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To :

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From : DECT Forum

Subject: Relpy Comments on TRAI Consultation Paper No. 9/2011 "Allocation of Spectrum Resources for Residential and Enterprise Intra-telecommunication Requirements/ Cordless Telecommunication Systems (CTS)".

Hereby DECT Forum is pleased to provide reply comments on the comments to the issues for consultation. Information about DECT Forum, the international association of the cordless home and enterprise communication industry, is found at the end of this document.

Introduction – summary of categories of comments

Over 40 comments have been received to the TRAI Consultation Paper No. 9/2011, indicating the interest of the general public in the subject matter.

The responses can be classified into:

a) Responses from Indian Mobile Service Providers and their Association/s & Consultants.

b) Response from GSMA - the global Association of mobile service providers/ manufacturers and other organizations with an interest in GSM technology .

c) The largest wireline service provider in India – BSNL .

d) Indian Consumer Associations and Associations of organizations interested in use of digital cordless equipment .

e) DECT Forum Associations – DF & DFI

f) Manufacturers/Dealers of digital cordless equipment

Other than (a) & (b) above, all the rest of the organizations (>32), and more specifically the Indian consumer organizations, are strongly in favour of de-licensing of the existing 1880-1900MHz band for digital cordless technology.

GSMA, the organization at (b) has also expressed no objection against de-licensing of the 1880-1900 MHz band but have suggested certain procedures to be followed to avoid interference into adjacent cellular bands.

Indian cellular public service organizations at (a) are the only ones (about 7) who have objected to de-licensing of the digital cordless band.

1. General Reply Comments by DECT Forum

DECT Forum supports the comments made by the 32 organizations including Indian consumer organizations under points c) – f) above. These comments are not further commented in this document.

The comments from the Indian Mobile Service Providers and their Association/s & Consultants are negative to de-licensing of the band 1880-1900 MHz. Counter arguments to most of their objections are already expressed in the TRAI Consultation paper. Contrary to the clear GSMA document, these comments contain a number of comments which seem to result from misunderstanding and/or lack of information on the relevance of private de-licensed services. To ease the expressed concern of Indian cellular operators, DECT Forum below provides Reply comments to five concepts related to misunderstandings, that have appeared in the comments from several companies. These concepts are: Mixing Public Services and Private services on de-licensed spectrum, Stating that de-licensed CTS including DECT is outdated and is not needed, Using support of IMT-2000 as an argument against DECT and Using technology neutrality as an argument against DECT. It is difficult to refer these concepts to specific questions Q1 – Q9, since they appear in the comments to several questions.

The comment from GSMA, representing over 800 cellular operators and over 160 manufacturers and suppliers, is a relevant well written document. It does not express objection against de-licensing (of the 1880-1900 MHz band), as long as good coexistence with adjacent band cellular systems is provided. This is most relevant and to the point, and should be the only issue of importance for cellular service providers. Therefore DECT Forum has below provided further detailed information on the coexistence with adjacent band cellular services.

DECT Forum concludes that there is a substantial support for de-licensing. The proposed de-licensed CTS services do not include public services and do not threaten the core business of cellular service providers, and therefore the main issue for cellular service providers should be the coexistence with adjacent band cellular services.

The conclusion on the coexistence with adjacent band cellular services is found in section 3.4 below. This refers to the question Q6 on coexistence issues.

2. Specific Reply Comments to Indian Mobile Service Providers

In this paragraph DECT Forum provides reply comments to comments from the Indian Mobile Service Providers and their Association/s & Consultants, except on the relevant coexistence issues, which is covered in section 3 below.

2.1 Mixing Public Services and Private services on de-licensed spectrum

Most of the concerns expressed by the Indian Mobile Service Providers and their Association/s & Consultants seem to come from mixing of regulatory conditions and features between public and private systems. Either the proposed de-licensed services are supposed to be public, or regulations for public services are supposed to apply for de-licensed private on-site systems. This is not correct and very confusing.

DECT Forum believes that most of the concerns expressed may disappear, by just making clear and again stress that the proposed de-licensing only regards the private on-site systems, and does not (can not) include public system applications.

Reply comments to some specific statements or concerns resulting from the above explained mixing are found below under points 2.2 – 2.4.

The proposed de-licensed CTS services do not include public services and do not threaten the core business of Indian cellular service providers, but are providing up to date complementing service offerings for private use to the Indian community.

2.2 Stating that de-licensed CTS including DECT is outdated and is not needed. Questions Q1-Q5.

Again there is a non-relevant mixture between licensed and unlicensed services.

The European DECT standards include both licensed public (WLL and public pedestrian mobility systems) and unlicensed private (residential and enterprise) on-site systems.

From a radio coexistence perspective these public and private DECT systems are designed to coexist very well on a common frequency band, e.g. 1880-1900 MHz, due to the common instant dynamic channel selection procedures.

DECT Forum again has to stress that the proposed de-licensing only regards the private on-site systems, and does not (can not) include public system applications.

Some comments express that DECT has lost its relevance. An example used is the failure of the Italian public pedestrian mobility system Fido. It is true that DECT and CT2 (and now also PHS) public pedestrian mobility systems have lost their relevance, due to the improved low

cost full mobility cellular services. Also the DECT public WLL service is being hit by higher bandwidth technologies.

However, the DECT de-licensed residential and enterprise applications are by no means outdated, with massive investment in new features as HD voice, IP access and Ultra low energy versions. They are indeed needed and appreciated. They make a perfect complement and match to Wi Fi WLANs in residents and enterprises.

The US etiquette rules for the unlicensed PCS band were modified to include DECT year 2005, and unlicensed DECT was 2010 introduced in Japan in the PHS band.

Earlier comments from DECT Forum and others show the increasing market dominance for DECT for the de-licensed residential and enterprise applications. Some comments do not seem to be aware that the residential market is the main market, and that the enterprise market is a smaller market for mission critical applications.

The proposed de-licensed CTS services do not include public services and do not threaten the core business of Indian cellular service providers, but are providing complementing new or improved up to date services for private use.

2.3 Using support of IMT-2000 as an argument against DECT. Question Q6

The Cellular Operators Association of India and others write in their comment to Q6 that the 1900 MHz band (1885-1980 MHz) internationally has been identified for IMT-2000 public services and that that also has been acknowledged by TRAI. This is correct regarding public services, but is not limited to public services. This band has been identified by ITU for all IMT-2000 family member technologies.

As mentioned in Comments and known to TRAI, DECT is the IMT-2000 family member denoted ITU IMT-2000 TDMA/FDMA (DECT). It is the only IMT-2000 technology, that provide coexistence of uncoordinated system installations on a common spectrum allocation.

Being an IMT-2000 technology, DECT allocations all over the world are within the identified IMT-2000 band (specifically within 1800-1930 MHz, depending on Region).

Furthermore, these DECT allocations are in used guard bands between cellular up-links and down-links.

That the 1900 MHz has been identified as an IMT-2000 band amplifies the reason for allowing allocation for DECT in this band, rather than objecting as some cellular service providers suggest.

2.4 Using technology neutrality as an argument against DECT

When cellular operators refer to technology neutrality, they are mixing private de-licensed services with public licensed services. Secondly they are also supposing that DFI and other companies supporting a de-licensed CTS spectrum are proposing a single technology, which is not true.

Technology neutrality is a world wide trend, and it should be understood by the cellular operators that the term “technology neutrality” applies to licensed spectrum, where *one* operator has control of the installation. The concept of technology neutrality allows the operator to use any technology on his spectrum, provided that the new technology will *coexist well with* already installed cellular *technologies on adjacent spectrum blocks.* This coexistence with adjacent block technologies, is normally met by specifying the out-of-block emission levels. *Thus technology neutrality provides for coexistence between spectrum blocks, but does not care about coexistence between technologies within a spectrum block.* To fix and coordinate coexistence within the spectrum block, is up to the single operator that holds the block license.

Thus the term and the concept of “technology neutrality” does not apply to a de-licensed spectrum. For a de-licensed service, the main issue is to provide for coexistence *within* the band for uncoordinated installations, since no single operator is there to coordinate and plan,

To provide this coexistence property (within the band) for uncoordinated installations, all technologies using the common spectrum have to obey some common rules for conduct, they have to be educated, obey an etiquette of conduct. This etiquette looks different for best effort data services (WiFi on the 2,4 GHz and 5 GHz bands), and for high quality real time services (the proposed CTS service). The etiquette permits use of the de-licensed spectrum by every technology having the coexistence properties, that are mandated by the etiquette.

The Cellular Operators are wrongly presuming that the TRAI consultation paper is only about a specific technology – DECT. DECT is *one* of the important digital CTS technologies, which should be included by the etiquette. Examples of different levels of etiquette definitions for de-licensed CTS bands, and respective countries of application (Europe, US etc), were given by DECT Forum in its earlier comment to question 3.9. DECT Forum is not suggesting a single technology.

3 Coexistence with adjacent band cellular services. Question Q6

This reply comment is to provide information on coexistence between DECT de-licensed residential and enterprise systems and cellular services on adjacent bands. It addresses the issues raised by GSMA, and is also a reply to concerns on possible interference expressed by the Indian Mobile service providers, including comments on Q6 Coexistence d) – g) by Cellular Operators Association of India. Specific statements of each comment are not addressed. The assessments below give the answers.

The proposed de-licensed CTS services do not include public services and do not threaten the core business of cellular service providers. Therefore the coexistence issue should be the only issue of real importance for cellular service providers.

3.1 General

DECT Forum has in earlier comments stated that no harmful interference is to be expected with a proper coexistence etiquette for the de-licensed CTS systems. The reason for this statement is already in the Counter comments in paragraph 2.8.3 of the Consultation Paper. The potential interference cases similar to those that will occur in India have in Europe already been studied and analysed for DECT.

The studies and hundreds of millions of DECT installations all over the world confirm good coexistence properties and there are no complaints.

Due to the comments there is obviously a need to make the above statement on good coexistence clear and transparent for the specific potential interference cases for the bands 1880–1900 MHz and 1910-1920 MHz in India.

Below 1880 MHz is the GSM down-link band, and spectrum above 1920 MHz is reserved for the 3G (WCDMA, LTE) up-link band (IND 59). The band 1900-1910 MHz is supposed to be planned for possible future use as up-link band for cellular 3G (2G?) (CDMA) systems (IND 58).

The CTS coexistence etiquette is proposed to include the DECT technology. Therefore the available DECT technology, its radio specification and dynamic channels selection ability, is used as the reference CTS technology for the interference assessment below. It is supposed that this assessment is valid also for other CTS technologies complying with the etiquette.

3.2 The specific Indian case

The Consultation paper has two spectrum allocation candidates for a de-licensed CTS band, 1880–1900 MHz and 1910-1920 MHz. The band 1880 – 1900 MHz is preferred since it is

already allocated to CTS in India (IND 57) and is since many years de-licensed for CTS in the main part of Region 1 and in several parts of Region 3.

3.2.1 Coexistence with CTS in the band 1880-1900 MHz

The figure below illustrates well the situation in India for the proposed de-licensing of the existing CTS band 1880-1900 MHz. Below the 1880 MHz boarder is the GSM down-link band, and above the 1900 MHz boarder is a cellular up-link band.

There are also corDECT WLL above roof top installations within the 1880-1900 MHz band. These types of services and installations are out of the scope for de-licensing.

The residential and enterprise CTS systems are of pico-cell type. The devices are mainly indoors, but may occur at garden/street level just outside a home or building with a CTS installation. The coexistence analysis below is divided into three cases:

- Coexistence within the band with corDECT WLL systems
- Coexistence with adjacent band macro cellular base stations
- Coexistence with adjacent band cellular handsets

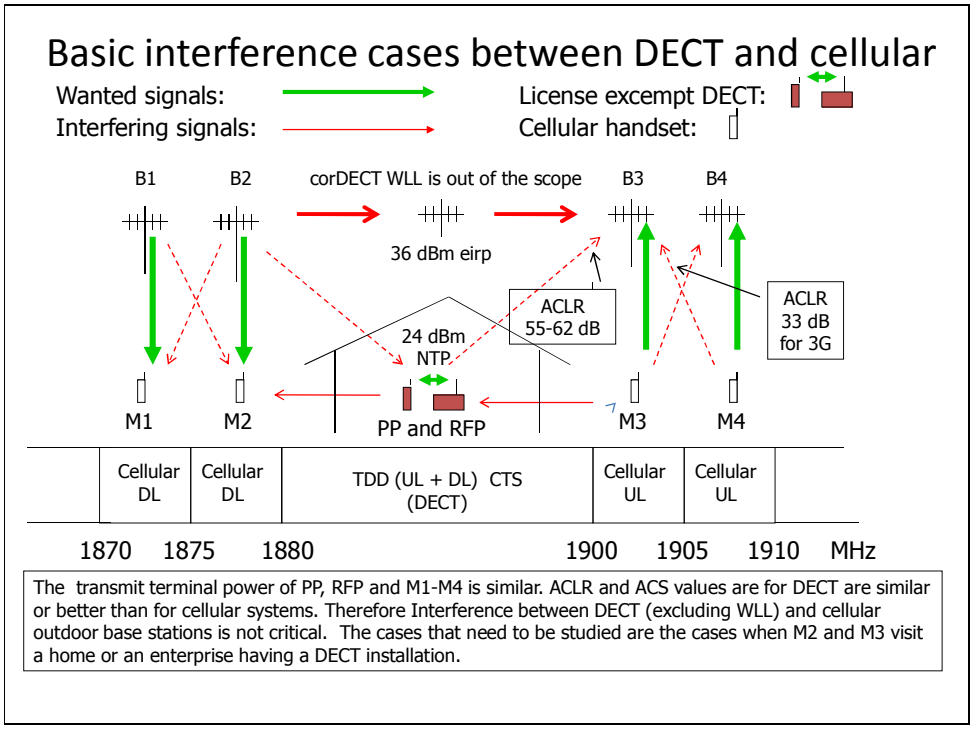

Figure 1. Basic interference cases between DECT and public cellular systems

3.2.1.1 Coexistence within the band with corDECT WLL systems

From a radio coexistence perspective the public corDECT systems and private DECT CTS systems are designed to coexist very well on the common frequency band, 1880-1900 MHz, due to the common instant dynamic channel selection procedures. The same will be the case for other CTS technologies complying to a proper coexistence etiquette that includes DECT.

Note on coexistence between Public DECT (corDECT) WLL and cellular base stations:
As seen from the figure above, the above roof top CorDECT installations suffer from substantial potential interference from GSM base station down-links and the CorDECT base stations may cause substantial potential interference to CDMA/WCDMA base station up-links. This is also the assessment from all CEPT and ERC coexistence studies referred to in earlier comments.

Therefore the public WLL system installations have to be coordinated (may be with implemented special mitigation techniques, filters etc.) with adjacent band cellular systems and cannot be de-licensed. The coordination is required to avoid harmful interference to corDECT base stations and to the cellular base station above the 1900 MHz boarder.

This note has been included because cellular service providers have wrongly used properties of public CorDECT WLL systems in assessing coexistence with residential/enterprise pico-cell CTS systems.

3.2.1.2 Coexistence with adjacent band macro cellular base stations

There is an important distinction between above DECT (corDECT) WLL installations and de-licensed residential and enterprise installations. Again we stress that public services are not included in the de-licensed regime (which some cellular service providers seem to fear, see section 2 above).

As seen from the figure above the residential and enterprise DECT applications are mainly indoors. Devices will also occasionally be used at garden/street level just outside the home/building with the DECT installation. Thus for residential and enterprise systems, the RFPs and PPs are in relation to the cellular base stations geographically used in the same positions as cellular terminals, but mainly indoors. See figure. Furthermore, DECT (24 dBm) base stations, RFPs, and handsets, PPs, have about the same transmit power as cellular handsets, and the relevant adjacent channel transmitter leakage ratio (ACLR) and receiver selectivity ratio (ACS) of the DECT equipment is better than for the cellular terminals. Therefore, principally, the coexistence will be as good as or better between DECT and adjacent band base stations, than between adjacent block cellular systems. The interference probability to cellular base stations (above 1900 MHz) and from cellular base stations (below 1880 MHz), will not exceed the related interference probability to and from cellular handsets MSs M1 and M4 on an adjacent cellular blocks.

The conclusion (see Annex B for details) is that *interference between macro cell cellular base stations and DECT residential/enterprise systems is not critical* (opposite to the case for corDECT WLL). This conclusion is supported by the above mentioned European CEPT/ERC

coexistence studies.

3.2.1.3 Coexistence with adjacent band cellular handsets

The remaining coexistence scenario is coexistence between residential/enterprise DECT systems and adjacent block cellular handsets visiting a DECT site. This is the only case that requires special attention. This conclusion is supported by the above mentioned European CEPT/ERC coexistence studies, as regards de-licensed residential/enterprise DECT systems.

As seen from the figure above, two distinct cases need to be analysed,

- interference probability from DECT to GSM handsets at the 1880 MHz boarder, and

- interference probability from 3G (2G?) handsets to DECT at the 1900 MHz boarder

a) Interference probability DECT to GSM handsets at the 1880 MHz border

As seen from figure 1 above, the potential victim is the GSM handsets M2 when visiting a DECT site. Exactly this case exists in Europe and e.g. Australia since many years. There are no reports of coexistence problems. This should calm the cellular operators. The relevant study report on this issue is ERC Report 100 [1]. The conclusion is that no guard band is required to protect the GSM cellular handsets. GSM systems are though recommended to allocate the BCCH control channels below 1878 MHz. See section 7.7.1 of ERC Report 100 [1]. This recommendation is valid also for India. See Annex B for more information.

In Europe the unlicensed band was allocated as a primary service before the adjacent cellular bands were allocated (in the US simultaneously with the adjacent cellular bands). Thus cellular operators could plan a proper position of the GSM BCCH channel from the beginning.

The different condition for de-licensing the 1880-1900 MHz band in India is that the adjacent cellular blocks have already been allocated. It is possible that Indian cellular operators by default as a precaution have put the BCCH channels more that 2 MHz from the 1880 MHz boarder, or that they easily can move the BCCH channels. But this is not known. This may lead to a defendable request from cellular operators to push the de-licensed lower limit a few MHz above the 1880 MHz boarder and/or request that the de-licensed service is a secondary service.

The conclusion is that *DECT cannot be interfered*, and that the *interference probability to GSM handsets is acceptably low*, especially by *introducing a 2 MHz guard band 1880-1882 MHz* to adjust to the special conditions in India.

b) Interference probability from 3G (2G?) handsets to DECT at the 1900 MHz boarder

As seen from figure 1 the victim is DECT, when a mobile handset M3 enters the DECT site. There is no interference to the cellular handset M3 because it is the cellular up-link band.

The resent study CEPT Report 39 [2] shows that an active 3G cellular handset entering a DECT site may reduce the useful de-licensed local spectrum to 1880-1895 MHz. But no regulated guard band is required, because the inherent dynamic channel selection of DECT will when required create the local dynamic guard band of the size temporarily required. See Annex 3 section A3.3 of CEPT Report 39 [2]. A 2G CDMA UL instead of a 3G UL on the band 1900-1910 MHz is expected to create similar interference as a 3G terminal.

The conclusion is that the *cellular handsets cannot be interfered*, and that *DECT may be interfered* by visiting active cellular handsets, but that DECT has a an inherent mitigation technique, *whereby DECT avoids the interference by creating a local dynamic guard band of the size temporarily required*.

3.2.1.4 Conclusion on Coexistence with CTS in the band 1880-1900 MHz

The summary of the above assessment of coexistence between de-licensed CTS in the band 1880 – 1900 MHz and adjacent band cellular systems is as follows:

- Interference between macro cell cellular base stations and DECT residential/enterprise systems is not critical
- Interference probability from DECT to GSM handsets at the 1880 MHz boarder is acceptably low, especially by introducing a 2 MHz guard band 1880-1882 MHz to adjust to the special conditions in India. Many years of real life experience from Europe and the US confirms this.
- DECT systems cannot be interfered by visiting GSM handsets.
- Cellular 3G/2G handsets above 1900 MHz cannot be interfered by DECT.
- A visiting active cellular handset above 1900 MHz may interfere the DECT system, but DECT has an inherent mitigation technique, whereby DECT avoids the interference by creating a local dynamic guard band of the size temporarily required.

Furthermore, public corDECT systems and private DECT CTS systems coexist very well on the common frequency band, 1880-1900 MHz. The same is the case for other CTS technologies complying to a proper coexistence etiquette that includes DECT.

The conclusion of the above assessment is that de-licensed on-site residential and enterprise CTS systems on the present CTS band 1880 – 1900 MHz will coexist very well with adjacent band cellular systems. To further ease any concern from cellular operators, and adjust to Indian conditions, it is proposed to reduce the de-licensed band to 1882 – 1900 MHz and regulate the de-licensed CTS services as secondary services as proposed by GSMA. The latter may also ease any concern from CorDECT operators, although the assessment made shows that there will be no coexistence issues with de-licensed DECT or other CTS technologies complying to a proper etiquette.

3.2.2 Coexistence with CTS in the band 1910-1920 MHz

For the band 1910 -1920 MHz option, the cellular adjacent bands are up-links both at the 1910 MHz (3G/2G) and 1920 MHz (3G) boarders. There is no planned allocation in NFAP-11 for this band.

The coexistence analysis below is divided into two cases:

- Coexistence with adjacent band macro cellular base stations
- Coexistence with adjacent band cellular handsets

The analysis from section 3.2.1 can be directly reused.

3.2.2.2 Coexistence with adjacent band macro cellular base stations

The analysis from section 3.2.1.2 applies.

The conclusion is that *interference between macro cell cellular base stations and DECT residential/enterprise systems is not critical.*

3.2.2.3 Coexistence with adjacent band cellular handsets

The analysis from section 3.2.1.3 b) applies. DECT will cause no interference to cellular handsets at adjacent cellular bands, because these are up-link bands.

Active adjacent band cellular handsets, that are entering a DECT site, may reduce the local and temporarily useful 1910 - 1920 MHz band from both edges. As explained in section 3.2.1.3 b) DECT will when required create the local dynamic guard band of the size temporarily required. The remaining useful spectrum, with potential interference from both edges, could be very small and/or the DECT cell size may be very much reduced. The likelihood is however very low, that cellular handsets from both adjacent bands will visit the

same DECT site and be active at the same time. Thus DECT Forum regards this allocation still feasible for residential CTS applications, but not for (high capacity) enterprise systems.

The conclusion is that the *cellular handsets cannot be interfered*, and that *DECT may be interfered* by visiting active cellular handsets from both band edges, but that DECT has a an inherent mitigation technique, *whereby DECT avoids the interference by creating a local dynamic guard band of the size temporarily required*. *The remaining useful spectrum could be too small to support (high capacity) enterprise CTS systems.*

3.2.2.4 Conclusion on Coexistence with CTS in the band 1910-1920 MHz

The summary of the above assessment of coexistence between de-licensed CTS in the band 1910 – 1920 MHz and adjacent band cellular systems is as follows:

- Interference between macro cell cellular base stations and DECT residential/enterprise systems is not critical
- Cellular 3G/2G adjacent band handsets cannot be interfered by DECT.
- Visiting active cellular handset from both adjacent bands may interfere the DECT system, but DECT has an inherent mitigation technique, whereby DECT avoids the interference by creating a local dynamic guard band of the size temporarily required. The remaining useful spectrum could be too small to support (high capacity) enterprise CTS systems.

The conclusion of the above assessment is that de-licensed on-site residential and enterprise CTS systems on the present CTS band 1910 – 1920 MHz will coexist very well as regards potential interference to the adjacent band cellular systems. DECT avoids the potential interference from visiting cellular handsets by creating a local dynamic guard band of the size temporarily required. The remaining useful spectrum could however be too small to support (high capacity) enterprise CTS systems.

3.3 Influence of the DECT antenna gain. Question Q5.

It is shown in Annex A that for DECT residential and enterprise systems, it is the total emitted transmit power (NTP of 24 dBm or 250 mW), rather than the shape of the pattern of the passive antenna, that is relevant for the potential interference probability to adjacent band cellular systems. The antenna gain has for these systems a very limited secondary influence.

Annex A also describes which antenna gains are typical for different DECT systems.

Residential systems have small integral antennas and may have irregularities up to 2-3 dBi. Normal enterprise base stations have 2 dBi, and 6-10 dBi for few difficult or special cases. See figure 3 of Annex A.

The higher antenna gains are used for special situations, and do also in average increase the spectrum efficiency of DECT systems. See figures 1 and 2 of Annex 2.

Several Comments have proposed <12 dBi for the de-licensed CTS. Maximum 12 dBi is specified for DECT in Europe.

It is known from experience that it is difficult to communicate that the antenna gain has no or little influence on the interference probability for the scenarios typical for de-licensed CTS applications.

Therefore antenna gain of maximum 3 dBi is proposed for the Indian de-licensed CTS. 3 dBi will provide for maximum antenna gain of residential systems and normal enterprise base stations, see above.

3.4 Conclusion on Coexistence with adjacent band cellular services

It has been shown that de-licensed residential and enterprise CTS systems will coexist very well on both bands 1880 -1900 MHz and 1910 – 1920 MHz as regards potential interference to the adjacent band cellular systems. The potential interference to DECT in the band 1910-1920 MHz is likely to make the remaining useful spectrum too small for (high capacity) enterprise systems, and the band 1910 – 1920 MHz is therefore the second choice.

The frequency band 1880 – 1900 MHz is for several reasons listed below the natural and preferred choice for de-licensing:

- The 1880 – 1900 MHz band is already allocated for digital CTS "capable of coexistence with multiple operators" within the band (NFAP-11 IND 57).
- The 1880 – 1900 MHz band is already allocated for de-licensed digital CTS within the main part of Region 1 and many parts of Region 3.
- Besides the studies, many years of real life experience from Europe and the US confirms the good coexistence between de-licensed residential and enterprise CTS systems in the band 1880 – 1900 MHz and adjacent band cellular services. There are no complaints.

To further ease any concern from cellular operators, and adjust to Indian conditions, it is proposed to:

- Reduce the de-licensed band to 1882 – 1900 MHz
- Regulate the de-licensed CTS services as secondary services as proposed by GSMA. (This may also ease any concern from CorDECT operators, although the assessment made shows that there will be no coexistence issues with de-licensed DECT or other CTS technologies complying with a proper etiquette.)
- Reduce the allowed antenna gain to 3 dB. (Although it has been shown in Annex A that antenna gain does not increase the interference probability, from typical residential and enterprise CTS systems, to adjacent band cellular services of typical de-license. 12 dBi is specified for DECT in Europe).

4 References

[1] ERC Report 100 "Compatibility between certain radio communications systems operating in adjacent bands, evaluation of DECT / GSM 1800 compatibility"

[2] CEPT Report 39 "Report from CEPT to the European Commission in response to the Mandate to develop least restrictive technical conditions for 2 GHz bands"

The DECT Forum

The DECT Forum is the international association of the cordless home and enterprise communication industry, embracing suppliers and operators of DECT based terminals, systems, and networks. DECT stands for "Digital Enhanced Cordless Telecommunications" and denotes a radio technology suited for voice data and networking applications with range requirements up to a few hundred meters.

The DECT Forum represents the interests of the DECT industry with the following primary objectives:

- To promote DECT as the worldwide cordless communication standard.
- Pursue worldwide harmonization of frequencies for DECT products.
- To provide an interactive forum for sharing information and experience between regulatory and standardization agencies, operators, users and manufacturers.
- To manage the evolution of DECT in a way which protects legacy investments and permits orderly service migration and expansion.

The CAT-iq technology is an evolution of DECT based on the DECT radio interface.

CAT-iq stands for Cordless Advanced Technology – internet and quality. It is being developed to support new consumer product categories in the home. CAT-iq is positioned in the broadband telephony application field, but embraces technology convergence with other application fields.

The DECT Forum has established a certification program for CAT-iq 2.0 wireless communication devices for broadband home connectivity. The qualification program guarantees full interoperability of devices from different manufacturers.

CAT-iq is designed for the next generation of IP-voice and IP-radio services, with plans for migration into the home gateways, enabling consumers to manage their home communication, information and entertainment need.

The DECT Forum represents the DECT/CAT-iq industry, including equipment manufacturers, chip suppliers, operators and test houses and promotes the technology globally, and cooperate with e.g. the Home Gateway Initiative and ETSI.

The Home Gateway Initiative is the industry association for major operators. It advices and supports prioritization of use cases and feature sets of new technologies and interoperability.

The European Telecommunications Standards Institute (ETSI) creates the standards and test specifications for the certification programs.

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Annex A. Power and typical antenna characteristics of DECT residential and enterprise systems

A.1 Residential systems (single cell)

The DECT residential systems are *single cell systems*, covering a flat, or a villa including its basement, main floor, upper floor and garden (medium size). Since the DECT system normally provides the main telephony service of the home, it is very essential that good *coverage is provided everywhere within the premises of the home*.

DECT handsets have very small integral antennas. Because of the small size and interaction with other parts of the handset, the antenna pattern will not be circular but normally rather irregular. This irregularity may correspond to up to 1 or 2 dBi antenna gain in a specific direction.

Residential DECT base stations are not provided with specific antenna directivity, because both upper floor and the basement is supposed to be covered, and it is unknown where or how the customer will place his base station. See figure 1.

A residential bas station is small and has small integral antennas, and acts normally also as a handset charger. Because of the small size and interaction with other parts of the transmitter and the charger, the antenna pattern will not be circular but normally rather irregular. The base station has two antennas for diversity purpose. They may use different polarisation or use space diversity. This irregular pattern of an antenna may correspond to up to 2 or maximum 3 dBi antenna gain in a specific direction, because the antenna parts are somewhat larger than in a handset. See figure 3.

A.2 Enterprise systems (multi-cell)

DECT enterprise systems provide on-premises local mobility and *full coverage* through seamless handover between pico-cell base stations. The services offered are the wireless PBX telephony service and different low and medium rate data services for supervision, control, maintenance and alarms. The DECT local mobility pico-cell system is preferred when the cellular service is unable to provide the required quality, coverage, services or required integration with local key administrative and production systems.

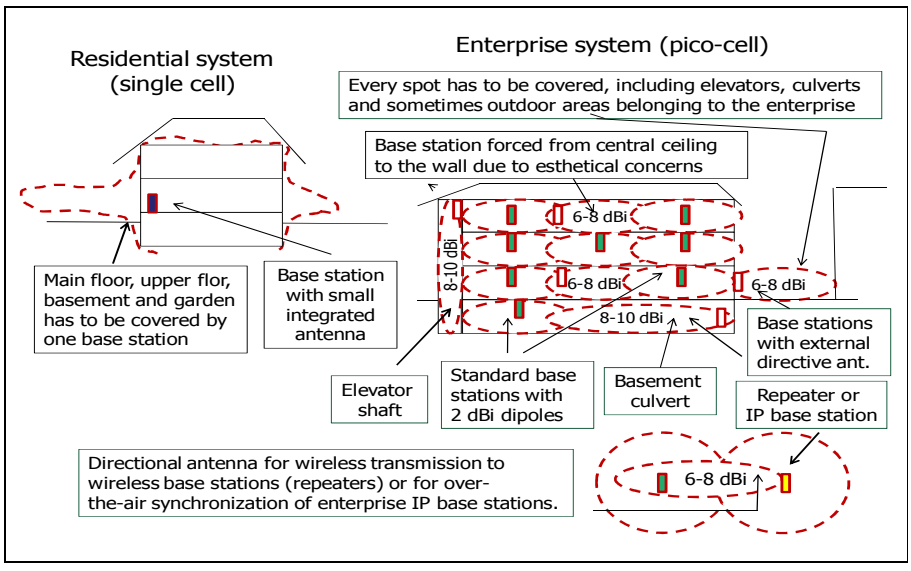

Figure 1: DECT cells in residential and enterprise systems

The enterprise handsets have the same antennas as the residential handsets.

The enterprise base stations are mounted on walls or in the ceiling. They are normally equipped with two integrated half-wave dipole antennas. Enterprise base stations are larger and the antenna space is less encumbered than for residential base stations, thus they have 2 dBi antenna gain in the horizontal plane, typical for a half-wave dipole. See figure 1.

A.2.1 High gain antennas are few, but important for the functionality and economy of DECT enterprise systems

About 5 % of the enterprise base stations have external antennas with 6-12 dBi. This corresponds to 0,026% of all DECT base stations, and 0,01 % of all DECT transmitters. These base stations are very few, but very important for meeting the requirements for coverage, cable access points and esthetical concerns. Figure 1 shows important examples where antenna gain of typically 6-8 dBi are required: Covering an elevator shaft, a base station forced from the central ceiling to the wall due to esthetical concerns and cases where transmission cables or power outlets are not generally available. Besides, the wireless base stations (selective repeaters) and wireless synchronization links for IP base stations also benefit from use of 6-8 dBi directional antennas, sometimes as an outdoor base station to provide a wireless synchronization link to the bases in an adjacent building.

A.3 Basics on the DECT instant Dynamic Channel Selection (iDCS) feature and antenna gain

The mandatory Instant Dynamic Channel Selection messages and procedures provide effective co-existence of uncoordinated private and public systems on the common designated DECT frequency band and avoid any need for traditional frequency planning. Each device has access to all channels (time/frequency combinations). Ten DECT RF carriers are defined in the band 1880-1900 MHz and provide totally 120 duplex access channels. When a control channel or a connection is needed, the channel is selected, that at that instant and at that locality, is least interfered of all the common access channels. This avoids any need for traditional frequency planning, and greatly simplifies the installations. This procedure also provides higher and higher capacity by closer and closer base station installation, while maintaining a high radio link quality. Not needing to split the frequency resource between different systems, services or users gives a very efficient use of the allocated spectrum.

Much unique knowledge and experience is available in the DECT community on the subject of sharing spectrum between uncoordinated installations. To assist regulators, operators and manufacturers, information on this subject has been collected in an ETSI Technical Report, TR 101 310.

To provide effective and fair dynamic sharing of spectrum resources between radio end points, but also between uncoordinated system installations, the (conducted) terminal power of each radio has been limited to 250 mW or 24 dBm. This limits the total radiated power from each antenna to 250 mW.

The DECT spectrum is shared in three geographical dimensions. Antenna gain improves in average the spectrum efficiency of the DECT installations:
DECT residential and enterprise systems are designed for, and generally used in, multi-storey buildings. The DECT spectrum is shared in a three dimensional space, The largest space (volume) that can be covered by the 250 mW, is in principle the coverage by using an ideal isotropic antenna (0 dBi). The reason is that a gain antenna (> 0 dBi in some direction), provides longer range in some direction and shorter in other directions, and the decay index of propagation models normally increases with the distance. The conclusion is that allowing gain antennas do not in average increase the space covered, but only redirects the 250 mW and moves the space covered. See figure 2 below:

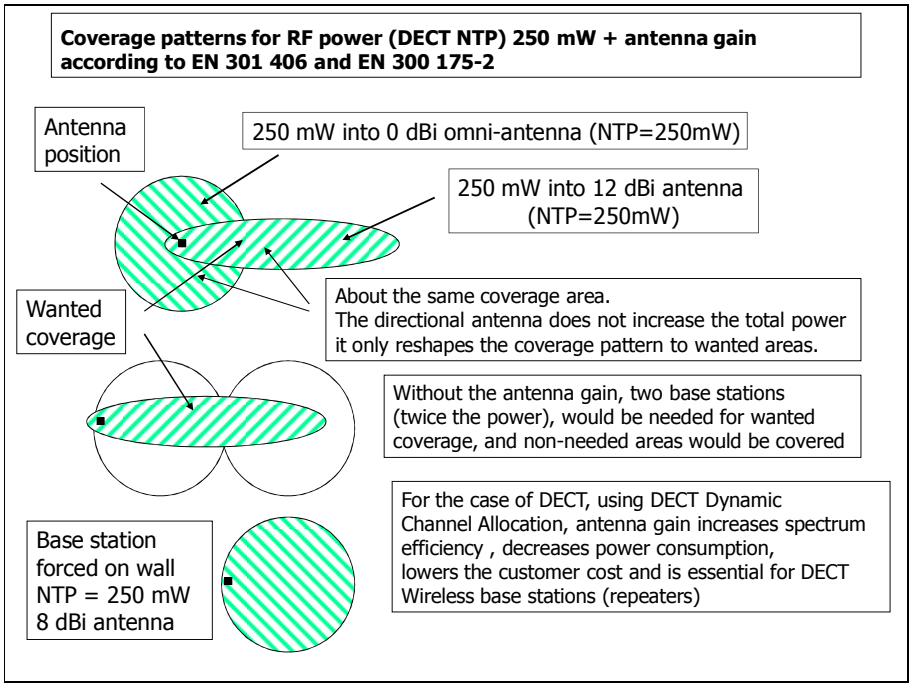

Figure 2: Coverage of DECT with different antenna radiation patterns

A.3.1 Directional antennas improve the spectrum efficiency of DECT systems

Due to the total emitted power not being increased, and due to the DECT instant Dynamic Channel Selection provision, gain antennas do not jeopardize the coexistence between DECT base stations or systems. On the contrary, directional antennas in pico-cell systems on an average increase the DECT spectrum efficiency, since it directs the power where the own devices are, and reduce the power where they are not. The antenna gain also reduces the total emitted power and reduces power consumption.
Furthermore, the antenna gain provision is important to give freedom for feasible design of the small antennas in handsets and residential base stations, and is essential to solve installation problems due to practical and esthetical restrictions on placement of base stations in enterprises.

A.3.2 The DECT antenna gain provision does not increase the total radiated power

Passive antennas with directionality do not increase the total emitted power (24 dBm), but only redirect the same power, as has been shown in figure 2 above. Nor does the passive antenna increase the 3 dimensional space covered, as discussed in section A.3 above.

This is expressed in the early DECT regulatory document TBR6 2nd ed. January 1997 ANNEX H.2. Note: *"The antenna gain notation is, in this context, an expression for directing the emitted power, but not to increase the total emitted power. The total emitted power is always limited to 250 mW, independent of the antenna used. In systems with instant dynamic channel selection, gain antennas direct the signal in the wanted direction and decrease interference in the other directions, and make the infrastructure more cost efficient."*

Figure 2 above illustrates three typical examples where the coverage area is not increased: two cases for a single cell and one case where one single cell with antenna gain replaces two cells without antenna gain. Therefore it can be shown below that DECT antenna gain has limited influence on the interference probability.

A.4 DECT operates in NLOS environments, where the sum of all reflections make up the interfering power

DECT residential and enterprise systems are installed and used indoors, and the few outdoor base stations are installed below roof top. This is basically a non line of sight, NLOS, environment, both for the wanted DECT transmission links and for the interference links related to cellular outdoor base stations.

Secondly, in dispersive NLOS environments it is in principle the total power of all reflections, rather than the emission in a specific direction, that decides which power reaches the base station. Thus the range will basically be dependent of the totally emitted power (the conducted terminal power), and rather independent of the shape of the antenna pattern. See figure 3 below, where the sum of all reflections reaching an outdoor cellular base station site.

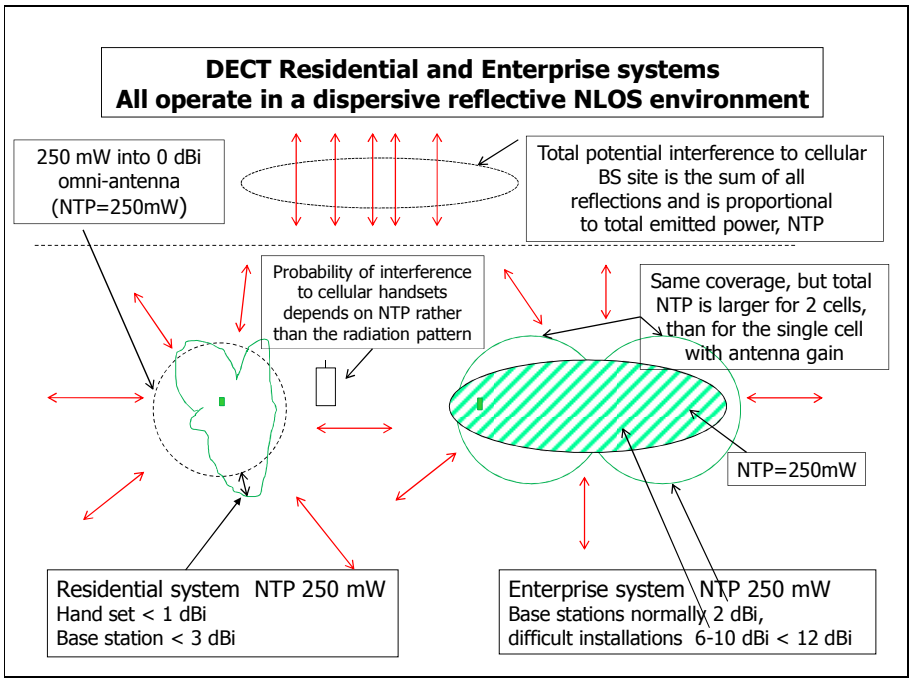

Figure 3 Emitted power and antenna radiation patterns in an indoor or below roof-top NLOS environment

Thus for the reflective NLOS environment, that is typical for the DECT license exempt residential and enterprise applications, both interference from DECT indoor and outdoor transmitters to outdoor cellular base stations basically depends on the totally emitted power (NTP =240 mW) and is rather independent of the shape of the antenna pattern.
Furthermore, as stated in section A.2.1 high gain antennas are only used for multi-cell systems. A DECT base station with high gain antenna will replace two base stations with 0 dBi antenna gain. It is obvious that the potential interference from one base station with high gain antenna will not be greater than from the two base stations it is replacing. See example in figure 3 above.
Figure 3 also indicates the probability to interfere with cellular handsets directly depends on NTP and is rather independent of the shape of the antenna radiation pattern.

Annex B. Coexistence with adjacent band cellular services

This annex contains complementing information on section 3.2.1.2 “Coexistence with adjacent band macro cellular base stations”, and also a figure B1 showing spectrum options for de-licensed CTS including nominal DECT carrier positions.

B.1 Complementing information on section 3.2.1.2 “Coexistence with adjacent band macro cellular base stations”

There is an important distinction between above DECT (corDECT) WLL installations and de-licensed residential and enterprise installations.

As seen from the figure 1 of section 3 above the residential and enterprise DECT applications are mainly indoors, and somtimes at garden/street level just outside the home/building with the DECT installation. Thus for residential and enterprise systems, the RFPs and PPs are in relation to the cellular base stations geographically used in the same positions as cellular MSs, but mainly indoors. Furthermore, DECT (24 dBm) base stations, RFPs, and handsets, PPs, have about the same transmit power as cellular handsets MS (23-24 dBm for 3G). (About 50% of the cellular MSs operate within 6 dB of their maximum power).

Therefore, principally, the interference probability to cellular base station B3 (above 1900 MHz) from DECT will not exceed the interference probability from cellular MSs M4 on an adjacent cellular block, especially since the ACLR figure for DECT is considerably better than for cellular MSs (20 dB better that for UMTS, LTE and Wimax). Since the cellular system B3 is designed to operate well with a cellular operator B4 and its mobiles M4 on the adjacent block, potential *interference* from DECT residential/enterprise (mainly indoor) systems *to cellular base station up-links will not be an issue.*

A more detailed calculation of the interference from adjacent channels to cellular base stations is made below, supposing the cellular technology is 3G (WCDMA, LTE or WiMax). The handsets 3G technologies have an adjacent channel leakage ratio ACLR or 33 dB. DECT has an ACLR of 55-62 dB depending on DECT carrier F0 – F9. See DECT carrier positions in figure B1 below. (If required, DECT Forum will provide the calculations of the DECT ACLR figures 55-62 dB in relation to 3G technologies). See figure 1 of section 3 above, where these ACLR figures have been indicated in relation to cellular base station B3.

The actual interference level to the base station B3 receiver does not only depend on the ACLR of interfering transmitters, but also on the adjacent channel selectivity ACS of the receiver of the base station B3.

Theoretically the adjacent channel leakage power ratio, ACLR, and adjacent channel selectivity, ACS, are combined to give an adjacent channel interference ratio, ACIR, according to the following equation:

$$ACIR^{-1} = ACLR^{-1} + ACS^{-1} \qquad \text{(for ACIR, ACLR and ACS as linear ratios)}$$

The ACIR for DECT becomes 46-56 dB and for 3G handsets 33 dB. (If required DECT Forum will provide the calculations of the DECT ACIR figures). Thus the ACIR for DECT is 13-23 dB better than for 3G handsets. It is thus obvious that the potential interference to adjacent block cellular base stations from DECT is not critical, since the cellular system has been designed to operate satisfactory with adjacent block cellular handsets having much higher ACIR than DECT. The ACS of cellular base stations are often better than the specification in the standard. If so, the difference will be even higher, up to the difference in ACLR.

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B.2 Spectrum options for de-licensed CTS including nominal DECT carrier positions

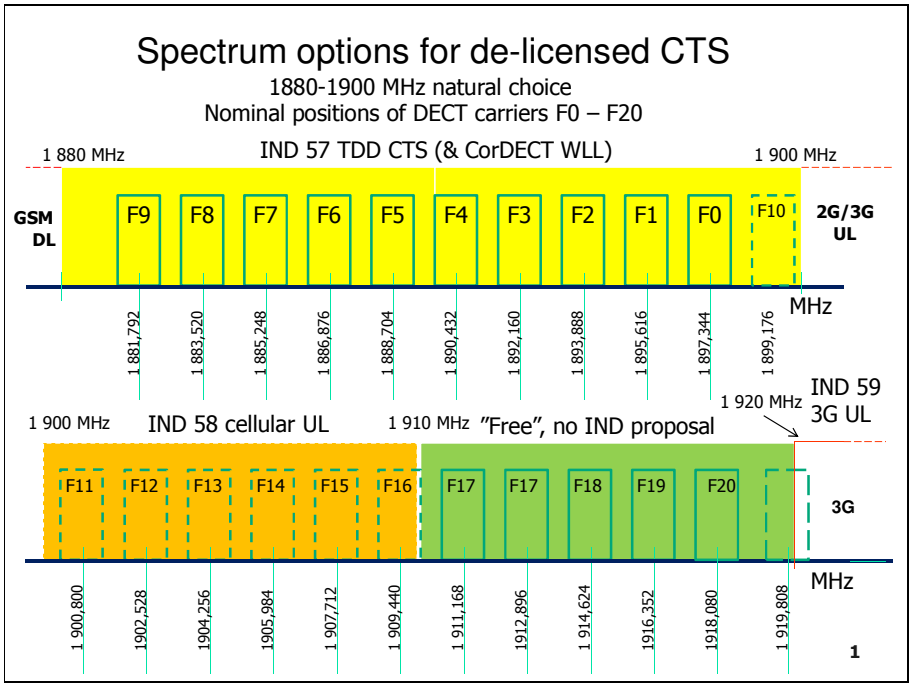

Figure B1. Spectrum options for de-licensed CTS including nominal DECT carrier positions