

International Telecommunication Union

ITU-R
Radiocommunication Sector of ITU

Report ITU-R SM.2404-0
(06/2017)

**Regulatory tools to support enhanced
shared use of the spectrum**

SM Series
Spectrum management



International
Telecommunication
Union

Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups.

Policy on Intellectual Property Right (IPR)

ITU-R policy on IPR is described in the Common Patent Policy for ITU-T/ITU-R/ISO/IEC referenced in Annex 1 of Resolution ITU-R 1. Forms to be used for the submission of patent statements and licensing declarations by patent holders are available from <http://www.itu.int/ITU-R/go/patents/en> where the Guidelines for Implementation of the Common Patent Policy for ITU-T/ITU-R/ISO/IEC and the ITU-R patent information database can also be found.

Series of ITU-R Reports

(Also available online at <http://www.itu.int/publ/R-REP/en>)

Series	Title
BO	Satellite delivery
BR	Recording for production, archival and play-out; film for television
BS	Broadcasting service (sound)
BT	Broadcasting service (television)
F	Fixed service
M	Mobile, radiodetermination, amateur and related satellite services
P	Radiowave propagation
RA	Radio astronomy
RS	Remote sensing systems
S	Fixed-satellite service
SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management

Note: This ITU-R Report was approved in English by the Study Group under the procedure detailed in Resolution ITU-R 1.

Electronic Publication
Geneva, 2017

© ITU 2017

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without written permission of ITU.

REPORT ITU-R SM.2404-0

Regulatory tools to support enhanced shared use of the spectrum

(2017)

Scope

This Report is developed in response to Question ITU-R 208-1/1 – Alternative methods of national spectrum management, which asks, in *decides 4*, to study the following question:

“4 What measures, of a technical, operational and regulatory nature, would it be necessary for an administration to consider implementing when adopting one or more of these spectrum management approaches in the context of:

- the country's infrastructure;
- national spectrum management;
- regional and international aspects (e.g. notification, coordination, monitoring)?”

This Report addresses possible regulatory solutions which may be implemented on a national basis in order to facilitate the share use of the spectrum and therefore, to encourage an efficient use of the spectrum by allowing applications of different and/or similar nature (for example, identical radio services/technologies) to coexist in an identified spectrum environment.

Based on the experience from different countries, this Report includes a collection of regulatory mechanisms which have been experimented and are recognized as best practices in terms of spectrum management solutions.

Table of Contents

		<i>Page</i>
1	Introduction	4
2	Sharing at allocation level vs sharing at authorisation level	5
	2.1 Frequency allocation and Licensed Shared Access (LSA).....	5
	2.2 Frequency authorisation and Shared Spectrum Access for Similar Technologies.....	5
3	Regulatory framework and sharing aspects.....	6
	3.1 Regulatory framework.....	6
	3.2 Spectrum sharing approach.....	6
4	Regulatory methods for enhanced spectrum management.....	6
	4.1 Licensed shared access	6
	4.2 Shared Spectrum Access for Similar Technologies.....	8
	Annex 1 – Licensed Shared Access (LSA).....	10
	A1-1 LSA as a complementary tool for spectrum management.....	10
	A1-1.1 Definition.....	10
	A1-1.2 Sharing framework	10
	A1-1.3 Practical implementation	12
	A1-2 Case study: European experience	12
	A1-2.1 European approach	12
	A1-2.2 Justification.....	13
	A1-2.3 Applicability criteria.....	13
	A1-2.4 LSA stakeholders and responsibilities.....	14
	A1-2.5 Licensed Shared Access in the current regulatory framework	15
	A1-2.6 Steps for setting a LSA sharing framework and issuing individual authorizations to LSA licensees.....	16
	A1-2.7 Technical measures to support the implementation of LSA.....	17
	A1-2.8 Management of cross-border coordination under LSA	17
	Annex 2 – Russian Federation’s experience in the use of shared spectrum access for similar technologies method (the example of cellular networks).....	18
	A2-1 Regulatory aspects of spectrum sharing in SSA-ST.....	18
	A2-2 Practical application of spectrum sharing in SSA-ST	19

A2-3 Regulatory aspects of active infrastructure sharing in SSA-ST as a supplementary part of spectrum sharing	20
A2-4 Practical application of active infrastructure sharing in SSA-ST	20
A2-5 Conclusions	22
Annex 3 – Spectrum Sharing Tools	22

Acronyms and Abbreviations

3GPP	3 rd Generation Partnership Project
BEM	Block Edge Mask
CAPEX	CAPital EXpenditure
CEPT	European Conference of Postal and Telecommunications Administrations
ETSI	European Telecommunications Standards Institute
EC	European Commission
EESS	Earth Exploration-Satellite Service
EU	European Union
FS	Fixed Service
ICT	Information and Communication Technologies
IMT	International Mobile Telecommunications
LSA	Licensed Shared Access
LTE	Long-Term Evolution
MFCN	Mobile/Fixed Communications Networks
MNO	Mobile Network Operator
MTS	Mobile Tele Systems; operator in Russia, Central and Eastern Europe
NRA	National Regulatory Authority
NTFA	National Table of Frequency Allocations
PMR	Private Mobile Radio
PMSE	Programme Making and Special Events
QoS	Quality of Service
RAN	Radio Access Network
RF	Radio Frequency
RLAN	Radio Local Area Network
RRS	Reconfigurable Radio System
RSPG	Radio Spectrum Policy Group (European Commission)

SCRF	State Commission for Radio Frequencies (Russia)
SSA-ST	Shared Spectrum Access for Similar Technologies
UAS	Unmanned Aircraft System
UMTS	Universal Mobile Telecommunication System

1 Introduction

The scarcity of frequency spectrum is a reality. This is illustrated by more and more wireless applications competing to access spectrum and also by the increased demand for higher Quality of Service (QoS) such as higher data rate or greater coverage. Even if the improvement of current technologies contributes to a more efficient use of the spectrum, administrations are increasingly being requested to clarify their national policy in terms of spectrum sharing as well as to identify new frequency bands either to extend existing allocations or to identify a new band for several applications.

Spectrum sharing can refer both to various regulatory approaches in spectrum management implemented by administrations and to technology solutions developed by industry. It can indeed take place at different levels:

- among different radio communication services or applications, whether at international level for services with a global footprint (satellite, aeronautical, maritime), based on provisions in the Radio Regulations and coordination of frequency assignments, or at national level;
- among different entities or type of users (e.g. governmental vs commercial use);
- among different licensed users of the same/similar application (e.g. PMR services, Point-to-point links);
- between protected primary users and licence-exempt users (e.g. radars and EESS vs 5 GHz RLANs);
- between different licence-exempt users.

In practice, the effective level of sharing that a user will have to bear will be derived from the conditions of use of the spectrum specified in the frequency authorization, whether on a general or an individual basis, and by the knowledge of the other types of users that have access to the same spectrum.

Qualifying properly spectrum sharing from a regulatory perspective requires actually well distinguishing the two key steps in a national regulatory process to enable access to spectrum at national level: 1) frequency allocation; 2) frequency authorization.

Frequency allocation does refer here in a broad sense to defining at national level the services and/or applications that have access to a frequency band, while frequency authorization refers to procedures for assigning spectrum to users and market regulation.

License-exempt regulations (e.g. regulations for short range devices), where no frequency channel is assigned to specified users, also rely on the principle of spectrum sharing but are not considered in the context of this report which focus on regulatory approach applicable with individual licensed users.

This report includes the clarification of some key features, stemming from this first distinction between allocation and authorization and also includes a collection of regulatory mechanisms which have been experimented and are recognized as good practices in terms of spectrum management solutions for the benefit of each country which seeks for a regulatory solution to encourage enhanced spectrum sharing under the terms of Question ITU-R 208-1/1 – Alternative methods of national spectrum management.

2 Sharing at allocation level vs sharing at authorisation level

2.1 Frequency allocation and Licensed Shared Access (LSA)

National Table of Frequency Allocations (NTFAs) constitutes the national basis of radio frequency spectrum management in most countries. NTFAs primarily specify the radio services authorized by a national administration in frequency bands and the entities which have access to them. Frequency bands may be allocated to certain services or application on an “exclusive” or “shared” basis.

The Licensed Shared Access (LSA) concept has been originally introduced as an enabler to unlock access to additional frequency bands for mobile broadband under individual licensed regime while maintaining incumbent uses. It was also developed with the aim of making a dynamic use of spectrum possible, whenever and wherever it is unused by incumbent users.

LSA offers a regulatory tool to make available additional spectrum resource for use by mobile broadband when spectrum refarming is not feasible or desirable. It is however defined as a general concept which does not specify the nature of the incumbents and LSA users. LSA licensees and incumbents operate different applications and are subject to different regulatory constraints. They would each have exclusive individual access to a portion of spectrum at a given location and time.

Considered the above-mentioned, Licensed Shared Access is “A regulatory approach aiming to facilitate the introduction of radiocommunication systems operated by a limited number of licensees under an individual licensing regime in a frequency band already assigned or expected to be assigned to one or more incumbent users. Under the Licensed Shared Access (LSA) approach, the additional users are authorized to use the spectrum (or part of the spectrum) in accordance with sharing rules included in their rights of use of spectrum, thereby allowing all the authorized users, including incumbents, to provide a certain QoS”¹.

2.2 Frequency authorisation and Shared Spectrum Access for Similar Technologies

The baseline method for a stakeholder to acquire an individual spectrum usage right consists of applying to the National Regulatory Authority (NRA), which may apply different approaches to assign this spectrum (first-come/first-served, comparative administrative review, auctions). Alternatively, in countries when “spectrum trading” is permitted, he may seek a commercial agreement with a licensee that detains a “tradable right”.

In the case of deployment of some types of service and application specific technologies, it can be beneficial as a spectrum management tool, to consider the facilitation of transferring rights for use of specific portion of spectrum assigned for one specific user, to a different user, for a temporary period of time, and upon agreement among the users of spectrum. This function can be helpful to address differences in temporary spectrum needs among different users of similar applications.

Considered the abovementioned, Shared Spectrum Access for Similar Technologies (SSA-ST) is a regulatory method allowing shared use of radio spectrum by two or more operators operating within the same radio service using the same or similar radio technology. With the SSA-ST method, telecommunication operators can share the spectrum resource, rights for which are issued to one of the operators.

¹ [RSPG Opinion on Licensed Shared Access, Doc. RSPG13-538](#)

3 Regulatory framework and sharing aspects

3.1 Regulatory framework

The ITU legal instruments such as the Radio Regulations (RR) are binding for the Member States and are related to spectrum management as far as they have international implications. These instruments are not directly applicable to individuals, operators or others, concerned by spectrum utilization. Compliance with those instruments therefore presupposes that each Member State will take the measures required (legislation, regulations, clauses in licences and authorizations) to implement domestically those obligations to other spectrum users (operators, administrations, individuals, etc.).

Authorizing the use of the spectrum is a national prerogative, subject to international obligations.

Article 18 of the Radio Regulations stipulates that “no transmitting station may be established or operated by a private person or by any enterprise without a licence issued in an appropriate form and in conformity with the provisions of these Regulations by or on behalf of the government of the country to which the station in question is subject”. The term “licence” should be understood above in its broad acceptance or reach an agreement. This basically means that the use of spectrum must be explicitly permitted.

Spectrum management may be considered as the combination of regulatory procedures and tools for managing the spectrum resource at radio service or application level in view of delivering regulatory solutions to accommodate different types of use, address new spectrum demand while accounting for existing uses especially in the context of spectrum sharing.

3.2 Spectrum sharing approach

Spectrum sharing may be understood as usage of the same spectrum resource by more than one user, and/or more than one service, and/or more than one application in a way that interference is avoided.

Spectrum sharing holds the potential for:

- improving the overall efficiency and effectiveness of spectrum use;
- improve the quality of providing telecommunication services;
- promoting economies of scale and encouraging investments;
- exploiting temporal and geographical dimensions by allowing users to access a particular piece of spectrum for a defined time period or in a defined area to increase the utilization of spectrum.

Sharing can be made with respect to all four domains: frequency, time, signal separation and location. Each of these domains could be individually or mutually taken into consideration in order to assess a sharing opportunity.

Spectrum sharing access could be achieved either by technical mechanisms or by regulatory mechanisms. This report focusses on the regulatory mechanisms.

4 Regulatory methods for enhanced spectrum management

4.1 Licensed shared access

General description and applicability

LSA is a complementary spectrum management tool that fits under an “individual licensing regime”.

LSA facilitates the introduction in a frequency band of new users, so called LSA licensees, while maintaining incumbent services in the band.

LSA aims to ensure a certain level of guarantee in terms of spectrum access and protection against harmful interference for both the incumbent(s) and LSA licensees, thus allowing them to provide a predictable QoS.

LSA excludes concepts such as “opportunistic spectrum access”, “secondary use” or “secondary service” where the applicant has no protection from primary user(s).

LSA licensees and incumbents operate different applications and are subject to different regulatory constraints. They would each have exclusive individual access to a portion of spectrum at a given location and time.

Sharing framework

The implementation of LSA relies on the concept of a “sharing framework” that is under the responsibility of the Administration NRA. Its development requires the involvement of all relevant stakeholders.

The “sharing framework” can be understood as a set of compatibility rules or conditions that will materialize the change, if any, in the use spectrum rights of the incumbent(s) and define the corresponding technical and operational conditions that can be made available for alternative usage of the spectrum under LSA.

Frequency allocation

LSA impacts the national allocation of a frequency band, which is a sovereign decision on the destination of this public resource.

National administrations decide which existing applications need to be considered as incumbent uses within the sharing framework and maintained in the long term according to national policy objectives, and taking into account international obligations and other restriction relevant to specific regional situations.

Authorization process

The Administration / NRA would set the authorization process with a view to delivering, in a fair, transparent and non-discriminatory manner, individual rights of use of spectrum to LSA licensees, in accordance with the sharing framework defined beforehand.

LSA does not prejudge the modalities of the authorization process to be set by Administration / NRAs taking into account national circumstances and market demand.

LSA is not a tool to regulate the Electronic Communication Service market and is based on different principles than “Spectrum trading”. It could nevertheless be necessary to check that competition is not adversely affected. The possibility for a governmental entity to engage in trading its spectrum holdings is a national institutional issue.

Advantages and limitations

An advantage of the LSA concept is that it allows more efficient use of spectrum whilst also providing an alternative to permanent segmentation or re-farming of a band when there is a need to find new spectrum. The LSA concept allows continued use of spectrum for the incumbent, while also providing potential use of the same spectrum for other users. Such users could potentially provide other applications or radio services, in accordance with Chapter 5 of the Radio Regulations (ITU-R).

Another advantage of the LSA concept is that it also provides operators and industry with new opportunities, taking into consideration the needs of the current users.

A general advantage of the LSA concept is that it gives some rights to a new user, thus making it possible for them to provide services where a predictable QoS can be ensured. In this respect, spectrum sharing conditions have to be sufficiently attractive and predictable to provide incentive for new users to invest in equipment and networks.

The success of LSA, however, depends on the availability of the following critical elements, which require further study:

- 1) a reliable sharing agreement among primary user and LSA licensee (which is implemented under the direction of the NRA);
- 2) in environments where dynamic changes to spectrum access conditions are envisaged, a data base or other system for updating the conditions of spectrum access will be required.

The implementation of the LSA concept may take advantage of recent advances in cognitive technology, thereby allowing for more dynamic spectrum sharing.

The LSA approach is further detailed in Annex 1 of this ITU-R Report.

The first use case of the LSA concept

The first use case of the LSA, considered in the European regulation and standardization, is the application of LSA to the 2.3-2.4 GHz band to allow mobile broadband use in countries that wish to maintain their incumbent use in a long term. CEPT has developed guidelines for the sharing framework for LSA for this first use case by identifying technological and regulatory options for sharing between mobile broadband and the existing incumbent services in all European countries: PMSE (commercial and governmental video links), telemetry, fixed links, unmanned Aircraft Systems (UAS) and amateur service [3]. CEPT has also provided a more detailed study on the technical sharing solutions between the mobile broadband and PMSE which is the most common incumbent usage in the 2.3-2.4 GHz band and the technical characteristics are similar from one country to another [4]. The study includes a step-by-step approach on how the administrations can implement a sharing framework between mobile broadband and PMSE. The identified steps include: determining the extent and type of incumbent use, calculating the protection criteria for the incumbent and identifying operational conditions for sharing such as implications of the sharing on the mobile network.

In European standardization, European Telecommunications Standards Institute (ETSI) has been actively working on the LSA. The work has included an overview of the LSA concept introducing e.g. the operational features, performance requirements and high level functions for LSA[5]; the system requirements for the mobile broadband access to the 2.3-2.4 GHz band [6] as well as on defining high level functions, procedures and messaging between the LSA architecture elements [7]. Also international standardization efforts are initiated in 3GPP SA5 “Telecom Management” to identify how the solution and architecture for LSA may provide a global solution also supported by the 3GPP Network Management architecture. The implementation and practical details of the LSA on the 2.3-2.4 GHz band will depend on national circumstances such as incumbent usage type and extent. Live trials and experiments have shown the feasibility of the LSA concept [3] and new ones are being developed to provide proof of concept for its interoperability with the architecture of the current mobile networks.

4.2 Shared Spectrum Access for Similar Technologies

General description

SSA-ST is an effective tool (method) for managing the use of spectrum as part of the process of market and telecommunication development for operators of one radio service and/or use the same radio technology. This enables them to improve the quality of providing telecommunication services for customers and capacity of their networks by using the merged frequency resource.

Regulatory aspects of SSA-ST

In the context of legal regulation, spectrum sharing should be considered as the use of the spectrum assigned to one of the communication operators by the other operators, based on authorization from the regulator and agreements between the operators. In order to ensure the proper use of this method, a regulatory solution should be implemented for spectrum sharing by more than one communication operator. One example of an Administration using SSA-ST is provided in Annex 2.

In this case, general practical implementation of the SSA-ST method is as follows:

- 1) Operators notify for spectrum sharing
- 2) For radio monitoring, the communication facilities using the spectrum sharing method are assigned with additional identifier of the user;
- 3) Spectrum sharing fee is regulated by the Administration of the State.

References

- [1] EC RSPG13-538: Opinion on Licensed Shared Access, European Commission, Radio Spectrum Policy Group, Nov. 2013.
- [2] ECC Report 205: Licensed Shared Access (LSA), CEPT, Feb. 2014.
- [3] CEPT Report 56: Technological and regulatory options facilitating sharing between Wireless broadband applications (WBB) and the relevant incumbent services/applications in the 2.3 GHz band, CEPT, March 2015.
- [4] CEPT Report 58: "Report B2 from CEPT to the European Commission in response to the Mandate on 'Harmonised technical conditions for the 2300-2400 MHz ('2.3 GHz') frequency band in the EU for the provision of wireless broadband electronic communications services; Technical sharing solutions for the shared use of the 2300-2400 MHz band for WBB and PMSE", Report approved on 3 July 2015 by the ECC.
- [5] ETSI TR 103.113 v 1.1.1: "Mobile Broadband services in the 2 300-2 400 MHz frequency band under Licensed Shared Access regime," ETSI, July 2013.
- [6] ETSI TS 103 154, v1.1.1: "System requirements for operation of Mobile Broadband Systems in the 2 300-2 400 MHz band under Licensed Shared Access (LSA)," ETSI, Oct. 2014.
- [7] ETSI TS 103 235, v0.0.9: "System Architecture and High Level Procedures for operation of Licensed Shared Access (LSA) in the 2 300-2 400 MHz band," ETSI, Apr. 2015.

Annex 1

Licensed Shared Access (LSA)

A1-1 LSA as a complementary tool for spectrum management

A1-1.1 Definition

Licensed Shared Access is “A regulatory approach aiming to facilitate the introduction of radiocommunication systems operated by a limited number of licensees under an individual licensing regime in a frequency band already assigned or expected to be assigned to one or more incumbent users. Under the Licensed Shared Access (LSA) approach, the additional users are authorised to use the spectrum (or part of the spectrum) in accordance with sharing rules included in their rights of use of spectrum, thereby allowing all the authorised users, including incumbents, to provide a certain QoS”.

Based on the above definition, the analysis of regulatory framework for the use of the radio spectrum and of various spectrum management regulatory tools and procedures, as well as the management of frequency authorisations, the following key regulatory features of the LSA approach can be highlighted:

- 1) A “sharing framework”, for a given frequency band, will define the spectrum, with corresponding technical and operational conditions, that can be made available for alternative usage under LSA framework.
- 2) Establishing a “sharing framework” under the responsibility of the Administration / NRA requires the involvement of all relevant stakeholders.
- 3) The NRA sets on the basis of “sharing framework” adequate procedure for issuing individual authorisations to LSA users.

LSA is a complementary spectrum management tool that fits under an “individual licensing regime”, a fact which allows fine management of network deployment and effective control of the sharing arrangement, as opposed to licence-exempt regulatory approach.

LSA aims to ensure a certain level of guarantee in terms of spectrum access and protection against harmful interference for both the incumbent(s) and LSA licensees, thus allowing them to provide a predictable QoS. Incumbent(s) and LSA licensees each have exclusive access to spectrum at a given location at a given time.

LSA excludes concepts such as “opportunistic spectrum access”, “secondary use” or “secondary service” where the applicant has no protection from primary user.

A1-1.2 Sharing framework

The “sharing framework”, which is established under the responsibility of the Administration / NRA, can be understood as a set of “sharing rules” or “sharing conditions”. It is the central piece for the implementation of LSA at national level.

The “sharing framework” 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.

National administrations decide which existing applications need to be considered as incumbent uses within the sharing framework and maintained in the long term. Such decision should be made

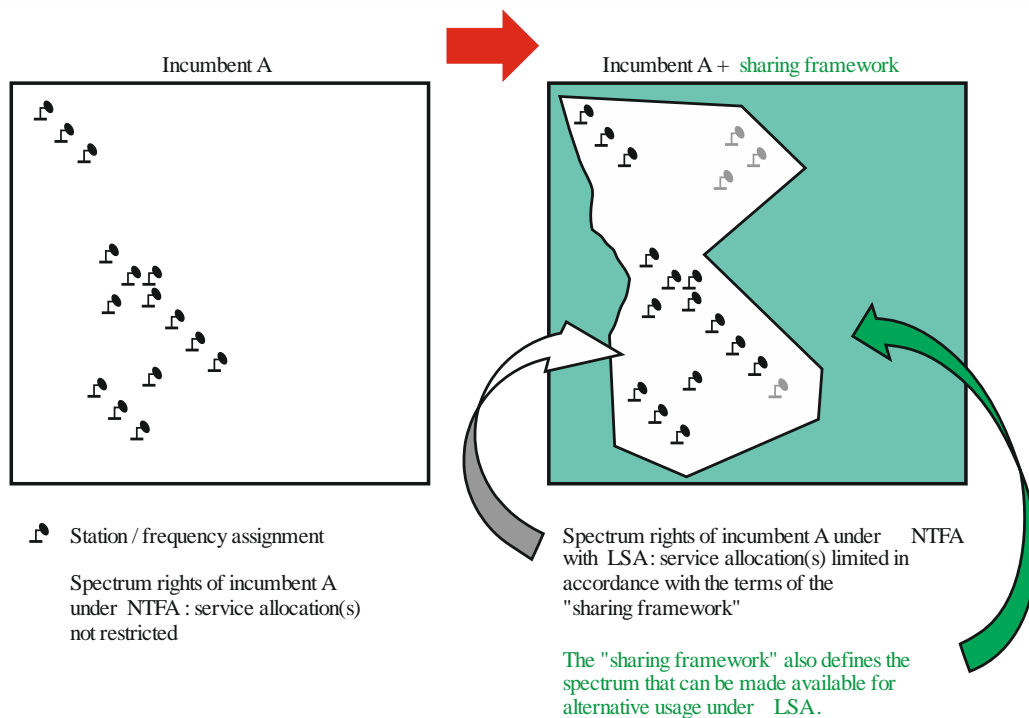
according to national policy objectives and taking into account international obligations and possible other regional restrictions.

LSA licensees require a certain level of guarantee in terms of spectrum access in order to incentivize and secure investments in network and equipment. The adequate level of guarantee is to be determined on a national basis taking into account user requirements and sharing constraints.

A review and negotiation process is required on a national basis to establish an effective “sharing framework”, which may vary significantly from country to country. It requires the involvement of all relevant stakeholders and should consider both the spectrum requirements of the incumbent(s) and the demand for alternative usage.

This concept is illustrated in Fig. A1-1 below. In the Figure, the spectrum availability is based on geographical separation. In the area marked green, the “sharing framework” defines the spectrum availability to LSA users. It should be noted that in LSA the sharing can be done in the three dimensions, namely, time, frequency and area. The sharing framework can also account for future needs of an incumbent, as depicted with grey stations in the Figure.

FIGURE A1-1
Sharing framework



Report SM.2404-A1-01

The “sharing framework” strictly addresses the conditions of access to the LSA spectrum enabling the protection of the incumbents’ services.

The concept of “sharing framework” also implies that LSA should not be mixed with a conventional sharing arrangement that is applied for e.g. FS (microwave links) or PMR-like services. In such case, there is no “incumbent” having priority or exclusive spectrum access across a territory and new systems can be introduced on a first-come / first-served basis by applying appropriate geographic or frequency separation measures.

A1-1.3 Practical implementation

It is currently envisaged that the initial major opportunities of implementation of the LSA concept arise with an incumbent being a governmental body.

In practical cases however, different types of incumbent are likely to operate in a frequency band where the implementation of LSA is foreseen (e.g. 2.3-2.4 GHz).

LSA should therefore also consider other types of incumbent such as PMSE users and support possible dynamic sharing arrangements.

As underlined previously, National Tables of Frequency Allocations (NTFAs) specify the frequency bands and radiocommunication services to which governmental users have access to perform their own duties.

LSA applies only when the incumbent user(s) and the LSA “licensees” are of different nature (e.g. governmental versus commercial) and operate different types of applications, and are subject to different regulatory constraints.

The sharing framework has therefore limited impact – likely no impact – on the market regulation policy objectives since incumbent and LSA licensees belong to two different vertical markets.

From the incumbent’s perspective, LSA could be an alternative to spectrum refarming. Spectrum refarming requires migration of incumbent systems to alternative frequency band. LSA is a tool that enables to maintain systems operated by a governmental body while accommodating new commercial use. LSA can be implemented by Administration when spectrum refarming cannot be achieved.

In practice, LSA and spectrum refarming can obviously complement each other as the review of spectrum needs of an incumbent can lead to distinguish between systems that need to be maintained in a frequency band from others which can be migrated or adjusted to enable alternative usage.

A1-2 Case study: European experience

A1-2.1 European approach

From a European perspective, the LSA approach allows addressing the market demand for harmonized introduction of new applications in specific bands where incumbent uses have to be maintained in different countries. National administrations therefore require some flexibility in the national implementation to enable the protection of incumbent services.

A CEPT harmonization measure would designate a frequency band and define harmonized conditions for the use of a band (e.g. BEM, radio interface). Investigations at European level on the various sharing constraints aim to ensure that corresponding harmonized standard include the necessary tools for implementation of sharing mechanisms required for operation in the band.

In the context of identifying additional spectrum for mobile broadband services (MFCN), LSA offers to administrations a complementary regulatory approach to the conventional approach (permanent segmentation and refarming), noting that the conventional approach will obviously continue to be essential to meet future demand.

Therefore, LSA is seen as a complementary solution for mobile network operators (MNO) for accessing spectrum for MFCN in specific bands, within specified geographical, time or technical limits. LSA complements the traditional exclusive access based on individual authorization when re-allocation / refarming of spectrum is impracticable due to incumbent use. Thus, the purpose of LSA is not to replace the traditional exclusive access. LSA would enable the sharing of spectrum with non MNOs incumbents.

A1-2.2 Justification

LSA provides a number of benefits justifying its implementation for the deployment of MFCN:

- LSA would enable the efficient use of spectrum and fosters innovation in mobile broadband therefore significantly contributing to Europe 2020 policy goals.
- Inventory activities within the spectrum review process highlight many instances where spectrum rights have not been awarded according to Directive 2002/20/EC. LSA could support using this spectrum more efficiently supporting the objectives of the Radio Spectrum Policy Programme.
- LSA is a complementary tool to make available additional spectrum resource for use by MFCN when spectrum refarming is not feasible or desirable. LSA creates an opportunity for mobile broadband use in specific bands in a timely manner under the terms of the Authorisation Directive for Electronic Communication Services.
- LSA represents an opportunity for Europe to lead the global debate on the shared use of spectrum.

A1-2.3 Applicability criteria

In order for LSA bands to be in a position to support successful commercial MFCN services, a number of additional key conditions, named hereafter applicability criteria, have to be fulfilled. In the following a set of applicability criteria are presented that are necessary for the implementation of LSA for MFCN.

A1-2.3.1 Criterion 1: Identification of the incumbent(s) and their usage of the spectrum

National administrations decide which existing applications need to be considered as incumbent uses within the sharing framework and maintained in the long term according to national policy objectives and taking into account international obligations and community law in the case of EU Member States.

In order for the LSA licensee to consider making investments, first the LSA licensee needs to understand precisely where/when the band may be available, so that he knows exactly if the spectrum availability corresponds to his need for the delivery of the intended service.

This implies to know exactly who the incumbent(s) is (are), and what their statistical usage of the band is. Agreeing on a sharing framework under LSA approach also requires the incumbent(s) to inform the LSA Licensee not only of the current availability of spectrum in the band but also of the spectrum availability for the whole duration of the sharing framework. Long-term availability is one of the key enablers of LSA.

A1-2.3.2 Criterion 2: Voluntariness

For MFCN, the goal of LSA is to make available additional spectrum resource in specific bands used by incumbent applications through enabling more advanced sharing than what is possible through existing regulatory frameworks. Sharing through LSA requires close cooperation between the incumbent and the LSA licensee, due to the priority in the spectrum access right.

Furthermore, in order for LSA to bring spectrum to the market more quickly than through band clearance, it is necessary for the incumbent to be proactive in the process.

Therefore, LSA should be implemented on a voluntary basis.

A1-2.3.3 Criterion 3: Based on market demand and incumbent's interests

For LSA to support successful commercial services, it requires both a proactive incumbent (seeing benefits in sharing the band) and a clear business benefit for the LSA licensee. It is essential for LSA

to leverage interests of parties involved, i.e. incumbents and LSA licensees. Extensive discussion between the incumbent and the future LSA licensee are essential in order to identify the sharing options that will provide the most benefits to both parties.

The incumbent will be incentivized by the fact that spectrum access can be maintained in the longer term and by adequate compensation for sustained sharing in specific bands. LSA licensee motivation will be based on attractive sharing conditions and timely access to spectrum with supportive economies of scale and at a lower cost, such as the absence of coverage obligations.

LSA should be based on incentive and market demand.

A1-2.3.4 Criterion 4: Exclusivity among LSA licensees

Mobile operators usually rely on dedicated spectrum (spectrum available to a single MNO). LSA will only bring benefits for the delivery of mobile broadband services if it allows provision of QoS at the same level as what dedicated spectrum supports, when and where spectrum is available. When it comes to coverage, QoS can only be provided through licensed spectrum where MNOs have full control/knowledge of the interference they face, and therefore have full understanding of the performance that will be delivered by their network.

MNOs also need to have full visibility over their future access to spectrum in order to be in a position to develop investment plans. Overall, the exclusivity among LSA licensees for a spectrum resource at a given place, at a given time, for a predictable future, is a critical aspect of the concept in order to trigger infrastructure investment and deliver services with coverage QoS.

The incumbent users also benefit from this exclusivity. The exclusivity guarantees to the incumbent that it can identify in a straightforward manner the particular LSA licensee that has right of access to the band at a given time, in a given location.

A1-2.3.5 Criterion 5: Harmonization

Maintaining opportunities for economies of scale remains a top priority for the mobile broadband industry. Identification of LSA opportunities without consideration of wider industry and standardization may not lead to successful commercial deployment.

Inter alia, LSA could target spectrum that offers potential for effective global harmonization (e.g. spectrum that has been identified for IMT and that may not have been made available due to the needs of specific incumbents on a national or regional level) and is supported by standardization activities.

LSA addresses bands with significant potential for global harmonization and supported by appropriate standardization.

A1-2.4 LSA stakeholders and responsibilities

Several stakeholders must cooperate closely together at national level in order to introduce MFCN in a band under LSA:

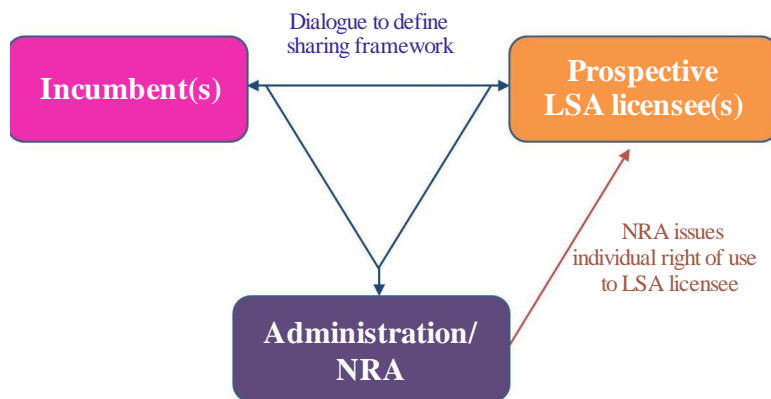
- the Administration/NRA;
- the incumbent(s) (i.e. non MNOs);
- the prospective LSA licensee(s) (i.e. MNOs).

The exact nature and implementation of LSA is likely to differ from country to country, in order to adapt to national circumstances. In any case, the introduction of MFCN under LSA will always require:

- a dialogue involving Administration / NRA, Incumbent(s) and prospective LSA Licensees, in order to define the sharing framework;

- the Administration/NRA issuing an individual right of use to the LSA Licensee, following a procedure that is compliant with the Authorisation Directive.

FIGURE A1-2
Regulatory process required before the introduction of MFCN in a band under LSA



Report SM.2404-A1-02

A1-2.5 Licensed Shared Access in the current regulatory framework

Under the EU Regulatory Framework, the process for awarding spectrum rights of use – general authorization and/or individual rights of use – is a task assigned to Member States, and particularly to administrations and NRAs, as per the general provision set forth by the Authorisation Directive, whose Art. 5(1) states that:

“Member States shall facilitate the use of radio frequencies under general Authorisations. Where necessary, Member States may grant individual rights of use in order to: 1) avoid harmful interference, 2) ensure technical QoS; 3) safeguard efficient use of spectrum, or 4) fulfill other objectives of general interest as defined by Member States in conformity with Community law.”

The Authorisation Directive also contains a provision that allows each Member State to review its particular market structure and take into account desirable national specificities when granting individual spectrum rights of use.

LSA rights of use:

- entail specific provisions to avoid harmful interference to the incumbent and ensure technical QoS;
- take into account national specificities (the use of the band by the incumbent);
- are granted as individual rights of use and associated with a number of obligations – usually defined in a ‘cahier des charges’ for the licensee.

As such, LSA rights of use are fully within the scope of the Authorisation Directive, and most generally the current EU Regulatory Framework for electronic communications.

In compliance with the Framework and Authorisation Directives, the procedure for the assignment of individual LSA rights of use should be ‘objective, transparent, non-discriminatory and proportionate. This would also be applicable to LSA rights of use.

As LSA implementation remains a voluntary national decision, each Member State may determine the subset of harmonized LSA frequencies that can be made available to the market under an LSA license, according to its own appropriate timeline. Each Member State may devise its own path for awarding LSA licenses, in accordance with national authorization regimes, including deciding the

number of LSA licensees that may be present in each LSA frequency band and the duration of each LSA license. However, policy coordination across Member States on general principles for LSA implementation should be considered so as to streamline the process and facilitate provision of pan-European services.

Finally, it can be noted that a national consultation phase could give interested parties the opportunity to comment on draft measures relating to the implementation of LSA.

A1-2.6 Steps for setting a LSA sharing framework and issuing individual authorizations to LSA licensees

In setting up the sharing framework and issuing individual authorizations to LSA licensees, the following steps could be followed as an example:

- 1) The initiative to introduce MFCN in a band under LSA could be either triggered by the incumbent or requested by market driven demand.
- 2) Administration / NRA should identify the relevant parties to be involved in the development of the sharing framework. A dialogue between Administration / NRA, incumbent(s) that are deemed to be protected under LSA and prospective LSA licensees is initiated, with the aim of determining the terms of the sharing framework:
 - a) The incumbent reports the conditions under which LSA will be facilitated. These should include its statistical current and future spectrum requirements in order to operate its services in the band. In particular, it may report frequency band, pre-defined time, geographical area frequency use, statistical use of the band or other technical conditions such as pre-emption conditions, in case of urgency, where the incumbent may retrieve use of the spectrum.
 - b) The prospective LSA licensees provide some indication of the minimum duration of the sharing framework required to enable adequate return on investment. It may also be useful for the LSA prospective licensees to report on the frequencies, locations and times where spectrum is most acutely required. These conditions are needed to ensure the proper spectrum usage by both the incumbent and the LSA licensee in adjacent time/space/frequency domain(s).
 - c) The Administration determines the relevant conditions in particular to ensure operations of the incumbent services to be protected. Based on these conditions, the Administration would set a sharing framework, which can be referenced under the National frequency allocation table, on the basis of which an LSA licensing process can be issued. The administration may also need to modify the incumbent authorization accordingly.
- 3) The NRA establishes a LSA licensing process. A prospective LSA licensee interested applies to the NRA for an LSA authorization.
- 4) Depending on the dynamic nature of spectrum access for which the incumbent has an authorization, the LSA licensee may need to be provided (e.g. through a data base) with information on the area(s)/time of availability of the spectrum. If this information remains constant over time it can be provided when the LSA licensee applies for its LSA authorization.
- 5) When the incumbent needs to have access to (a part of) the band used by the LSA licensee, the LSA Licensee has to be informed by agreed means and has to modify its use. This must be in accordance with the conditions defined in its LSA authorization. The dynamic nature of this request, and the urgency of the request, may influence the practical implementation by the LSA licensee.

A1-2.7 Technical measures to support the implementation of LSA

The following functional blocks may be required when implementing LSA on a national basis.

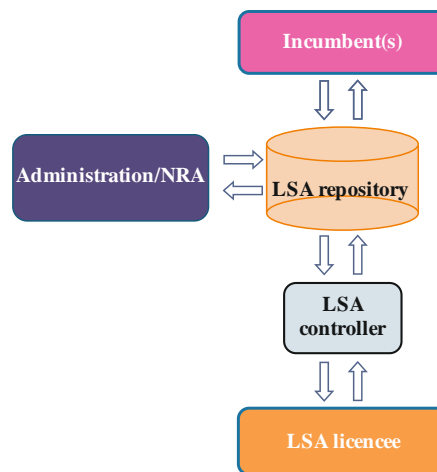
A LSA repository is required to deliver the information on spectrum availability and associated conditions when this information is subject to changes over time. The LSA repository may be managed by the Administration, the NRA or the incumbent, or be delegated to a trusted third party.

The LSA controller manages the access to the spectrum made available to the LSA licensee based on sharing rules and information on the incumbent's use provided by the LSA repository. It retrieves information about spectrum from the LSA repository through a secure and reliable communication path.

The LSA controller can interface with one or multiple LSA repositories as well as with one or multiple LSA licensee's networks. The LSA controller may be managed by the Administration, the NRA, the incumbent, the LSA licensee(s) or be delegated to a trusted third party.

There could be one or more repositories and/or controllers per country, depending e.g. on the LSA band and the incumbents' nature. The following figure depicts an example of implementation of LSA with repository and controller.

FIGURE A1-3
An example of LSA functional blocks and interactions



Report SM.2404-A1-03

The LSA repository contains in particular the relevant information on LSA spectrum that must be protected together with the level of protection provided by the incumbent(s).

It should be noted that ETSI RRS has presented possible architecture that enables the LSA concept in document TR 103 113 (“System Reference Document on Mobile broadband services in the 2 300-2 400 MHz frequency band under Licensed Shared Access regime”).

A1-2.8 Management of cross-border coordination under LSA

Cross-border coordination is usually conducted through bilateral agreements between administrations / NRAs. Individual right of use delivered at national level request MNOs to respect the terms and conditions of such agreements. In traditional MFCN bands, the CEPT may conduct studies and product guidelines in order to support administrations / NRAs in their bilateral/multilateral negotiations.

Cross border coordination for MFCN services introduced in a band under LSA follows the exact same framework. Bilateral/multilateral agreements must be contracted between relevant administrations / NRAs and the LSA licensee will be requested to comply with such agreement under its individual right of use.

Annex 2

Russian Federation's experience in the use of shared spectrum access for similar technologies method (the example of cellular networks)

A2-1 Regulatory aspects of spectrum sharing in SSA-ST

In 2015, the State Commission for Radio Frequencies (SCRF) decided to assign frequency bands for sharing by radio systems for UMTS cellular communications in the following frequency bands: 890-915 MHz, 935-960 MHz, 1 920-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz, and LTE communications in the following bands: 791-820 MHz and 832-861 MHz, 890-915 MHz and 935-960 MHz, 1 710-1 785 MHz and 1 805-1 880 MHz, 2 570-2 620 MHz, 2 500-2 570 MHz and 2 620-2 690 MHz.

Spectrum sharing assumes integration of frequency bands assigned to different operators, to improve QoS provided. The use of frequency bands shall be authorized by the consent of radio spectrum users jointly notifying to the Federal Service for Supervision of Communications, Information Technology, and Mass Media (Roskomnadzor), based on a civil law contract concluded among them.

In June 2016, several amendments were introduced into Federal Law No 126-FZ "On communications". In particular, the notion of "multi-stakeholder spectrum use" was introduced, namely: a multi-stakeholder spectrum sharing contract – an agreement between two and more spectrum users under which the spectrum is shared as specified by Federal Law "On Communications".

In this context, changes were made in regard to frequency assignments, namely: a frequency or radio channel shall be assigned (to a civilian radio system, under the spectrum sharing, only with the multi-stakeholder spectrum sharing contract available, and according to procedures established by the SCRF, within the limits of the frequency band assigned to the parties to the contract, and indicated in the multi-stakeholder spectrum sharing contract. Also, in case of the spectrum use for provisioning communication services, the parties to the multi-stakeholder spectrum sharing contract must have licences for provisioning the same communication services.

The multi-stakeholder spectrum sharing contract must include the following:

- 1) reference to the frequency bands allocated to spectrum users, parties to the contract, which are supposed for the sharing;
- 2) rights and obligations of spectrum users, including spectrum users' obligations on the observance of the terms specified by relevant decision on the frequency band allocation;
- 3) settlement of accounts among spectrum users for spectrum sharing, and amount of corresponding payment;
- 4) procedure for the settlement of disputes among spectrum users on the issue of spectrum sharing;
- 5) procedure for the termination of the multi-stakeholder spectrum sharing contract.

Spectrum allocation (assignment) notification for spectrum sharing is submitted to the regulator by one of the legal entities authorized to use the frequency bands notified for the sharing. Notification of changes to or extension of the spectrum sharing authorization can be also submitted by one of the Users of the relevant frequency bands. The notification should include agreement to authorize the arrangement/extension/changing/re-arrangement of the frequency or channel sharing, and be signed by all legal entities planning to share the spectrum.

Currently, a mandatory condition of the spectrum sharing notification is to enable the use of the frequency bands by all the Users. An electromagnetic compatibility (EMC) report on the possibility of the notified radio system sharing and their electromagnetic compatibility with existing and planned radio systems shall be provided to the notifying party and all the Users indicated in the spectrum sharing notification.

In case of spectrum sharing, the spectrum fee is charged only from the communication operator to whom the SCRF allocated a specific spectrum range.

To ensure possible identification during radio monitoring activities, the Russian Federation's Decree stated that in case of a radio device sharing, the registration certificate for radio device and high-frequency device shall be made individually for each notifying party considering technical characteristics and emission parameters of the radio device subject to registration (network identifier of a specific communication operator).

A2-2 Practical application of spectrum sharing in SSA-ST

Once offering an opportunity to share the spectrum, mobile communication operators submitted several frequency notifications for frequency or radio channel allocation (assignment) for spectrum sharing in the bands 800 MHz, 1 800 MHz and 2 500-2 700 MHz based on the multi-stakeholder spectrum sharing contracts concluded. Having considered the above notifications, authorizations for spectrum sharing were granted.

In the case of using the method of SSA-ST in Russian Federation, there is very important requirement to have regulatory availability of active infrastructure sharing. For example, an operator A may indeed use the radio network of operator B under 2 fundamentally different approaches:

- Roaming.
- Infrastructure mutualisation.

Under national roaming, only the frequencies of operator B are used. Operator A leases access to the infrastructure and frequencies of operator A.

Under the principles of infrastructure mutualisation (sharing of active network elements), operators A and B share the same infrastructure locally. They may use their frequencies independently or share them (“frequency sharing”) as illustrated in the table below:

Active infrastructure sharing	
National roaming	Network mutualisation
	Frequency sharing

Conversely, it should be noted that “frequency sharing” can take place without an “active infrastructure sharing”.

A2-3 Regulatory aspects of active infrastructure sharing in SSA-ST as a supplementary part of spectrum sharing

In the context of legal regulation, the active infrastructure sharing (AIS) should be understood as the use of communication infrastructure (base stations, antennas, and network controllers) by communication operators jointly within the same physical telecommunication site and on a contractual basis. However, at this site, each operator should use only the frequency resource allocated to this operator. In spectrum sharing, AIS is supplementary part for spectrum sharing which should be considered by national regulation in the SSA-ST model.

In order to ensure the proper use of this method, a regulatory solution should be implemented for the AIS/ by more than one communication operator

Concluding an agreement between communication operators is the most common practical application of this method, where:

- 1) Communication operators share among themselves the area of potential building for the networks to become the AIS framework (for example, by administrative units).
- 2) Each operator builds communication networks under the above distribution.
- 3) Operator who built a specific network or station is its owner, while allowing other operators to use the telecommunication network according to the agreement, either getting in return an opportunity to use the similar communication facilities built by other operators, or for a fee.

Despite the fact that in some countries this kind of agreement between operators is not regulated, it's viable to have regulatory basis for it especially in economic aspects.

Since 2004 Russian operators jointly built and shared only passive parts of networks – antenna and mast (tower) installations for base stations, fibre optic lines etc. Sharing of network active equipment was prohibited by the law until 27 November 2014.

Decree of the Government of the Russian Federation of 27 November 2014 No. 1252 “Amendments to the Rules of registration for radio electronic systems and HF devices” currently allows registration of a radio system or an HF device for two and more operators. Thus, all restrictions to RAN sharing in the territory of the Russian Federation were removed.

Earlier, to ensure the infrastructure sharing, Russian Minkomsvyaz also adopted the rules of application for communication equipment sharing RANs, for all basic mobile standards (GSM, UMTS, LTE). The rules for UMTS were established in 2012, for GSM 900/1800 and LTE in 2014.

A2-4 Practical application of active infrastructure sharing in SSA-ST

In December 2014, VimpelCom (Beeline trade mark) and MTS signed an agreement on the joint building of LTE networks in 36 Russian regions. It is assumed that MTS will build networks in 19 regions and VimpelCom in 17 regions. Accordingly, in all these regions both operators will provide base stations, sites, infrastructure and backhaul resources to each other.

MTS and VimpelCom shared the regions depending on a better own infrastructure in a region. VimpelCom has already been using MTS's LTE networks in the following six regions: the Republic of Dagestan, Vologda, Irkutsk, Murmansk, Pskov and Yaroslavl regions. MTS in its turn has already been using VimpelCom's LTE networks in the following five regions: Astrakhan and Kaliningrad regions, the Republics of Altai, Kalmykia and Ingushetia.

The full list of regions covered by the agreement is shown in Table 1 below. The agreement is in effect from 2014 to 2016. It also specifies that apart from using a partner's LTE network in any region,

an operator is authorized to build its own infrastructure. It might be required, for example, to provide services for corporate clients.

TABLE 1 of Annex 2

Regions where MTS will build networks	Regions where VimpelCom will build networks
Vologda region	Astrakhan region
Ivanovo region	The Republic of Kabardino-Balkaria
Irkutsk region	Kaliningrad region
Kaluga region	The Karachay-Cherkess Republic
Kirov region	Kemerovo region
Krasnoyarsk region	Novgorod region
Murmansk region	Orenburg region
Nizhny Novgorod region	Orel region
Omsk region	Penza region
Perm region	The Altai Republic
Pskov region	The Republic of Ingushetia
The Republic of Dagestan	The Republic of Kalmykia
The Republic of Mari El	The Republic of Mordovia
The Republic of Udmurtia	Sakhalin region
The Republic of North Ossetia – Alania	Tula region
Tver region	The Chechen Republic
Khabarovsk region	The Chuvash Republic
Chelyabinsk region	
Yaroslavl region	

In the above 36 regions of the Russian Federation (with population of about 50 million of people) each operator would built about 10.000 base stations. Considering that one LTE base station costs about 10 000 USD, each operator would save 100 mln USD for CAPEX due to active RAN sharing.

Since the end of 2011, Megafon as the third player of the Big Three launched LTE networking together with Skartel (Yota brand) which was later bought by Megafon. As the regulation was not finalized, they collaborated on the basis of “virtual operator” model where Megafon operated Skartel’s frequencies. Megafon has announced its readiness to share its infrastructure with rival operators but only in small settlements.

Thus, communication operators got an opportunity to build LTE networks in locations which were not attractive earlier for single-handed building, to provide excellent coverage due to better choice of sites for base stations. It means that in two years some millions of people in different regions of Russia will assess the benefits of high-speed mobile Internet access not only in big cities but also in small settlements.

A2-5 Conclusions

Improved QoS and their better affordability are of high priority for the Russian Minkomsvyaz. The Ministry's activity in the improvement of the regulatory framework is aimed at solving these tasks.

Key tasks of the Ministry of Communications and Mass Media include the development of communications network infrastructure, rapid penetration of broadband Internet access across the entire territory of the country, bridging the digital divide and ICTs' mass proliferation in all areas of life and economy of the Russian Federation.

Use of SSA-ST method in the territory of the Russian Federation could contribute a lot in solving the desired objectives. They would help to substantially decrease costs and time for the telecommunication development.

Annex 3

Spectrum Sharing Tools

The following Table compares LSA and SSA-ST.

	LSA	SSA – ST
Frequency assignments	Administrations have to identify which existing uses need to be considered as incumbent	N.A.
Licensing regime or authorizations	Administrations should define the sharing framework	Administrations should define the sharing framework. A stakeholder can access to the spectrum through an individual authorization or a commercial agreement, if spectrum trading is allowed.
Applicability	<ul style="list-style-type: none"> • Same radio service/ different radio technology. • Different radio service/different radio technology. 	Same radio service/same or similar radio technology
Interferences protection	Yes	Yes
Advantages of using sharing tool compared to non-shared use	<ul style="list-style-type: none"> • Enables more efficient use of spectrum • Allows continued use of the spectrum for the incumbents and potential use for others users, at the same time • It gives some rights to new users, in a way that makes possible for them to provide services where a foreseeable QoS can be ensured 	<ul style="list-style-type: none"> • Enables more efficient use of spectrum • Allows to improve the QoS and the capacity of networks

	LSA	SSA – ST
Requirements	<ul style="list-style-type: none">• Agreements among primary user and LSA licensee (implemented under the NRA's direction)• A database or other system for updating the spectrum access conditions	Agreements among operators and regulator authorization A regulation should be implemented
