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| **Radiocommunication Study Groups** |  |
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| Annex 12 to Working Party 5A Chairman’s Report  |
| Working document towards a preliminary draft New Report ITU-R M.[LOCAL\_CoVERAGE] |
| **[Operational guidelines for the deployment of broadband mobile systems for local coverage in the frequency bands below 6 GHz /**Local coverage operation of broadband wireless access systems in the bands below 6 GHz] |

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*[It describes [modelling/examples and analysis of the scenarios] in a draft new report to define clearly the new concept and [requirements] for operation of local coverage of BWA systems. The draft new report also addresses efficient and [flexible operation of frequency bands] [taking advantage of properties of local coverage] and technical and operational requirements for radio stations to realize the new operational framework.]*

## Scope

*[Editor’s note: the following is a direction to developed*

*[Editor’s note: “local coverage” should be defined. The term “local coverage” needs further study and should be replaced with other better wording to avoid confusion with local area network.]*

*This working document is intended to provide operational guidelines and examples for the deployment of mobile broadband systems[[1]](#footnote-1) for [local coverage] in the frequency bands below 6 GHz.*

*Different from conventional macro-cell radio access networks which are operating mainly in the bands below 3GHz, BWA systems above 3GHz are more suitable for local coverage such as small cells and hot spots due to radio propagation characteristics.
[As technical and operational requirements for such local coverage have not been well studied.]*

*The scope of the study is defined by the following items:*

*– Effective and efficient use of frequency bands below 6GHz for operation of BWA systems.*

*– Development of operational scenario and criteria for local coverage of such BWA systems in the bands below 6 GHz.*

*– [Technical requirements/functional features] for radio stations for local coverage of BWA systems.*

The working assumption for the study are as follows:

*– The study objective focuses on flexible and efficient operation of BWA systems that includes multi-standard radio operation taking advantage of properties of local coverage.*

*– The study also takes account of flexible migration from a radio access standard to another standard [in Recommendation ITU-R M.1801-2].*

*[Editor’s Notes: Rec. ITU-R M.1801-2 defines BWA technologies, including IMT.]*

*– Frequency sharing with other services is out of the scope of this study. ]*

# 1 Introduction [To be developed]

*[Editor’s note:*

*This section should address the following;*

*– A definition of local coverage will be reviewed such as size of coverage, area limitation, and concept of so-called hot spot from technical and operational view points and for various use cases. (e.g. hot-spot). (see definition and terminology section)*

*[Nomadic and low mobility usage could be considered for operation of local coverage. [Editor’s note: this could be considered for the development of definition.]]
(see definition part, 4th bullet)*

*[Applications of local coverage will focus on [cost-efficient] [Editor’s note: rewording is required.] broadband mobile data transmission.] [Editor’s note: this could be considered for the development of definition.] (see first bullet in definition)*

– *Local coverage is intended to serve for a limited area having very high density of traffic demands. It is assumed that such local coverage is deployed mainly in urban areas or for indoor usage. (see 2nd and 4th bullets of definition part).*

*– [Sufficiently Large /contiguous] bandwidth could be used for such local coverage in order to provide large transmission capacity and high throughput for practical broadband mobile applications. Being suitable for local coverage, higher frequencies are assumed, where [large contiguous] bandwidths could be available. (see section 3.1 Technical properties of local coverage. )*

*– The proposed operational guidelines to be developed are not intended for a specific wireless access technology. (see section 3.2 Use cases: “any specific radio standard …)*

– *The study will explore generic guidelines to enhance the use of local coverage within [the existing wireless access framework]. [Editor’s note: clarification needed.].
(see section 41 Operational scenarios )*

*– [Mobility management functions of high complexity for macro-cell mobile systems are not necessarily required.] [Editor’s note: this could be defined after the identification of use cases.] (see 3rd bullet of the definition part.)*

*– [The study on local coverage should consider various operational conditions including unlicensed band shared by multiple operators, unlicensed band shared by registered radio stations [Editor’s note:* Clarification needed –‘unlicensed registered radio
station’ ?*], licensed band shared by multiple operators, licensed band exclusively used by a single operator.] [Editor’s note: Issues of a regulatory nature are not covered in this [report] (see 4.1 Operation scenarios)*

*– The study is intended to develop guidelines for the effective operation of local coverage and the efficient use of frequency spectrum. To this end, the study may include operator control and management functions for stable operation of broadband mobile systems. (see 2nd paragraph in section 4.1 Operational scenario.)*

*– The study subjects may also include integrated use of macro cell and local coverage of homogeneous mobile systems as well as interworking between heterogeneous mobile systems.*

*]*

# 2 Definition and terminology

## 2.1 Definition

*[Editor’s note: “local coverage” should be defined. The term “local coverage” needs further study and should be replaced with other better wording to avoid confusion with local area network.]*

*Section 2 “Basic concept and framework” of Annex 12 to Document* [*5A/421*](http://www.itu.int/md/R12-WP5A-C-0421/en)

*[Editor’s note: Nomadic and low mobility usage could be considered for operation of local coverage.*

*[Editor’s note: this could be considered for the development of definition.]]*

*[Mobility management functions of high complexity for macro-cell mobile systems are not necessarily required.]*

*[Editor’s note: this could be defined after the identification of use cases.]]*

*The study focuses on operation of standard Broadband wireless access (BWA) systems included
[in Recommendation ITU-R M.1801-2] in the bands below 6 GHz. As described in the previous section, radio access networks by these standard BWA systems will be mainly deployed to provide small local coverage. The concept of local coverage is described as follows:*

– *local coverage is intended to provide broadband wireless access for a limited area for high speed data communications by the standard BWA systems [in Recommendation ITU-R M.1801-2]; [Editor’s note: User densification] [Editor’s note: “ high speed data communications” should be clarified. Definitions for these terminology should de provide in the future meeting.]*

*– size of coverage has not been rigidly defined for local coverage, which may include indoor pico cell, femto cell, access points of radio local area networks, outdoor pico cell or equivalent coverage. [Editor’s note: High density of traffic demands]*

*– different from conventional macro cell radio access networks, local coverage does not assume mandatory requirement of seamless and full coverage for wide area and seamless handover capabilities. Integrated or coordinated operation with macro cell is not a mandatory requirement either for local coverage. However, this does not mean such capabilities should be precluded for local coverage;*

*– local coverage is therefore used mainly for nomadic and low-mobility operation for both indoor and outdoor coverage; [Editor’s note: High density of traffic demands]*

*– it is not assumed that local coverage shares the same frequency band with a macro-cell, which is overlapping with local coverage. Operation of local coverage is therefore intended for frequency bands higher than macro-cell frequency bands (for example, 3 to 6 GHz band). Local coverage however may share the same frequency bands with other neighboring local coverage;*

 *[Editor’s note: In case of local coverage, better definitions for the cell sizes above should be provided.]*

*]*

Figure 1

Typical Deployment of Local Coverage

Seamless Coverage

(Case 3)

(Case 1)

(Case 2)

Macro Cell

Local Coverage

The above described local coverage can be characterized further as summarised in the following table.

Table 1

Characteristics of Local Coverage

|  |  |
| --- | --- |
| Item by layer | Description |
| Physical transmission | – Outdoor and Indoor use.– Example use cases : Cellular Femto-cell BTS and Wi-Fi Access Point.– Type of Coverage : - isolated; - edge connecting to adjacent one(s); - overlapped coverage with adjacent one(s).– Power-limited in the isolated coverage.– Interference-limited in the overlapped cases. |
| Shared access | – Frequency division multiple access for the shared use by sensing prior to transmission for channel selection control.– Independent channel assignment control by a base station.– Coordinated channel assignment control by base stations. |
| Network control | – Network control by a single base station.– Coordinated network control among base stations of the same network.– Coordinated network operation by a centralized or distributed control. |

## 2.2 Terminology [To be developed]

## 2.3 Abbreviations [To be developed]

# 3 General concept and framework

## 3.1 Technical properties of local coverage

Broadband wireless access (BWA) systems included [in Recommendation ITU-R M.1801-2] are intended to operate in the bands below 6GHz. Conventional macro-cell radio access networks have been deployed mainly in the bands below 3GHz. Due to radio propagation characteristics, within this range of BWA (below 6GHz), the bands in the range of 3 to 6 GHz are more suitable for local coverage such as small cells and hot spots, as deployment of seamless coverage becomes more difficult for wide areas in these bands. Indoor penetration tends to be more limited in these bands.

In deployment of BWA systems in the range 3 - 6GHz, the following properties should be taken into consideration.

– Small area coverage is more suitable as larger fading margin may be needed for NLOS operation.

– Limited coverage may be provided by a low transmit power and low antenna height base station (so-called low power and low tower).

– Small local coverage may be isolated in some cases such as indoor coverage with sufficiently large penetration loss by building walls.

– Such isolated local coverage may be operated without any interference to and from other cells.

The following cell deployment cases may be considered.

Figure 2

Various cases of Local Coverage

**Case 1:** Isolated Coverage

**Case 2:** Adjacent Coverage

**Case 3:** Overlapping Coverage (Co-coverage)

In some cases, these local coverage may be operated for the same radio access network whereas they may belong to different radio access networks in other cases. It should be noted that the isolated coverage in Case 1 may be operated in a more flexible and less constrained manner owing to very little inter-coverage interference. For example, two different radio access technologies may be operated in adjacent sub-bands without any guard band if the adjacent sub-bands are used in a pair of isolated local coverage respectively. Due to very little inter-coverage interference, the link design in Case 1 is generally power-limited. Inter-coverage interference is unavoidable for Case 2 due to loose coupling between the adjacent coverage. For Case 3, the same constraints should be considered as the macro-cell case for frequency sharing because of the co-coverage area. Thus the link design in Case 2 and Case 3 can be regarded as interference-affected/limited.

## 3.2 Examples of Use cases

The following use cases may be considered as examples for deployment of broadband mobile systems by local coverage in frequency bands below 6 GHz. These examples will fall under the scope of operational guidelines discussed in Section 4. [A study should clarify various use cases that characterize the typical use of local coverage in frequency bands below 6 GHz.]

Local coverage as above defined has been used for wide variety of applications which include but are not limited to the following use cases. In these example use cases, any specific radio access standard is not assumed. Any BWA systems [in Recommendation M.1801-2] may be applicable.

– Local access to fixed broadband (corporate network and consumer network).

– Traffic offloading from mobile data networks.

– Outdoor hot spot.

– Public facilities (Railway stations, Airport, Stadium, Conference hall, etc.).

– Indoor local access (Office LAN and home network).

– Pico-cell and Femto-cell.

– Occasional use for a big event.

– Emergency applications.

It should be noted that there are various cases for the operator/owner of such local access networks. *[Editor’s note: other use case examples are invited to this section in the future meetings.]*

## 3.3 Planned studies

Scope of the planned studies

– Sensing of co-channel and adjacent channel interference.

– Decision criteria for shared operation of spectrum.

– Decision criteria for adjacent band compatibility.

– Management of guard band between adjacent sub-bands and spectrum mask.

– Requirement of radio network synchronization.

Three operational scenarios are here considered for a frequency band to be used for local coverage, for which the following technical conditions are assumed.

Assumptions for the Study

– A number of local coverage is deployed in such a way as in Cases 1, 2 and 3 in
Section 1.

– All the local coverage commonly uses a same frequency band under consideration.

– For the use of the subject frequency band, both segmentation into sub-bands and shared use of an entire band are considered.

– [Recommendation ITU-R M.1801-2] contains various Radio Access Technologies.
Use of multiple RATs in a frequency band may be taken into consideration. So far, a series of sub-bands have often been used for a single RAT. It may also be possible that adjacent sub-bands are used for different RATs.

Scenario 1：Licensed & Dedicated

– A licensed frequency band is divided into several sub-bands, each of which is assigned for a single network for dedicated and exclusive use.

Scenario 1:

Network A 　 Network B Network C

Sub-band 1 Sub-band 2 Sub-band 3

– Multiple Radio Access Technologies may be operated in these sub-bands for isolated cells in Case 1. For example, sub-band 1 is operated by RAT X whereas sub-band 2 employs RAT Y. For adjacent or co-coverage cells in Cases 2 and 3, further studies are needed as follows.

– Appropriate criteria will be needed to operate each sub-band by multiple RATs for local coverage.

– Coordination should be managed between adjacent sub-bands operated by different networks.

– To this end, requirements for guard bands and network synchronization should be carefully studied.

Figure 3

Operational Cases for Scenario 1

**Case 1: Isolated Coverage**

Sub-band 1 Sub-band 2

Network A Network B

RAT X RAT Y

**Case 3: Overlapping Coverage**

 Sub-band 1 Sub-band 2

 Network A Network B

 RAT X RAT Y

Guard Band

Sub-band 2

Network B

RAT X

Sub-band 1

Network A

RAT X

Scenario 2：Unlicensed & Shared

– A subject unlicensed band is used by multiple networks for shared operation.

**Scenario 2**

Networks A, B, C

– The investigation should assume two scenarios which include shared operation by a single RAT of BWA and shared operation allowing multiple RATs.

– The shared operation by multiple RATs may be feasible for isolated coverage in Case 1.

– Subjects for further study include possibility of shared operation by networks of multiple RATs for adjacent coverage or overlapping coverage in Cases 2 and 3. Mechanisms of frequency selection and interference avoidance should be first investigated. Carrier sensing prior to start of transmission is required. Adjacent band compatibility should also be analysed taking account of requirements of guard band and network synchronization.

Figure 4

Operational Cases for Scenario 2

Case 1: Isolated Coverage

Network B

RAT Y

Network A

RAT X

Case 2: Overlapping Coverage

Networks A, B

RATs X, Y

## Scenario 3：Licensed and Shared

Operation of licensed band for shared use is generally similar to the shared operation of unlicensed band in Scenario 2. Methodologies to support operation of Scenario 2 may be applicable to Scenario 3 as well. It should be noted for the licensed band that the number of operating networks is limited and fixed in Scenario 3 whereas the number of networks sharing the unlicensed band is uncertain and unlimited.

## 3.4 Currently available technologies [To be developed]

# 4 Operation of frequency band for local coverage

## 4.1 [Examples of] Operational scenarios

*[Editor’s notes: The study will explore generic guidelines to enhance the use of local coverage within the existing wireless access framework. [Editor’s note: Clarification needed.].]*

The objective of the study is to describe the effective and flexible operation of BWA systems for local coverage in the range of 3 to 6 GHz. The operation of local coverage may be categorized into three cases presented in Section 3.1. In some deployment cases of local coverage, the frequency band may be operated in a more efficient and flexible manner (as described in Chapter 5). Various operational scenarios may be considered in this study for operation of local coverage in the subject frequency bands as follows.

Operational Scenarios

– Licensed band / Unlicensed band.

– Dedicated use of a sub-band by a single network.

– Shared use of a frequency band by multiple networks.

– Operation of multi-standard Radio Access Technologies within a frequency band.

– Migration of a conventional Radio Access Technology (RAT) of BWA to another
RAT to facilitate refarming of a frequency band.

 For these operational scenarios, the study may include the following technical subjects for detailed investigation to develop new and flexible criteria for operation of local coverage and methodology to support such operational framework. It should be noted that the investigation may take account of coexistence of multiple Radio Access Technologies in a subject frequency band.

## 4.2 Modelling and analysis [To be developed]

## 4.3 Operational requirements [To be developed]

## 4.4 Possible management scheme

*[Editor’s note: The requirements should be clarified since the requirement shown below seems qualitative rather than quantitative. “Requirement” should be changed to other wording]*

For these three operational scenarios, a new operation concept and supporting technologies should be studied to derive new operational [requirements/guidelines] and criteria for efficient and flexible operation of frequency bands taking advantage of local coverage operation. Such new scheme may require advanced functions and methodologies for monitoring and control, for which fundamental mechanisms have to be elaborated for management of guard band and network synchronization as well as carrier sensing and frequency channel selection control. To this end, application of cognitive radio technologies is highly expected [1]. Adaptive beam forming of base station is another promising technology for interference mitigation among adjacent local coverage. Such advanced technologies that WP5A is now studying should be fully utilized.

# 5 Technical [Requirements/guidelines] for Radio Stations

*[Editor’s note: Some preliminary examples are provided as follows for the functionality of network management and radio resource management to facilitate initial studies.]*

Operational guidelines will be dependent on various [examples of] use cases. Operational guidelines should be studied for typical operational scenarios of local coverage. It is currently assumed that operational guidelines may be categorized into network management functions and radio resource management functions. Some of the operational guidelines may be used as optional.

## 5.1 [Examples of] Network management functions

– Monitoring of operational status for base stations and mobile stations.

– Identification and management of mobile stations under control of each base station.

– Monitoring and management of traffic loading of base station and mobile station.

– Monitoring and management of transmission performance of base station and mobile station.

– Access admission control for mobile station by base station to maintain required throughput per user.

– Authentication process of mobile station by base station.

It is assumed that these functions are implemented within a broadband mobile network operated by a single service provider.

## 5.2 [Examples of] Radio resource management functions

– Monitoring of radio spectrum usage at base station and mobile stations.

– Monitoring of radio resource quality of base station and mobile stations.

– Radio signal sensing for nearby base and mobile stations (for detection of co-channel interference and usage of adjacent channels) [2], [3], [4].

– Collection of monitoring data from mobile stations for control functions of base station.

– Control of frequency channel selection by base station.

– Transmit power control for base station.

– Transmit power control for mobile station by base station.

– Priority control of radio resource assignment for delay-sensitive traffic.

– Access admission control for mobile stations to maintain minimum acceptable throughput performance (e.g. Rejection of a new connection of mobile station of extremely low throughput around the edge of area coverage).

– Disconnection of a mobile station of extremely low throughput around the edge of area coverage to encourage reconnection to another base station providing better transmission quality and performance.

– Integrated implementation of radio resource management functions through capabilities of cognitive radio technologies [1].

These functions were originally intended for optimized operation of a single broadband mobile network. These functions may also be applicable across multiple broadband mobile networks.

## 5.3 [Examples of] Control and management functions [required for licensed band]

– Initiation of operation of mobile station in accordance with the control by base station.

– Access control of mobile station by base station.

– Monitoring of operational conditions of mobile station by base station.

– Forced termination of mobile station operation by the control of base station.

# 6 Conclusion [To be developed]

References

[1] Report ITU-R M.2225 “Introduction to cognitive radio systems in the land mobile service”.

[2] Tevfik Yucek and Huseyin Arslan : “A survey of spectrum sensing algorithms for cognitive radio applications”, IEEE Communications Surveys & Tutorials, Vol. 11, No. 1, pp. 116-130, First Quarter 2009.

[3] Amir Ghasemi and Elvino S. Sousa : “Spectrum sensing in cognitive radio networks: Requirements, Challenges and Design Trade-offs”, IEEE Communications Magazine, pp. 32-39, April 2008.

[4] Kanshiro Kashiki et. al. : “Analytical study for performance evaluation of signal detection scheme to allow the coexistence of additional and existing radio communication systems”, IEICE Transactions on Communications, Vol. E97-B, No.2, pp. 295-304, February 2014.

1. Mobile broadband system refers to the systems operating in the land mobile service between 30 MHz and 6 GHz [excluding IMT/ in Recommendation ITU-R M.1801-2]. [↑](#footnote-ref-1)