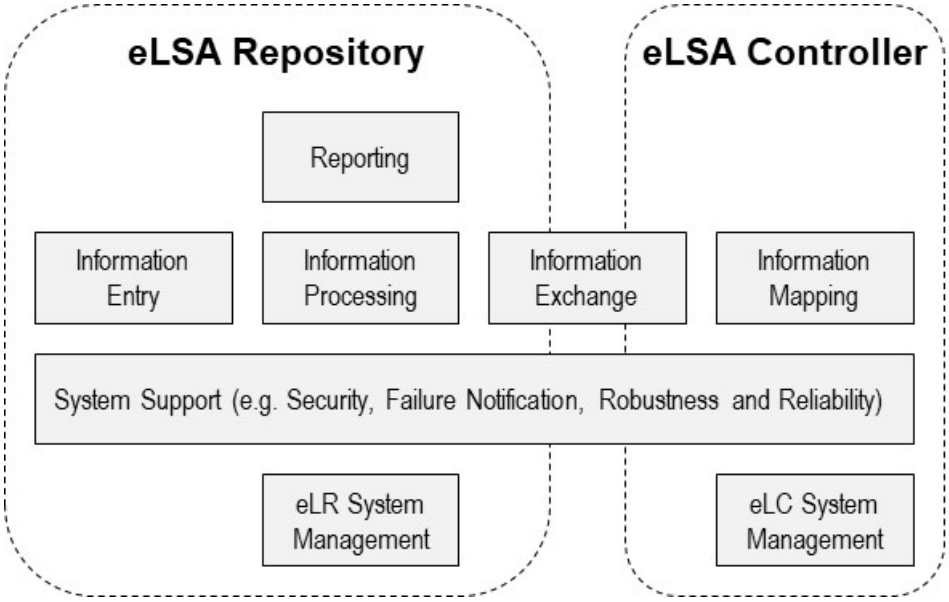

Figure 3: Mapping of high-level functions and function groups to logical elements

The System Support functions group may be considered to map across all elements and reference points of the eLSA System.

The corresponding functionality at the $eLSA_1$ reference point is covered by the eLSA Information Exchange function and the System Support functions group.

5 $eLSA_1$ Functional Description and Information Flows

5.1 Introduction

This clause describes procedures, procedural flows and additional functional aspects related to the interface between eLR and eLC ($eLSA_1$ interface).

The $eLSA_1$ interface provides support for the exchange of eLSA Spectrum Resource Availability Information (eLSRAI, clause 5.4.2) and respective acknowledgement information between eLR and eLC, and for maintaining and recovering synchronization of such information between eLR and eLC.

As described in [1], VSPs may want to operate and control their local MFCNs in a detached mode, i.e. without a permanent network connection to the eLSA System. The procedures and procedural flows listed below supports when a VSP is operating in detached mode.

NOTE 1: It is expected that either the individual right of use, the sharing framework and/or the spectrum sharing arrangement contain details on the procedure and periodicity for network reconnection between the eLR and a VSP operating in detached mode.

NOTE 2: The start and end of the Detached Operation Mode will be signalled from the eLC to the eLR. The details which procedures to be used will be specified in stage 3.

5.2 Protocol Stacks

The $eLSA_1$ application layer protocol shall ensure the application part, in eLR and eLC, conforms to the regulatory requirements, thereby the requirements on underlying transport protocols are kept to minimum. Supported network layer protocol is IP. No eLSA specific requirement is set on the transport layer protocol.

NOTE: Supported Transport layer mechanisms include TCP and UDP. Depending on the security requirements, use of IPsec, TLS or DTLS may be applicable.

5.3 $eLSA_1$ Interface Management Functions

The $eLSA_1$ Interface shall provide Management functions and corresponding procedures to ensure means for a defined start of interface operation and means to identify application or protocol failure.

The node that initiates a particular procedure is responsible for supervising the overall procedure status and detecting corresponding failures. In case of failure (e.g. the respective response message is not received, or the response message is not valid), the action taken is unspecified and left for implementation. A typical behaviour would be to re-initiate the procedure a number of times, before further recovery action is invoked.

If failures occur during procedures concerned with exchange of eLSRAI, the supervising node may consider that synchronization has been lost between eLC and eLR and should initiate actions to restore eLSRAI synchronization. The protocol should ensure that eLSRAI is consistent in both nodes.

5.4 $eLSA_1$ Protocol Elements

5.4.1 Identities

The following defines identities that shall be employed by the eLSA System in general, and particularly over the $eLSA_1$ interface:

- **VSP Identity:** identifies a specific VSP.
- **eLR Identity:** identifies a specific eLR.
- **eLC Identity:** identifies a specific eLC.

VSP Identity, eLR Identity and eLC Identity shall be unique and unambiguous within a particular set of interconnected eLSA network elements (for example, multiple eLCs of the same or different VSP(s) connected to an eLR).

Transaction Identity: identifies a specific instance of a procedure, and all messages within the same procedure instance shall include the same Transaction Identity. The node initiating the procedure shall assign a Transaction Identity which is not currently used by any other procedure initiated by the same node.

5.4.2 eLSA Spectrum Resource Availability Information

The eLSA Spectrum Resource Availability Information (eLSRAI) is conveyed to the eLC in messages originated in the eLR (e.g. eLSRAI Notification message, see clause 5.5.5).

Under normal operating conditions, the eLR is aware of the eLSRAI that is known to the eLC, and stores relevant associated information such as status of eLC acknowledgements. After successful registration of the eLC at the eLR, eLSA operation starts in order to synchronise eLSRAI of eLR with the eLC.

In scenarios where the evolved LSA spectrum resource eLSR needs to be granted according to a license or a lease, the frequency resources, radio conditions, local area definition and validity time information are included in the relevant eLSRAI.

eLR and eLC should take steps to ensure that valid and relevant eLSRAI will always be synchronized, especially with respect to eLSRAI handling for detached operation.

eLSRAI may be associated with a validity time when received by the eLC. When the validity time expires, the eLC shall consider that the associated eLSRAI is no longer applicable and may initiate actions to obtain updated eLSRAI.

eLSRAI includes support for the definition of exclusion, restriction, protection and allowance zones (as per requirements R-FUNC-INC-05 and R-FUNC-INC-06, R-FUNC-GEN-17 in ETSI TS 103 652-1 [1]).

NOTE 1: Examples of exclusion and protection zone parameters are contained in ECC Recommendation (15)04 [i.3] and in CEPT Report 58 [i.4]

NOTE 2: The eLSRAI format may include further definitions and support future extensions in order to enable the evolution of sharing rules, or the needs of particular deployments.

5.5 High Level Procedures

5.5.1 Introduction

This clause specifies high level procedures which describe the interaction between eLR and eLC in normal operation. Some procedures imply the reconfiguration of the VSP's network through the interaction between the eLSA System and the MFCN. These procedures, how they apply, and the related lead, latency and response times are expected to be in accordance with the Sharing Framework and the Sharing Arrangement(s), and constrained by the VSP network reconfiguration performance.

In case of encountered failure during execution of a high-level procedure, such as a missing response or acknowledgement message, the initiating node in general is in charge of supervising the execution of the procedure and initiating the respective failure measure. The content of the failure handling is specific for each high-level procedure. General aspects of the failure management for eLSA are treated in clause 6.

5.5.2 Registration Procedure

The purpose of the registration procedure is to register an eLC with an eLR. This is the first procedure executed on the $eLSA_1$ interface. After successful completion of this procedure, the eLC is able to initiate requests or receive notifications on eLSRAI.

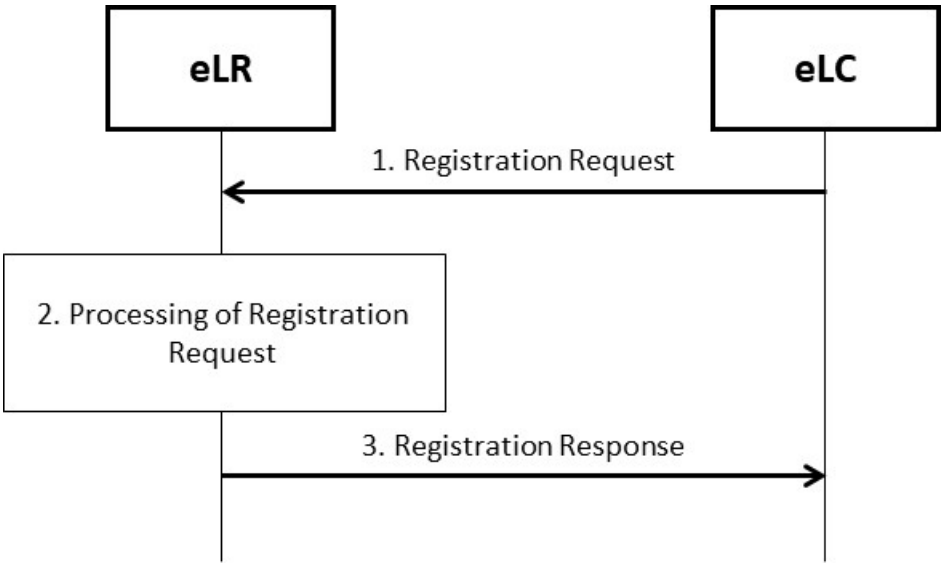

Figure 4: Registration Procedure

1) The eLC sends a registration request message to the eLR, including its node identity and VSP identity, requesting establishment of application protocol communication.

2) The eLR checks the validity of the identities and stores the eLC node identity in the list of registered eLCs.

3) The eLR sends a registration response message to the eLC including its node identity to confirm the registration of eLC in eLR, and the indication whether the next information exchange is started by eLR or triggered by request from eLC.

Upon reception of the registration response, the eLC stores the eLR node identity and considers itself registered to the eLR. For obtaining the initial eLSRAI, the eLC proceeds according to the indication sent by the eLR, e.g. awaiting eLSRAI notification from the eLR or sending a respective request message, e.g. eLSRAI Request or eLSR Grant Request to the eLR.

5.5.3 Deregistration Procedure

The purpose of the eLC-initiated Deregistration procedure is to allow an eLC to deregister with an eLR. After successful completion of this procedure, the eLC can close its connectivity with eLR. To re-establish the dialogue with eLR, eLC shall proceed with a Registration Procedure (see clause 5.5.2).

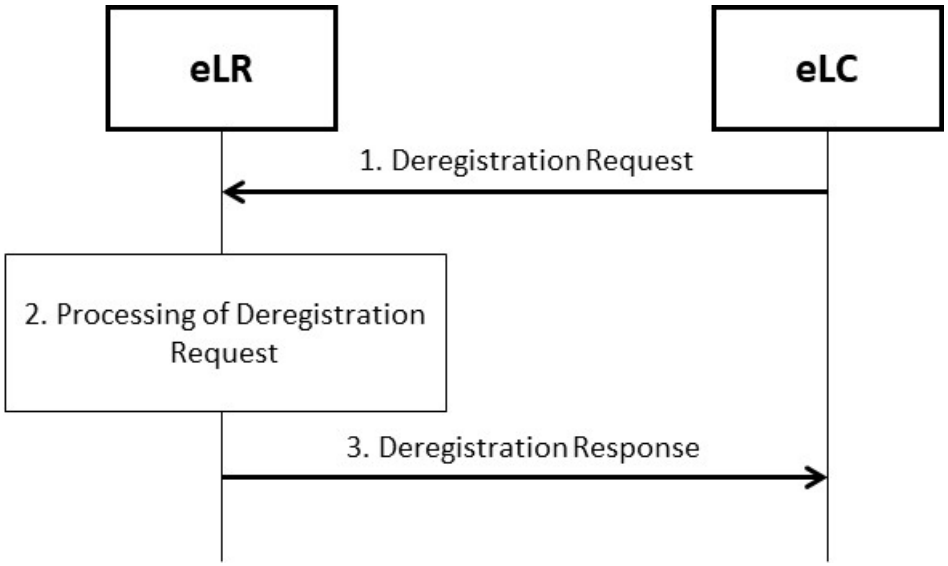

Figure 5: Deregistration Procedure

1) The eLC sends a Deregistration Request message to the eLR, including its node identity and the VSP identity the eLC belongs to.

2) The eLR checks the validity of both identities, terminates any ongoing procedures and removes the eLC node identity from the list of registered eLCs.

3) The eLR sends a Deregistration Response message to the eLC, including its node identity, to confirm the deregistration of eLC in eLR. From this point in time the eLC can close its connectivity with eLR.

5.5.4 eLSR Grant Procedure

The purpose of the eLSR Grant procedure is to enable the eLC to request a grant for an eLSR. The grant is provided as eLSRAI containing Allowance Zone information. The procedure is used to synchronize eLSRAI between eLR and eLC for the eLSA supported spectrum access schemes.

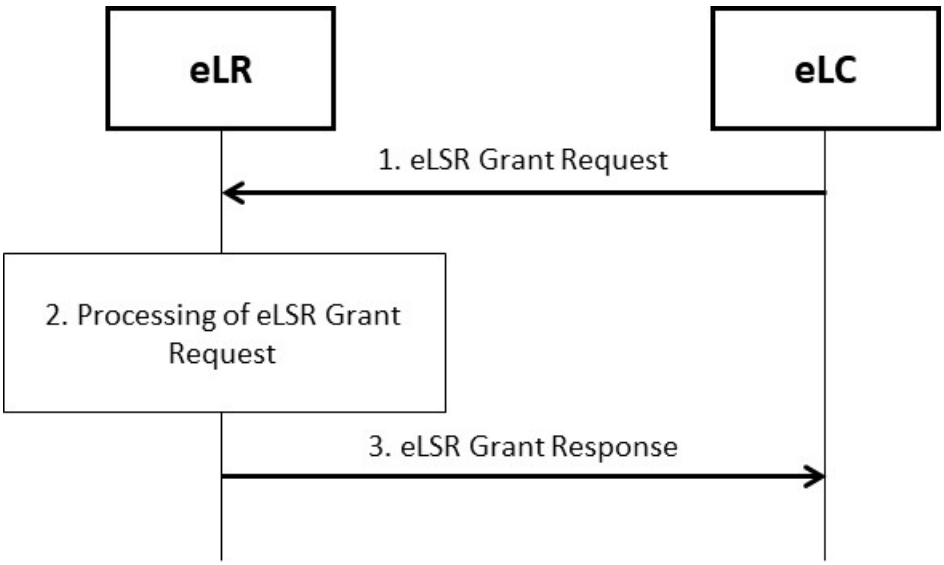

Figure 6: eLSR Grant Procedure

1) The eLC sends an eLSR Grant Request message to the eLR.

2) The eLR checks the consistency of the eLC request, marks respective eLSR as granted, and builds the relevant eLSRAI including the allowance zone information.

3) The eLR sends an eLSR Grant Response message including information on the current eLSRAI, such as spectrum, geographical area and timing and respective restrictions. The eLSRAI may include e.g. associated information resulting in immediate, delayed or periodic actions.

5.5.5 eLSR Grant Relinquishment Procedure

The purpose of the eLSR Grant Relinquishment procedure is to enable the eLC to relinquish grants for eLSR. The procedure is used to release a granted eLSR before the grant time expires.

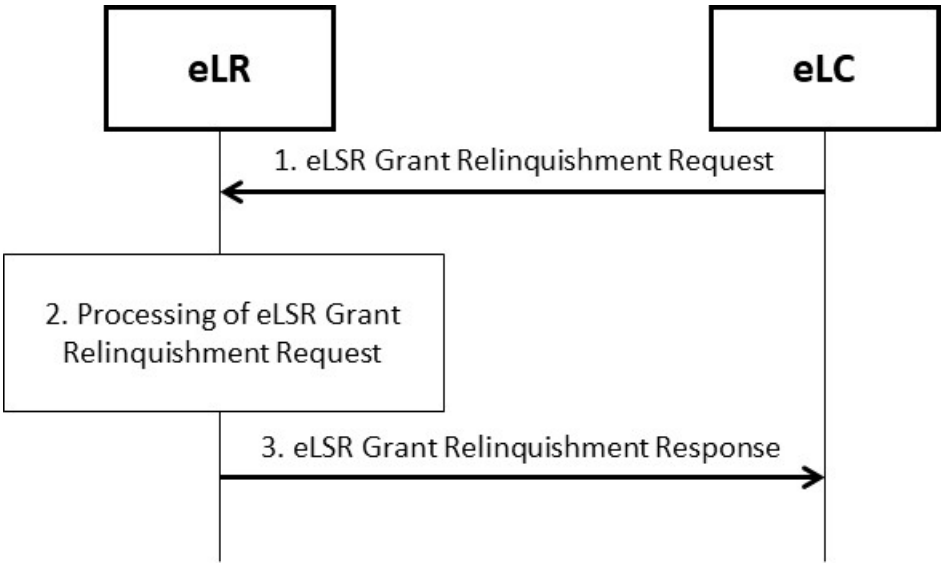

Figure 7: eLSR Grant Relinquishment Request Procedure

1) The eLC sends an eLSR Grant Relinquishment Request message to the eLR.

2) The eLR checks the consistency of the eLC request, releases the eLSR, and builds the resulting eLSRAI including the new allowance zone information.

3) The eLR sends an eLSR Grant Relinquishment Response message including information on the current eLSRAI, such as spectrum, geographical area and timing and respective restrictions. The eLSRAI may include e.g. associated information resulting in immediate, delayed or periodic actions.

5.5.6 eLSRAI Request Procedure

The purpose of the eLSRAI Request procedure is to enable the eLC to request an eLSRAI. The procedure is used to synchronize eLSRAI between eLR and eLC.

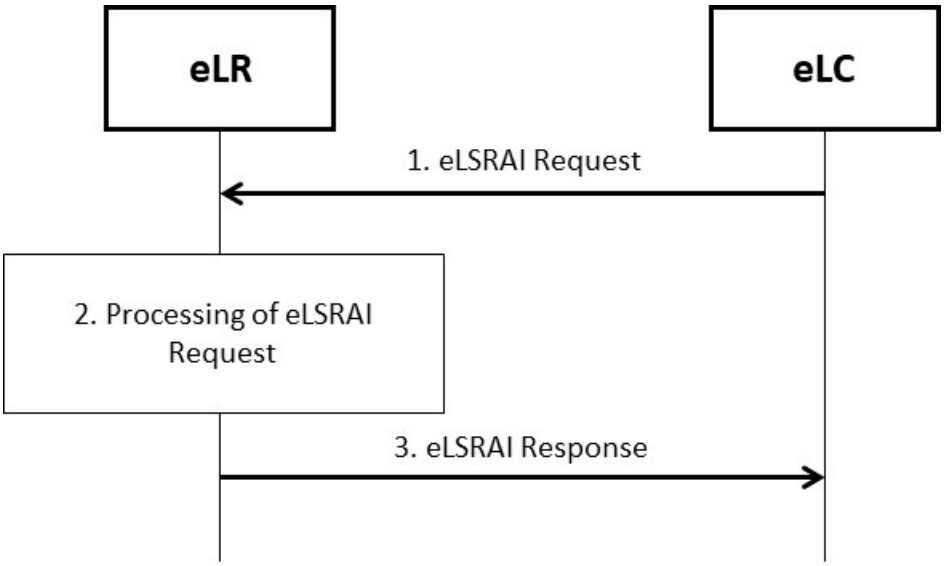

Figure 8: eLSRAI Request Procedure

1) The eLC sends an eLSRAI Request message to the eLR.

2) The eLR checks the consistency of the eLC request and builds the relevant eLSRAI.

3) The eLR sends an eLSRAI Response message including information on the current eLSRAI. The eLSRAI may include e.g. associated information resulting in immediate, delayed or periodic actions.

5.5.7 eLSRAI Notification Procedure

The purpose of the eLSRAI Notification procedure is to enable the eLR to send eLSRAI to the eLC. It can be used to send either specific immediate notifications or periodic updates to the eLC.

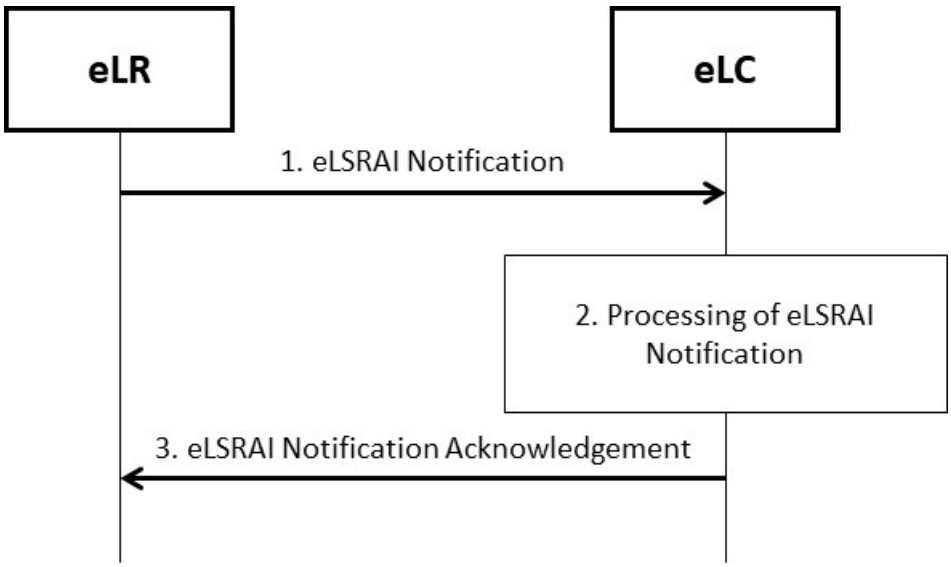

Figure 9: eLSRAI Notification Procedure

1) The eLR sends an eLSRAI Notification message to the eLC containing eLSRAI. The eLSRAI may include e.g. associated information resulting in immediate, delayed or periodic actions.

2) The eLC checks the consistency of the eLSRAI notification, and initiates respective actions related to the received eLSRAI.

3) The eLC responds with an eLSRAI Notification Acknowledgement message to confirm the reception of eLSRAI.

5.5.8 eLSRAI Confirmation Procedure

The purpose of the eLSRAI Confirmation Procedure is for the eLC to notify the eLR once the necessary configuration changes in the MFCN have been applied according to the eLSRAI provided by the eLR.

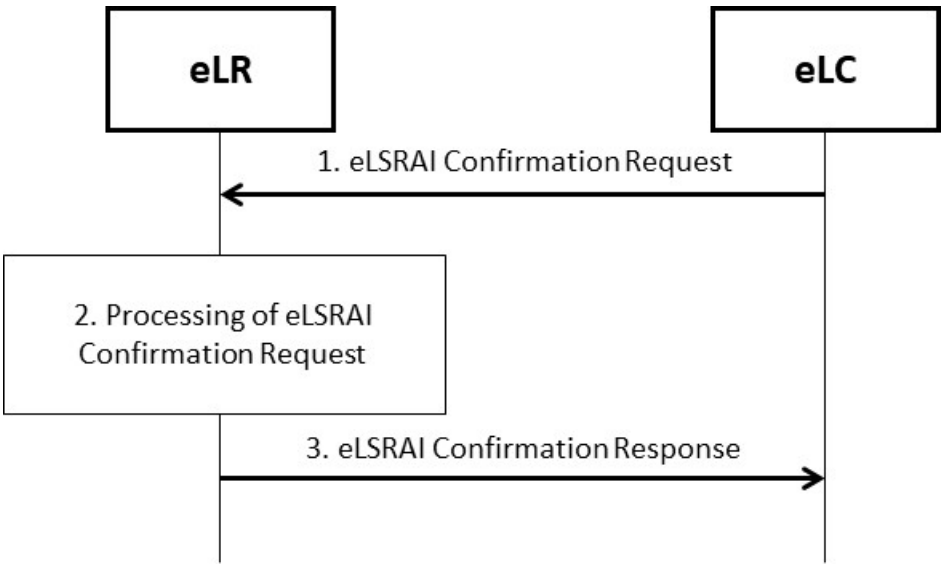

Figure 10: eLSRAI Confirmation Request Procedure

1) The eLC sends an eLSRAI Confirmation Request message to the eLR to confirm successful execution of configurations of eLSA spectrum resources in the MFCN according to received eLSRAI.

2) The eLR processes the eLSRAI Confirmation Request and stores the confirmation.

3) The eLR acknowledges the reception of the eLSRAI confirmation by sending an eLSRAI Confirmation Response message to the eLC.

NOTE: under detached operation scheduled confirmation is possible.

5.5.9 Connectivity Check Notification Procedure

The eLR-initiated Connectivity Check procedure allows the eLR to test the connectivity with any registered eLC. The procedure can be invoked at any time after Registration Procedure and throughout the lifetime of the eLC registration, and on specific events and/or on periodic basis. However, the eLR may take into account previous successful Connectivity Check procedures initiated by eLC when deciding whether to perform a Connectivity Check procedure at a certain time.

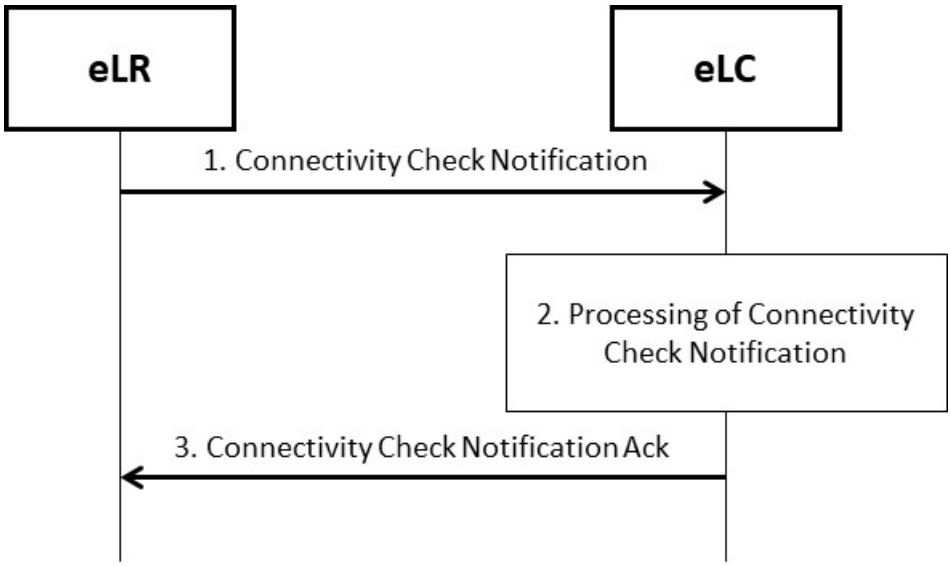

Figure 11: Connectivity Check Notification Procedure

1) The eLR sends a Connectivity Check Notification message to the eLC.

2) Upon reception of the Connectivity Check Notification, the eLC checks the consistency of the information provided.

3) If consistency check is successful, the eLC will respond with a Connectivity Check Notification Acknowledgement message to confirm the reception of Connectivity Check Notification.

The Connectivity Check procedure works at application layer and does not preclude other connectivity checks from lower protocol layers.

5.5.10 Connectivity Check Request Procedure

The eLC-initiated Connectivity Check procedure allows the eLC to test the connectivity with the eLR. The procedure can be invoked at any time after Registration Procedure and throughout the lifetime of the eLC registration, and on specific events and/or on periodic basis. However, the eLC may take into account previous successful Connectivity Check procedures initiated by eLR when deciding whether to perform a Connectivity Check procedure at a certain time.

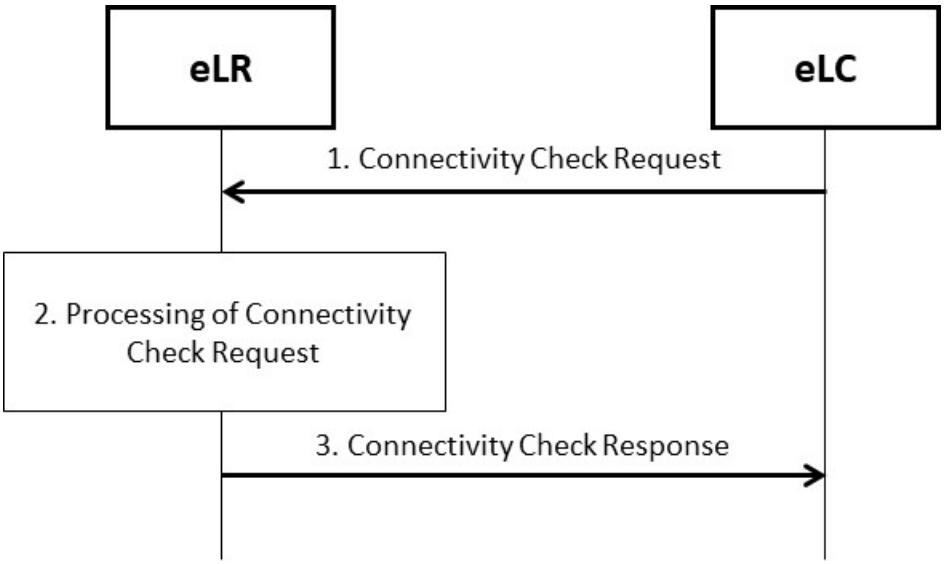

Figure 12: Connectivity Check Request Procedure

1) The eLC sends a Connectivity Check Request message to the eLR.

2) Upon reception of the Connectivity Check Request, the eLR checks the consistency of the information provided.

3) If consistency check is successful, the eLR will respond with a Connectivity Check Response message to confirm the reception of Connectivity Check Request.

The Connectivity Check procedure works at application layer and does not preclude other connectivity checks from lower protocol layers.

5.6 Procedure Flows

5.6.1 Introduction

This clause describes procedure flows that shall be supported by the $eLSA_1$ application protocol. Each flow may be composed of several procedures, and provides support for a particular operational activity (e.g. eLC start-up with dedicated eLSR or variable eLSR). Additional flows (and respective operational activities) may be supported by the protocol.

The protocol may allow additional variants for a given flow. For example, the protocol may support the option to use either a single instance or multiple sequential instances of a particular procedure within a flow.

NOTE: For instance, in the case of the eLSRAI Confirmation procedure, the protocol should support the use of multiple instances in all of the documented flows, since the procedure may in general need to be initiated at different times for a particular eLSRAI received by the eLC.

5.6.2 eLC Operation Start-up for granted eLSR

This message flow shall be used during eLC start-up when eLSR are dedicated (e.g. eLSA Licensing), and provides the $eLSA_1$ support for the use case A.3 (see annex A). At the end of the flow, the eLC has the necessary eLSRAI, and the eLR will have received confirmation that relevant changes have been executed.

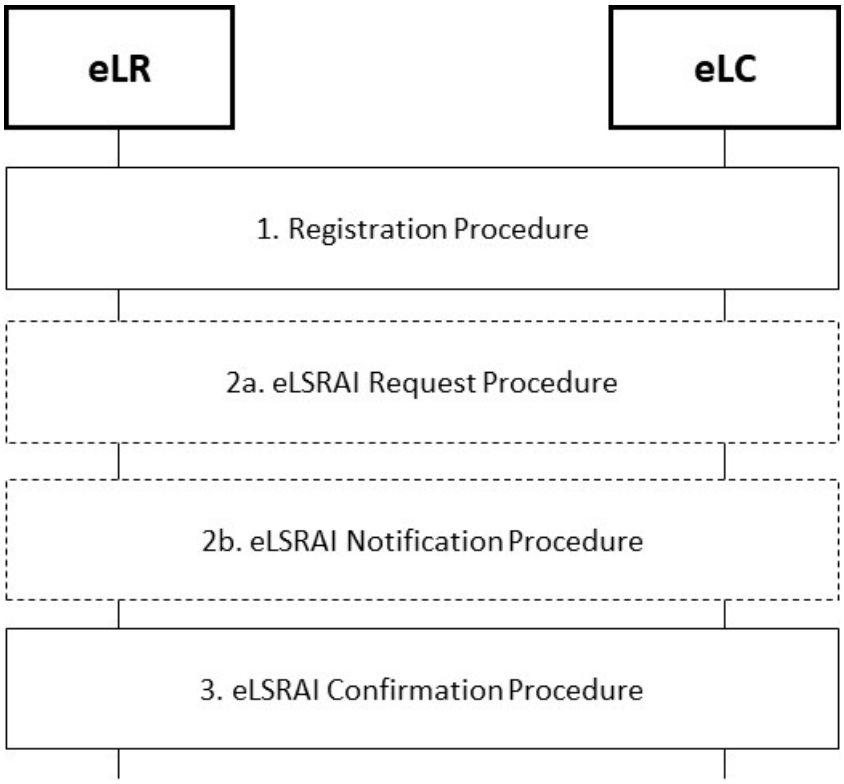

Figure 13: eLC Operation Start-up procedure flow for granted eLSR

1) The Registration procedure is performed.
Depending on the eLR decision, either step 2a or 2b is performed.

2a) The eLC initiates the eLSRAI Request procedure.

2b) The eLR initiates the eLSRAI Notification procedure.
On completion of steps 2a or 2b, the LC has received the necessary eLSRAI.

3) Upon successful configuration change of the LSA spectrum resources in the MFCN, the eLC initiates the eLSRAI Confirmation procedure.

5.6.3 eLC Operation Start-up for non-granted eLSR

This message flow shall be used during eLC start-up when eLSR needs to be granted before operation per request, and provides the $eLSA_1$ support for the use case A.3 (see annex A). At the end of the flow, the eLC has the necessary eLSRAI, and the eLR will have received confirmation that relevant changes have been executed.

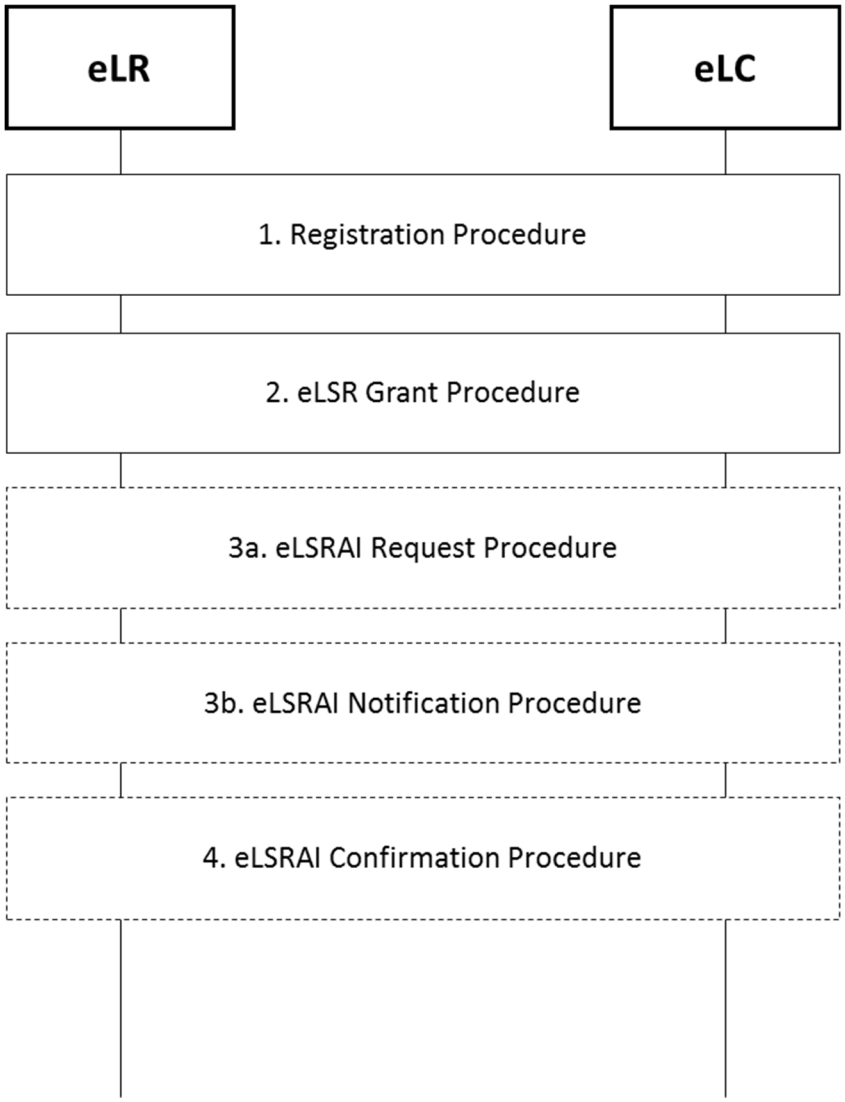

Figure 14: LC Operation Start-up procedure flow for variable eLSR

1) The Registration procedure is performed.
eLR waits for a request message from eLC. Depending on the eLC decision, either step 2 or 3 is performed.

2) The eLR initiates the eLSR Grant procedure.
Depending on the eLR decision the eLSRAI is provided with the eLSR Grant Response message or either step 4a or 4b is performed.

3a) eLC initiates the eLSRAI Request procedure.
Depending on the eLR decision either the eLSRAI is provided with the eLSRAI Response message or step 3b is performed.

3b) eLR initiates the eLSRAI Notification procedure.

On completion of steps 2, 3a, or 3b the eLC has received the necessary eLSRAI:

4) Upon successful configuration change of the eLSR in the MFCN, the eLC initiates optionally the eLSRAI Confirmation procedure.

5.6.4 eLR Notification of new eLSRAI

When eLSR is granted and the eLR becomes aware of new eLSRAI, it may decide to notify immediately the eLC using this procedure flow. This flow may happen at any time following completion of the Registration procedure.

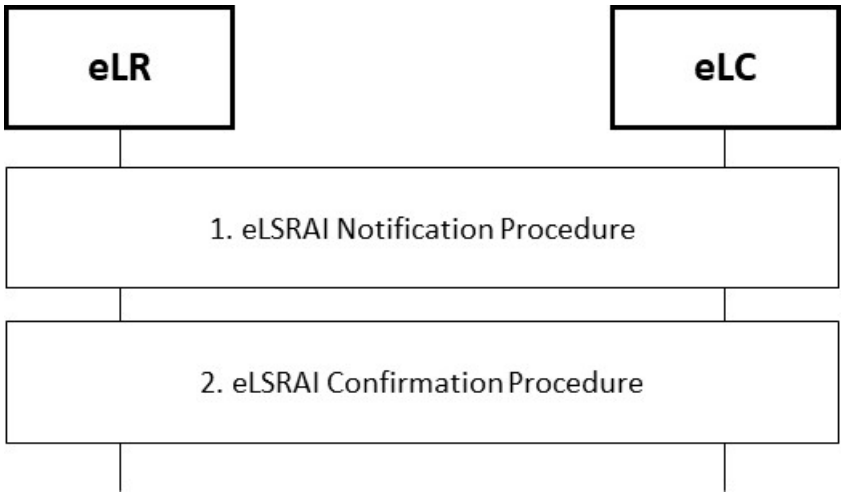

Figure 15: eLR Notification of new eLSRAI procedure flow

1) The eLR initiates the eLSRAI Notification procedure to inform the eLC of new eLSRAI.

2) Upon successful configuration change of the eLSA spectrum resources in the MFCN, the eLC initiates the eLSRAI Confirmation procedure.

5.6.5 eLSRAI Synchronization

This procedure flow is used to synchronize the eLSRAI of eLR and eLC. Either eLC or eLR may consider the possibility that the eLSRAI is no longer synchronized. To solve or avoid loss of synchronization, eLC or eLR can initiate eLSRAI synchronization at any time. At the end of the flow, the eLC has the necessary eLSRAI, and the eLR will have received confirmation that relevant changes have been executed.

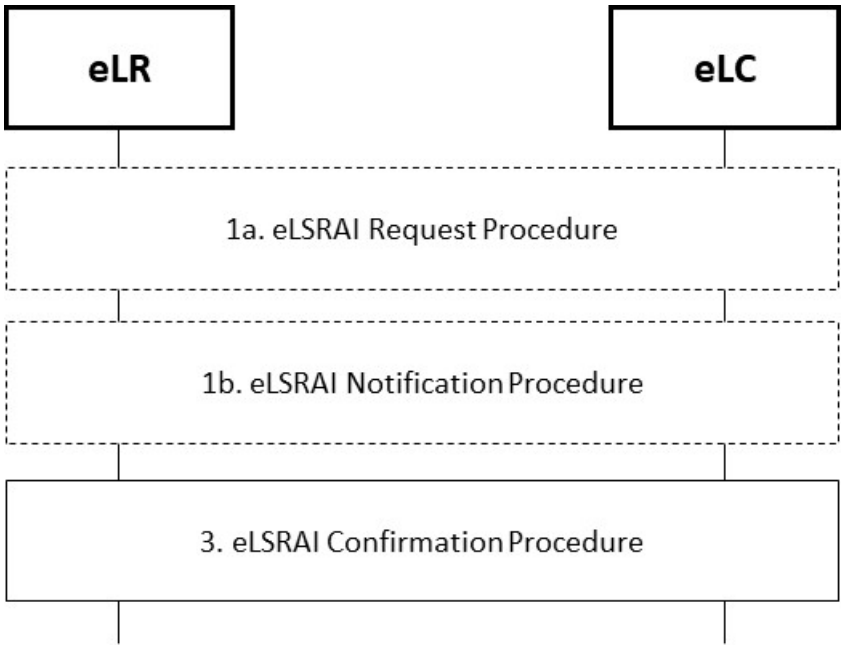

Figure 16: eLSRAI Synchronization procedure flow

Depending on the eLR decision either step 1a or 1b is performed:

1a) eLC initiates the LSRAI Request procedure.
Depending on the eLR decision either the eLSRAI is provided with the eLSRAI Response message or step 1b is performed.

1b) eLR initiates the eLSRAI Notification procedure.

On completion of step 1a or 1b, the eLC has received the necessary eLSRAI:

2) Upon successful configuration change of the eLSRAI in the MFCN, the eLC initiates the eLSRAI Confirmation procedure.

5.6.6 eLC Request for new eLSRAI with optional eLR Notification

This procedure flow is used when the eLC requests the eLR to send it new eLSRAI. Optionally, the procedure flow enables the eLR to receive an acknowledgement from the eLC upon reception of the new eLSRAI. The acknowledgement may allow informing the Incumbent that the VSP has received the new eLSRAI (e.g. changed protection zone) successfully in advance of the eLSRAI Confirmation Procedure (which is expected to be asynchronous, since the processing in the MFCN requires a longer time). This flow may happen at any time following completion of the Registration procedure.

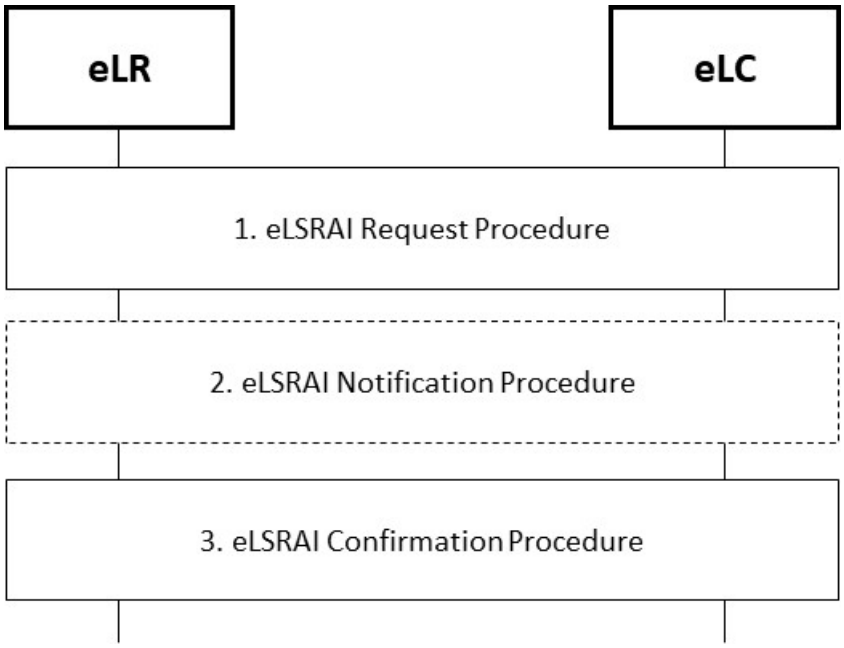

Figure 17: eLC Request for new eLSRAI with optional acknowledgement

1) eLC initiates the eLSRAI Request procedure. eLR may indicate in the eLSRAI Response message that a eLSRAI Notification procedure will follow.

2) When eLR has indicated that an eLSRAI Notification procedure will follow the eLR initiates the eLSRAI Notification procedure.

   eLR may provide new eLSRAI in the eLSRAI Response message, the eLSRAI Notification message, or in both messages, i.e. on completion of either step 1 or step 2, the eLC has received the new eLSRAI.

3) Upon successful configuration change of the eLSRAI in the MFCN, the eLC initiates the eLSRAI Confirmation procedure.

6 eLSA Failure Management

Failures may originate due to hardware or software problems at the eLC, eLR or $eLSA_1$ interface. The eLSA failure management provides respective functions to guarantee the Incumbent and the VSP protections even in case that eLC, eLR, or $eLSA_1$ interface is out of operation. Failures may occur either during the eLSA system setup or the eLSA operation phase.

Since system setup is covered by the eLSA system management functions group, respective failures are handled by the system management of the eLR and/or eLC only. Instead, failures which are related to the eLSA operation are considered by the eLSA failure management as follows:

- Failures that are encountered during execution of the high-level procedures are treated in the respective procedure.
- Failure management of eLR should detect malfunctions of high-level functions located at the eLR including outage of the eLC and $eLSA_1$ interface.
- Failure management of eLC should detect malfunctions of high-level functions located at the eLC including outage of the eLR and $eLSA_1$ interface.

In case eLR or eLC failure management detects system operation malfunction or outage, it initiates actions (e.g. inform Incumbent or VSP, generate alarm message for eLSA system management, change eLSRAI, restore eLSRAI synchronization between eLR and eLC) to guarantee the Incumbent and the VSP protections. The Incumbent and the VSP protections are considered to be specified in the Sharing Framework and/or Sharing Arrangement, including the case of eLSA system failures.

Fall-back measures may be applied by the eLC when its failure management has determined that eLSRAI consistency at both ends of $eLSA_1$ cannot be guaranteed.

7 eLSA Deployment Scenario Rules

eLSA deployments may comprise multiple physical eLSA Repositories and/or eLSA Controllers (motivated by practical requirements such as extended reliability concepts, private repositories at Incumbents side, performance extensions, support of eLC outside of the VSP domain based on business agreements, or the parallel use of eLSA spectrum access schemes). A general rule set is defined for the eLSA system to limit the complexity in eLSA deployment scenarios:

- In case that a private repository does not support all functions of an eLR (e.g. Sharing Framework) a public repository may be established that contains at least the missing functionality.
- Multiple independent eLRs are supported under condition that each of the eLR is responsible for a set of unique non-overlapping frequency ranges.
- In cases where the condition that each eLR is responsible for a set of unique non-overlapping frequency ranges cannot be met, each eLC sees multiple physical repositories as one eLR structure (or single $eLSA_1$ endpoint), i.e. the eLC does not need to know how the functionality is mapped to physical repositories or be aware of their existence.
- In general, eLR provides a eLSA information exchange function to multiple eLCs. This function also includes support for sub-networks of a MFCN, using either a single eLC for the MFCN or multiple physical eLCs.

NOTE: The interconnection of multiple physical eLRs and especially the interworking of a private and public repository is outside the scope of the present document.

Examples of deployment architectures are provided in annex C.

Annex A (informative): eLSA Operational Use Cases

A.0 Introduction

This annex describes some use cases introduced by local spectrum access. The LSA uses cases defined in [1] are inherently supported.

The evolved LSA system is designed to support the NRA and spectrum owners like MNOs in a flexible way. The system intends to provide means to automate the licencing and leasing process to assign authorizations for the use of spectrum with individual right to use. The most commonly used method currently, is that the licenses to operate in a given area for a given time period and in a given spectrum resource (frequency allocation) is authorised before the licensee can start using the license transmitting radio signals. This type of authorisation process was the assumption in LSA. Another method is e.g. the case when the VSP obtain a license to operate frequencies for local operation in a more automated process. This requires the NRA to initialise the eLSA system and authorise the VSPs so they can later apply for licenses within the eLSA system. The license is provided by the eLSA procedures. The VSP requests a spectrum resource grant for a defined local area and time period. The eLSA Repository checks if the spectrum resource grant can be accepted, considering the sharing terms and conditions defined by the NRA, and informs the VSP about its decision. When the spectrum resource grant was successful, i.e. the spectrum resource (i.e. spectrum, local area, and time) is assigned to the VSP, the VSP has a license and can commence operation. The leasing process follows the same principle. Main difference is that, when leasing is allowed nationally, the sharing terms and conditions are defined by the Incumbent (MNO). The sharing framework and conditions as given for the license is still valid.

This annex provides the description of a non-exhaustive list of operational activities related to the eLSA System operations:

- Activate eLSA Repository for eLSA operation.
- Input of the Sharing Framework, Sharing Arrangement and eLSA License/Lease information to the eLSA Repository.
- VSP activates eLSA support operation.
- VSP starts to operate in the available eLSA spectrum resources.
- VSP receives information on eLSR Spectrum Resource Availability Information updates when license/lease expires.

A.1 Pre-checking of Spectrum Availability

In general, and before deploying a network that will be accessing spectrum via an eLSA system, a VSP should have the means to check the availability of spectrum for the desired location and period of operation. Further, the pre-checking of spectrum availability should help the VSP to estimate if the available spectrum fulfils the targeted business objectives and requirements. To support this process, e.g. the grant of a license/lease, the eLSA system supports an off-line interface, e.g. a web-based interface, to the eLR (hosted by the NRA in case of local licenses or by the incumbent in case of leasing, see Figure 1).

A.2 Activate eLSA Repository for eLSA operation

In this activity the following pre-requisites and actions are foreseen.

Pre-requisites:

- The operation of the eLR belongs to the Regulator and/or Incumbent for the licensing and leasing cases respectively.

Activation actions:

- Relevant interfaces and access control are configured to allow the Regulator, Incumbent, and VSP to access the System via the applicable interfaces such as eLSA1, eLSA2. eLSA3, and eLSA5.

Output:

- eLSA Repository is activated and allows at least Regulator and Incumbent to access the system.

A.3 Input of the Sharing Framework, Sharing Arrangement and eLSA License/Lease information to the eLSA Repository

The licensing conditions are determined and defined by the NRA and contained in the eLR. In a leasing scenario those conditions typically do not change. However, the Lessor may impose additional conditions in the sharing arrangement. That is, in a leasing scenario between an Incumbent (e.g. an MNO) and a VSP, the input to the Incumbent's eLSA Repository is typically performed by the Incumbent, who provides then beside the sharing arrangement the given terms and conditions for the Incumbent´s licensed spectrum resource that has been defined by the NRA. In this activity the following pre-requisites and actions are foreseen.

Pre-requisites:

- The NRA or Incumbents has allocated spectrum for eLSA use (i.e. spectrum for local access) by definition of shared spectrum resources for licensing and/or leasing.
- NRA has, together with the relevant stakeholders, decided on the sharing terms and conditions for supported spectrum access schemes.
- eLSA Repository is activated.

Regulator or Lessor operational actions:

- Information about the sharing terms and conditions, the spectrum assigned for local access and its spectrum access scheme as well as any license and/or lease information related to the VSPs will be entered into the eLSA Repository.

Output:

- eLSA Repository is put into operation.

A.4 VSP activates eLSA support operation

In this activity the following pre-requisites and actions are foreseen.

Pre-requisites:

- eLSA Repository is put into operation.
- The address of the eLSA Repository and the necessary security information to access the eLR has been initialised in the eLC.

eLC operator actions:

- VSP enters in the eLSA Controller the appropriate configuration information of the eLSA Repository.
- VSP activates the eLSA Controller.

- eLSA Controller registers with the eLSA Repository:
  - If a license/lease exists, necessary information related to authorized eLSA spectrum resources is exchanged between the eLR and eLC. eLSA Repository responds with eLSA spectrum resource availability information.
  - Or if a license/lease does not exist, the VSP requests a license/lease and if a license/lease is granted the eLSA Repository responds with eLSA spectrum resource availability information.
- eLSA Controller acknowledges the eLSA spectrum resource availability information to eLSA Repository once the MFCN of the VSP has applied the settings.

Output:

- eLSA Controller is put into operation and the eLSA spectrum resource availability information is synchronized with the eLSA Repository.

The exchange of data between eLSA Repository and eLSA Controller is supported by a set of procedure(s) at $eLSA_1$ reference point defined in clause 5.5.

A.5 VSP starts to operate in the available eLSA spectrum resources

In this activity the following pre-requisites and actions are foreseen.

Pre-requisites:

- The eLSA Controller has an up to date set of eLSA spectrum resource availability information.

VSP operational actions:

- The VSP determines based on the information in the eLSA Controller how to operate its MFCN in the available eLSA spectrum resources.

Output:

- MFCN operates within the available eLSA spectrum resources.

All of the above steps are outside of scope of standardization.

A.6 VSP receives information on eLSR Spectrum Resource Availability Information updates when license/lease expires

In this activity the following pre-requisites and actions are foreseen. This use case is used when a license/lease expires and is then used to update the possible prolonging of a license/lease.

Pre-requisites:

- eLSA Repository is put into operation.
- eLSA Controller is put into operation.
- eLSA Repository has a new eLSRAI.

VSP operational actions:

- eLSA Repository informs the eLSA Controller about the new eLSRAI.

- eLSA Controller acknowledges the reception of modified eLSA spectrum resources availability information, processes the changes and requests the VSP to update the MFCN configuration.
- eLSA Controller acknowledges the updated eLSA spectrum resources availability information to eLSA Repository.

Output:

- eLSA Controller has an up to date set of eLSA spectrum resources availability information and is synchronized with the eLSR Repository.
- The VSP operates on the available eLSA spectrum resource accordingly.

The exchange of data between eLSA Repository and eLSA Controller is supported by a set of procedure(s) at LSA_1 reference point defined in clause 5.5. Steps performed are outside of scope of standardization.

A.7 VSP operates in Detached Operation Mode (DOM)

As described in [1], VSPs may want to operate and control their local MFCNs in a Detached Operation Mode (DOM), i.e. without a permanent network connection to the eLSA System.

Typical use cases demanding detached operation are cultural, political, news-gathering or sport events. Some of these events may be scheduled, i.e. they can be well planned in advanced while others, particularly news-gathering, may happen on-demand. Some events happen only once at a given location, e.g. the Eurovision Song Contest that yearly changes its location depending on the winner country, others may happen regularly at the same location e.g. the "Rock am Ring" music festival in Germany.

The point of detachment between the VSP and the eLSA system can be located at the:

a) $eLSA_1$ interface, i.e. the connection between the eLC and the eLR can be temporarily disconnected

b) $eLSA_4$ interface, i.e. the connection between the MFCN and the eLC can be temporarily disconnected

The following describes the basic pre-requisites and actions for a VSP to switch in the detached operation mode.

Pre-requisites:

- The Sharing Framework, the Spectrum Sharing Arrangement and/or the individual right of use allows VSPs to operate in detached operation mode. They contain respective details on the maximum duration of the detached operation period, the acceptable response times and the periodicity for network reconnection between the MFCN and the eLSA System or the eLR and eLC connection.
- After a successful registration procedure (see clause 5.5.2), the eLC remains registered during the whole duration of the agreed detached operation period.
- If eLSRAI changes during the duration of the DOM the respective MFCNs changes may be delayed according to the allowed response time.

Actions before a VSP switches to DOM:

- eLR is put into operation.
- eLC is put into operation and registered to the eLR.
- eLSRAI is exchanged at least once between eLR and eLC.
- VSP informs the eLR about its intention to switch to the Detached Operation Mode (DOM).
- VSP switches to DOM.

Actions after expiration of the DOM period:

- VSP returns to the normal mode of operation. The eLC informs the eLR about the end of the DOM.

A.8 Deployment of VSPs. With nomadic and temporary operation

A music festival is organized at a certain location, e.g. stadium, concert hall or private property. Usually, those event locations do not have fixed PMSE equipment (e.g. cameras, microphones, IEM, etc.) or audio-visual (AV) production network infrastructure of their own, but PMSE equipment and AV network infrastructure is brought into the event location on-demand by an event production company (i.e. AV-VSP).

Typically, event production companies (AV-VSPs) apply to the NRA for a site license to obtain local spectrum rights for the duration of the event and coordinate the frequency use on site. In the context of eLSA and due to its nomadic and temporary operation character, event production companies would most probably implement an eLC in their network infrastructure since they cannot assume that every location owner has deployed a fixed network infrastructure and an eLC for requesting local spectrum access on its premises.

Note that in some countries the location owner may be entitled to request local spectrum for its property, using spectrum for its own purposes, and may then act as a VSP for others, e.g. for the AV-VSPs, or lease out spectrum to AV-VSPs.

Figure A-1 illustrates a situation where the owner of the event location is entitled to request local spectrum access for its property and deploys an eLC within its domain. Two AV-VSPs are involved in the production of the audio-visual content of the event.

Three example cases are shown in Figure A-1:

a) The AV-VSPs obtain local spectrum access rights in the event location area directly from the NRA or the incumbent. Therefore, each AV-VSP relies on its own eLC and the $eLSA_1$ interface to eLR.

b) The location owner acts as a proxy to the AV-VSPs for the purpose of accessing local spectrum to the AV-VSPs Therefore, the eLC of the location owner acts as an external eLC proxy to the eLCs of the AV-VSPs (assuming they have an eLC as discussed above). The proxy eLC and the eLCs of the AV-VSPs are connected through an interface that at least supports request and relinquishment of spectrum resources.

c) The location owner has a license of local spectrum and leases out spectrum to AV-VSPs for the event. It implements the necessary eLR functionality for this purpose.

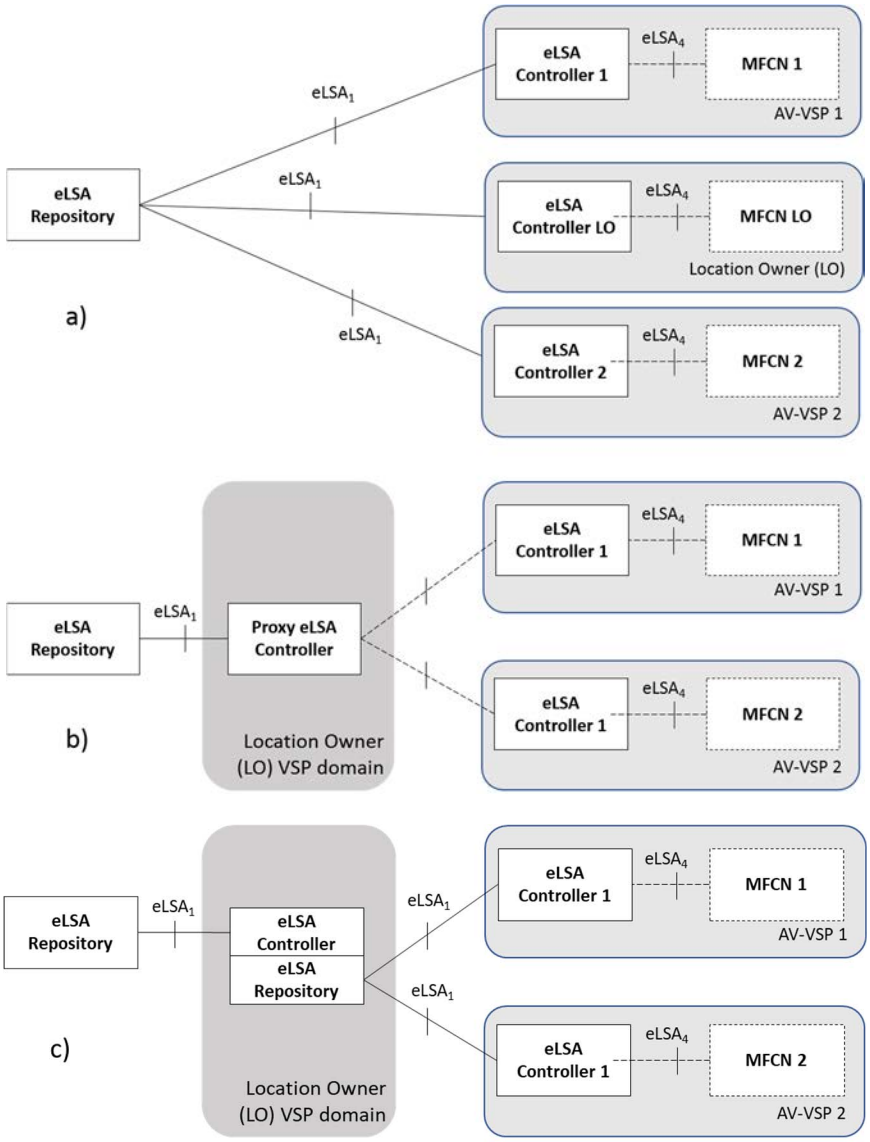

Figure A-1: Possible deployments of VSPs with nomadic and temporary operation

Annex B (informative): Guidance for LSA_2, LSA_3, $eLSA_4$ and $eLSA_5$

B.1 Introduction

This annex provides guidance on the functionality recommended to be supported by implementations of LSA2 LSA3, $eLSA_4$ and $eLSA_5$. Each functionality is referenced to the related clause (s) in ETSI 103 652-1 [1].

B.2 NRA-Related Guidance (LSA_2)

The LSA2 interface enables the Administration/NRA ("NRA") role to interact with an eLR. The following describes the basic functionality which is recommended to be supported on this interface.

Fundamental components of NRA I/O:

- Configuration of sharing framework in the eLR (see clauses 6.1.6 and 6.1.9 of ETSI TS 103 652-1 [1]):
  - Definition of eLSA spectrum resources (see clause 6.1.9 of ETSI TS 103 652-1 [1]).
  - Assignment of spectrum resources to licensees/lessees (see clause 6.1.4 of ETSI TS 103 652-1 [1]).
  - Definition of regulatory sharing rules (see clause 6.1.6 of ETSI TS 103 652-1 [1]).
- Report delivery or access (see clause 6.1.10 of ETSI TS 103 652-1 [1]):
  - Including possible configuration of report (see clause 6.1.10 of ETSI TS 103 652-1 [1]).

Additional aspects:

- Support for changes in the sharing framework and sharing rules (see clause 6.3.4 of ETSI TS 103 652-1 [1]).
- Support for pre-configuration (see clause 6.1.13 of ETSI TS 103 652-1 [1]), response times (see clauses 6.3.6 of ETSI TS 103 652-1 [1]) and protection of the eLSA licensee's operations (see clause 6.3.3 of ETSI TS 103 652-1 [1]).
- Support for security aspects (see clauses 6.4.1 to 6.4.5 of ETSI TS 103 652-1 [1]) including secure access and user authentication.

B.3 Incumbent-related Guidance (LSA_3)

The LSA3 interface enables the Incumbent role to interact with an LR. The following describes the basic functionality which is recommended to be supported on this interface.

Fundamental components of Incumbent I/O:

- Configuration of sharing arrangement (non-regulatory aspects) (see clauses 6.1.9, 6.2.2 and 6.3.2 of ETSI TS 103 652-1 [1]).
- Input of incumbent's usage and protection requirements (see clauses 6.2.1, 6.2.2, 6.2.3, 6.2.5 and 6.2.6 of ETSI TS 103 652-1 [1]).
- Access to acknowledgment information (see clauses 6.2.4 and 6.3.5 of ETSI TS 103 652-1 [1]).
- Report delivery or access (see clause 6.1.10 of ETSI TS 103 652-1 [1]).
- Including possible configuration of report (see clause 6.1.10 of ETSI TS 103 652-1 [1]).

- Access to failure indications caused by system malfunctions (see clause 6.1.8 of ETSI TS 103 652-1 [1]).

Additional aspects:

- Support for multiple incumbents (see clause 6.1.5 of ETSI TS 103 652-1 [1]).
- Support for input verification including rejection through consistency checking with sharing rules (see clause 6.1.14 of ETSI TS 103 652-1 [1]).
- Support for multiple types of inputs (for usage/protection requirements) including scheduled, on-demand, and also signalling of pre-configured requirements (see clauses 6.1.11, 6.1.12 and 6.1.13 of ETSI TS 103 652-1 [1]).
- Support for different input formats including exclusion, restriction and protection zones (see clauses 6.2.5 and 6.2.6 of ETSI TS 103 652-1 [1]).
- Support for changes in the sharing arrangement (see clauses 6.1.16 and 6.3.4 of ETSI TS 103 652-1 [1]).
- Support for expected response times (see clauses 6.3.6 and 7.2.1 of ETSI TS 103 652-1 [1]).
- Support for security aspects (see clauses 6.4.1 to 6.4.5 of ETSI TS 103 652-1 [1]) including secure access and user authentication.

B.4 VSP-related Guidance (LSA_5)

The LSA5 interface enables the VSP role to interact with an eLR. The following describes the basic functionality which is recommended to be supported on this interface.

Fundamental components of VSP I/O:

- Access to sharing framework and sharing arrangements (see clause 6.1.6 of ETSI TS 103 652-1 [1]).
- Access to information related to availability of eLSA resources (see clauses 6.1.1, 6.1.3, 6.1.7 and 6.1.4 of ETSI TS 103 652-1 [1]).
- Report delivery or access (see clause 6.1.10 of ETSI TS 103 652-1 [1]).
- Including possible configuration of report (see clause 6.1.10 of ETSI TS 103 652-1 [1]).

Additional aspects:

- Support for input verification including rejection through consistency checking with sharing rules (see clause 6.1.14 of ETSI TS 103 652-1 [1]).
- Support for multiple types of inputs (for usage/protection requirements) including bandwidth, QoS and protection requirements (see clauses 6.1.11, 6.1.12 and 6.1.13 of ETSI TS 103 652-1 [1]).
- Support for different input formats including allowance zones (see clauses 6.1.17, 6,2,5, 6.2.6 of ETSI TS 103 652-1 [1]).
- Support for security aspects (see clauses 6.4.1 to 6.4.5 of ETSI TS 103 652-1 [1]) including secure access and user authentication.

Annex C (informative): Deployment Architecture Examples

C.1 Introduction

This annex describes deployment architecture examples. The examples provided are not meant to be exhaustive and are included to illustrate some of the possibilities supported by the eLSA architecture. They are also not mutually exclusive, i.e. in a large deployment, several of these may coexist. In particular, an eLR may be connected to eLCs serving different VSPs, and each VSP may adopt a distinct deployment configuration.

C.2 Examples

C.2.1 eLSA Controller in the VSP domain

A VSP may deploy an eLC to handle all the eLSA related exchanges with an eLR. This option can be used for leasing and licensing scenarios.

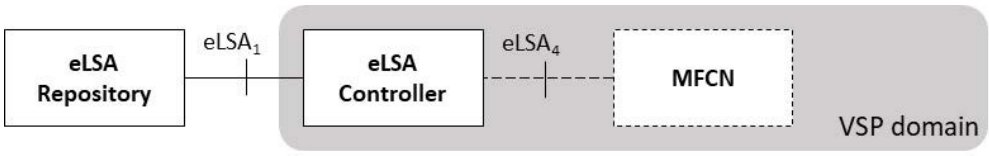

Figure C-1: eLSA Controller in the VSP domain

C.2.2 eLSA Controller outside the VSP domain

A VSP may have established an agreement with a third-party that provides all the eLSA related exchanges with an eLR acting on its behalf. This option can be used for leasing and licensing scenarios.

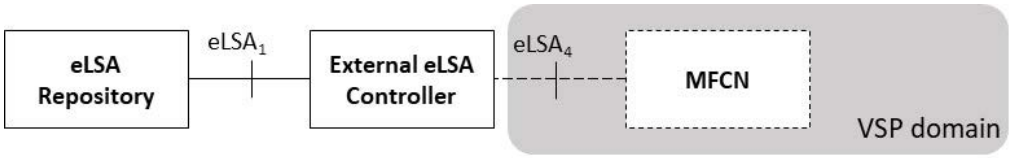

Figure C-2: eLSA Controller outside the VSP domain

C.2.3 eLSA Controller connecting to multiple eLSA Repositories

A VSP may need more spectrum resources than the NRA or an Incumbent can provide. To cover such scenarios, the eLSA Controller may connect to multiple eLSA Repositories as described in clause 7. Figure C-3 shows an example, how this deployment option is used in a mixed licensing and leasing scenario. This option can be used in a mixed licensing and leasing scenario, when the NRA manages different spectrum resources with dedicated eLSA Repositories, or when spectrum resources are provided by multiple Incumbents (MNOs).

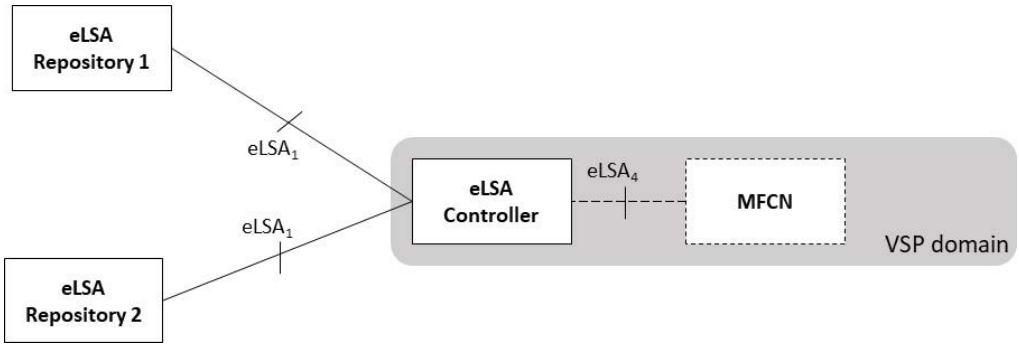

Figure C-3: eLSA Controller connecting to multiple eLSA Repositories

C.2.4 eLSA Controller for multiple MFCNs in VSP domain

A VSP may operate different MFCNs in different geographical areas which are served by the same eLSA Controller. In this case, the eLC is responsible for the mapping function in respect of the individual licenses and/or leases of the deployed MFCNs.

The eLSA Repository does not know about any network partitioning behind the eLC that could involve individual frequency or area partitioning between the MFCNs in the licenses or leases.

This does not exclude that each MFCN has its own dedicated eLC instead of a common eLC.

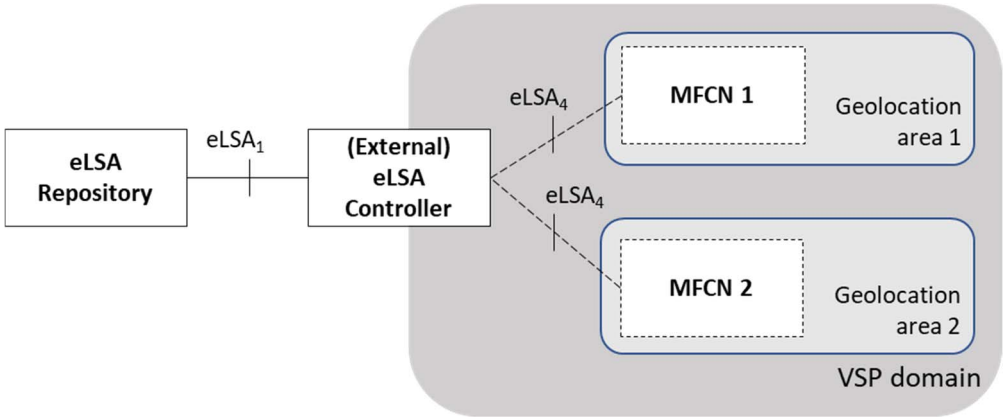

Figure C-4: eLSA Controller for multiple MFCNs in VSP domain

C.2.5 Proxy eLSA Controller

A VSP may operate different MFCNs and wants to deploy for each MFCN a dedicated eLSA Controller. In this case, each eLC is responsible for the mapping function in respect of a unique subset of the operator's eLSA spectrum resource. For example, this option can be used in a licensing and leasing scenario, when each eLC handles for each MFCN an individual spectrum license or lease.

From the perspective of the eLSA Repository, the eLSA Repository interacts with a single eLSA Controller (the proxy eLC). However, this configuration allows a VSP to deploy dedicated eLSA Controllers for multiple MFCNs. Note that this configuration imposes no new requirements on $eLSA_1$, since there are separate protocol instances on either side of the "Proxy eLC". The "Proxy eLC" terminates both interfaces, and therefore appears as a single eLC to the eLR. In addition to hiding the identities and complexity of the network towards the opposite endpoints, the proxy eLC may also coordinate the operation of eLC1- eLC2, e.g. by non-transparently modifying the eLSRAI received from the eLR before forwarding to each eLC.

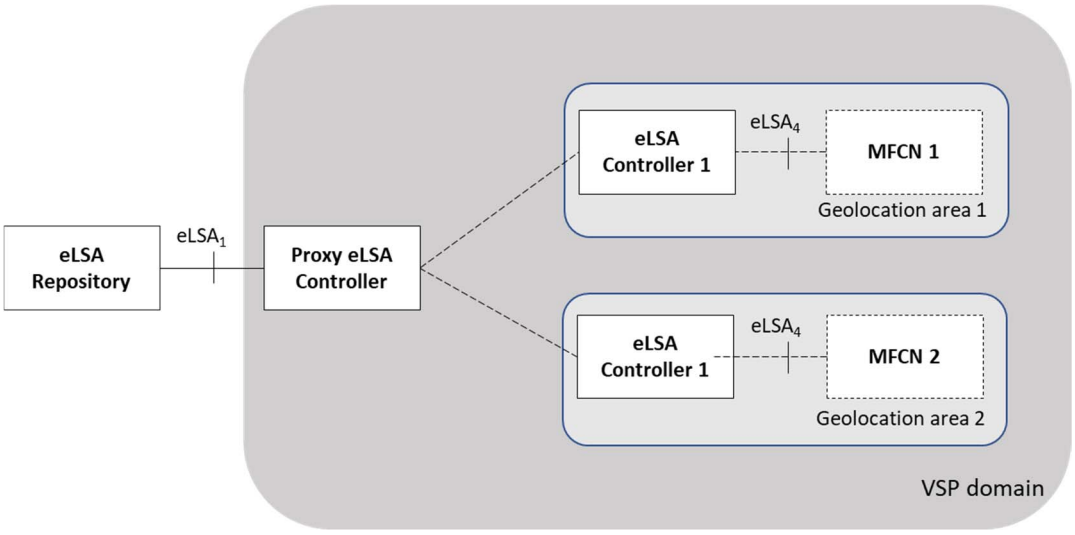

Figure C-5: Proxy eLSA Controller

History

Document history		
V1.1.1	January 2020	Publication