Question 1: IDA seeks views on whether the 700 MHz band should be allocated as a standalone, or coupled with other bands such as the 900 MHz, 800 MHz or the 1.9/2.1 GHz bands.

Motorola Solution's Views:

The APT 700 MHz bandplan, developed by the APT[1] Wireless Group for the Asia Pacific region, has seen wide adoption within the region as well as outside the region. It is potentially a global band for 4G. In addition to enabling global roaming, its wide adoption will create significant economies of scale.

The excellent propagation characteristic of this band allows 700 MHz radio signals to penetrate buildings and walls and to cover large geographic areas with less infrastructure than is required at higher frequencies. This makes the APT 700 MHz band a very desirable band for the deployment of nationwide network for budget sensitive, non-commercial organisations, such as government agencies.

The APT 700 MHz bandplan provides good spectrum planning flexibility in allowing channel widths ranging from 5 MHz to 20 MHz. One allocation scheme that can be used is the allocation of four 10 MHz pairs (2 x 10 MHz) for commercial use and one 5 MHz pair (2x5 MHz) for Government usage for Emergency communications. In this scheme the 5 MHz pair should be located at the bottom of the band, adjacent to the TV broadcast band. The lower user density of a non-commercial/Government network (compared to commercial network) will create an additional buffer between the TV channels below 604 MHz and commercial cellular systems operating above 708 MHz. This will provide a lower risk of interference to television receivers in the country.

A number of studies around the world have confirmed that reserving spectrum for communications by emergency services would improve public safety services and could fulfil one of the critical governance requirements. A summary of these studies is enclosed at Annex 1.

According to research by the London School of Economics and Political Science (LSE) reserving spectrum for Public safety could yield a high socioeconomic benefit that could potentially outweigh the opportunity cost of forgoing the sale of this reserved spectrum, (http://www.lse.ac.uk/businessAndConsultancy/LSEEnterprise/news/2014/Tetra.aspx and http://mccmag.com/newsArticle.cfm?news_id=10613)

The report, written ahead of the auction of the 700 MHz spectrum in the United Kingdom and other European countries, found that reserving a portion of the mobile broadband spectrum exclusively for emergency services could potentially lead to an improvement in public safety. The socioeconomic benefits of reserving spectrum are estimated to have a monetary value of 34 billion Euros ($47 billion), far outweighing the opportunity cost of a one-off sale to commercial operators, estimated to be around 6 billion Euros ($8 billion).

[1] Asia Pacific Telecommunity

The socioeconomic value of dedicated broadband spectrum with respect to safety-related crime reduction was calculated based on the increased ability to intervene; the lives saved due to reduced ambulance response times; mortality and serious accident reduction through enhanced visibility and time spent on the road by traffic police, and other areas.

The use of mobile broadband for field communication within the emergency services improves productivity, enhances the performance of other resources and can bring wider socioeconomic benefits, said the report. Police can communicate safety-critical decisions and file reports on the move, while front-line paramedics could use it for navigation and congestion alerts, to access full information about patients or to interact with a consultant in real time. Other emergency services such as the fire service could obtain in-the-field real time information for buildings, routes, traffic, and other elements that aid situational awareness.

Key results across the EU included:

- 5.57 billion Euros in annual socioeconomic benefit could result from an estimated 12 percent reduction in current homicide, serious wounding and sexual assault crime costs given the likelihood of more favourable outcomes;
- 3.98 billion Euros in annual socioeconomic benefit could result from ambulance crews saving an additional 1,858 out-of-hospital cardiac arrest victims faster, especially within the eight-minute target critical for 'Type A' life threatening responses, and from crews being better informed;
- 4.20 billion Euros in potential socioeconomic benefit per year could result if European traffic police could reduce traffic stop times and thereby avoid an estimated total annual 9,800 major serious injuries and some fatalities that could otherwise occur if an officer is engaged on an existing stop.

We propose that this band be allocated as a standalone band and a part of this band be reserved for Government use for the following reasons:

1. The APT band plan is a standalone digital dividend band with a dual duplexer providing 45+45 MHz LTE spectrum
2. Most countries are considering this as a standalone spectrum. In the recent past both Australia and New Zealand have auctioned this band as a standalone spectrum.
3. The Lower duplexer of this band is likely to be harmonised globally with EU expected to adopt this band plan in 698-790 MHz and hence this band will have a huge eco system of its own
4. While the government public safety mobile broadband services in Singapore will primarily be operating in 800 MHz band, it would be desirable to reserve a single channel of 5+5 MHz at the lower end of 700 MHz for Government services to support global cooperation in disasters and other emergencies

Question 2: IDA seeks views on:

(a) Whether the 800 MHz band should be re-farmed for mobile services;

(b) the bandplan that should be preferred by Singapore and the underlying reasons;

(c) details of transitional issues to migrate existing services and systems in the 800 MHz band to the revised bandplan;

(d) possible impact to end users of digital trunked radio and SRD/RFID, if, as a result of the eventual 800 MHz band plan: (i) the end users do not have to be migrated but will have to coexist with mobile broadband services; or (ii) the end users have to be migrated; and

(e) possible co-existence issues between mobile broadband, and digital trunked radio and SRD/RFID.

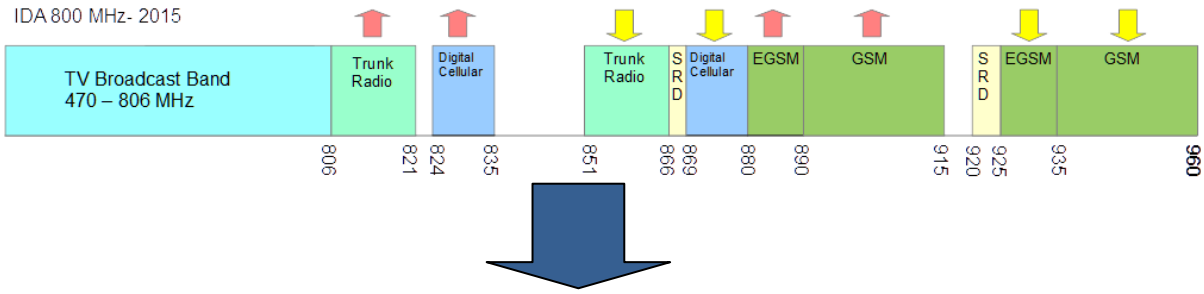
Motorola Solutions Views:

1. We support the proposal to refarm the 800 MHz band to support growth of mobile broadband services for all users including Government, commercial cellular and non commercial industrial services. We also support the IDA's position of the need to ensure that the requirements of existing users in the 800 MHz band are met and a reasonable migration timeframe be afforded to the users upon the decision to re-farm the band. The migration timeframe should take into account the availability of infrastructure and user equipment to avoid transition delay due to lack of equipment for the re-farmed bandplan.
2. In line with the iDA position, we propose a long term band plan for the 800 MHz band. The timeframes indicated in the band plan are based on the assumption that equipment supporting the band plan is available.
3. There are two possible refarm plans for the 800/900 MHz band. One is based on the LTE-4G Plan and the other is the EGSM Plan. Considering the need for harmonisation across the ASEAN in general and the in particular with the neighbouring countries, we propose that Singapore should adopt the LTE-4G plan for 800/900 MHz as detailed in the following paragraphs. This plan will harmonise seamlessly with the neighbouring countries such as Malaysia and Indonesia and will also align with most other Asian countries including India, China, Hong Kong and South Korea.
4. This proposal will provide an additional of 70+70 MHz of additional 4G/LTE spectrum to support increased Mobile competition by 2017-2020.This includes 40+40 in the APT band, 10+10 MHz in 834-844/879-889 MHz and 20 MHz in 895-915/940-960 MHz and will also meet the needs of Government and commercial users.
5. The proposal also includes relocating the RFID/SRD from 866 MHz to 920-925 MHz. This is in line with global harmonisation of the GSM Gap band for such services. In July of 2012, Japan moved their UHF frequency band for RFID from 955 MHz (952.2 - 957.4 MHz) to 920 MHz (916.8 - 923.4 MHz), which is in harmony with the FCC UHF band for RFID at 902 – 928 MHz. Administrations in Europe are exploring the possibility of assigning the band 915 - 921 MHz for RFID applications to satisfy future market requirements. CEPT ECC WG FM (May and October 2011 meetings) endorsed the conclusions of the April 2011 Workshop dedicated to SRD developments in the 900 MHz

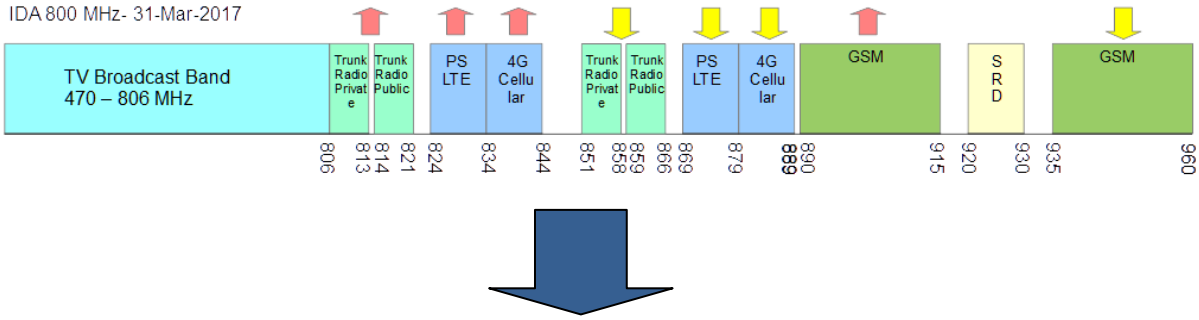
GSM centre Gap. Thus there is a global movement towards use of 900 MHz band for RFID

6. Our proposed refarm strategy is summarised in the following paragraphs

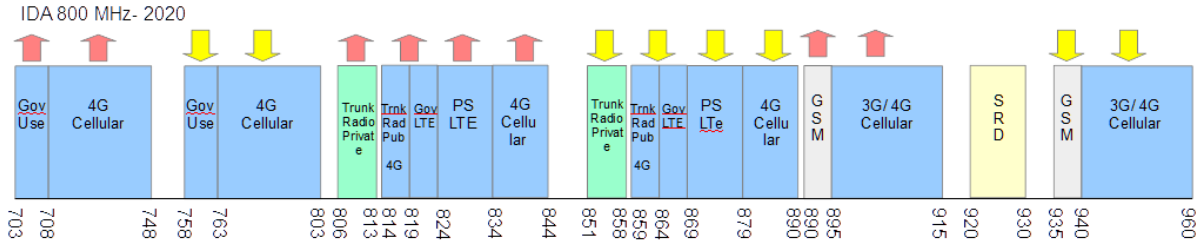
   a. <u>IDA 800 MHz – 2015</u>



   b. <u>IDA 800 MHz – 31st March - 2017</u>



   c. <u>IDA 800 MHz – 2020</u>



7. Our proposed plan, based on a 2015-2020 refarm period is summarised in the following paragraphs

   i. 806-813/851-858 MHz – to be retained for private trunking users. Existing private/government trunking users within 806-821/851-866 MHz to relocate to this part of the band by 2017. This 7 MHz (for narrow band) will also provide the necessary guard band between the 4G-LTE services below 803 MHz and those above 814 MHz. Studies have shown that guard band between two reversed LTE channels should be at least equal to the size of the smaller channel bandwidth. Assuming a 10 MHz channel use in APT band and in the 814-844 refarmed LTE band, a guard band or a buffer of about 10 MHz is minimum necessary between 803 and 814 MHz. (see studies included in Motorola Solutions inputs to APT in Annex 2 and 3)

ii. 813-814 /858-859 MHz be reserved as guard band between narrow band and broadband. Studies have shown that 1 MHz guard band is reasonable between narrow band and broadband services. (See http://www.ntia.doc.gov/files/ntia/technical_white_paper.pdf)

iii. 814-819 MHz/859-864 MHz – the existing Public trunking (PAMR) operator should refarm to this band using the current IDEN technology in the short term, with a view to in future upgrade to LTE public trunking with access to 5+5 MHz LTE spectrum in 800 MHz band available during 2017-2020 time frame.

iv. Short Range devices within 866-869 MHz should be relocated to 920-925 MHz starting from 2015 and such relocation be completed by 2017-2020 time frame.

v. 819-824/864-869 MHz (5MHz LTE Channel) to be refarmed and reserved for Government LTE use, available by 2020 after RFID and trunking users have relocated as above.

vi. 824-834/869-879 MHz to be reserved and allocated for government Public safety use. This should be available immediately.

vii. EGSM operations to be phased out by 2017 and 834-844/879-889 MHz to be made available to commercial operators for LTE in 2017.

viii. 889-890 MHz to be kept as guard band between the LTE and GSM.

ix. 890-895/935-940 to be retained for GSM for roaming visitors to the country and also to act as a guard band between LTE down link below 889 MHz and 3G/4G uplink above 895 MHz.

x. 895-915/940-960 MHz for 3G/4G commercial cellular operators.

xi. 920-924 MHz to be reserved and allocated for short range devices including RFID.

8. **Details of transitional issues to migrate existing services and systems in the 800 MHz band to the revised band plan;**

a. **Digital Cellular band#1 (824-835/ 869-880 MHz)**

We propose that the Digital Cellular band be designated for government use. As it is unassigned at present, it can be made available much sooner than other bands.

SRD (866-869 MHz)

- We note that the ERA Technology report 2011-0299 "*Investigation on the receiver characteristics of SRD equipment in the 863 – 870 MHz band*" concerns the study to assess the potential for interference from LTE User Equipment (UE) operating in the 3GPP Band 20 uplink band (in 832 – 862 MHz) into SRDs operating in the adjacent band in 863 – 870 MHz.
- In Singapore there are two potential interference scenarios: 1) the SRDs (in 866-869 MHz) operating inside (co-channel with) the downlink band of a mobile network and; 2) the SRDs operating adjacent to the downlink band of a mobile network. In scenario -(1), interference risk to SRD receivers is due to transmissions from the base station(s) of a mobile network in the same frequency range and at the same time SRD transmitters could cause interference to the receivers of mobile user equipment in the vicinity of the SRD transmitters.

- In scenario (2), the interference risk is due to out-of-band (OOB) emissions from mobile base station(s) to SRD receivers and OOB emissions from SRD transmitters to the receivers of mobile UE.
- We propose that the transition plan to migrate SRD users from the band 866-869 MHz to 920-925 MHz commence in 2015. As indicated by IDA the impact to existing SRD users is the replacement of their devices in migrating to the frequency band (920-930 MHz).
  The impact of SRD operating in the same frequency range as the downlink of a broadband network is the interference to the receivers of mobile user equipment around the SRD transmitters.
- With the conversion of the EGSM uplink band we propose that the SRD band be extended by 5 MHz to 920-930 MHz

b. **Trunked radio (806-821/ 851-866 MHz)**

- We propose that the trunked radio band be split into two sub-bands:
- The sub-band 806-813/ 851-858 MHz be designated for private trunked radio systems of existing users, government services and strategic installations (airport, port, industrial complex, high speed rail).
- The sub-band 814-821/ 859-866 MHz be designated for public (commercial) trunked radio users. The existing iDEN public trunking network be refarmed to this band. This band should eventually be converted to a Public LTE trunking band to meet the continuing needs of transportation, courier services, event management agencies etc.
- The possible impact to existing trunked radio users are:
  a) User equipment (portables & mobiles): Trunked radio user equipment for this band can operate over the range 806-824/851-869 MHz. The re-programming of some of the user terminals is expected.
  b) Re-tuning of affected base station transmitters and the modification to the base station RF filters (e.g. combiner) is expected.

b. **EGSM uplink (880-890 MHz)**
Upon the expiry of the EGSM assignment we propose the conversion of the EGSM uplink to become the downlink of the band 834-844/ 879-889 MHz, as the first extension to the Digital Cellular band.
We propose that the band 834-844/ 869-889 MHz be designated as a new 4G cellular band. We concur with IDA that the impact to users the GSM service will be minimal

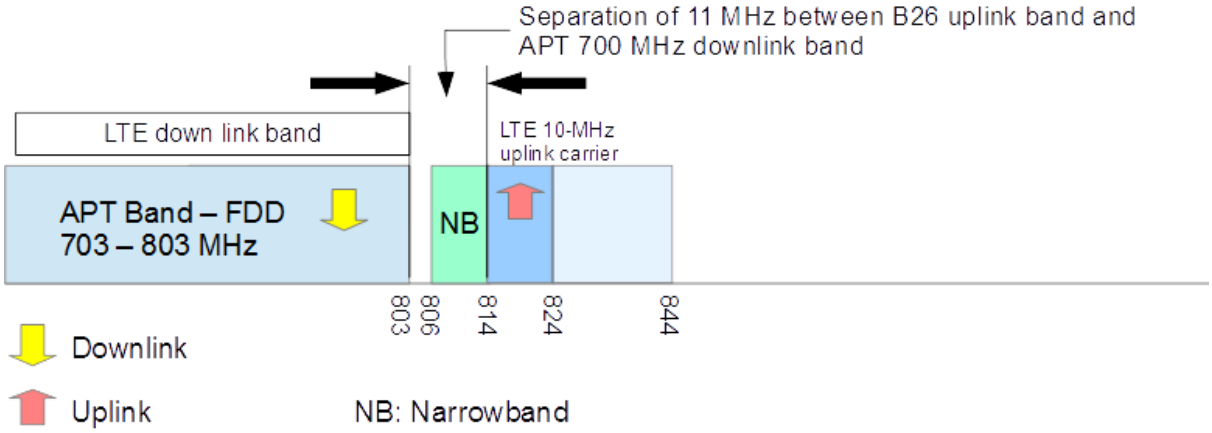
c. **GSM band (890-915/ 935-960 MHz)**
Depending on market conditions the GSM band can be converted into two sub-bands:

- 890-895/ 935-940 for GSM or other narrowband radio technology. This sub-band provides a 'guard band' between the broadband downlink in 879-889 MHz and the 3G (or 4G) uplink in 895-915 MHz.
- 895-915/ 940-960 MHz for 3G or 4G services.

d. 4G LTE in 814-844/859-889 MHz - With refarm process completion, the entire band 814-844/859-889. For this we propose that Singapore adopt 3GPP Band 26 for the following reasons:

i. A separation of at least 10 MHz is required to protect user equipment (UE) in the downlink band from the out-of-band emission of UE transmitting in the adjacent uplink band.

The uplink of 3GPP Band 26 at 814 – 849 MHz provides a separation of 11 MHz from the downlink APT 700 MHz band.



ii. 3GPP Band 26 (814-849/ 859-894) covers 3GPP Band 5 (824-849/ 869-894) so UEs supporting 3GPP Band 26 will be able to roam into networks supporting 3GPP Band 5. The adoption of 3GPP Band 26 will facilitate interoperability within the 800 MHz band and create economies of scale for equipment operating in that band.

Question 3: IDA seeks views on the allocation approach for the 900 MHz spectrum band, particularly:

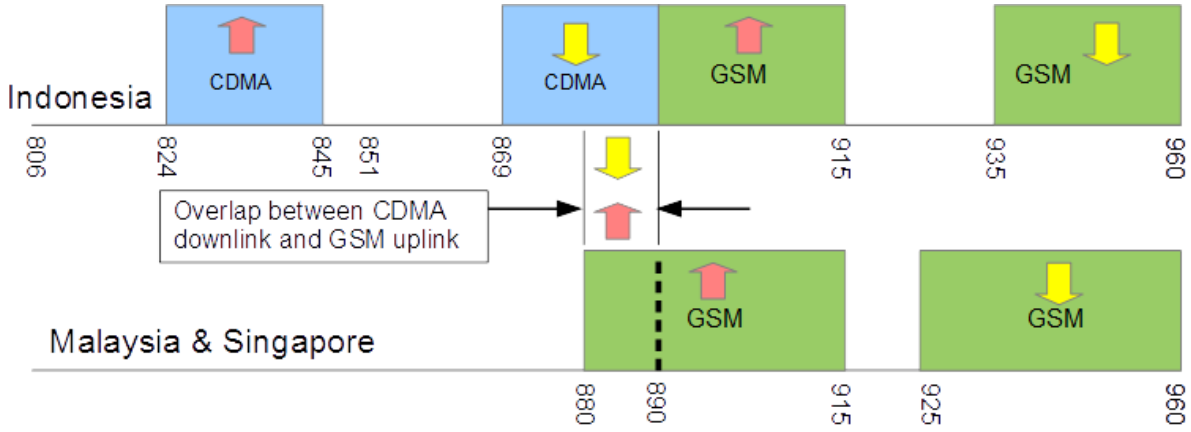
(a) whether the band should be re-allocated as a standalone band in a market-based allocation framework, and if so, the preferred timeframe for such an allocation exercise;

(b) whether the band should be coupled with other spectrum bands for allocation, and if so, which bands and the preferred timeframe for such an allocation exercise; and

(c) the underlying reasons for your views on the above.

Motorola comment:

At present both Malaysia and Singapore use the band 880-890/925-935 MHz for EGSM while in Indonesia the band 824-845/ 869-890 MHz is used for CDMA. As a result there is an overlap between the downlink of CDMA and the uplink of GSM as shown in below figure. This overlap can be a source of cross border interference and IDA should take the opportunity to re-align the GSM band so that it begins at 890 MHz.
We believe that significant economies of scale can be created if ASEAN members can adopt 3GPP Band 26 in the band 814-844/ 859-889 MHz.



Question 4: IDA seeks views and proposals on the technical issues relating to the allocation of the Sub-1 GHz bands for mobile broadband services, in particular, the guard band requirements between the adjacent bands (e.g., 700, 800 and 900 MHz bands) for mobile broadband services.

Motorola comment:

I. Co-existence between IMT in APT 700 MHz and (narrowband) trunked radio operating above 806 MHz.

We refer to Motorola Solutions input contribution to the AWG: Document AWG-11/INP-46, that considered two interference scenarios:

a. A narrow band (25 kHz) trunked radio UE operating in the uplink above 806 MHz interfering with a LTE UE operating in the downlink below 803 MHz.

In summary the out-of-band (OOB) emission of a 25 kHz UE operating in the uplink into the downlink of the APT 700 MHz band will low and should not present an issue.

b. A LTE base station transmitter operating in the downlink below 803 MHz causing interference to a trunked radio base station receiver operating in the uplink above 806 MHz.

In summary, the OOB emission from a LTE base station operating in the downlink below 803 MHz and causing interference to a trunked radio base station operating in the uplink above 806 MHz can be mitigated with the installation of additional filters in the LTE base station.

II. Co-existence between IMT operating in APT 700 MHz and IMT operating above 806 MHz

We refer to:

a. Motorola Solutions input contribution to the AWG: Document AWG-12/INP-27 (See Annex 2)

b. APT Report Number APT/AWG/REP-44: COEXISTENCE BETWEEN SERVICES AT THE BOUNDARY OF THE 700 MHz AND 800 MHz BANDS;
it is recommended that this report is read together with the AWG information paper: Document AWG15/INF-01 - COMMENTS ON THE DRAFT NEW REPORT ON COEXISTENCE OF 700/800 MHZ BANDS

In both documents we have asserted that the required guard band between a LTE uplink operating above 803 and a LTE downlink operating below 803 is 10 MHz for a 10-MHz carrier. The guard band width is dependent on the OOBE[2] requirements on the UE of the LTE uplink. The use of the A-MPR[3] function on the UE of the LTE uplink can reduce the guard band requirements. However this comes at the expense of reducing the uplink throughput.

III. Guard band between a narrowband and broadband.

To minimise interference between narrowband and broadband the FCC adopted a 1-MHz guard band between the narrowband and broadband operations in their 700 MHz bandplan. The purpose of the 1 MHz guard band is twofold[4]: to protect traditional noise limited land mobile radio systems from out-of- band emissions (OOBE) of adjacent broadband networks (primarily base stations), and to protect broadband systems from OOBE of higher-powered LMR transmitters.
We propose that the same 1-MHz guard band be employed in the 800 MHz bandplan.

[2] Out-of-band emission
[3] Additional maximum power reduction.
[4] http://www.ntia.doc.gov/files/ntia/technical_white_paper.pdf : "Application of the Upper 700 MHz A-Block To Public Safety"

ANNEX 1

Summary of Various Global Reports on Mobile Broadband for Public Safety

Summary of Various Global Reports on Mobile Broadband for Public Safety

1. **ECC Report 199, "User requirements and spectrum needs for future European broadband PPDR systems (Wide Area Networks) May 2013".** http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP199.PDF - This ECC Report concludes that an amount of spectrum in the range of 2x10 MHz is needed for future European broadband PPDR Wide Area Networks (WAN) and there could be additional spectrum requirements on a national basis to cater for Direct Mode Operations (DMO), Air-Ground-Air (AGA), ad-hoc networks and voice communications over the WAN.

2. **WIK Consult, "Final Full Public Report Study on behalf of the German Federal Ministry of Economics and Technology (BMWi) PPDR Spectrum Harmonisation in Germany, Europe and Globally" December 2010.** http://www.wik.org/uploads/media/PPDR_Harmonisation_en_public_final_01.pdf - The report concludes that the main driver for spectrum demand is real-time video while other data applications (e.g. database/Internet access) are less demanding, because some latency/contention is permissible. The Report estimate that based on realistic user requirements the data bit rates is 1.2 Mbps downlink and 1.9 Mbps downlink and concludes that PPDR broadband systems require 10 MHz for the uplink and 15 MHz for the downlink.

3. **London School of Economics, "Socioeconomic Value of Mission Critical Mobile Applications for Public Safety in the EU: 2x10MHz in 700MHz in 10 European Countries" December 2013.** http://www.lse.ac.uk/businessAndConsultancy/LSEEnterprise/pdf/tetraReport.pdf - The Report notes that the consolidation of estimates on the utilisation of 700MHz for mobile broadband on a more dedicated basis by emergency services indicates that they outweigh the opportunity cost of the 'one-off' sale of spectrum to commercial operators. The degree to which these potential benefits are realised depends on a range of factors including regulatory and license conditions; the network mode of delivery; the speed of mobile broadband adoption; the nature of the services that are provided, and others."
4. **Defence Research and Development Canada, "700MHz Spectrum Requirements for Canadian Public Safety Interoperable Mobile Broadband Data Communications" February 2011.** -http://cradpdf.drdc-rddc.gc.ca/PDFS/unc122/p535072_A1b.pdf - According to this Report, the global demand for mobile broadband data is experiencing exponential growth in the commercial space fuelled primarily by the continued deployment of laptop and net book computers, and smart phones. It is expected that tactical video will play an increasingly important role to enhance situational awareness and by limiting public safety to 10 MHz (5+5 MHz) will require significant reduction in public safety broadband requirements, including a 50% reduction in video data rate and quality, and limiting simultaneous data users to 1 in 20 instead of 1 in 4. Even 20 MHz (10+10 MHz) is insufficient bandwidth to support the needs of public safety in the 10-15 year

horizon. The report also notes that the narrow band land mobile radio(LMR) will remain the key voice communications tool for the foreseeable future

5. **CITEL Recommendation on PPDR Spectrum Harmonisation in Americas:** https://www.citel.oas.org/en/SiteAssets/PCCII/Final-Reports/P2!R-3323r1_i.pdf The Permanent Consultative Committee of CITEL on radiocommunications meeting in November 2013 in Nicaragua recognizing that there are Administrations of Region 2 which are considering implementation of PPDR broadband applications based on IMT systems, either in dedicated spectrum or shared spectrum with commercial networks, approved a new recommendation on PPDR BASED ON IMT SYSTEMS that recommends to the CITEL Administrations that wish to deploy broadband networks to meet PPDR needs in the 700 MHz band, consider the following bands conforming the channel plan they have adopted for the 700 MHz band:
    a. 703-748/758-803 MHz (A5 scheme of Recommendation ITU-R M.1036-4) - In Administrations that wish to define a particular frequency range for PPDR, it is recommended to preferably use the lower portion of this band.
    b. 758-768/788-798 MHz (A4 scheme of Recommendation ITU-R M.1036-4)
6. **APT Report on "PPDR Applications Using IMT Based Technologies and Networks" April 2012. (APT/AWG/REP-27)** - PPDR systems based on IMT broadband wireless technology have a critical role to play in effectively and efficiently satisfying local, national and international public safety objectives. PPDR organizations need to able to communicate between themselves and the community at large, many times across jurisdictional boundaries, in order to meet modern day challenges The effectiveness of providing PPDR organizations a broadband mobile capability through the use of IMT technologies will, however, be undermined without regional harmonization of spectrum bands for broadband PPDR applications and the harmonization of the relevant technology standards.
7. **APT Report on "Technical Requirements for Mission Critical Broadband PPDR Communications" September 2013.** (APT/AWG/REP-38) - This report provides an outline of the technical requirements of mobile wireless broadband communications systems to meet mission critical broadband PPDR requirements. It presents a high-level framework and broad rationale, along with a fundamental set of recommended operational and functional requirements that might be found useful to regional administrations for a variety of purposes.
8. **TRPC "Public Protection and Disaster Relief (PPDR) Services and Broadband in Asia and the Pacific: A Study of Value and Opportunity Cost in the Assignment of Radio Spectrum" May 2013**. http://trpc.biz/wp-content/uploads/PPDR-_Report_June-2013_FINAL.pdf -The Telecommunications Research Project (TRP) based in the Centre of Asian Studies at the University of Hong Kong, under the directorship of Dr. John Ure published a study on the value and opportunity cost in the assignment of Radio Spectrum to PPDR broadband in the eight countries in Asia .The study notes that with the digital dividend on the agenda of economies of the Asia Pacific region it is timely to review the spectrum requirements of Public Safety services, also known as Public Protection and Disaster Relief (PPDR) services. The report further notes the increasing use of broadband Internet-connected networks and devices by the civil society as well as the criminals and terrorists. The case for PPDR services using broadband applications such as high definition real-time video, location based services with maps, fast access to remote databases and biometric information, multi-channel secure dedicated networks, is becoming all too clear as public safety is threatened by both a rise in the incidence and cost of natural

and man-made disasters and by the costs of crime, not least the growing cost of cybercrime.

ANNEX 2

Motorola Solutions Input Document AWG-12/INP-27 –

PPDR CO-EXISTANCE CONSIDERATIONS

ASIA-PACIFIC TELECOMMUNITY
The 12th Meeting of APT Wireless Group (AWG-12)
10 – 13 April 2012, Xiamen, Peoples Republic of China

Document AWG-12/INP-27
10 April 2012

PPDR CO-EXISTANCE CONSIDERATIONS

By

Motorola Solutions India

1. Introduction

This paper provides a brief comment on PPDR user distributions that are used in real world mission critical systems.

In this paper we show that while uniform distribution assumptions are reasonable assumptions for interference analysis between cellular services, re-using these same assumptions for interference analysis involving mission critical services like PPDR will likely to underestimate the interference. This is critical as both narrowband and broadband PPDR systems are proposed in parts of 806-834/851-879 MHz in some countries in Asia and the high likelihood of interference between these PPDR systems and the mobile cellular services using LTE in the 700/800 MHz band.

2. Discussion

Most of current simulations on coexistence between cellular LTE and PPDR assume uniform distributions of both LTE and PPDR users. Uniform distribution of users is a reasonable assumption when co-existence is considered for commercial deployment. In this paper we shown that uniform distribution assumptions will provide an optimistic interference estimate for PPDR scenarios and will cause degradation to mission critical services

3. PPDR user distribution

There are many PPDR or mission critical scenarios where uniformly distributed users do not reflect real world PPDR scenarios, including:

3.1 Incident scenes

A survey conducted jointly by Motorola Solutions and active public safety professionals in the US has shown that in a typical incident scene there could be as many as 62 public safety personnel in two square city blocks (around 100m by 200m). These incidents can happen several times a month in a typical urban area and hence are not a rare occasion. These sorts of sudden increase in PPDR user density can occur in any part of the PPDR cell

As commercial LTE equipment is deployed, we can expect increased concentrations of LTE user traffic due to bystanders at incident scenes as well. This increase in cellular traffic would be due to increased number of voice, text, pictures and videos originating in the vicinity of the event:

- I am ok update, see my video now.
- Here is a video of what is going on here
- I need help with transport,
- I am being taken to the hospital.
- Here is a set of pictures of the incident that I just took.
- I am reporting live from this event location.
- Etc, Etc.

When such scenarios occur, the probability of interference between LTE users and PPDR users is much higher than predicted with a uniform distribution model. And it is exactly in these scenarios where PPDR services are needed most and need to be well protected.

3.2 Public events and hot-spot areas

When large public events occur, such as sports events, or in hot-spot areas such as shopping malls or city centres, much higher concentration of LTE users as well as public safety personnel can be observed. Below example shows cellular phone (highlighted in red) next to large number of PPDR personnel. PPDR personnel are linked to major incident control room, which pass real time information to PPDR user on either an individual or on a common voice or data channel.

3.3 Protest march, riots, major incident

When large gathering of people such as protest march or riot much higher concentration of users as well as public safety personnel can be observed. Again these sudden increases in PPDR user density can occur in any part of the PPDR cells example plane/train crash in a rural area or more frequently in urban areas.

From the discussion above, it can be seen that uniform distribution of users is not an accurate assumption when performing coexistence studies involving PPDR systems and would underestimate the interference due to close proximity.

4.0 Reliability & Performance Criteria for PPDR systems

A PPDR system is designed to achieve certain service area reliability and a Coverage Acceptance Test (CAT) needs to be performed as the proofs of performance test i.e. TIA TSB88.1-C.

The service area reliability for PPDR systems can be calculated by averaging over individual tile reliabilities in the whole service area. The service area is divided into tiles normally in the size of 30 meters by 30 meters blocks. For each tile, there could be minimal reliability requirement, for example 90%. This means in each tile, the probability of meeting the CPC requirement is 90%. *To achieve the guaranteed service area reliability of 95%, the service area reliability needs to be at least 97% and the minimal tile reliability requirement is usually 90%. It is especially important that tiles at cell edge are still able to meet the minimal tile reliability requirement.*

5.0 Conclusion

It can be seen that uniform distribution of users is not an accurate assumption when performing coexistence studies involving PPDR systems. This assumption underestimates the probability of an LTE user getting closer to the PPDR personnel in critical situations; hence underestimate the interference between an LTE user and PPDR user.

The required guard band between a PPDR broadband LTE UL operating above 803 MHz and a commercial LTE DL operating below 803 MHz will depend on the OOBE[5] requirements on the

[5] Out of band emission

PPDR or through the use A-MPR[6] on LTE UE that could reduce the guard band requirement. A 10MHz guard band between 10MHz LTE UL and 10MHz LTE DL can be implemented without sacrificing LTE UL throughput. However, one could reduce the guard band to 5MHz by reducing the power output at the LTE UE UL and reducing the LTE UL throughput. Any guard band less than 5 MHz will be detrimental to LTE PPDR systems operating in band above 808 MHz as well as to the LTE cellular services operating below 803 MHz.

[6] Additional maximum power reduction

ANNEX 3

Motorola Solutions Input Document AWG-11/INP-46 –

CO-EXISTENCE OF IMT IN 698-806 AND PPDR SERVICES IN 806-824 MHZ

ASIA-PACIFIC TELECOMMUNITY
The 11th Meeting of the APT Wireless Group

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14 September 2011

CO-EXISTENCE OF IMT IN 698-806 AND PPDR SERVICES IN 806-824 MHZ

Motorola Solutions India

1. Background

The purpose of this document is to provide information and recommendations to assist in assessing the coexistence of the narrow band Public Safety (Public Protection and Disaster Relief -PPDR) operating 806-824/851-896 MHz spectrum (800 MHz) in India and the proposed IMT services in 698-806 MHz (700 MHz) Digital Dividend spectrum. In implementing the IMT services in 700 MHz band, the coexistence issues with broadcasting services at 698 MHz are being considered by the correspondence group of the AWG. The other co-existence scenarios for co-existence with adjacent PPDR services at 806 MHz are highlighted in this document.
The focus of this document is to only consider the deployment of narrow band existing PDPR applications in 806-824/851-896 MHz spectrum.
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2. Current status

In many Asian countries, the band 806-824/851-869 MHz is extensively used for PPDR and Public Mobile Radio Trunking narrow band services. Typically the technologies used are TETRA (ETSI EN 300 392-2) , APCO P25 (TIA 102) or DIMRS (Report ITU-R M.2014-1). In addition analogue trunking technologies are also used by some PMRTS operators and other captive users. These services typically have the following parameters:

	Base Station	**Terminal (UE)**
Carrier frequency	806-824 MHz/851-869 MHz	
Channel bandwidth	25 kHz	
Effective noise bandwidth	18kHz	18kHz
Antenna gain	11dBi omni-directional	-6dBi
Noise figure	5.4 dB	8.4 dB
Transmit power	44 dBm	30 dBm
Emission mask	-55dBc @25kHz,-65dBc @50kHz -70dBc from 100kHz to 250kHz -74dBc from 250kHz to 2500kHz	-55dBc @25kHz,-65dBc @50kHz -70dBc from 100kHz to 250kHz -74dBc from 250kHz to 2500kHz

Receiver blocking	-40dBm from 50kHz to 100kHz -35dBm from 100kHz to 200kHz -30dBm from 200kHz to 500kHz -25dBm beyond 500kHz	-40dBm from 50kHz to 100kHz -35dBm from 100kHz to 200kHz -30dBm from 200kHz to 500kHz -25dBm beyond 500kHz

Note: The above parameters are based on "ETSI EN 300 392-2 Terrestrial Trunked Radio (Tetra)

Discussions

Based on the assumption that APT 700 MHz Digital Dividend Band Plan in 698-806 MHz is likely to be used with channel bandwidth of 5, 10 and 20MHz, two interference scenarios are considered here:

a) Narrow band Public Safety user terminal (UE) Tx operating at 806 MHz interfering with APT 700 MHz Digital Dividend LTE user terminal (UE) receiver. Such UE to UE interference can lead to desense of the LTE UE terminal when there is close geographical proximity between the two

b) APT 700 MHz Digital Dividend LTE Base Station Tx below 803MHz interfering with Narrow band Public Safety Base Station Rx above 806MHz

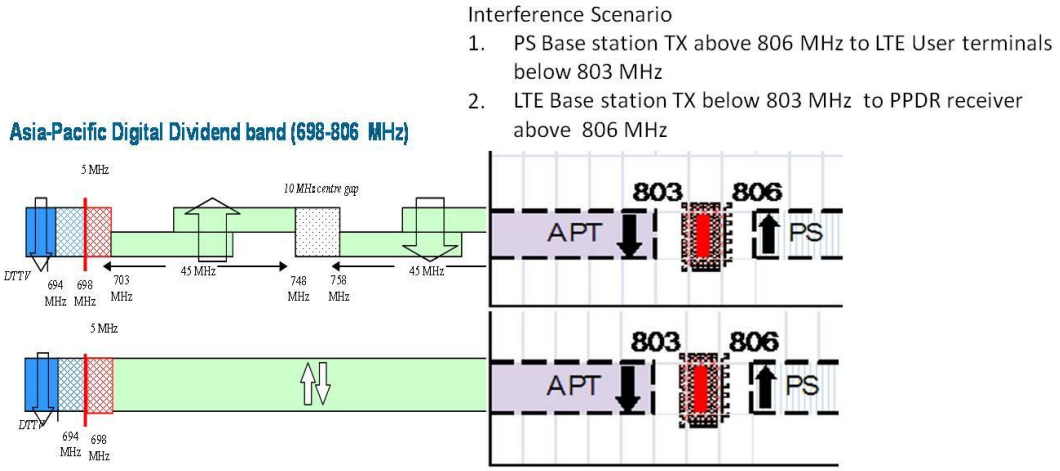

Figure 1-Interference Scenario

In this document we only consider scenario of a 25 KHz public safety system at 806 MHz.
a) UE to UE interference when there is close geographical proximity between a PSNB and a co-located APT LTE UE receiver s shown in figure 2 below. In this case, the main OOBE issue will be between the APT band at F_{DL_high} (803MHz) and the PPDR band plan at $FDL_{\_low}$ (806MHz). Since PS (PPDR) is a narrow band system the OOBE emission into the APT band will be low and therefore should not present an issue.

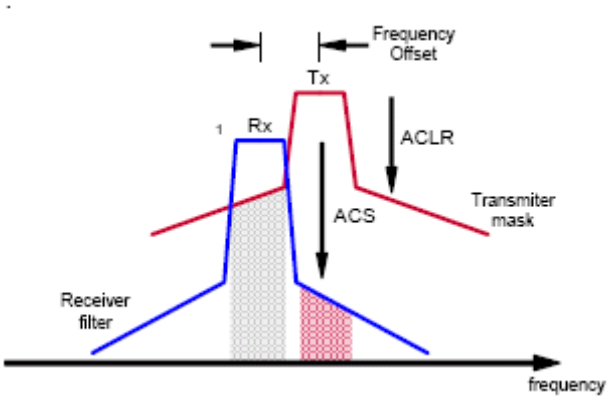

Figure 2-Scenerio a) interference Scenario

Scenario b) is the APT 700 MHz Digital Dividend LTE Base Station Tx below 803MHz interfering with Narrow band Public Safety Base Station Rx above 806MHz . This scenario of BS Tx OOBE below 803MHz interfering with PSNB BS above 806MHz can be solved by extra filtering on either or both BS sites. AWG needs to work out the necessary filtering specifications and include the same in their report.

Summary

It is important that AWG take note of these likely interference scenarios while planning the band 698-806 MHz. This is based on the assumption is that APT 700 MHz Digital Dividend Band Plan in 698-806 MHz will be used adjacent to a narrow band PPDR system with 25KHz bandwidth. Therefore while planning the APT 700 MHz band, AWG may also like to recommend limiting the PPDR systems operating in band above 806 MHz to narrow band systems only and also prescribing necessary filtering requirements for the LTE and PPDR base stations. AWG may also like to consider recommending additional guard band if PPDR does deploy higher band width systems in 806-824 MHz.

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Motorola Solutions input to the Correspondence Group on Coexistence between Systems Operating in the 700MHz and 800 MHz Bands

Motorola Solutions input to AWG Corresp