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| WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFTNEW REPORT ITU-R M.[GEO.SHARE] **Sharing schemes in the land mobile service on the basis of geographical use**([Question ITU-R 238-2/5](http://www.itu.int/pub/R-QUE-SG05.238)) |
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# 1 Introduction

This Report studies the use of the frequency spectrum for different services/applications by zones by taking advantage of the properties of alternative wireless access technologies on the basis of user density and traffic requirements. Indeed, certain combinations of frequencies and technologies (e.g., multiuser detection (MUD), smart antennas) are able to provide high capacity and high density coverage through frequency reuse and densification, while others are more suitable to provide more effective wide area coverage (e.g., satellite). It is now technologically possible to mix and match wireless access technologies to optimize the coverage in urban, sub-urban, rural, and remote areas.

Recommendation ITU-R F.1401 provides characteristic of various bands for terrestrial wireless access and certain ITU-R studies on compatible operations with systems in other radio services sharing the same bands, characteristics and operational requirements, spectrum requirements, and interference mitigation technologies. It appears that the propagation characteristics of bands above 3 GHz, which include allocations to the mobile service, the fixed service, and the fixed satellite service, offer good opportunities to explore the shared used on a geographical basis by arranging the coverage area into zones and using the most appropriate technology in each zone.

Therefore, it may be possible to develop a scheme to use a frequency band allocated to multiple services more efficiently (e.g., appropriate design of cell sizes, use of technologies such as multiuser detection (MUD) and smart antennas) by using geographical separation, while protecting incumbents. This is investigated in Section 3. The use of new radio technologies to improve spectrum utilization has already been investigated previously and covered in reports, such as Reports ITU-R M.2038 and ITU-R M.2320. Mitigation techniques to reduce interference and thereby the impact on an intended communication have also been investigated to help different equipment and users to share the same frequency space, such as in Recommendation
 ITU-R M.1825. These approaches are not repeated in this report, which focuses on the use of the frequency spectrum for different services/applications by separating them by zones.

# 2 Relevant ITU-R Recommendations and Reports

*[Editor’s Note: Suggestions are invited to add relevant Recommendations]*

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| Recommendation [ITU-R F.1401](http://www.itu.int/rec/R-REC-F.1401/en) | Considerations for the identification of possible frequency bands for fixed wireless access and related sharing studies |
| Recommendation [ITU-R M.1825](http://www.itu.int/rec/R-REC-M.1825/en) | Guidance on technical parameters and methodologies for sharing studies related to systems in the land mobile service |
| Recommendation [ITU-R SM.1603](http://www.itu.int/rec/R-REC-SM.1603/en)  | Spectrum redeployment as a method of national spectrum management |
| *[Editor’s Note:* Preliminary draft revision of Recommendation ITU-R SM.1132-2 ([Annex 1](https://www.itu.int/md/dologin_md.asp?lang=en&id=R12-WP1A-C-0234!N01!MSW-E) to Doc. [1A/234](http://www.itu.int/md/R12-WP1A-C-0234/en)) or draft new ITU-R Report (cf. [Annex 13](https://www.itu.int/md/dologin_md.asp?lang=en&id=R15-WP1A-C-0060!N13!MSW-E) to Doc. [1A/60](http://www.itu.int/md/R15-WP1A-C-0060/en))*Update the reference as the draft report progresses; only references to Recommendations and Reports in force may appear in the final draft].* | *[Editor’s Note:* General principles and methods for sharing between radiocommunication services*This draft revised Recommendation contains general principles and technical sharing methods for facilitating efficient and effective sharing of spectrum by multiple radiocommunication services. The presented methods imply sharing dimensions of frequency, space, time and signal separation. Any sharing of the spectrum will have to take into account one or more of these four dimensions. Other ITU-R Recommendations could be developed to provide guidance on the use of these principles in sharing situation The draft revision includes: licensed shared access, spectrum database, spectrum access controller, geo-location database, beacon, and sensing.]* |
| Report [ITU-R M.2038](http://www.itu.int/pub/R-REP-M.2038) | Technology Trends |
| Report [ITU-R M.2109](http://www.itu.int/pub/R-REP-M.2109) | Sharing studies between IMT Advanced systems and geostationary satellite networks in the fixed-satellite service in the 3 400-4 200 and 4 500-4 800 MHz frequency bands |
| Report [ITU-R M.2225](http://www.itu.int/pub/R-REP-M.2225) | Introduction to cognitive radio systems in the land mobile service   |
| Report [ITU-R M.2242](http://www.itu.int/pub/R-REP-M.2242) | Cognitive Radio Systems specific for IMT Systems   |
| Report [ITU-R M.2320](http://www.itu.int/pub/R-REP-M.2320) | Future technology trends of terrestrial IMT systems |
| Report [ITU-R M.2330](http://www.itu.int/pub/R-REP-M.2330) | Cognitive radio systems (CRSs) in the land mobile service |
| Report [ITU-R S.2199](http://www.itu.int/pub/R-REP-S.2199) | Studies on compatibility of broadband wireless access (BWA) systems and fixed-satellite service (FSS) networks in the 3 400-4 200 MHz band |
| *[Editor’s Note:* Working document towards a preliminary draft new Recommendation ITU-R S.[INTERF.AREA] ([Annex 2](https://www.itu.int/md/dologin_md.asp?lang=en&id=R15-WP4A-C-0063!N02!MSW-E) to [Doc. 4A/63](http://www.itu.int/md/R15-WP4A-C-0063/en))*Update the reference as the draft report progresses; only references to Recommendations in force may appear in the final draft].* | *[Editor’s Note:* A guiding methodology for providing compatibility between ubiquitously deployed earth stations of the fixed-satellite service and stations of the fixed and/or mobile services in adjacent areas for the cases described in the Tables of Appendix 7 of the Radio Regulations*The methodology may be useful for the development of this report.]* |
| *[Editor’s Note:* Working document towards a preliminary draft new Report ITU-R SM.[innovative regulatory tools] ([Annex 13](https://www.itu.int/md/dologin_md.asp?lang=en&id=R15-WP1B-C-0051!N13!MSW-E) to [Doc. 1B/51](http://www.itu.int/md/R15-WP1B-C-0051/en))*Update the reference as the draft report progresses; only references to Reports in force may appear in the final draft].* | *[Editor’s Note:* Innovative regulatory tools to support enhanced shared use of the spectrum.*The original proposal for this new report in* [*Doc. 1B/171*](http://gsims.lmc.ericsson.se/ITU-R/1B-2014-06-Geneva/Inputs/R12-WP1B-C-0171-E.htm) *was based on* [*ECC Report 205*](http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP205.PDF)*; 14 pages of the working document are devoted to licensed shared access and other tools could be added at future meetings based on contributions (the working document has placeholder annexes).]* |
| *[Editor’s Note:* Working document towards a preliminary draft new Report ITU-R SM.[CRS SPECTRUM MANAGEMENT CHALLENGES]([Annex 12](https://www.itu.int/md/dologin_md.asp?lang=en&id=R15-WP1B-C-0051!N12!MSW-E) to [Doc. 1B/51](http://www.itu.int/md/R15-WP1B-C-0051/en))*Update the reference as the draft report progresses; only references to Reports in force may appear in the final draft].* | *[Editor’s Note:* Spectrum management principles, challenges and issues related to dynamic access to frequency bands by means of radio systems employing cognitive capabilities. |

# 3 Use of the frequency spectrum for different services/applications by zones

Various sharing alternatives are possible and available, including geographical separation and/or frequency separation (cf. Recommendation ITU-R [SM.1132](http://www.itu.int/rec/R-REC-SM.1132/en)). One of the approaches being investigated here is the use of geolocation databases, in cases whenever it is applicable, to determine which frequencies are available in each zone by systems operating under different radiocommunication services.

Figure 1 illustrates the concept whereby certain frequencies can be used by the mobile and fixed services in urban and suburban areas and at the same time can be used by the fixed satellite service in rural and remote areas. Carefully delineated specific coordination zones (e.g., as can be provided by using Appendix **7** of the Radio Regulations) provide mutual protection between services.

Figure 1

Example of shared use of certain frequencies by terrestrial mobile broadband
and fixed satellite by differentiating geographical zones



This approach can be effectively implemented using Licensed Shared Access (LSA) and similar schemes such as geo-location databases. The working document towards a preliminary draft new Report ITU-R SM.[innovative regulatory tools] (cf. [Annex 13](https://www.itu.int/md/dologin_md.asp?lang=en&id=R15-WP1B-C-0051!N13!MSW-E) to [Doc. 1B/51](http://www.itu.int/md/R15-WP1B-C-0051/en)) describes LSA.

Cognitive Radio Systems, as described in Report [ITU-R M.2225](http://www.itu.int/pub/R-REP-M.2225), Report [ITU-R M.2242](http://www.itu.int/pub/R-REP-M.2242) and Report [ITU-R M.2330](http://www.itu.int/pub/R-REP-M.2330), describe technical capabilities which could be used for the implementation of LSA.

Using the zonal approach for sharing the frequency spectrum, in this example, both satellite and terrestrial networks could work together in the band. Each network “complements” the other’s coverage – and with technical capabilities such as “inter-system handover,” coverage could be optimized. Report ITU-R M.2330 describes many ways to utilize CRS capabilities for inter-system handover, e.g., implementing the capabilities to terminals, base stations, and core networks.

In order to implement the new schemes, spectrum redeployment approaches, may be used to evolve the radio operations based on the new technologies and changing operational requirements. This needs further study.

# 4 Use of technologies that improve spectrum usage by zones

The following technologies are relevant for the implementation of sharing schemes on a geographical basis, and may not be applicable to all services and/or cases:

*Geolocation database:* Data base that contains information on what frequencies can be used by stations at their current locations, which may be obtained using geo-location techniques and other possible information, such as allowed transmit power levels, time and duration of the availability of the frequencies, information on operational environment, the policies, usage patterns and user preferences (Ref.: [Report ITU-R M.2225](http://www.itu.int/pub/R-REP-M.2225)).

*Smart antenna:* A system of antennas that combines multiple antenna elements with a signal-processing capability to optimize its radiation and/or reception pattern automatically in response to the signal environment (Ref.: [Recommendation ITU-R M.1797](http://www.itu.int/rec/R-REC-M.1797/en)).

*Adaptive antenna system (AAS):* An array of antennas and associated signal processing that together is able to change its antenna radiation pattern dynamically to adjust to noise environment, interference and multipath (Ref.: [Recommendation ITU-R M.1797](http://www.itu.int/rec/R-REC-M.1797/en)).

*Switched-beam antenna system:* An antenna system that creates a number of fixed beams at an antenna site, allowing the receiver to select the beam that provides the greatest signal enhancement and interference reduction (Ref.: [Recommendation ITU-R M.1797](http://www.itu.int/rec/R-REC-M.1797/en)).

*Cognitive radio system (CRS):* A radio system employing technology that allows the system to obtain knowledge of its operational and geographical environment, established policies and its internal state; to dynamically and autonomously adjust its operational parameters and protocols according to its obtained knowledge in order to achieve predefined objectives; and to learn from the results obtained (Ref.: [Report ITU-R SM.2152](http://www.itu.int/pub/R-REP-SM.2152)).

*Dynamic Frequency Selection (DFS):* An interference mitigation technique under frequency sharing environment, where the selection of a suitable channel is performed based on interference detected or certain quality criteria [Ref.: [Annex 25](https://www.itu.int/md/dologin_md.asp?lang=en&id=R12-WP5A-C-0079!N25!MSW-E) to [Doc. 5A/79](http://www.itu.int/md/R12-WP5A-C-0079/en) (2012)].

*Integrated real/near real-time spectrum occupancy information*: spectrum knowledge is collected via distributed sensors/radios. A system of cognitive radio systems where there is a continual feedback of spectrum occupancy knowledge combined with access to historical usage trends is used to predict near-term usage while updating historical use trends.

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# 5 Application to suitable bands allocated to both mobile and satellite services

Spectrum in the bands above 3 GHz are expected to be in high demand to help service providers address future capacity constraints. Although the propagation properties of the spectrum are not ideal for mobile systems covering large rural and remote areas, the spectrum is expected to be highly useful in expanding the wireless capacity of mobile systems in urban areas and may also be deployed for fixed wireless systems in rural areas. In a complementary manner, satellite networks can effectively support rural areas with capacity and extended coverage requirements.

Therefore, it would be advantageous to structure the terrestrial mobile broadband and satellite networks in such a manner that the spectrum usage is maximized. This could be accomplished by many techniques, not limited to Recommendation [ITU-R M.1825](http://www.itu.int/rec/R-REC-M.1825/en), including the sharing scheme presented in Figure 1.

*[Editor’s Note: It is suggested to study specific scenarios taking into account existing sharing studies in suitable bands and the zonal sharing approach described in Section 3.]*