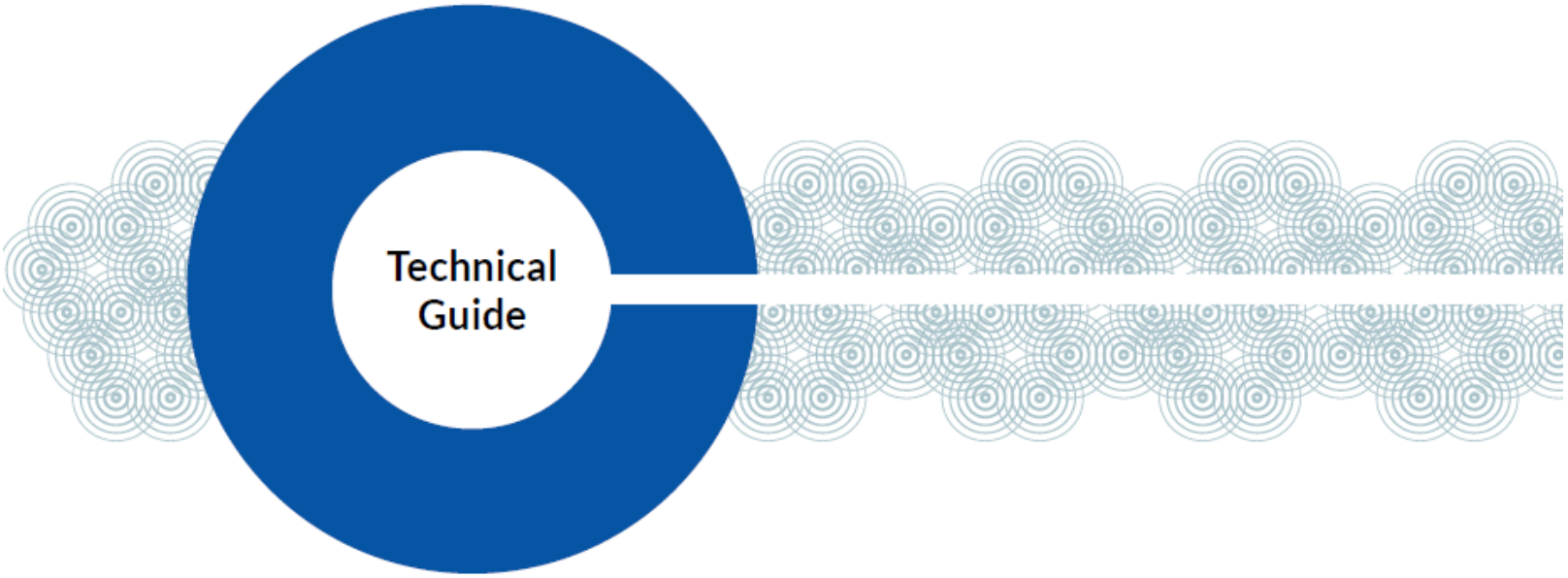
Clear-Com
AN HME COMPANY



Digital Enhanced Cordless Telecommunications and Wireless Intercoms

Topics

What is DECT?

How is it allocated by the ETSI

How has the FCC regulated DECT.

Why manufacturers choose the DECT band for wireless intercoms

How manufacturers adapt to the regulations

What are the limitations for expanded use of DECT based wireless intercoms

Alternatives- SPECIAL TEMPORARY AUTHORIZATION

STA explained properly

Special Conditions

Intent and Scope of this Document:

The past few decades have shown a significant increase in the use of wireless devices, especially in the world of personal devices like cell phones, tablets, and laptops. With this transformation has come additional scrutiny and policing by government agencies around the world. This paper will examine Digital Enhanced Cordless Telecommunications (DECT) wireless technology as applied specifically to the design and use of a wireless intercom system and legal policies and procedures for allowed changes to the configuration of the equipment in the United States.

What is DECT?

DECT stands for Digital Enhanced Cordless Telecommunications. It's a secure wireless technology originally developed as a means for a portable phone to access a fixed telephone network via radio. DECT was developed by The European Telecommunications Standards Institute (ETSI).

The original abilities of a domestic DECT Generic Access Profile (GAP) system include multiple handsets to one base station and one phone line socket. This allows several cordless telephones to be placed around the house, all operating from the same telephone jack. Handsets can in many cases be used as intercoms, communicating between each other or the base unit, and sometimes as walkie-talkies, intercommunicating without telephone line connection.

DECT products operate in the 1880–1930 MHz band, specifically the duplex gap for PCS/DCS mobile services. A DECT system will operate in a smaller segment of this range based upon regional regulatory restrictions. For example, in the United States, DECT systems operate from 1920-1930 MHz (the duplex gap for LTE band 2, Personal Communications Service – PCS). In Europe, unlicensed DECT systems may operate from 1880-1900 MHz (the Digital Telecommunications Service – DCS – duplex gap).
DECT operates as a multicarrier Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA) system.

Time Division Multiple Access (TDMA) is a channel access method used in digital cellular telephone and mobile radio communications. TDMA is one of a number of ways to divide a bandwidth limited channel into smaller parts to effectively have more channels and thus greater capacity. In this case, it divides a given RF channel.

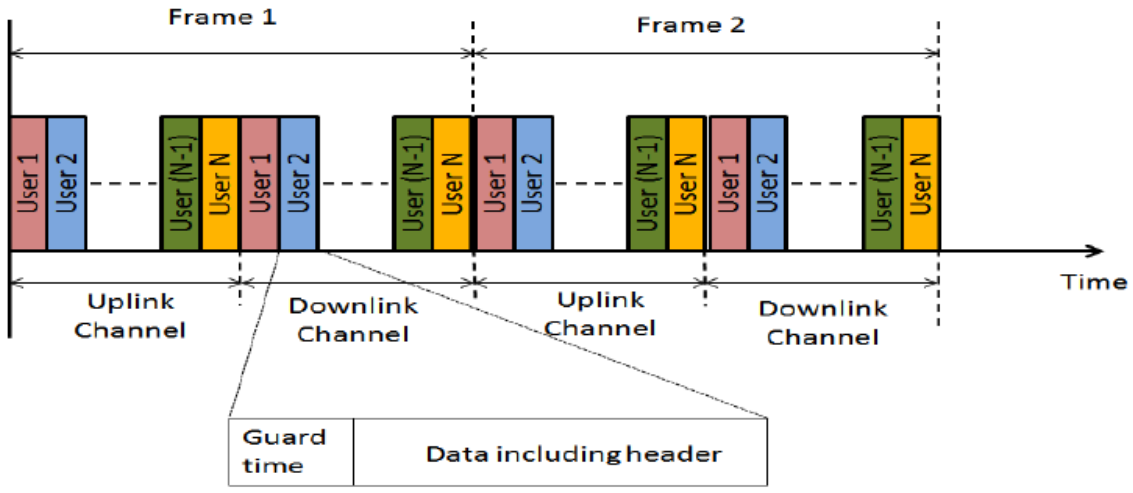


Figure 1: TDMA Time Slots

The graphic in figure 1 shows conceptually how TDMA allows multiple users to share a single frequency channel by dividing the time into frames, and these frames into time slots. Each user is allocated a unique time slot in which to transmit and receive their data. This methodology allows multiple users to share a single channel and increases the overall capacity of the channel.

What this means is that the radio spectrum is divided into physical carriers in two dimensions, frequency, and time. FDMA access provides up to 10 frequency channels dependent on regional regulatory requirements. DECT channels are 1.728MHz wide, with the carrier occupied bandwidth of 1.19MHz . In the United States, where 10MHz is allocated, a DECT system will utilize 5 channels. In Europe, where 20MHz is allocated, DECT systems will have roughly twice the capacity as systems deployed in the United States, as 10 channels will be allocated.

TDMA will then divide each channel into 10 millisecond frames. Each frame contains 24 time slots which are then allocated to users. Full duplex communication is possible as DECT uses time-division duplex (TDD), which means that down and uplink use the same frequency but different time slots. Thus, a base station provides 12 duplex speech channels in each frame, as a duplex channel requires a downlink time slot and an uplink time slot. Only 10 of these duplex channels are allocated for user traffic as some capacity is required for handoff in roaming systems, considering propagation delay. Each slot has enough time to allow for a few hundred meters of delay.

The European Telecommunications Standards Institute (ETSI) [1]

ETSI standards documentation prescribe the following technical properties:

- Frequency: the DECT physical layer specifies RF carriers for the frequency ranges 1880 -1980 MHz and 2010-2025MHz. The most common spectrum allocation is 1880-1900 MHz in Europe; outside Europe, 1900-1920 MHz and 1910-1930 MHz spectrum is available in several countries. DECT type systems may also operate in the license free Industrial, Scientific, and Medical (ISM) band from 2400-2483 MHz, as well as 902-928 MHz in the United States. These ISM based systems usually utilize a frequency hopping methodology with time slot redundancy, as these bands are heavily used. DECT type systems operating in the ISM bands will typically have lower user capacity than systems which operate in the DECT bands. [1] (https://www.etsi.org/technologies/dect)

GLOBAL DECT FREQUENCY BANDS

FREQUENCY BAND	COUNTRIES & DETAILS
1880 – 1900 MHz	Europe, South Africa, much of Asia, Hong Kong, Australia, and New Zealand (10 channels)
1786 – 1792 MHz	Korea (3 channels only)
1880 – 1895 MHz	Taiwan (8 channels)
1893 – 1906 MHz	Japan (J-DECT)
1910 – 1920 MHz	Brazil (10 channels)
1910 – 1930 MHz	Much of Latin America excluding Brazil.
1920 – 1930 MHz	USA & Canada known as UPCS (Unlicensed Personal Communications Service) band (5 channels)

As can be seen from the chart above, DECT system capacity will be determined by local regulatory restrictions.

How has the FCC regulated DECT.

From 1994 to 1996 the first FCC auctions took place that primarily involved the newly designated Personal Communications Service (PCS) mobile services band consisting of 1850-1910 (uplink) / 1930-1990 (downlink), with 1910-1930 being the duplex gap hosting unlicensed service - UPCS. Unlicensed Transition and Management, Inc. (UTAM, Inc.) was designated by the FCC to manage the transition of the prior fixed microwave incumbents out of this auctioned spectrum and to act as the duplex gap bands coordinator. Within the 20-megahertz duplex gap, enterprise/commercial cordless phone systems were permitted in two sub-bands 1910-1920 MHz and 1920-1930MHz. This was a band licensed by rule (no individual licenses required, much like the 27MHz Citizens Band radio service).
In 2004, the Federal Communications Commission re-designated the lower 10 megahertz of the Unlicensed Personal Communication Service band (1910-1920 MHz) for licensed Fixed and Mobile Services on a primary basis, to support the types of high-powered mobile applications associated with Advanced Wireless Service (AWS) and Broadband PCS use, after finding that portion of the UPCS band was underutilized. Of this 10 MHz of UPCS spectrum that was re-designated for PCS/AWS use, the Commission assigned the lower 5 megahertz (1910-1915 MHz) to Nextel (now T-Mobile) in conjunction with the 800 MHz-band relocation proceeding.

The Federal Communications Commission in 2005 changed channelization and licensing costs in the remaining UPCS band (1920–1930 MHz allowing DECT devices to be sold in the U.S. These channels are reserved exclusively for voice communication applications and therefore are less likely to experience interference from other types of wireless devices.

In North America, technically, DECT suffers from deficiencies in comparison to DECT elsewhere, since the UPCS band is not free from heavy interference. Bandwidth allocated is half as wide as in Europe (1880–1900 MHz). Additionally, peak transmit power is limited to 100 milliwatts in the US, while in Europe peak transmit power of 250 milliwatts is allowed.

North American products may not be used in any other region of the world as they cause interference with the local cellular networks. European DECT products may not be used in the United States and Canada, as they likewise cause interference with American and Canadian cellular networks; use is prohibited by the Federal Communications Commission and Innovation, Science and Economic Development of Canada respectively.

Why do manufacturers choose the DECT band for wireless intercoms

The history of how manufacturers of wireless production intercoms came to develop solutions based on DECT is manyfold, including the fact that the PCS duplex gap in most regulatory jurisdictions is designated for use only by DECT devices on an unlicensed basis.

The primary contributing factor were the changes in spectrum availability in that portion of the UHF band typically used by entertainment wireless equipment, the UHF-TV band above 470MHz. Since 2007, the available UHF TV band spectrum in most world-wide regions has been reduced by as much as 55%

in order to provide additional spectrum for mobile services. Subtract from the remaining TV band spectrum the active television stations, which can be virtually all TV channels in some major markets.

Manufacturers of wireless production intercoms were also aware of the ever-increasing channel counts of wireless microphones and in-ear monitors. Given these high channel counts for microphones and IEMs and the continued use in TV band spectrum, the choice to utilize alternate spectrum, and DECT development in particular, made sense.

Clear-Com was the first intercom manufacturer to develop and offer a DECT based wireless intercom in 2005. Since then, the solution has been reinvented and upgraded many times to its current format including IP connectivity to transceivers. In 2017, two other manufacturers introduced DECT wireless intercom solutions. All manufacturers of DECT wireless intercoms must follow the regulations as described above.

How do intercom manufacturers adapt to the regulations?

Manufacturers of DECT based wireless intercoms must offer products defined and limited to the ETSI standards and restricted to operate on frequencies allocated by country specific regulatory authorities in the frequency band between 1880 and 1930MHz. Furthermore, in the USA, the Federal Communications Commission stipulates that a manufacturer of DECT products cannot give users, dealers or other third parties the ability to tune their devices such that they would be in violation of FCC regulations for DECT regional settings. Other countries have similar restrictions on tunability of DECT systems.

Manufacturers usually limit the frequency range of DECT intercom systems through factory programming. **Due to regulations, only the equipment authorization holder, which is usually the manufacturer, is allowed to change the configuration of the equipment.** In the US, the FCC does allow dynamic region selection. Use of such methods typically have other restrictions. For example, if GPS location is used to determine region, the system will require a GPS fix prior to initiating transmission.

Example of Clearcom product labeling noting the regional frequency setting for use in the U.S. (left) and EU (right)

Of important note is that the beltpacks, or portable units, may receive their regulatory information by connecting to a base station or fixed node. In normal operation, the portable does not initiate transmission until connection with a base. Upon power up, the beltpack searches for compatible DECT

transmissions. Once the associated base station is detected, the beltpack will connect and conform with the regional regulatory settings of the base. Therefore, regulatory agencies typically do not require DECT portables to be locked to a particular region.

To clarify this restriction, the FCC issued the following memorandum:

FCC Office of Engineering and Technology Laboratory Division, July 17, 2014

> *The FCC rules require that any radio, in which the software is designed or expected to be modified by a party other than the manufacturer that would affect the operating parameters of frequency range, modulation type, maximum output power or other radio frequency parameters outside the range under which the transmitter has been approved in accordance with the Commission rules, must comply with the requirements in Section 2.944 (a) and must be certified as a software defined radio.*

All industry manufacturers who offer radio(s) used in their DECT based wireless intercoms are not certified as software defined radios and are designated non-SDR.

The FCC states non-SDR(s) are fixed to only operate on approved frequencies, are limited to all applicable conditions of the certification, and cannot be generally modified in the field outside the grant conditions. Non-SDR equipment third parties (end users, professional installers, and distributors) cannot have any ability to configure or operate transmitters on non-US frequencies or operate in any way that violates the approved certification*.

* *Operating the device on any other regulatory frequency bands, modulation types, bandwidth, power, etc. that is not permitted by the rules, and/or not in compliance with the certification as granted.*

User Capacity and Audio Bandwidth

One DECT timeslot contains 320 bits of what is called payload data. This is the data that may be used for audio traffic. With frame rate of 10 milliseconds, or 100 frames per second, this equates to an effective data rate of 32 kbps. A user data rate of 64 kbps is possible by allocating two slots, or what is known as a DECT long slot, but this will reduce user capacity by two.

Clear-Com's FSII uses 1 timeslot in each direction for the FreeSpeak II 1.9 BPs, therefore we have a capacity of 100 Beltpacks - 10 slots x 10 channels = 100 BPs. FS utilizes Broadcom's BroadVoice 32 (BV32) audio codec which supports a 7 kHz audio bandwidth at 32 kbps.

RTS/Telex uses 1 or 2 timeslots for their BPs, 2 slots allow them to use a 7 kHz audio codec, 1 slot allows them to use a 3 kHz audio codec (giving them 50/100 users in the same place depending on codec selected). The RTS codec requires 64 kbps to support a 7 kHz codec.

Riedel uses 1 timeslot for their BPs, whilst using a 7KHz audio codec giving them 100 users in the same place. They use a BV32 codec same as Clear-Com FSII.

Live Event RF challenges

At a live event it is not uncommon to find several production company suppliers onsite deploying wireless for various show elements, some supplying wireless intercom for broadcasters and some for entertainment. Quite succinctly, the use of wireless anything at live events is challenging. Use is growing and the spectrum shrinking, with frequency coordinators at shows/events are increasingly common.

As shows get bigger so do the technical crews and so the demand for more communication arises. No one wants to be tied to a wire anymore and we look to full duplex intercom, not 2-way radios to fill that communications need. The answer to supply additional wireless intercom isn't so simple.

Expanding the DECT profile…

Referring to the above July 17, 2014, FCC Office of Engineering and Technology Laboratory Division statement we read it is basically illegal for third parties (end users, professional installers, and distributors) to configure or operate transmitters on non-US frequencies, or in any way that violates the approved certification. There has of late been application by wireless communication intercom system vendor/providers for Special Temporary Authority (STA) licenses.

> **25.120 Application for special temporary authorization.**
> (a) In circumstances requiring immediate or temporary use of facilities, request may be made for special temporary authority to install and/or operate new or modified equipment. The request must contain the full particulars of the proposed operation including all facts sufficient to justify the temporary authority sought and the public interest therein.

An applicant may request a Special Temporary Authorization (STA) for operation of a conventional experimental radio service station during a period of time not to exceed 6 months.

SPECIAL TEMPORARY AUTHORIZATION

The Federal Communications Commission (FCC) grants Special Temporary Authority (STA) to permit immediate or temporary operation of certain radio facilities during emergencies or other urgent conditions.

STA may be granted in the following circumstances:

1. In emergency situations, such as natural disasters.
2. To permit restoration or relocation of existing facilities to continue communication service.
3. For a temporary, non-recurring service where a regular authorization is not appropriate.
4. In other situations, involving circumstances which are of such extraordinary nature that delay in the instruction of temporary operation would seriously prejudice the public interest.

Special Conditions:

STA grants usually contain operational conditions. As it relates to operating DECT communications equipment outside the standard 1920-1930 MHz, the conditions will typically be:

1) Licensee should be aware that other stations will be licensed on the other frequencies and if any interference occurs, the licensee of this authorization will be subject to immediate shut down.
2) In lieu of frequency tolerance, the occupied bandwidth of the emission shall not extend beyond the band limits set forth by the FCC.
3) The applicant shall secure consents from all incumbent Advanced Wireless Service licensees in the proposed areas prior to accessing the other frequencies
4) Prior to commencing any operations outside of 1920-2930 MHz, the applicant must obtain consent from the license holders
5) Stop Buzzer POC: [onsite point of contact name; mobile number].

STAs are granted with a fixed expiration date, up to six months, or for the term necessary to cover a special event, etc. STAs do not have grace periods and are valid only through their expiration date.

Clear-Com and STA grant guidelines.

Based on the FCC's guidelines for a Special Temporary Authorization, Clear-Com has created a way for a person or a business to switch the regional restrictions of their 1.9 GHz transceiver after they have collected all the required documents. There are three main steps to do this:

1) The user must apply and be approved for a grant from the FCC via the STA request form to use frequencies designated in the authorization.
2) The applicant must get written approval from the license holder (or holders) of the frequencies wishing to use.
3) The applicant must sign an agreement with Clear-Com which states that they have secured all of the necessary paperwork and will follow the FCC regulations and STA guidelines. The applicant also agrees that Clear-Com shall not be held liable should the STA not be followed for any reason and the FCC levies a fine. After the applicant fulfills all the requirements, Clear-Com will send an Applications Engineer to the applicant's site to modify the regional settings before and after the STA. The FCC requires that only the manufacturer can alter the region or frequency of a wireless device, consequently Clear-Com cannot legally give any software to the applicant that executes this change. This is a chargeable service.
4) After the applicant fulfills all the requirements, Clear-Com will send an Applications Engineer to the applicant's site to modify the regional settings before and after the STA. The FCC requires that only the manufacturer can alter the region or frequency of a wireless device, consequently Clear-Com cannot legally give any software to the applicant that executes this change. This is a chargeable service

Unlicensed radio operation cautioning

- No radio transmitter shall be operated in the Experimental Radio Service in the United States and its Territories except under and in accordance with a proper station authorization granted by the Commission such as a Special Temporary Authorization.
- Be aware that if you operate a radio transmitter that requires a license or use a radio that is authorized for only a specific service for an unauthorized service, you may be fined or imprisoned, and/or the equipment may be confiscated.

- It is also a violation of FCC rules for a technician to program a transmitting frequency into a radio that the user is not licensed for or otherwise legally authorized to use.

Final Message

Since 2005, Clear-Com has led the industry for wireless production intercom as they were the first to develop and launch a roaming 1.9 GHz DECT system. This has led to a transformation in the media and production industry by allowing 50+ users to wirelessly roam a production environment. As the industry has grown and competitors have adopted the same type of technology, Clear-Com has continued to look at the next generation of wireless communications which has led to the advent of FreeSpeak Edge and mobile applications like Agent-IC and Station-IC.
Along the way Clear-Com has advocated to uphold that all regulations and FCC guidelines have not only been met, but exceeded to safeguard all end users are protected and never fined by a government agency. In that spirit, we urge that all users of wireless DECT systems follow the guidelines as explained in this document, no matter if you are using a Clear-Com device or any other wireless DECT system.

Glossary:

Accepted Interference. Interference at a higher level than defined as permissible interference and which has been agreed upon between two or more administrations without prejudice to other administrations.

Authorized frequency. The frequency assigned to a station by the Commission and specified in the instrument of authorization.

Experimental radio service. A service in which radio waves are employed for purposes of experimentation in the radio art or for purposes of providing essential communications for research projects that could not be conducted without the benefit of such communications.

Experimental station. A station utilizing radio waves in experiments with a view to the development of science or technique.

Harmful interference. Any radiation or induction that endangers the functioning of a radionavigation or safety service, or obstructs or repeatedly interrupts a radio service operating in accordance with the Table of Frequency Allocations

PCS/DCS. The Broadband Personal Communications Service (PCS) is in the 1850 – 1990 MHz spectrum range. The most common use is mobile voice and data services, including cell phone, text messaging, and Internet. DCS. Digital Cellular Service

AWS. Advanced Wireless Services is a wireless telecommunications spectrum band used for mobile voice and data services, video and messaging

SDR. A software-defined radio system is a radio communication system which uses software for the modulation and demodulation of radio signals.