# ETSI TS 103 235 V1.1.1 (2015-10)


**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**

Reference
DTS/RRS-0141

Keywords
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# Foreword

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

# 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).

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# 1 Scope

The present document specifies the system architecture for operation of mobile broadband service in the 2 300 MHz - 2 400 MHz band under Licensed Shared Access (LSA) [i.2] and [i.3], aimed at enabling access for mobile/fixed communication networks (MFCNs) in those CEPT countries where access to the band is foreseen but cannot be provided without restrictions due to Incumbent usage, as documented in ETSI TR 103 113 [i.1]. Application to other bands is not precluded and depends on future regulatory decisions.

The documented system architecture includes definition of the logical elements, reference points and functions supported by the architecture, and the definition of the procedures and procedure flows. The present document has been developed following, and in accordance with, the System Requirements for LSA as documented in ETSI TS 103 154 [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 reference document (including any amendments) applies.

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

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

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

[1] ETSI TS 103 154: "Reconfigurable Radio Systems (RRS); System requirements for operation of Mobile Broadband Systems in the 2 300 MHz - 2 400 MHz band under Licensed Shared Access (LSA)".

## 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 reference 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 103 113 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference document (SRdoc); Mobile broadband services in the 2 300 MHz - 2 400 MHz frequency band under Licensed Shared Access regime".

[i.2] ECC Report 205: "Licensed Shared Access (LSA)", February 2014.

[i.3] RSPG Opinion on Licensed Shared Access, RSPG13-538, November 2013.

[i.4] IETF RFC 791: "Internet Protocol (IP)", September 1981.

[i.5] ECC Recommendation (15)04: "Guidance for the implementation of a sharing framework between MFCN and PMSE within 2300-2400 MHz", July 2015.

[i.6] CEPT Report 58: "Technical sharing solutions for the shared use of the 2300-2400 MHz band for WBB and PMSE", July 2015.

# 3 Definitions and abbreviations

## 3.1 Definitions

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

**LSA licensee:** entity operating a MFCN, which holds individual rights of use to an LSA spectrum resource

**LSA spectrum resource:** spectrum resource which is to be shared between an Incumbent and a LSA Licensee on a static or dynamic basis according to the Sharing Framework defined by the Administration/NRA

**LSA spectrum resource availability information:** information provided to a Licensee, which conveys the LSA spectrum resource that may be used by the Licensee, and the respective operational conditions

**sharing arrangement:** set of practical details for sharing an LSA spectrum resource

**sharing framework:** set of sharing rules or sharing conditions that will materialize the change, if any, in the spectrum rights of the Incumbent(s) and define the spectrum, with corresponding technical and operational conditions, that can be made available for alternative usage under LSA

**spectrum resource:** resource or set of resources defined in time, space and frequency domains

## 3.2 Abbreviations

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

| | |
|---|---|
| 3GPP | 3rd Generation Partnership Project |
| DTLS | Datagram Transport Layer Security |
| ECC | Electronic Communications Committee of the CEPT |
| IP | Internet Protocol |
| IPsec | Internet Protocol security |
| ITU | International Telecommunications Union |
| LC | LSA Controller |
| LR | LSA Repository |
| LSA | Licensed Shared Access |
| LSRAI | LSA Spectrum Resource Availability Information |
| LTE | Long Term Evolution |
| MFCN | Mobile/Fixed Communications Network |
| NRA | National Regulatory Authority |
| OAM | Operation, Administration and Maintenance |
| RSPG | Radio Spectrum Policy Group |
| TCP | Transmission Control Protocol |
| TLS | Transport Layer Security |
| UDP | User Datagram Protocol |

# 4 Architecture Model

## 4.1 Architecture Reference Model

The LSA Architecture reference model is shown in figure 4.1. 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 (see annex B).

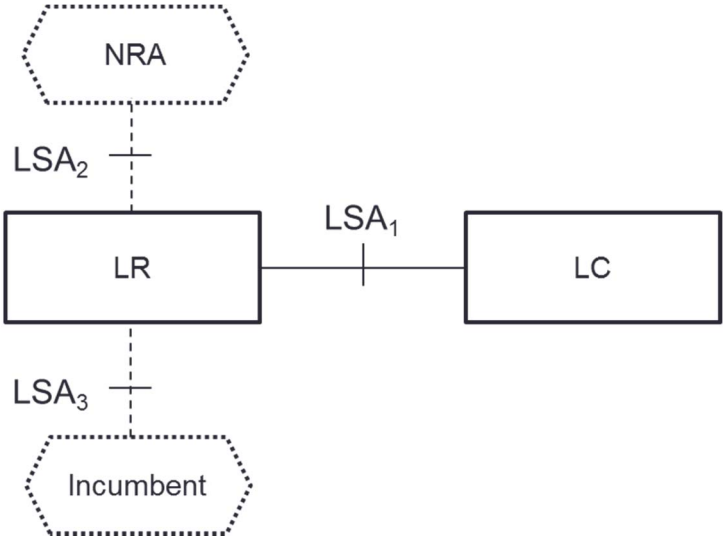


**Figure 4.1: LSA Architecture Reference Model**

## 4.2 Logical Elements

**LSA Repository (LR)**: The LR supports the entry and storage of information describing Incumbent's usage and protection requirements [1]. It is able to convey the related availability information to authorized LSA Controllers, and is also able to receive and store acknowledgement information received from the LSA Controllers. The LR also provides means for the NRA to monitor the operation of the LSA System [1], and to provide the LSA System with information on the Sharing Framework and the LSA Licensees. The LR ensures that the LSA system operates in conformance with the Sharing Framework [i.2] and the licensing regime, and may in addition realize any non-regulatory details of the Sharing Arrangement [1].

**LSA Controller (LC)**: The LC is located within the LSA Licensee's domain, and enables the LSA Licensee [1] to obtain LSA spectrum resource availability information from the LR, and to provide acknowledgment information to the LR. The LC interacts with the Licensee's MFCN in order to support the mapping of availability information into appropriate radio transmitter configurations, and receive the respective confirmations from the MFCN.

## 4.3 Reference Points

**$LSA_1$:** Reference point between LR and LC.

**$LSA_2$:** Reference point for Administration/NRA interaction with the LR. Some of the functionality associated with this reference point is described in annex B.

**$LSA_3$:** Reference point for Incumbent interaction with the LR. Some of the functionality associated with this reference point is described in annex B.

## 4.4 High Level Functions

### 4.4.0 Introduction

This clause lists and describes the high level functions performed by the LSA System. The high level functions cover the aspects of LSA System operation in line with requirements of ETSI TS 103 154 [1].

### 4.4.1 Information Entry Function

Allows the entry and storage of information that is needed for the operation of the LSA 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).

- LSA License information (Licensee identity and related information).
- Sharing Arrangement information for each Incumbent and Licensee (set of practical details for sharing an LSA spectrum resource, whereby LSA spectrum resource may be used by Incumbent or LSA Licensee).
- Incumbent's LSA spectrum resource usage and protection requirements.

The function also supports the verification of inputs (consistency with Sharing Framework/Arrangement).

### 4.4.2 Information Processing Function

This function supports the derivation of LSA spectrum resource availability information for each Licensee, to be provided to the Information Exchange function for forwarding to the respective Information Mapping function of the LSA Licensee. The LSA spectrum resource availability information is derived based on the data collected by the Information Entry Function. The function further supports the processing of Licensee acknowledgment information.

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

### 4.4.3 Information Mapping Function

The information mapping function receives LSA spectrum resource availability information, 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.

### 4.4.4 Reporting Function

The reporting function is responsible to create and provide reports regarding the LSA System operation to Administration/NRA, Incumbent(s), and/or LSA Licensee(s) on an on-demand or scheduled basis.

### 4.4.5 LSA Information Exchange Function

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

### 4.4.6 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 LSA System;
- subsequent generation and delivery of respective failure notification(s) to LSA Licensee(s) and Incumbent(s);
- initiation of respective operations in the LSA System.

### 4.4.7 System Management Functions Group

This includes:

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

System management is separate for LR and LC 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 LR only.

## 4.5 Mapping of High Level Functions to Logical Elements

Figure 4.2 shows how the high level functions and function groups are mapped to the logical entities LR and LC.

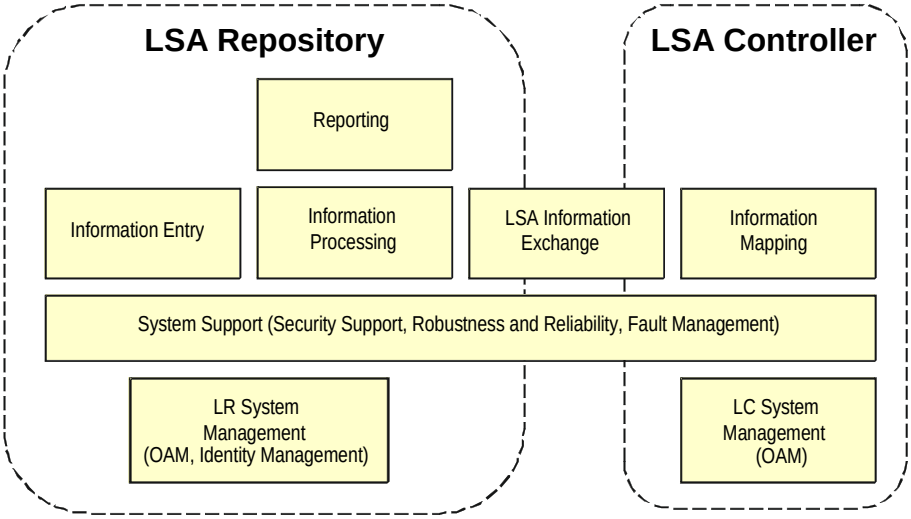


**Figure 4.2: Mapping of high level functions and function groups to logical elements**

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

The corresponding functionality at the $LSA_1$ reference point is covered by the LSA Information Exchange function and the System Support functions group.

# 5 $LSA_1$ Functional Description and Information Flows

## 5.1 Introduction

This clause describes procedures, procedural flows and additional functional aspects related to the interface between LR and LC ($LSA_1$ interface).

The $LSA_1$ interface provides support for the exchange of LSA Spectrum Resource Availability Information (LSRAI, clause 5.4.2) and respective acknowledgement information between LR and LC, and for maintaining and recovering synchronization of such information between LR and LC.

## 5.2 Protocol Stacks

The $LSA_1$ application layer protocol shall ensure the application part, in LR and LC, conforms to the regulatory requirements, thereby the requirements on underlying transport protocols are kept to minimum. Supported network layer protocol is IP [i.4]. No LSA 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 $LSA_1$ Interface Management Functions

The $LSA_1$ 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 LSRAI, the supervising node may consider that LSRAI synchronization has been lost between LC and LR, and should initiate actions to restore LSRAI synchronization. The protocol should ensure that LSRAI is consistent in both nodes.

## 5.4 $LSA_1$ Protocol Elements

### 5.4.1 Identities

The following defines identities that shall be employed by the LSA System in general, and particularly over the $LSA_1$ interface:

**Licensee Identity:** identifies a specific LSA Licensee.

**LR Identity:** identifies a specific LR.

**LC Identity:** identifies a specific LC.

Licensee Identity, LR Identity and LC Identity shall be unique and unambiguous within a particular set of interconnected LSA network elements (for example, multiple LCs of the same or different LSA Licensee(s) connected to one LR).

**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 LSA Spectrum Resource Availability Information

The LSA Spectrum Resource Availability Information (LSRAI) is conveyed to the LC in messages originated in the LR (e.g. LSRAI Notification message, see clause 5.5.5).

Under normal operating conditions, the LR is aware of the LSRAI that is known to the LC, and stores relevant associated information such as status of LC acknowledgements. The LC shall not initiate LSA operation unless it has received the relevant LSRAI, and should take steps to ensure on an ongoing basis that it holds valid and relevant LSRAI.

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

LSRAI includes support for the definition of exclusion, restriction and protection zones (as per requirements R-FUNC-05 and R-FUNC-06 in ETSI TS 103 154 [1]).

NOTE 1: Examples of exclusion and protection zone parameters are contained in ECC Recommendation (15)04 [i.5] and in CEPT Report 58 [i.6].

NOTE 2: The LSRAI 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 LR and LC in normal operation.

Some procedures imply the reconfiguration of the LSA Licensee's network through the interaction between the LSA 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, and constrained by the LSA Licensee 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 LSA are treated in clause 6.

### 5.5.2 Registration Procedure

The purpose of the registration procedure is to register an LC with an LR. This is the first procedure executed on the $LSA_1$ interface. After successful completion of this procedure, the LC is able to initiate requests or receive notifications on spectrum resource availability information.

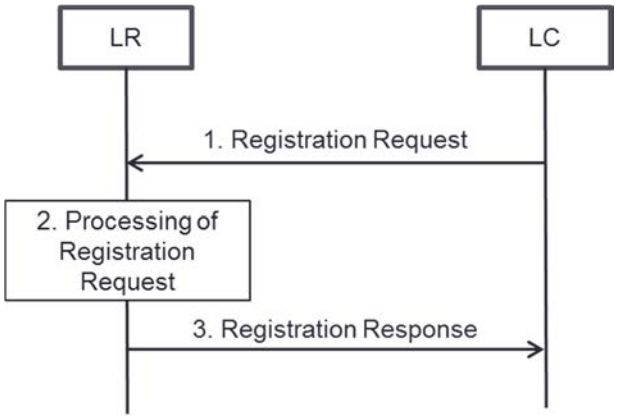


**Figure 5.1: Registration Procedure**

1) The LC sends a registration request message to the LR, including its node identity and LSA Licensee identity, requesting establishment of application protocol communication.

2) The LR checks the validity of the identities and stores the LC node identity in the list of registered LCs.

3) The LR sends a registration response message to the LC including its node identity to confirm the registration of LC in LR, and the indication whether the initial LSA spectrum resource availability information after registration is sent via notification by LR or triggered by request from LC.

Upon reception of the registration response, the LC stores the LR node identity and considers itself registered to the LR. For obtaining the initial LSA spectrum resource availability information, the LC proceeds according to the indication sent by the LR, i.e. awaiting LSA spectrum resource availability notification from the LR or sending the LSA spectrum resource request to the LR.

### 5.5.3 Deregistration Procedure

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

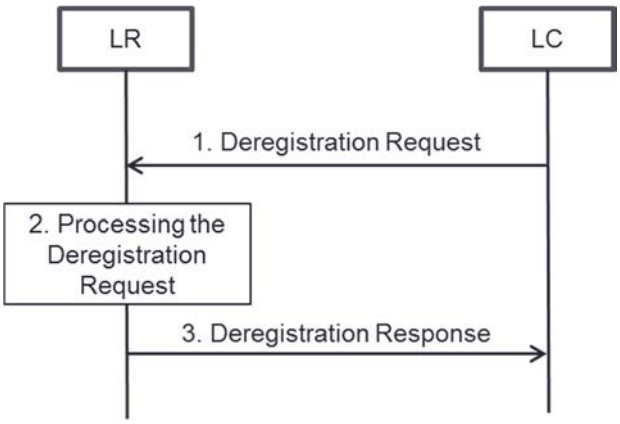


**Figure 5.2: Deregistration Procedure**

1) The LC sends a Deregistration Request message to the LR, including its node identity and the LSA Licensee identity the LC belongs to.

2) The LR checks the validity of both identities, terminates any ongoing procedures and removes the LC node identity from the list of registered LCs.

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

### 5.5.4 LSRAI Request Procedure

The purpose of the LSRAI Request procedure is to enable the LC to request LSA spectrum resource availability information. The procedure is used to synchronize LSRAI between LR and LC.

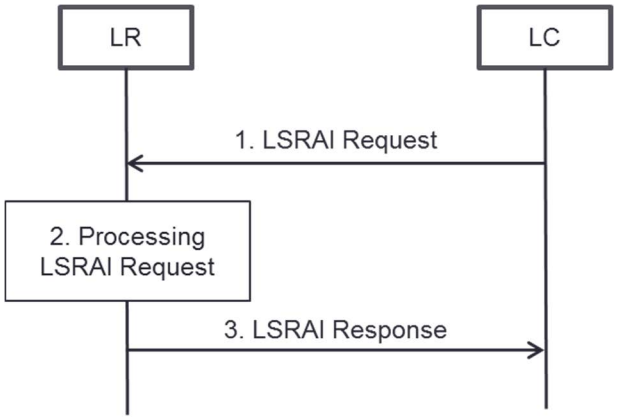


**Figure 5.3: LSRAI Request Procedure**

1) The LC sends an LSRAI Request message to the LR.

2) The LR checks the consistency of the LC's request, and builds the relevant LSRAI.

3) The LR sends an LSRAI Response message including information on the current LSA spectrum resource availability, such as spectrum, geographical area and timing restrictions.

### 5.5.5 LSRAI Notification Procedure

The purpose of the LSRAI Notification procedure is to enable the LR to send LSA spectrum resource availability information to the LC. It can be used to send either specific immediate notifications or periodic updates to the LC.

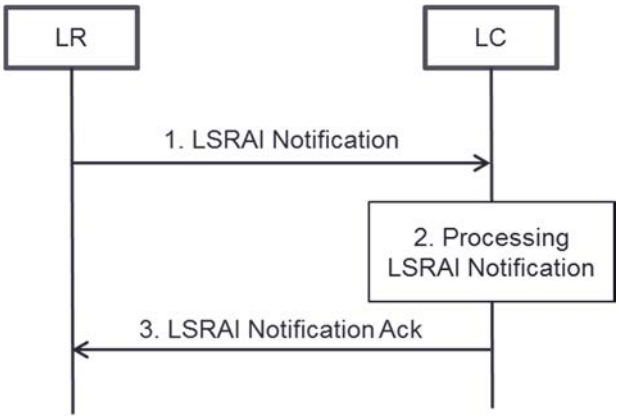


**Figure 5.4: LSRAI Notification Procedure**

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

2) The LC checks the consistency of the LR notification.

3) The LC responds with a LSRAI Notification Acknowledgment message to confirm the reception of LSRAI.

### 5.5.6 LSRAI Confirmation Procedure

The purpose of the LSRAI Confirmation Procedure is for the LC to notify the LR once the necessary configuration changes in the MFCN have been applied according to the LSA spectrum resource availability information provided by the LR.

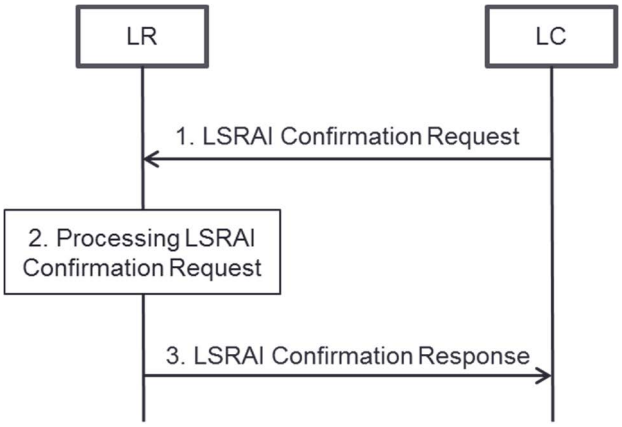


**Figure 5.5: LSRAI Confirmation Procedure**

1) The LC sends a LSRAI Confirmation Request message to the LR to confirm successful execution of configurations of LSA spectrum resources in the MFCN according to received LSRAI.

2) The LR processes the LSRAI Confirmation Request and stores the confirmation.

3) The LR acknowledges the reception of the LSRAI confirmation by sending a LSRAI Confirmation Response message to the LC.

### 5.5.7 Connectivity Check Notification Procedure

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

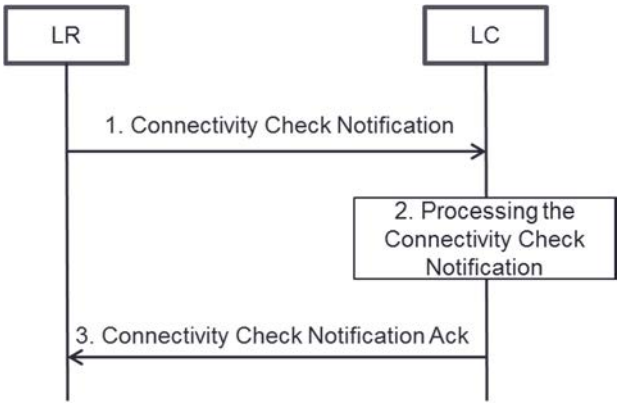


**Figure 5.6: Connectivity Check Notification Procedure**

1) The LR sends a Connectivity Check Notification message to the LC.

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

3) If consistency check is successful, the LC will respond with a Connectivity Check Notification Ack 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.

### 5.5.8 Connectivity Check Request Procedure

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

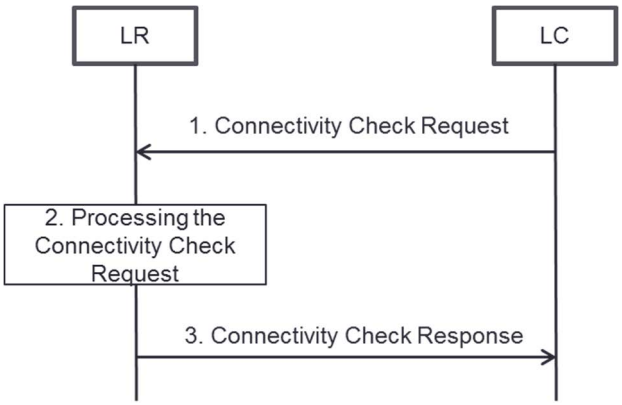


**Figure 5.7: Connectivity Check Request Procedure**

1) The LC sends a Connectivity Check Request message to the LR.

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

3) If consistency check is successful, the LR 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 $LSA_1$ application protocol. Each flow may be composed of several procedures, and provides support for a particular operational activity (e.g. LC start-up). 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 LSRAI 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 LSRAI received by the LC.

### 5.6.2 LC Operation Start-up

This message flow shall be used during LC start-up, and provides the $LSA_1$ support for the use case A.3 (see annex A). At the end of the flow, the LC has the necessary LSRAI, and the LR will have received confirmation that relevant changes have been executed.

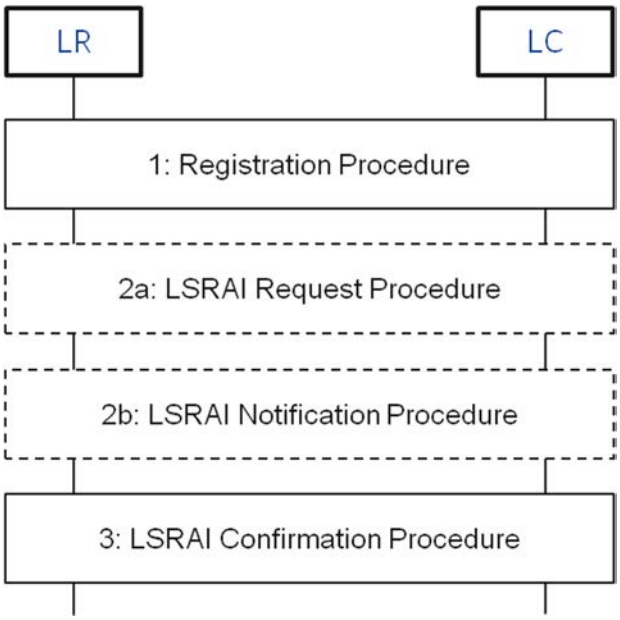


**Figure 5.8: LC Operation Start-up procedure flow**

1) The Registration procedure is performed.

   Depending on the LR decision, either step 2a or 2b is performed.

2a) The LC initiates the LSRAI Request procedure.

2b) The LR initiates the LSRAI Notification procedure.

   On completion of steps 2a or 2b, the LC has received the necessary LSRAI.

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

### 5.6.3 LR Notification of new LSRAI

When the LR becomes aware of new LSRAI, it may decide to notify immediately the LC using this procedure flow. This flow may happen at any time following completion of the Registration procedure.

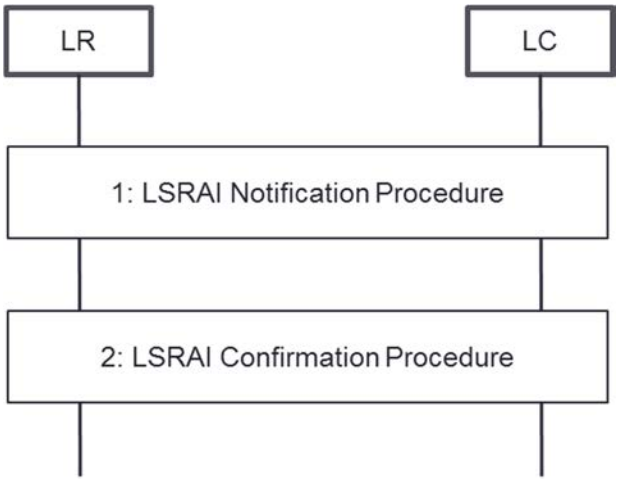


**Figure 5.9: LR Notification of new LSRAI procedure flow**

1) The LR initiates the LSRAI Notification procedure, to inform the LC of new LSRAI.

2) Upon successful configuration change of the LSA spectrum resources in the MFCN, the LC initiates the LSRAI Confirmation procedure.

### 5.6.4 LSRAI Synchronization

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

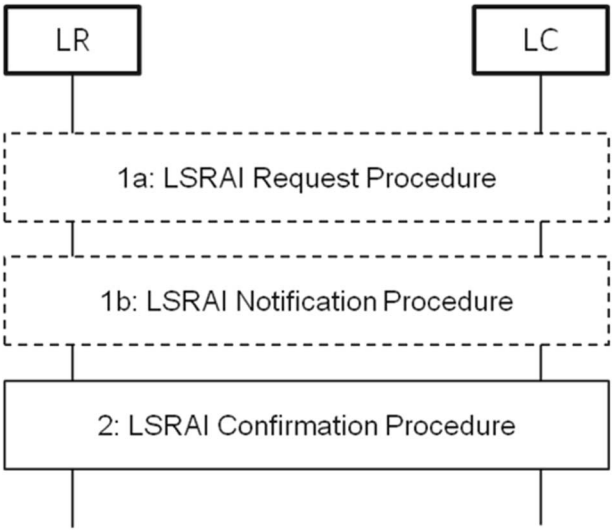


**Figure 5.10: LSRAI Synchronization procedure flow**

Depending on the LR decision either step 1a or 1b is performed.

1a) LC initiates the LSRAI Request procedure.

1b) LR initiates the LSRAI Notification procedure.

On completion of step 1a or 1b, the LC has received the necessary LSRAI.

2) Upon successful configuration change of the LSA spectrum resources in the MFCN, the LC initiates the LSRAI Confirmation procedure.

### 5.6.5 LC Request for new LSRAI with optional LR Notification

This procedure flow is used when the LC requests the LR to send it new LSRAI. Optionally, the procedure flow enables the LR to receive an acknowledgement from the LC upon reception of the new LSRAI. The acknowledgement may allow informing the Incumbent that the LSA Licensee has received the new LSRAI (e.g. changed protection zone) successfully in advance of the LSRAI 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.

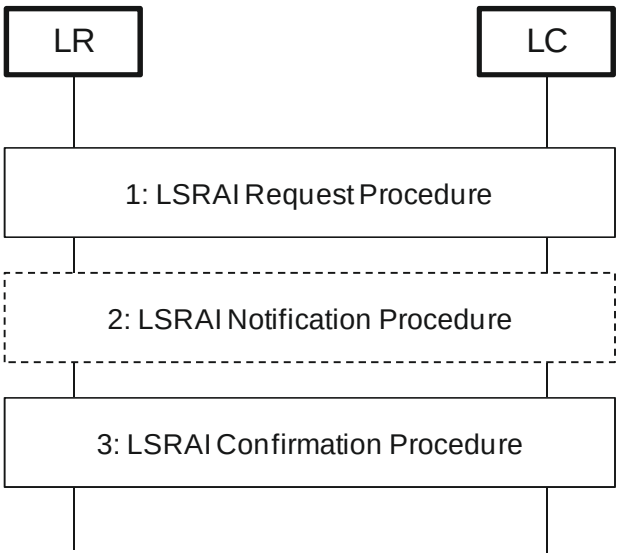


**Figure 5.11: LC Request for new LSRAI with optional acknowledgement**

1) LC initiates the LSRAI Request procedure. LR may indicate in the LSRAI Response message that a LSRAI Notification procedure will follow.

2) When LR has indicated that a LSRAI Notification procedure will follow the LR initiates the LSRAI Notification procedure.

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

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

# 6 LSA Failure Management

Failures may originate due to hardware or software problems at the LC, LR or $LSA_1$ interface. The LSA failure management provides respective functions to guarantee the Incumbent and the LSA Licensee protections even in case that LC, LR, or $LSA_1$ interface is out of operation. Failures may occur either during the LSA system setup or the LSA operation phase.

Due to the fact that system setup is covered by the LSA system management functions group, respective failures are handled by the system management of the LR and/or LC only. Instead, failures which are related to the LSA operation are considered by the LSA failure management as follows:

- Failures that are encountered during execution of the high level procedures are treated in the respective procedure.
- Failure management of LR should detect malfunctions of high level functions located at the LR including outage of the LC and $LSA_1$ interface.
- Failure management of LC should detect malfunctions of high level functions located at the LC including outage of the LR and $LSA_1$ interface.

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

Annex D provides examples of fall-back measures to be applied by the LC when its failure management has determined that LSRAI consistency at both ends of $LSA_1$ cannot be guaranteed.

# 7 LSA Deployment Scenario Rules

LSA deployments may comprise multiple physical LSA Repositories and/or LSA Controllers (motivated by practical requirements such as extended reliability concepts, private repositories at Incumbents side, or performance extensions). A general rule set is defined for the LSA system to limit the complexity in LSA deployment scenarios:

- In case that a private repository does not support all functions of a LR (e.g. Sharing Framework) a public repository needs to be established that contains at least the missing functionality.
- Each LC sees multiple physical repositories as one LR structure (or single $LSA_1$ endpoint), i.e. the LC does not need to know how the functionality is mapped to physical repositories, or be aware of their existence.
- In general LR provides a LSA information exchange function to multiple LCs. This function also includes support for sub-networks of a MFCN, using either a single LC for the MFCN or multiple physical LCs.

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

Examples of deployment architectures are provided in annex C.

# Annex A (informative): LSA Operational Use Cases

## A.0 Introduction

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

- Input of the Sharing Framework, Sharing Arrangement and LSA License information to the LSA Repository;
- Input of Incumbent's usage and protection requirements;
- LSA Licensee activates LSA support;
- LSA Licensee starts to operate in the available LSA spectrum resources;
- Updates of the Incumbent's usage and protection requirements.

## A.1 Input of the Sharing Framework, Sharing Arrangement and LSA License information to the LSA Repository

Pre-requisites:

- Regulator has allocated part or all of the 2 300 MHz - 2 400 MHz band for licensed shared access by definition of shared spectrum resources.
- Regulator has, together with the relevant stakeholders, decided on the sharing terms and conditions.
- Regulator has provided and assigned operation of the LSA Repository either within own authority or to a trusted (by the relevant stakeholders) third party.

Regulator operational actions:

- Information about the sharing terms and conditions and the spectrum assigned for shared use will be entered into the LSA Repository.

Output:

- LSA Repository is put into operation.

## A.2 Input of Incumbent's usage and protection requirements

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

Pre-requisites:

- LSA Repository is activated.

Incumbent operational actions:

- Incumbent enters its usage and protection requirements into the LSA Repository.
- LSA Repository checks if the above requirements complies with the Sharing Framework and Sharing Arrangement provisions.

Output:

- LSA Repository is configured with an up to date set of requirements of at least one Incumbent and sharing terms and conditions from the Regulator.

## A.3 LSA Licensee activates LSA support operation

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

Pre-requisites:

- LSA Repository is activated.
- Regulatory and Incumbent information have been entered into the LSA Repository.
- The address of the LSA Repository and the necessary security information to access it is known.

LSA Licensee operational actions:

- LSA Licensee enters in the LSA Controller the appropriate configuration information of the LSA Repository.
- LSA Licensee activates the LSA Controller.
- LSA Controller registers with the LSA Repository and exchanges necessary information related to authorized LSA spectrum resources.
- LSA Repository responds with LSA spectrum resource availability information.
- LSA Controller acknowledges the LSA spectrum resources availability information to LSA Repository once the Mobile Network has applied the settings.

Output:

- LSA Repository to LSA Controller communication is established and LSA Controller has an up to date set of LSA spectrum resource availability information based on at least one Incumbent's usage and protection requirements.

The exchange of data between LSA Repository and LSA Controller is supported by a set procedure(s) at $LSA_1$ reference point defined in clause 5.5. Steps performed for the cell configurations are part of LSA Licensee management domain and outside of scope of standardization.

## A.4 LSA Licensee starts to operate in the available LSA spectrum resources

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

Pre-requisites:

- The LSA support is activated and the LSA spectrum resource availability information is known in the LSA Controller.

LSA Licensee operational actions:

- The LSA Licensee determine based on the information in LSA Controller and Mobile Network whether a cell can be activated or not.
- If a cell has specific parameter restrictions the LSA Licensee ensures these comply with the available LSA spectrum resource availability information before activation of cell.

Output:

- Cells are activated for service within the available LSA spectrum resources.

All of the above steps are part of LSA Licensee management domain and outside of scope of standardization.

## A.5 Updates of the incumbent's usage and protection requirements

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

Pre-requisites:

- LSA Repository is activated.
- At least one LSA Controller has registered with LSA Repository.
- LSA Repository is configured and has an up to date set of requirements of at least one Incumbent.

Incumbent operational actions:

- Incumbent modifies the usage and protection requirements and inputs them to the LSA Repository.
- LSA Repository checks if the modifications are compliant with the Sharing Framework and Sharing Arrangement provisions.
- LSA Repository processes the changes taking into account other Incumbent's requirements.
- LSA Repository informs the LSA Controller about the updates.
- LSA Controller acknowledges the reception of modified LSA spectrum resources availability information, processes the changes and requests the MFCN to update the cell configuration(s).
- LSA Controller acknowledges the updated LSA spectrum resources availability information to LSA Repository once the changes have been applied by the MFCN.

Output:

- LSA Controller has an up to date set of LSA spectrum resources availability information from at least one Incumbent.
- The MFCN operates on the available LSA spectrum resources accordingly.

The exchange of data between LSA Repository and LSA Controller is supported by a set procedure(s) at $LSA_1$ reference point defined in clause 5.5. Steps performed for the cell configurations are part of LSA Licensee management domain and outside of scope of standardization.

# Annex B (informative): Guidance for $LSA_2$ and $LSA_3$

## B.0 Introduction

This annex provides guidance on the functionality recommended to be supported by implementations of $LSA_2$ and $LSA_3$. Each functionality is referenced to the related clause(s) in ETSI TS 103 154 [1].

## B.1 NRA-Related Guidance ($LSA_2$)

The $LSA_2$ interface enables the Administration/NRA ("NRA") role to interact with an LR. 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 LR (clauses 6.1.6 and 6.1.9 of [1])
  - Definition of LSA spectrum resources (clause 6.1.9 of [1])
  - Assignment of spectrum resources to licensees (clause 6.1.4 of [1])
  - Definition of regulatory sharing rules (clause 6.1.9 of [1])
- Report delivery or access (clause 6.1.10 of [1])
  - Including possible configuration of report (clause 6.1.10 of [1])

**Additional aspects:**

- Support for changes in the sharing framework and sharing rules (clause 6.3.4 of [1])
- Support for pre-configuration (clause 6.1.13 of [1]), response times (clauses 6.3.6 and 7.2.1 of [1]) and protection of the licensee's operations (clause 6.3.3 of [1])
- Support for security aspects (clauses 6.4.1 to 6.4.5 of [1]) including secure access and user authentication

## B.2 Incumbent-related Guidance ($LSA_3$)

The $LSA_3$ 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) (clauses 6.1.9, 6.2.2 and 6.3.2 of [1])
- Input of incumbent's usage and protection requirements (clauses 6.2.1, 6.2.2, 6.2.3, 6.2.5 and 6.2.6 of [1])
- Access to acknowledgment information (clauses 6.2.4 and 6.3.5 of [1])
- Report delivery or access (clause 6.1.10 of [1])
- Including possible configuration of report (clause 6.1.10 of [1])
- Access to failure indications caused by system malfunctions (clause 6.1.8 of [1])

**Additional aspects:**

- Support for multiple incumbents (clause 6.1.5 of [1])
- Support for input verification including rejection through consistency checking with sharing rules (clause 6.1.14 of [1])
- Support for multiple types of inputs (for usage/protection requirements) including scheduled, on-demand, and also signalling of pre-configured requirements (clauses 6.1.11, 6.1.12 and 6.1.13 of [1])
- Support for different input formats including exclusion, restriction and protection zones (clauses 6.2.5 and 6.2.6 of [1])
- Support for changes in the sharing arrangement (clauses 6.1.16 and 6.3.4 of [1])
- Support for expected response times (clauses 6.3.6 and 7.2.1 of [1])
- Support for security aspects (clauses 6.4.1 to 6.4.5 of [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 possibilities supported by the architecture. They are also not mutually exclusive, i.e. in a large deployment, several of these may coexist. In particular, an LR may be connected to LCs serving different LSA Licensees, and each LSA Licensee may adopt a distinct deployment configuration.

All configurations shown include a single LR. Multiple LR configurations are out of scope of the present document.

## C.2 Examples

### C.2.1 LR and single LC

An MFCN may deploy a single LC to handle all LSA related exchanges with the LR, as shown in figure C.1. In this case, the LC is responsible for the mapping function in respect of all of the MFCN's operations in the operator's LSA spectrum resource (for which it is licensed).

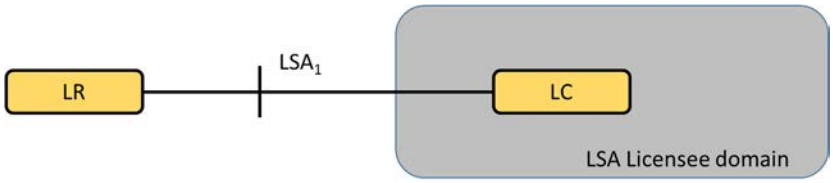


**Figure C.1: Example with single LC**

### C.2.2 LR and multiple LCs

An MFCN may deploy multiple LCs where each LC is directly connected to the LR as shown in figure C.2. In this case, each LC is responsible for the mapping function in respect of a unique subset of the operator's LSA spectrum resource. For example, each LC could handle a different region.

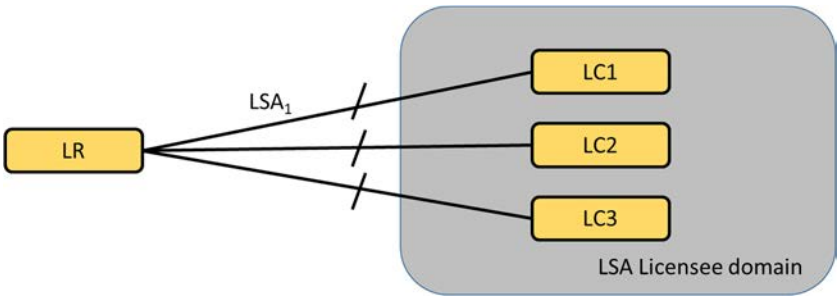


**Figure C.2: Example with multiple LCs**

The LR does not handle any required intra-MFCN coordination between the actions of the multiple LCs in this case (e.g. to handle cumulative effects of interference in regional border areas). Such coordination can be provisioned within the LSA Licensee domain, and is not required in several deployment scenarios, for example: (1) where each LC controls an area such as a city, and there is no geographical proximity between the areas controlled by any two LCs, or (2) if the possible incumbent geographical positions are such that only one of the LC-controlled areas may contribute to incumbent interference.

## C.2.3 LR and "proxy LC"

This possible configuration can be considered to be a hybrid of the previous two examples, and is shown in figure C.3. From the perspective of the LR, operation is identical to that in figure C.1 since the LR interacts with a single LC. However, this configuration allows for distributed LCs (similar to clause C.2), where each LC handles a unique subset of the operator's LSA spectrum resource.

Note that this configuration imposes no new requirements on $LSA_1$, since there are separate protocol instances on either side of the Proxy LC. The Proxy LC terminates both interfaces, and therefore appears as a single LC to the LR, and as the LR towards LC1-3 from a protocol perspective. In addition to hiding the identities and complexity of the network towards the opposite endpoints, the proxy LC may also coordinate the operation of LC1-3, e.g. by non-transparently modifying the LSRAI received from the LR before forwarding to each LC.

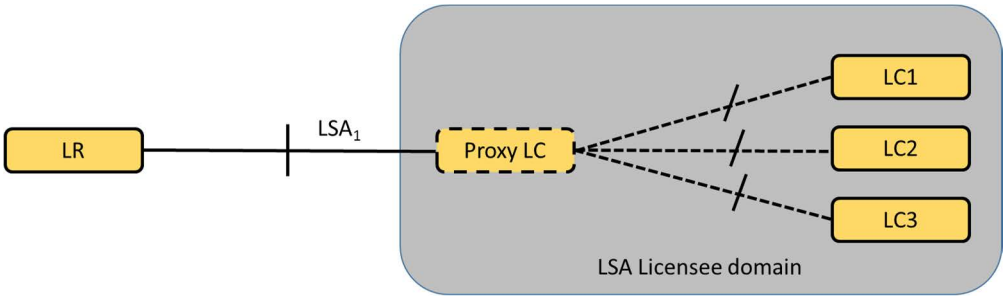


**Figure C.3: Example with "proxy LC"**

# Annex D (informative): Example for possible LC fall-back measures if LSRAI consistency cannot be guaranteed on both ends of $LSA_1$

This annex provides examples on how the LC may implement LC fall-back measures if LSRAI consistency cannot be guaranteed on both ends of $LSA_1$.

Under some circumstances, failures may occur which prevent normal operation of the LSA System and will result in a situation where the LSRAI consistency cannot be guaranteed between LR and LC. The LSA System has already means to provide failure indications to both the LSA Licensee and the Incumbent, but failure indications may not be sufficient to deal with the LSRAI and its processing in the MFCN. Additional pre-agreed LC fall back measures, which are expected to be defined within the Sharing Arrangement between Incumbent and LSA Licensee, may be used to resolve these situations.

Examples of LC fall back measures are:

i) LSA Licensee continues to use the LSA spectrum resource according to the last known LSRAI, or

ii) LSA Licensee continues to use the LSA spectrum resource according to the last known LSRAI for a pre-agreed amount of time before fall back to (iii), (iv) or (v), or

iii) LSA Licensee continues to use the LSA spectrum resource on the basis of a pre-agreed LSRAI for the LSA spectrum resource, or

iv) LSA Licensee continues to use the LSA spectrum resource on the basis of a pre-agreed LSRAI for the LSA spectrum resource for a pre-agreed amount of time before fall back to (v), or

v) LSA Licensee discontinues to use the LSA spectrum resource.

# History

| Document history | | |
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