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**APT REPORT ON**

**HARMONIZATION OF FREQUENCY RANGES FOR BY WIRELESS PPDR APPLICATIONS IN ASIA-PACIFIC REGION**

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**APT REPORT ON**

**HARMONIZATION of frequency ranges for use by wireless PPDR applications in Asia-pacific Region**

1. **Introduction**

Resolution **646 (Rev.WRC-15)** (copy attached at Annex 3) identifies a global frequency range and regional frequency ranges to encourage harmonized spectrum for PPDR solutions. Benefits of spectrum harmonization include: increased potential for interoperability, a broader manufacturing base and increased volume of equipment resulting in economies of scale and expanded equipment availability, improved spectrum management and planning and enhanced cross-border coordination and circulation of equipment.

More specifically, administrations are encouraged to consider parts of the frequency range 694-894 MHz, as described in the most recent version of Recommendation ITU-R M.2015, when undertaking their national planning for their PPDR applications, in particular broadband, in order to achieve harmonization.

Administrations are further encouraged to also consider parts of the following regionally harmonized frequency ranges, for their PPDR applications

* Region 1: 380-470 MHz
* Region 3: 406.1-430 MHz, 440-470 MHz and 4 940-4 990 MHz

Resolution ITU-R **646 (Rev.WRC-15)** also resolved that PPDR frequency arrangements within the frequency ranges specified in resolves 2 and 3, as well as countries’ frequency arrangements for PPDR, should be included in Recommendation ITU-R M.2015.

Additionally, the Resolution recognized[[1]](#footnote-1) that some countries in Region 3 have adopted parts of the frequency ranges 138-174 MHz, 351-370 MHz and 380-400 MHz for narrowband PPDR applications and the frequency ranges 174-205 MHz and 1 447-1 467 MHz for broadband PPDR applications

This Report provides guidance on the frequency arrangements for PPDR radiocommunications in Region 3 in accordance with Resolution **646 (Rev.WRC-15)**.

1. **Important considerations for the use of various frequency bands for PPDR applications:**

This Report provides guidance on the frequency arrangements for PPDR radiocommunications in Region 3 in accordance with Resolution 646 (Rev.WRC-15).

Annex 1 of this Report contain frequency arrangements based on *resolve 2* and *resolve* 3 of the Resolution and are recommended to administrations as guidance when making spectrum available for PPDR operations.

The frequency arrangements of Annex 1 are categorized into three sections:

* Section 1 contains frequency arrangements in parts of the frequency range 694-894 MHz.
* Section 2 contains frequency arrangements in parts of the frequency range 406.1-470 MHz
* Section 3 contains frequency arrangements in parts of the frequency range 4940-4990 MHz

Annex 2 of this Report contains frequency arrangements for PPDR operations on a national basis, in parts of frequency ranges described in the *recognizing l[[2]](#footnote-2)* of the Resolution as listed below:

a) for narrowband PPDR applications

* 138-174 MHz
* 351-370 MHz
* 380-400 MHz
* 400–406 MHz

b) for broadband PPDR applications

* 174-205 MHz
* 1 447-1 467 MHz

(Note: Annexes 2 will be further developed and updated in the next Revision of this Report)

The Annexes to this Report may also assist proposed updates to Recommendation ITU-R M.2015

Annex 4 illustrates the alternative band structures defined by 3GPP and falling within the PPDR frequency range designated by Resolution 646 (Rev.WRC-15) – and is specifically aimed at encouraging increased harmonisation amongst APT Members considering PPDR band options.

1. **Important considerations for the use of various frequency bands for PPDR applications:**

*3.1* APT administrations should consider using parts of the following frequency ranges for PPDR to the maximum extent possible when undertaking their national planning for their PPDR operations:

a) 694-894 MHz, as described in Annex 1, Section 1

b) 406.1-430 MHz and 440-470 MHz, as described in Annex 1, Section 2

d) 4 940‑4 990 MHz, as described in Annex 1, Section 3

3.2 When using parts of the following frequency ranges the APT administrations should take due regard to any needed consultation and cooperation with other concerned neighbouring countries:

a) for narrowband PPDR applications as described in Annex 2, Section 1

* 138-174 MHz
* 351-370 MHz
* 380-400 MHz
* 400–406 MHz

 b) for broadband PPDR applications as described in Annex 2, Section 1

* + 174-205 MHz
	+ 694–894 MHz
	+ 1 447-1 467 MHz
	+ 4 940–4 990 MHz

**Guide to Annexes:**

**ANNEX 1 contains Frequency arrangements and related information for PPDR frequency ranges in Asia Pacific Region (Region 3**)

Annex1 - Section 1 contains Frequency arrangements and other technical characteristics of frequency ranges for PPDR in 694-894 MHz

Annex 1 - Section 2 contains Frequency arrangements and other technical characteristics of frequency ranges for PPDR in 406.1-430 MHz and 440-470 MHz

Annex 1 - Section 3 contains Frequency arrangements and other technical characteristics of frequency ranges for PPDR in 4 940‑4 990 MHz

**Annex 2 contains Frequency arrangements and other technical characteristics of the following frequency ranges:**

 For narrowband PPDR applications in some APT countries

* + 138-174 MHz
	+ 351-370 MHz
	+ 380-400 MHz

For broadband PPDR applications in some APT countries

* + 174-205 MHz
	+ 1 447-1 467 MHz

**Annex 3 contains a copy of Resolution 646(Rev. WRC-15)**

**Annex 4 contains 3GPP Frequency arrangements within 694-894 MHz**

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| **Annex 1****Harmonized Frequency Arrangements in Region 3** |
| Section 1:Arrangements in parts of the frequency range 694-894MHz (as per *resolves* 2 of Resolution 646 (Rev.WRC-15)) |
| Arrangement Number[[3]](#footnote-3). | Band (MHz) |
| G3-1-1 | 703-748 / 758-803  |
| G3-1-2 | 806-824 / 851-869 |
| G3-1-3 | 806-824 / 851-869 |
| G3-1-4 | 806-824 / 851-869 |
| G3-1-5 | 806-824 / 851-869 |
| G3-1-6 | 806-834 / 851-879 |
| Section 2:Frequency Arrangements in parts of the frequency ranges 406.1-430 MHz and 440-470 MHz (as per *resolves* 3 of Resolution 646 (Rev.WRC-15)) |
| Arrangement Number. | Band (MHz) |
| R3-2-1 | 414.0125-414.1000 |
| R3-2-2 | 406.1125-411.5875 / 414.1125-419.5875 |
| R3-2-3 | 410-430 |
| Section 3:Frequency Arrangements in parts of the frequency range 4940-4990 MHz (as per *resolves* 3 of Resolution 646 (Rev.WRC-15)) |
| Arrangement Number | Band (MHz) |
| R3-3-1 | 4940-4990 |
|  |  |

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| **Annex 2****Country Frequency Arrangements**(as per *resolves* 4 of Resolution 646 (Rev.WRC-15)) |
| Annex 2 - Section1:Country Frequency Arrangements in the ranges 138-174 MHz, 351-370 MHz and 380-400 MHz for narrowband PPDR applications and the frequency ranges 174-205 MHz and 1447-1467 MHz for broadband PPDR applications |
| Country | Arrangement Number | Band (MHz) |
| Japan | C3-1-1 | 170-205 MHz (TDD) |
| China | C3-1-2 | 1447-1467 MHz (TDD) |
| Australia | C3-1-3 | 403.0000–403.9875 MHz |
| Australia | C3-1-4 | 405.0125–406.0000 MHz |
| Malaysia\* | C3-1-5 | 380.0125 – 389.8875 MHz |

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| **Annex 1****Harmonized Frequency Arrangements** |
| **Section 1:****Arrangements in parts of the frequency range 694-894MHz** **(as per *resolves* 2 of Resolution 646 (Rev.WRC-15))** |

|  |  |  |  |
| --- | --- | --- | --- |
| **Regional Organ-isation** | **Frequency Arrangement Number** | **Paired arrangements** |  |
| **Mobile station transmitter (MHz)** | **Base station transmitter (MHz)** | **Duplex separation (MHz)** | **Usage type** |
| APT | G3-1-1 | 703-748 | 758-803 | 55 | Broadband |
| APT | G3-1-2 | 806-824 | 851-869 | 45 | Narrowband -25kHz |
| APT | G3-1-3 | 806-824 | 851-869 | 45 | Narrowband- 25kH; 12.5 kHz & 6.25 kHz |
| APT | G3-1-4 | 806-824 | 851-869 | 45 | Broadband & Narrowband |
| APT | G3-1-5 | 806-824 | 851-869 | 45 | Broadband & Narrowband |
| APT | G3-1-6 | 806-834 | 851-879 | 45 | Broadband & Narrowband |

**A1.1 Example 1**

**G3-1-1:** **700 MHz Broadband PPDR**

Following channel arrangements in the band 703-748/758-803 MHz are used for Broadband public safety LTE systems. In the APT 700 MHz band, which is 45+45 MHz, any one or two 5+5 MHz channels or any one 10+10 MHz channel can be used for Broadband PS LTE system. As an example Korea plans to deploy Broadband PS LTE system in 718-728/773-783 MHz band with one 10+10 MHz Channel.

*803 MHz*

**Example of frequency arrangement for broadband PPDR systems in 703-748/758-803 MHz**

|  |  |  |
| --- | --- | --- |
| **Mobile station transmit (MHz)** | **Base station transmit (MHz)** | **Frequency block** |
| 703-748 | 758-803 | Broadband PPDR |
| 748-758 | Duplex Gap  |

**Channelization for broadband**

The channeling plan for broadband is based on a channel bandwidth of 5 MHz or 10 MHz as shown below:

The centre frequency (fN) of the Nth channel is given by:

**Broadband with 5 MHz channels**

|  |  |  |  |
| --- | --- | --- | --- |
| **Channel number** | **Mobile station transmitChannel centre frequency (MHz)** | **Base station transmitChannel centre frequency (MHz)** | **Channel bandwidth (MHz)** |
| *N* = 1 to 9 | *fN* = 705.5 + (5) × (*N* − 1) | *fN* = 760.5 + (5) × (*N-1*) | 5 |



**A1.2 Example 2**

**G3-1-2: 800 MHz Narrow band systems**

Following channel arrangements in the band **806-824/851-869 MHz** are used for various narrowband and wideband fixed and mobile systems

**806-824/851-869 MHz**

The sub-bands 806 – 812 MHz paired with 851 – 857 MHz are used to accommodate wideband bi-directional, fixed, point-to-point links and are unavailable for land mobile.

The sub-band 819 – 824 MHz is used to accommodate the ubiquitous deployment of short-range devices and is unavailable for land mobile use.

The sub-band 849 – 851 MHz is allocated for uni-directional, fixed, point-to-point links in support of radio broadcasting (studio to transmitter linking) and is also unavailable for land mobile use.

The sub-band 845 – 849 MHz provides an alternative pairing for 890 – 894 MHz sub-band potentially available for cellular telephony, and is not available for land mobile use.

The sub-bands 825.015 – 849 MHz band paired with 870.015 – 890 MHz have been allocated as private rights and are used for the provision of cellular telephony services.

868.100 – 869.025 MHz

This sub-band has been used to accommodate commercial narrowband analogue, simplex, land mobile systems for many years. Spectrum efficient digital technologies are expected to be introduced in this sub-band in the near future.

Simplex services are accommodated within a 25 kHz channel raster on the following centre frequencies (Fn):

Fn = 868.1125 + ((N-1) \* 0.025) N = 1, 2, 3,… 37

A 12.5 kHz channel raster is expected to be introduced in the near future.

813 – 819 MHz/858 – 864 MHz

This sub-band has been used to accommodate commercial narrowband analogue trunked land mobile systems for many years and aligns with a number of other countries. Spectrum efficient digital technologies are expected to be introduced in these sub-bands in the near future.

Duplex services are accommodated within a 25 kHz channel raster as follows:

Centre frequencies of the base station transmitting channel are (MHz):

Fn = 858.01250 + ((N-1) \* 0.025) N = 1, 2, 3,… 239

The centre frequencies of the base station receiving channel are (MHz):

Fn = 813.01250 + ((N-1) \* 0.025) N = 1, 2, 3,… 239

812 – 813 MHz /857 – 858 MHz

This sub-band is identified specifically for Public Protection and Disaster Relief use. These sub-bands are candidates for 12.5 kHz and 25 kHz channel plans. Even though there has not been demand to utilize these sub-bands to date potential demand has been identified by PPDR agencies.

Use of this sub-band by PPDR agencies will be characterized by flexibility including a mix between narrowband voice and data applications as well as wideband data applications such as those involving video, mapping data or high resolution scans and surveillance.

PPDR applications in this sub-band will also range from long term or permanent applications to short term uses set up in response to a specific emergency event.

**A1.3 Example 3**

**G3-1-3: 800 MHz Narrow band systems**

**C**hannel arrangements in the band **806-824/851-869 MHz for trunked Mobile Services**.

The entire band may normally be used with channel bandwidths of 25 kHz for digital trunked radio system. This section describes an example case of channeling. Three channeling schemes can be considered in this band. In sub-band of 806-811/851-856MHz the channel bandwidth is 25 kHz, in sub-band of 811-813.5/856-858.5MHz the channel bandwidth is 12.5 kHz and in sub-band 813.5-816/858-861MHz the channel bandwidth is 6.25 kHz.

Formulas to calculate frequency center of each channel are as follows:

*+ In sub-band of 806-811/851-856 MHz:*

The band is divided into 25 kHz channels.

Center frequency of Nth base station transmitting channel (MHz):

 FN = 851.0125 +(N-1) x 0.025 N= 1,2, 3,…, 200

Center frequency of Nth base station receiving channel (MHz):

 FN’ = 806.0125 +(N-1) x 0.025 N= 1,2, 3,…, 200

*+ In sub-band of 811-813.5/856-858.5 MHz:*

This sub-band is divided into 12.5 kHz channels.

Center frequency of Nth base station transmitting channel (MHz):

 FN = 856.00625 +(N-1) x 0.0125 N= 1,2, 3,…, 200

Center frequency of Nth base station receiving channel (MHz):

 FN’ = 811.00625 +(N-1) x 0.0125 N= 1,2, 3,…, 200

*+ In sub-band of 813.5-816/858.5-861 MHz:*

This sub-band is divided into 6.25 kHz channels.

Center frequency of Nth base station transmitting channel (MHz):

 FN = 858.503125 +(N-1) x 0.00625 N= 1,2, 3,…, 400

Center frequency of Nth base station receiving channel (MHz):

 FN’ = 813.503125 +(N-1) x 0.00625 N=1,2,3,400

**A1.4 Example 4**

**G3-1-4 – 800 MHz narrow band and Broadband**

**Example Channel arrangements for a combination of narrowband PPDR and broadband PPDR in the band 806-824/851-869 MHz**

This example shows how narrowband and broadband systems can be deployed in the band 806-824/851-869 MHz while ensuring the necessary protection of the APT 700 MHz band from adjacent band interference. The sub-band 806-813/ 851-858 MHz is used for narrowband systems with a channel bandwidth of 25 kHz; the sub-band 814-824/ 859-869 MHz is used for broadband (LTE) systems using carrier bandwidths of 5 to 10 MHz. The sub-band 813-814/ 858-859 MHz acts as guard band between narrowband and broadband systems

**Example of frequency arrangement for a combination of narrowband and broadband systems**



|  |  |  |
| --- | --- | --- |
| **Mobile station/Control station transmit (MHz)** | **Base station transmit (MHz)** | **Frequency block** |
| 806-813 | 851-858 | Narrowband PPDR |
| 813-814 | 858-859 | Guard band  |
| 814-824 | 859-869 | Broadband PPDR |

**Channelization for narrowband**

The channeling plan for the sub-band 806-813/ 851-858 MHz is based on the channel spacing of 25 kHz.

The centre frequency (fN) of the Nth channel is given by:

|  |  |  |  |
| --- | --- | --- | --- |
| **Channel number** | **Mobile station transmitChannel centre frequency (MHz)** | **Base station transmitChannel centre frequency (MHz)** | **Channel bandwidth (kHz)** |
| *N* = 1 to 280 | *fN* = 806.0125 + (0.025) × (*N* − 1) | *fN* = 851.0125 + (0.025) × (*N-1*) | 25 |

**Channelization for broadband**

The channeling plan for broadband is based on a channel bandwidth of 5 MHz or 10 MHz as shown below:The centre frequency (fN) of the Nth channel is given by:

**Broadband with two 5 MHz channels**

|  |  |  |  |
| --- | --- | --- | --- |
| **Channel number** | **Mobile station transmitChannel centre frequency (MHz)** | **Base station transmitChannel centre frequency (MHz)** | **Channel bandwidth (MHz)** |
| *N* = 1 to 2 | *fN* = 816.5 + (5) × (*N* − 1) | *fN* = 861.5 + (5) × (*N-1*) | 5 |



**Broadband with a single 10 MHz channel**

|  |  |  |  |
| --- | --- | --- | --- |
| **Channel number** | **Mobile station transmitChannel centre frequency (MHz)** | **Base station transmitChannel centre frequency (MHz)** | **Channel bandwidth (MHz)** |
| *N* = 1  | *f1* = 819 | *f1* = 864 | 10 |



**A1.5 Example 5**

**G3-1-5 800 MHz – Broadband and narrow band systems**

This example shows channel arrangements in the band 806-824/851-869 MHz for a wider broadband tuning range

To ensure maximum flexibility for administrations in accommodating particular local circumstances, needs and licensing arrangements (including whether or not the band 698-803 MHz is used in whole or in part) the following *minimum* tuning range is suggested for all PPDR systems and user terminal equipment intended for deployment in the band 807-824/852-869 MHz:

*807 MHz*

*824 MHz*

*852 MHz*

*869 MHz*

*Uplink tuning range*

*Downlink tuning range*

An example of this flexibility is illustrated in the following broadband channel plan, based on

paired frequency blocks with mobile station transmitters in the frequency range 806-824 MHz (uplink) and base station transmitters in the frequency range 851-869 MHz (downlink).

To allow for possible co-existence with legacy narrowband systems and adjacent broadband

channel arrangements, administrations could consider either:

***Plan ‘A’****:*

806 MHz

809

824

851 MHz

854

869

5 MHz

5 MHz

5 MHz

5 MHz

5 MHz

5 MHz

*Legacy narrowband systems*

*Downlink*

*Uplink*

807 MHz

822

824 MHz

5 MHz

5 MHz

5 MHz

852 MHz

*Legacy narrowband systems*

The raster for the broadband channels is 100 kHz, which allows for channel center frequencies to be an integer multiple of 100 kHz. The broadband channel bandwidth is an integer multiple of 5 MHz. This provides flexibility for administrations to implement appropriate channel in accordance with the above Plans ‘A’ or ‘B’, or some subset thereof, to suit specific national circumstances. Some administrations may wish to use different amounts of broadband and narrowband spectrum than the examples in Plan ‘A’ or ‘B’ to allow for transition.

**A1.6 Example 6**

**G3-1-6: 800 MHz Narrow band and Broadband systems**

Example channel arrangements for a combination of narrowband PPDR and broadband PPDR in the band 806-834/851-879 MHz.

This example shows how narrowband and broadband systems can be deployed in the band 806-834/851-879 MHz. The sub-band 806-823/ 851-868 MHz is used for narrowband systems with a channel bandwidth of 25 kHz; the sub-band 824-834/ 859-879 MHz is used for broadband PPDR (LTE) systems using carrier bandwidths of 5 or 10 MHz. The sub-band 821/823-824/ 866/868-869 MHz acts as guard band between narrowband and broadband systems or is used for legacy SRD devices such as RFID

**Example of frequency arrangement for a combination of narrowband and broadband systems in 806-834/ 851-879**



|  |  |  |
| --- | --- | --- |
| **Mobile station/Control station transmit (MHz)** | **Base station transmit (MHz)** | **Frequency block** |
| 806-821/823 | 851-866/868 | Narrowband PPDR |
| 821/823-824 | 866/868-869 | Guard band /SRD |
| 824-834 | 869-879 | Broadband PPDR |

**Channelization for narrowband**

The channeling plan for the sub-band 806-823/ 851-868 MHz is based on the channel spacing of 25 kHz.

The centre frequency (fN) of the Nth channel is given by:

|  |  |  |  |
| --- | --- | --- | --- |
| **Channel number** | **Mobile station transmitChannel centre frequency (MHz)** | **Base station transmitChannel centre frequency (MHz)** | **Channel bandwidth (kHz)** |
| *N* = 1 to 680 | *fN* = 806.0125 + (0.025) × (*N* − 1) | *fN* = 851.0125 + (0.025) × (*N-1*) | 25 |

**Channelization for broadband**

The channeling plan for broadband is based on a channel bandwidth of 5 MHz or 10 MHz as shown below:

The centre frequency (fN) of the Nth channel is given by:

**Broadband with two 5 MHz channels**

|  |  |  |  |
| --- | --- | --- | --- |
| **Channel number** | **Mobile station transmitChannel centre frequency (MHz)** | **Base station transmitChannel centre frequency (MHz)** | **Channel bandwidth (MHz)** |
| *N* = 1 to 2 | *fN* = 826.5 + (5) × (*N* − 1) | *fN* = 871.5 + (5) × (*N-1*) | 5 |



**Broadband with a single 10 MHz channel**

|  |  |  |  |
| --- | --- | --- | --- |
| **Channel number** | **Mobile station transmitChannel centre frequency (MHz)** | **Base station transmitChannel centre frequency (MHz)** | **Channel bandwidth (MHz)** |
| *N* = 1  | *f1* = 829 | *f1* = 874 | 10 |



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| **Annex 1****Harmonized Frequency Arrangements** |
| **Section 2:****Arrangements in parts of the frequency ranges 406.1-430 and 440--470 MHz** **(as per *resolves* 3 of Resolution 646 (Rev.WRC-15))** |

|  |  |  |  |
| --- | --- | --- | --- |
| **Regional Organ-isation** | **Frequency Arrangement Number** | **Paired arrangements** |  |
| **Mobile station transmitter (MHz)** | **Base station transmitter (MHz)** | **Duplex separation (MHz)** |  **Usage type**  |
| APT | R3-2-1 | 414.0125-414.1000 | 414.0125-414.1000 | N/A | Narrowband |
| APT | R3-2-2 | 406.1125-411.5875 | 414.1125-419.5875 | 8 | Narrowband |
| APT | R3-2-3 | 410-420 | 420-430 | 10 | Narrowband |
| APT | R3-2-4 | 408.6375–410.5375 | 418.0875–420.0000 | 9.45 | Narrowband 12.5 kHz |
| APT | R3-2-5 | 420.0000–430.0000 | - | - | - |
| APT | R3-2-6 | 457.50625–459.9875 | 467.50625–469.9875 | 10 MHz | Narrowband 12.5 kHz |

**R3-2-1 and R3-2-2:**

**Example channel arrangements in the band 406.1 – 430 MHz for information only**

Example A: Following channel arrangements are currently used for narrowband wireless systems in New Zealand.

**406.1 – 420 MHz**

Parts of the band 406.1 – 420 MHz sub-band are used to accommodate commercial analogue trunked land mobile systems for many years, and is a candidate for the introduction of spectrum efficient digital land mobile systems in the future. Current channel arrangements for this spectrum are shown below.

(**R3-2-1**)

Simplex services are accommodated within a 12.5 kHz channel raster on the following centre frequencies (MHz):

Fn = 414.01250 + ((N-1) \* 0.0125) N = 1, 2, 3,… 8

(**R3-2-2**)

Duplex services are accommodated within a 12.5 kHz channel raster as follows:

Centre frequencies of the base station transmitting channel are (MHz):

Fn = 414.11250 + ((N-1) \* 0.0125) N = 1, 2, 3,… 439

The centre frequencies of the base station receiving channel is (MHz):

Fn = 406.11250 + ((N-1) \* 0.0125) N = 1, 2, 3,… 439

**420 – 430 MHz**

The 420 – 430 MHz sub-band is used to accommodate bi-directional fixed point to point links and is not considered as a candidate band for land mobile applications.

**R3-2-3**: The following channel arrangements are used in some APT countries for narrowband PPDR and digital trunked radio systems

**410-430 MHz**

The frequency band 410 to 430 MHz provides a total bandwidth of 20 MHz for digital trunked radio Systems. The channelling plan is based on 12.5 kHz channel spacing, providing a total of 800 pairs of physical radio channels. Although the standard channel spacing is 12.5 kHz, there is flexibility to assign two or more contiguous channels (i.e. 25 KHz, 50 KHz or 100 KHz) as required. Administrations normally assign one or more channels based on channel width of 12.5 kHz or 25 KHz. The channelling plan based on a raster of 12.5 KHz is shown below:

CHANNELLING PLAN (12.5 kHz)

|  |  |
| --- | --- |
| **CHANNEL NUMBER** | **FREQUENCY (MHz)** |
| **Base Tx** | **Base Rx** |
| **N ( N= 1 to 800)** | **420.00625 +( N-1)\*0.0125** | **410.006125 +( N-1)\*0.0125** |

The channel arrangements are divided into 4 pairs of frequency blocks (blocks A/A’, blocks B/B’, blocks C/C’, and blocks D/D’) with transmit/receive separation of 10 MHz.

The channel allotment plan is designed to minimize inter-modulation and frequency interference problems by assigning co-sited channels that are 250 kHz apart. The frequency blocks A, B, C and D, which contain 200 channels each, are divided into ten (10) channel groups (i.e. A01-A10, B01-B10, C01-C10 and D01-D10) respectively.

The numbers of channels/channel groups assigned are based on the service requirement of the user agency based among others on the area covered, grade of service (GOS), capacity and services provided.

CHANNEL ALLOTMENT PLAN

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Block** | **A** | **B** | **C** | **D** |
| **Group Nos. 01 to 10** | **X= 1 to 10****A = 1 to 10** | **X= 1 to 10****B = 1 to 10** | **X= 1 to 10****C = 1 to 10** | **X= 1 to 10****D =1 to 10** |
| **Channel Number N=** | **2\*A-1+20\*(X-1) and****2\*A+20\*(X-1)** | **2\*B+199+20\*(X-1) and****2\*B+200+20\*(X-1)** | **2\*C+399+20\*(X-1) and** **2\*C+400+20\*(X-1)** | **2\*D+599+20\*(X-1) and****2\*D+600+20\*(X-1)** |

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| **Annex 1****Harmonized Frequency Arrangements** |
| **Section 3:****Arrangements in parts of the frequency range 4940-4990 MHz** **(as per *resolves* 3 of Resolution 646 (Rev.WRC-15))** |

|  |  |  |  |
| --- | --- | --- | --- |
| **Regional Organ-isation** | **Frequency Arrangement Number** | **Paired arrangements** |  |
| **Mobile station transmitter (MHz)** | **Base station transmitter (MHz)** | **Duplex separation (MHz)** | **Usage type** |
| APT | R3-3-1 | 4940-4990 | 4940-4990 | N/A | Broadband |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

**Annex 1 – Section 3**

Frequency arrangements and other technical characteristics of regionally harmonized frequency range for PPDR in 4 940‑4 990 MHz

The frequency range 4940-4990 MHz or parts thereof may be used to support broadband networks designed for PPDR high rate data and video information transfer. Such networks will need to be highly reliable, secure, and designed with coverage capabilities based on PPDR agency requirements. These networks are expected to include both pre-deployed hotspots throughout a PPDR agency’s operational area and temporary ad hoc systems deployed at an incident scene as needed for incident scene management. Example detailed channeling plans, emission masks and power limits for use of this band for PPDR applications are given below:

**a) Channel Plan:** The following channeling plan (see Table 1) , which supports channel widths from 5 MHz to 20 MHz, to provide the flexibility needed for Administrations to support a variety of PPDR operational requirements. Because these channels overlap one another, Administrations may take precautions in their assignment procedures to ensure that overlapping channels do not occur in close enough proximity to cause conflicts between multiple PPDR users. Note that not all of the channels are available in some countries.

**b) Emission Masks:** The recommended emission masks for 4.9 GHz for low power devices is similar to the mask defined in the IEEE 802.11a standard and a tighter mask for higher power transmitters which provides better adjacent channel protection. The low-to-high power breakpoint, that is, the point at which the high power mask is required, varies by channel bandwidth: 20 dBm (100 milliwatts) for 20 MHz channels, 17 dBm for 10 MHz channels, and 14 dBm for 5 MHz channels. The less stringent mask for transmitting devices at lower power levels below these points allows existing 5 GHz commercial-off-the-shelf (COTS) wireless LAN equipment to be easily modified to operate in the 4.9 GHz band, thereby reducing costs for PPDR users. At the same time, the tighter mask used for powers above these levels provides additional adjacent channel protection needed to help reduce interference and increase the reliability for PPDR users. Manufacturers should also have the option to use the tighter mask for lower power transmitters as well, but would not be required to do so.

**c) Power Limits:** Power limits should be stipulated as a function of channel bandwidth. “High power” transmitters would require the use of a tighter mask to help prevent adjacent channel interference. “Low power” transmitters would have the option to operate with a less stringent mask. Example power limits are given in Table 2. Transmitters under the “High power” category which meet the tighter emission mask should be allowed to use transmit antennas with a directional gain up to 26 dBi at maximum transmit power output. Directional antenna gain could exceed 26 dBi, if both power transmit power and power spectral density are reduced dB-per-dB by the amount that directional antenna gain exceeds 26 dBi.

In some cases, Administrations may wish to impose lower power limits due to tighter frequency-sharing environment. An example set of such power limits is given in Table 3. The parameters are taken from a Broadband Wireless Access (BWA) system that has capability to accommodate broadband PPDR applications.

**Table 1**

Example channeling plan for 4940-4990 MHz

4987.5

19

4985.0

18

4982.5

17

4980.0

4980.0

16

4977.5

15

4975.0

4975.0

14

4972.5

13

4970.0

4970.0

12

4967.5

11

4965.0

4965.0

10

4962.5

9

4960.0

4960.0

8

4957.5

7

4955.0

4955.0

6

4952.5

5

4950.0

4950.0

4

4947.5

3

4945.0

2

4942.5

1

**Channel Center 20MHz**

**Channel Center 10MHz**

**Channel Center 5MHz**

**Channel Numbers \* (nch)**

**Table 2**

Example power limits for transmitters in 4940-4990 MHz by PPDR applications

|  |  |  |
| --- | --- | --- |
| Channel Bandwidth(MHz) | Low power peak transmitter power (dBm) | High power peak transmitter power (dBm) |
| 5101520 | 141718.820 | 273031.833 |

**Table 3**

Example parameters of BWA system to support PPDR applications

|  |  |  |  |
| --- | --- | --- | --- |
| Channel Spacing | Occupied bandwidth | Peak transmitter power | Peak equivalent isotropic radiated power |
| 5 MHz | 4.5 MHz |  |  |
| 10 MHz | 9.0 MHz | 24 dBm and 17 dBm/MHz | 37 dBm |
| 20 MHz | 19.7 MHz |  |  |

\* Listen-before-transmit protocol is used to avoid interference.

|  |
| --- |
| **Annex 2** **Country Frequency Arrangements****(as per *resolves* 4 of Resolution 646 (Rev.WRC-15))** |
| **Annex 2 - Section1:****Country Frequency Arrangements in the ranges 138-174 MHz, 351-370 MHz and 380-400 MHz for narrowband PPDR applications and the frequency ranges 174-205 MHz and 1447-1467 MHz for broadband PPDR applications** |

|  |  |  |  |
| --- | --- | --- | --- |
| **Country** | **Frequency Arrangement Number** | **Paired arrangements** |  |
| **Mobile station transmitter (MHz)** | **Base station transmitter (MHz)** | **Duplex separation (MHz)** | **Usage type** |
| Japan | C3-1-1 | 170-205 | 170-205 | NA (TDD) | Broadband |
| China | C3-1-2 | 1447-1467 | 1447-1467 | NA (TDD) | Broadband |
| Australia | C3-1-3 | 403.0000–403.9875 | 412.4625–413.4375 | 9.4625 MHz | Narrowband 12.5 kHz |
| Australia | C3-1-4 | 405.0125–406.0000 | 414.4625–415.4375 | 9.45 | Narrowband 12.5 kHz |
| Malaysia\* | C3-1-5 | 380.0125 – 389.8875 | 390.0125 – 399.8875 | 10 | Narrowband 25 kHz |

Note: \* - In Malaysia, part of this frequency band allocated for PPDR

Frequency Arrangement C3-1-5

|  |  |  |
| --- | --- | --- |
| Frequency arrangement | Paired arrangements | Notes |
| Mobile station TX (MHz) | Centre gap (MHz) | Base station TX (MHz) | Duplex separation (MHz) |
| (a) | 380.0125 – 389.8875 | 0 | 390.0125 – 399.8875 | 10 | Duplex |

Frequency arrangement (a):

|  |  |  |  |
| --- | --- | --- | --- |
| **Channel number** | **Mobile station transmitChannel center frequency (MHz)** | **Base station transmitChannel center frequency (MHz)** | **Channel bandwidth (kHz)** |
| *N* = 1 to 395 | *fN* = 380.025 +( N-1)\*0.025 | *fN* = 390.025 +( N-1)\*0.025 | 25 |

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**Annex 3**

RESOLUTION 646 (Rev.WRC‑15)

**Public protection and disaster relief**

The World Radiocommunication Conference (Geneva, 2015),

*considering*

*a)* that the term “public protection radiocommunication” refers to radiocommunications used by responsible agencies and organizations dealing with maintenance of law and order, protection of life and property and emergency situations;

*b)* that the term “disaster relief radiocommunication” refers to radiocommunications used by agencies and organizations dealing with a serious disruption of the functioning of society, posing a significant widespread threat to human life, health, property or the environment, whether caused by accident, natural phenomena or human activity, and whether developing suddenly or as a result of complex, long-term processes;

*c)* the growing telecommunication and radiocommunication needs of public protection agencies and organizations, including those dealing with emergency situations and disaster relief, that are vital to the maintenance of law and order, protection of life and property, disaster relief and emergency response;

*d)* that many administrations wish to promote interoperability and interworking between systems used for public protection and disaster relief (PPDR), both nationally and for cross-border operations in emergency situations and for disaster relief;

*e)* that existing systems for PPDR applications mainly support narrowband/wideband voice and data applications;

*f)* that, although narrowband and wideband systems will continue to be used to meet PPDR requirements, there is a growing need for broadband applications to support improved data and multimedia capabilities, which require higher data rates and higher capacity, and appropriate spectrum may need to be made available on a national basis to meet these growing needs;

*g)* that new technologies for broadband PPDR applications are being developed in various standards organizations, e.g. International Mobile Telecommunications (IMT) technologies that support higher data rates and higher capacity for PPDR applications, and these technologies are also being used to meet the needs of PPDR agencies and organizations;

*h)* that continuing development of new technologies and systems, such as IMT and Intelligent Transportation Systems (ITS), may be able to further support or supplement advanced PPDR applications;

*i)* that some commercial terrestrial and satellite systems are complementing the dedicated systems in support of PPDR, and that the use of commercial solutions will be in response to technology development and market demands;

*j)* that administrations may have different operational needs and spectrum requirements for PPDR applications depending on the circumstances;

*k)* that an approach based on global and/or regional frequency ranges[[4]](#footnote-4)1 may enable administrations to benefit from harmonization while continuing to meet national planning requirements,

*recognizing*

*a)* the benefits of spectrum harmonization such as:

– increased potential for interoperability;

– clear guidance for standardization;

– increased volume of equipment resulting in economies of scale, more cost-efficient equipment and expanded equipment availability;

– improved spectrum management and planning;

– more effective international aid during disasters and major events; and

– enhanced cross-border coordination and circulation of equipment;

*b)* that the organizational distinction between public protection activities and disaster relief activities are matters for administrations to determine at the national level;

*c)* that national spectrum planning for PPDR needs to have regard to cooperation and bilateral consultation with other concerned administrations, which should be facilitated by greater levels of spectrum harmonization;

*d)* that the Tampere Convention on the Provision of Telecommunications Resources for Disaster Mitigation and Relief Operations (Tampere, 1998), an international treaty deposited with the United Nations Secretary-General and related United Nations General Assembly resolutions and reports are also relevant in this regard;

*e)* that Resolution 36 (Rev. Guadalajara, 2010) of the Plenipotentiary Conference urges Member States Parties to the Tampere Convention to take all practical steps for the application of the Tampere Convention and to work closely with the operational coordinator as provided for therein;

*f)* that Recommendation ITU‑R M.1637 offers guidance to facilitate the global cross-border circulation of radiocommunication equipment in emergency and disaster relief situations;

*g)* that Recommendation ITU R M.2009 identifies radio interface standards applicable to PPDR operations;

*h)* that Report ITU‑R M.2291 provides details of the capabilities of IMT technologies to meet the requirements of applications supporting broadband PPDR operations;

*i)* that Report ITU‑R M.2377 provides details of systems and applications supporting PPDR operations in narrowband, wideband and broadband use;

*j)* that PPDR agencies and organizations have an initial set of requirements, including but not limited to interoperability, secure and reliable communications, sufficient capacity to respond to emergencies, priority access in the use of non-dedicated systems, fast response times, ability to handle multiple group calls and the ability to cover large areas, as described in Reports ITU‑R M.2377 and ITU-R M.2291;

*k)* that Report ITU‑R BT.2299 provides a compilation of supporting evidence to the effect that terrestrial broadcasting plays an important role in disseminating information to the public in times of emergencies;

*l)* that Recommendation ITU‑R M.2015 contains regionally harmonized PPDR frequency arrangements*,* as well as frequency arrangements of individual administrations[[5]](#footnote-5)2;

*m)* that in times of disasters, if most terrestrial-based networks are destroyed or impaired, amateur, satellite and other non‑ground-based networks may be available to provide communication services to assist in PPDR efforts;

*n)* that the amount of spectrum needed for public protection on a daily basis differs significantly between countries, and that certain amounts of spectrum are already in use in various countries for PPDR applications;

*o)* that in response to a disaster or emergency, access to additional spectrum on a temporary basis may be required for PPDR operations;

*p)* that not all frequencies within an identified common frequency range will be available for PPDR use within each country;

*q)* that the identification of common frequency ranges within which equipment couldoperate may ease interoperability and/or interworking, with mutual cooperation and consultation, especially in national, regional and cross-border emergency situations and disaster relief operations;

*r)* that when a disaster occurs, the PPDR agencies and organizations are usually the first responders on the scene using their day-to-day communication systems and, additionally, other agencies and organizations may also become involved in disaster relief operations;

*s)* that some countries in Region 1 have identified certain parts of the frequency range 694‑791 MHz for broadband PPDR deployment;

*t)* that some countries in Region 1 have identified certain parts of the frequency range 790‑862 MHz for broadband PPDR deployment;

*u)* the provisions contained in Nos. **5.266** and **5.267**, and Resolution **205 (Rev.WRC-15)**;

*v)* that Metaids and Metsat services operate on a globally harmonized basis in the frequency band 400.15-406 MHz;

*w)* that the radio astronomy service operates on a primary basis in the frequency band 406.1‑410 MHz and there may be PPDR operations adjacent to that frequency band,

*noting*

*a)* that many administrations will continue to use different frequency bands below 1 GHz for narrowband systems and applications supporting PPDR and may decide to use the same range for future PPDR systems;

*b)* that some administrations also use certain frequency bands above 1 GHz for broadband PPDR applications;

*c)* that applications requiring large coverage areas and providing good signal availability would generally be accommodated in lower frequency bands;

*d)* that many administrations have made significant investments in PPDR systems;

*e)* that flexibility allows disaster relief agencies and organizations to use current and future radiocommunications, so as to facilitate their humanitarian operations;

*f)* that disasters and emergency events require response not only from PPDR agencies and organizations but also from humanitarian agencies and organizations;

*g)* that broadband PPDR can be realized and deployed in the frequency bands identified for IMT;

*h)* the benefits of cooperation between countries for the provision of effective and appropriate humanitarian assistance in case of disasters, particularly in view of the special operational requirements of such activities involving multinational response;

*i)* the needs of countries, particularly the developing countries[[6]](#footnote-6)3, for cost-efficient communication equipment;

*j)* that the use of technologies based on Internet protocols is well established,

*emphasizing*

*a)* that the frequency ranges that are covered by the *resolves* part of this resolution are allocated to a variety of services in accordance with the relevant provisions of the Radio Regulations and are currently used intensively by the fixed, mobile, mobile-satellite and broadcasting services;

*b)* that PPDR applications in the ranges listed in *resolves* 2 and 3 are intended to operate in the mobile service allocated on a primary basis according to the provisions of the Radio Regulations;

*c)* that flexibility must be afforded to administrations

to determine:

– how much spectrum to make available at a national level for PPDR from the ranges in the *resolve*s part of this resolution in order to meet their particular national requirements;

– the need and timing of availability as well as the conditions of usage of the bands used for PPDR, including those covered in this resolution and Recommendation ITU‑R M.2015, in order to meet specific regional or national situations[[7]](#footnote-7)4;

*d)* that the provisions of Nos. **1.59** and **4.10** of the Radio Regulations do not apply to PPDR;

*e)* that administrations can adopt their frequency arrangements for the terrestrial component of IMT, from those detailed in Recommendation ITU-R M.1036,

*resolves*

1 to encourage administrations to use harmonized frequency ranges for PPDR to the maximum extent possible, taking into account the national and regional requirements and also having regard to any needed consultation and cooperation with other concerned countries;

2 to encourage administrations to consider parts of the frequency range 694-894 MHz, as described in the most recent version of Recommendation ITU-R M.2015, when undertaking their national planning for their PPDR applications, in particular broadband, in order to achieve harmonization, taking into account *emphasizing* *c)* and *e)* above;

3 to further encourage administrations to also consider parts of the following regionally harmonized frequency ranges, for their PPDR applications:

– in Region 1: 380-470 MHz;

– in Region 3: 406.1-430 MHz, 440-470 MHz and 4 940‑4 990 MHz;

4 that PPDR frequency arrangements within the frequency ranges specified in *resolves* 2 and 3*,* as well as countries’ frequency arrangements for PPDR, should be included in Recommendation ITU‑R M.2015;

5 that the use of the frequency ranges for PPDR in *resolves* 2 and 3 above, as well as the use of the countries’ frequency arrangements for PPDR, as described in the most recent version of Recommendation ITU‑R M.2015, must not cause unacceptable interference, nor constrain the use of these frequency ranges by applications of the services to which these ranges are allocated in the Radio Regulations;

6 to encourage administrations, in emergency and disaster relief situations, to satisfy temporary needs for frequencies in addition to what may be normally provided for in agreements with the concerned administrations;

7 to encourage administrations to facilitate cross-border circulation of radiocommunication equipment intended for use in emergency and disaster relief situations through mutual cooperation and consultation without hindering national legislation;

8 that administrations encourage PPDR agencies and organizations to utilize relevant ITU‑R Recommendations in planning spectrum use and implementing technology and systems supporting PPDR;

9 to encourage administrations to continue to work closely with their PPDR community to further refine the operational requirements for PPDR activities,

*invites the ITU Radiocommunication Sector*

1 to continue its technical studies and to make recommendations concerning technical and operational implementation, as necessary, to meet the needs of PPDR radiocommunication applications, taking into account the capabilities, evolution and any resulting transition requirements of the existing systems, particularly those of many developing countries, for national and international operations;

2 to review and revise Recommendation ITU‑R M.2015 and other relevant ITU‑R Recommendations and Reports, as appropriate.

**Annex 4**

**3GPP frequency arrangements that may be suitable for deployment of broadband wireless PPDR systems**

Resolution **646 (Rev.WRC-15)** encourages administrations to consider parts of the frequency range of 694-894 MHz for meeting their PPDR requirements. The following 3GPP frequency arrangements (applicable to Region 3) fall within the PPDR frequency range designated by ITU-RResolution **646 (Rev.WRC-15)**, and could therefore be considered for use by administrations in relation to deployment of broadband wireless PPDR systems:

*694 MHz*

*894 MHz****Plan ‘B’****:*

*703703 MHz*

*718718*

*733733*

*748748*

*803*869 MHz

*758758*

*773773*

*788788*

*807*867

*824*5 MHz

*852*5 MHz

*869*5 MHz

*824*

*849*

*869*

*849*

*859*

***3GPP Band 27***

***3GPP Band 28*** *(B)****3GPP Band 28*** *(B)*

***3GPP Band 28*** *(A)****3GPP Band 28*** *(A)*

***3GPP Band 5***

***3GPP Band 26***

***PPDR frequency range (ITU-R Resolution 646 (rev WRC-15)***

*860*

*830*

*875*

*845*

*890*

***3GPP Band 18***

***3GPP Band 19***

*814*

*815*

Figure: 3GPP bands falling within the PPDR frequency range 694-894 MHz

1. *recognizing* l, footnote 2 [↑](#footnote-ref-1)
2. *Recognizing l,* Resolution 646 (Rev.WRC-15) [↑](#footnote-ref-2)
3. 1st = Letter; 2nd = Region; 3rd=Section; 4th = Arrangement No. [↑](#footnote-ref-3)
4. 1 In the context of this resolution, the term “frequency range” means a range of frequencies over which radio equipment is envisaged to be capable of operating but limited to specific frequency band(s) according to national conditions and requirements. [↑](#footnote-ref-4)
5. 2 For example, some countries in Region 3 have adopted parts of the frequency ranges 138‑174 MHz, 351-370 MHz and 380-400 MHz for narrowband PPDR applications and the frequency ranges 174-205 MHz and 1 447-1 467 MHz for broadband PPDR applications. [↑](#footnote-ref-5)
6. 3 Taking into account, for example, the latest version of the ITU‑D Handbook on disaster relief. [↑](#footnote-ref-6)
7. 4 For example, some countries in Region 1 have identified certain parts of the frequency range 694‑862 MHz for broadband PPDR applications. [↑](#footnote-ref-7)