CONTENTS

7.0 Cordless Phone Systems

OBJECTIVES

This section will:

- Consider the difference between cordless and cellular equipment
- Examine the difference between analog and digital cordless phones
- Examine the CT0 to CT3 family of standards
- Examine the DECT cordless standard

There are a number of cordless systems used throughout the world.

http://www.max.tele.ru/mobile/e_phone.htm
http://www.apspg.com/wc/cordlessphone.html

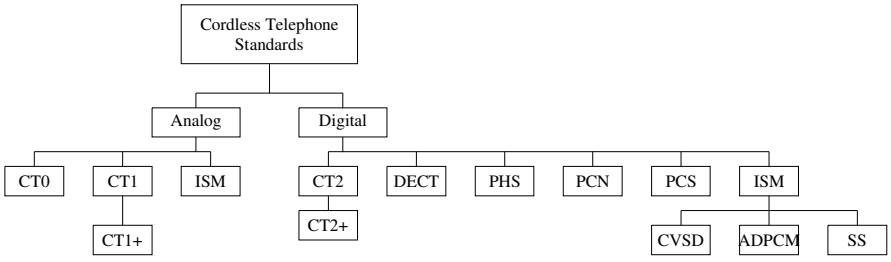
Analog cordless telephones

CTO
JCT
CT1/CT1+

Digital cordless telephones

CT2/CT2+
DECT
PHS

http://www.apspg.com/wc/ct2ct3.html provides the following chart to classify various cordless systems.



7.1 Cordless Telephone Systems

Cordless systems are distinguishable from conventional cellular systems, in that they require the end-user to have their own basestation connected to the

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PSTN. However, the massive growth of the cellular industry has forced the development of microcells to cover high-density areas such as downtown cores and office buildings. In such applications, the portable unit can be made quite small since it does not have to transmit over a long distance. Consequently, microcell networks start resembling home cordless telephones.

There are however, problems with extending the cordless telephone into the cellular environment. One difficulty is billing. Since cordless telephones do not contain identification codes, the Telco sends the bill to the basestation wired to the PSTN. In a cellular environment, the Telco owns the basestation and sends the bill to the registered handset owner.

7.2 Analog Cordless Telephones

The first cordless systems were intended to be an alternative to the standard analog wired telephone. Units consist of a base station and wireless phone. There was no attempt to provide features such as handoff or roaming.

The CT0 and CT1 series cordless telephones are entirely analog.

7.2.1 CT0-Cordless Telephone 0

Frequency Band [MHz]	2/48 [U.K.] 26/41 [France] 30/39 [Australia] 31/40 [The Netherlands, Spain] 46/49 [China, S. Korea, Taiwan, USA] 48/74, 45/48 [China]
Access Method	FDMA
Duplex Method	FDD
Number of Channels	10, 12, 15, 20 or 25
Channel Spacing	1.7, 20, 25 or 40 KHz
Modulation:	FM
Channel Bit Rate	—

7.2.2 JCT-Japanese Cordless Telephone

Frequency Band [MHz]	254/380
Access Method	FDMA
Duplex Method	FDD
Number of Channels	89
Channel Spacing	12.5 KHz
Modulation:	FM
Channel Bit Rate	—

7.2.3 CT1/CT1+ Cordless Telephone 1

System	CT1	CT1+
Frequency Band [MHz]	914/960	80
Access Method	FDMA	FDMA
Duplex Method	FDD	FDD
Number of Carriers	40	80
Channels per Carrier	1	1
Channel Spacing	25 KHz	25 KHz
Modulation:	FM	FM
Channel Bit Rate	—	—

Note: there is some contradictory information on this standard. The above frequency band is taken from *Telecommunications Standards: Overview* published by Philips Semiconductors at www.semiconductors.philips.com/telecom/backgroundinfo/telecom standards/overview.html. *Cordless Telephone Classification* published at www.apspg. com/wc/ct2ct3.html lists the tx frequency band as 46.67 - 46.97 MHz.

7.3 Digital Cordless Systems

The newer cordless systems such as CT2 and beyond use all digital techniques.

http://www.vtech.com.hk/products/cp/index.htm

7.3.1 CT2/CT2+

http://www.radio.gov.uk/document/consult/cordless/cordless.htm

	CT2	CT2+
Frequency Band [MHz]	864/868	944/948
Access Method	TDMA/FDMA	TDMA/FDMA
Duplex Method	TDD	TDD
Number of Carriers	40	38
Channels per Carrier	1	1
Channel Spacing	100 KHz	100 KHz
Modulation:	0.55 GMSK	0.55 GMSK
Channel Bit Rate	72 Kbps	72 Kbps
Vocoder	32 Kbps ADPCM	32 Kbps ADPCM
Peak Tx Power	10 mW	10 mW
Handoff Capability	No	Yes

CT2 is a second-generation cordless telephone and uses digital technology. Telepoint basestations are deployed in high traffic pedestrian areas. The system allows customers to place outbound calls, but not to receive inbound calls. The customer must also stay within range of the basestation, since there is no call hand-off capability.

The CT2 time frame contains a full duplex or TDD channel.

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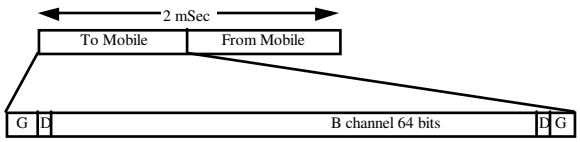

G - Gaurd B
D - Data Channel

Each time frame contains 64 bits of end-user information and 4 bits of control information. Added to this is an 8-bit guard time. The total channel therefore consists of 144 bits in a 2 mSec period.

CT2+ reserves two channels for signaling and thus has fewer end-user channels than CT2. The signaling channels help to support the handoff capability. Furthermore, a customer can register with a public basestation and receive incoming calls. This service has been adopted in the UK, France and by Nortel in Canada. However, in Europe it is being replaced by DECT.

7.3.2 CT3

CT3 is a proprietary system developed by Ericsson and sometimes called DCT900.

Frequency Band [MHz]	800 - 1000
Access Method	FDMA/TDMA
Duplex Method	TDD
Number of Carriers	4/8
Channels per Carrier	8
Channel Spacing	100 KHz
Modulation:	0.55 GMSK
Channel Bit Rate	72 Kbps
Vocoder	32 Kbps ADPCM
Peak Tx Power	10 mW
Handoff Capability	Yes

4 MHz of the allocated band is divided into 1 MHz segments. Each segment carries a 16 x 1 mSec time slots. Two slots are required for a full duplex channel. If all 4 MHz is allocated to a cell, a total of 32 full duplex channels can be handled. Two slots are reserved for control transactions between the handset and the basestation.

CT3 has hand-off capability, thus making if function like a cellular phone. Since the phone is only transmitting during a small fraction of the frame time, it can monitor available channels within its own or adjacent cells. This allows the handset to signal the need for a hand-off, and simplifies the basestation design. Furthermore, it allows for frequency reuse on adjacent cells.

7.3.3 DECT

http://fiddle.ee.vt.edu/courses/ee4984/Projects1997/lai.html

http://www.dect.ch/

Since its introduction in 1991, DECT† has become a pan-European standard, but it has also been adopted with some modifications throughout most of the world.

Frequency Band [MHz]	1880-1900
Access Method	TDMA/FDM
Duplex Method	FDD
Number of Channels	10
Users per Channel	12
Channel Spacing	1.728 MHz
Modulation:	0.5 GMSK
Channel Bit Rate	1.152 Mbps
Vocoder	32 Kbps ADPCM
Peak Tx Power	250 mW

DECT competes directly with CT2+ however; it provides a much richer feature set and higher user density. It uses the same speech coder as CT2+ and allows users to both receive and initiate calls almost anywhere.

There are five main applications for the DECT system:

- Wireless data
- Cordless PBX
- Wireless local loops
- Home cordless phones
- DECT/GSM dual phone

Initially DECT was adopted to support the wireless data market but has since grown to support wireless PBX and telepoint applications. Wireless PBXs are used in office buildings and industrial plants to replace or supplement intercom and radio paging systems. Telepoint can replace public pay phones.

Another potential use for DECT is the wireless local loop. In some areas, it is faster and more cost effective for telcos to deploy wireless loops rather than running twisted pair cables to individual homes.

DECT systems can supplement the cellular coverage in high-density areas. It is expected to be able to handle a user density of 10,000 erlangs per sq km. In order to interface with the PSTN or GSM networks, seamless call handover and roaming are required. To provide the same speech quality as the PSTN, DECT uses ADPCM†.

The 20 MHz spectrum contains 10 RF carriers spaced at intervals of 1.728 MHz. Each carrier channel is time division multiplexed into 12 full duplex digital channels. The 12-channel frame is 10 mSec long.

The basic channel rate is 32 Kbps per time slot. Higher speed data rates of 64, 128, or 256 Kbps for fax or PCs, can be handled by concatenating time slots.

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† Digital European Cordless Telecommunication or Digital Enhanced Cordless Telecommunication

† Adaptive Differential PCM

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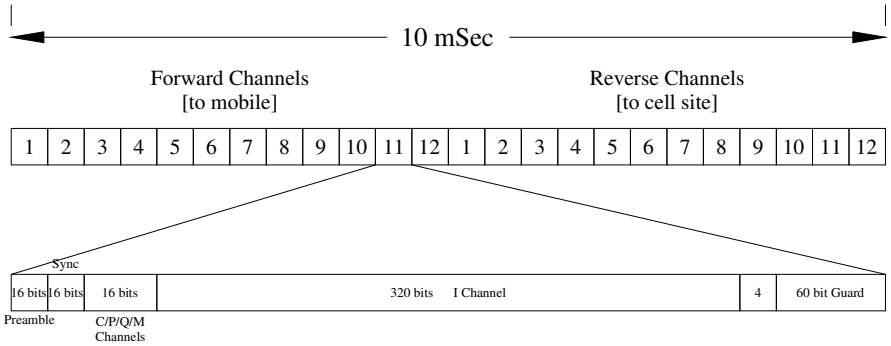

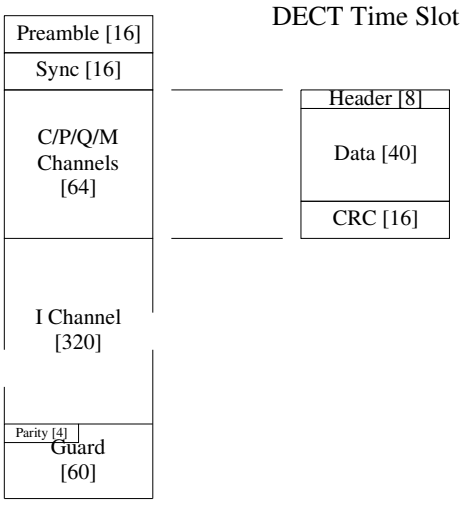

Since the telephone set is transmitting for a relatively short period of the time frame, the balance of the time can be spent on call processing functions such as channel selection and hand-off.

The typical range when deployed in side a building is 20 - 50 meters. When used outside, the range increases to about 300 meters. Cells of this size are called pico cells. However, some systems have extended the range to 15 km.

The set is constantly monitoring adjacent channels and cells for a better frequency. Once one is found, it signals the radio control unit to establish a parallel connection. Once achieved, a hand-off occurs. Since the system uses pico-cells, handoffs can occur quite frequently.

One distinguishing characteristic between cordless and cellular systems is the use of SIM†s. A cellular system must be able to identify the subscriber for billing purposes. This is crucial to support roaming. The DAM† can be implemented in two ways: it may be built-in to the set, or it may be a smart card.

It may even be that dual mode terminals, which can automatically switch between DECT and GSM, will form the basis of some PCS networks.

7.3.4 PHS

PHS† is a digital micro cellular or cordless telephone system that has been designed to provide affordable, high quality communications for the mass market. In Australia, PHS is being marketed as PCS.

Originally developed in response to a need for a digital cordless telephone standard and a compatible second tier public mobile system, PHS has been adopted in Japan in 3 main applications:

Public Mobile Service

Home Cordless

Wireless PABX

Roaming can be supported between all three modes. PHS is also suitable for wireless local loop and high bit rate mobile multimedia services.

Frequency Band [MHz]	1895-1918
Access Method	TDMA/FDM
Duplex Method	FDD
Number of Channels	300
Users per Channel	4
Channel Spacing	300 KHz
Modulation:	1/4 DQPSK
Channel Bit Rate	384 Kbps
Vocoder	32 Kbps ADPCM
Peak Tx Power	10 mW

This system has been developed in Japan, Australia and parts of Asia.

7.3.5 ISM

http://www.temic-semi.com/hn/wireless/ism/index.htm

http://www.x.net.au/white_paper.html

ISM Chip Design Guide by Temic

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† Subscriber Identity Modules

† DECT Authentication Module

† Personal Handy phone System

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ISM† has been authorized in three frequency bands. Each of these bands can be used to implement either analog or digital cordless systems. However, most interest appears to be in digital SS systems.

Frequency Band	Spectrum	Applications
902 – 928 MHz	26 MHz	Licensed vehicle location systems [2 kW fixed, 15 W mobile], old microwave ovens [750 W], industrial heaters 50-100 kW, military radar [1 MW], spread spectrum [1 W]
2.4 – 2.4835 GHz	83.5 MHz	Microwave ovens [900W], spread spectrum [1 W]
5.725 – 5.85 GHz	125 MHz	Spread spectrum [1 W], licensed users [10 W]

Of the three bands, only that at 2.4 GHz has been set-aside for unlicensed use in Europe.

Some of the regulations governing these bands include:

DS-CDMA	Minimum 6 dB bandwidth: 500 KHz Maximum peak output power: 1 watt Maximum radiated signal: 6 dBi
FH-CDMA	Minimum hopping channel separation: 25 KHz A minimum of 50 hopping channels in the 900 MHz band A minimum of 75 hopping channels in the other bands Maximum peak output power: 1 watt Maximum radiated signal: 6 dBi

COMPARISON OF DIGITAL CORDLESS SYSTEMS[1 2]

	CT–2	DECT	PHS	PACS
Region	Europe	Europe	Japan	United States
Frequency [MHz]	864 - 868	1880 - 1900	1895 1918	1850-1910 1930-1990
Carrier Spacing [KHz]	100	1728	300	300
# Carriers	40	10	77	16 pairs/10 MHz
Bearer Channels/Carrier	1	12	4	8/pair
Access Method	FDMA/TDD	TDMA/TDD	TDD	FDD
Channel Bit Rate [Kbps]	72	1152	384	384
Modulation	GFSK	GFSK	π/4 DQPSK	π/4 QPSK
Speech Coding [Kbps]	32 ADPCM	32 ADPCM	32	32
Av Tx Power [mW]	5	10	10	25
Peak Tx Power [mW]	10	250	80	200
Frame Duration [mSec]	2	10	5	2.5
Max. Channels per Area	40	132		
Handoff	No	Yes		
Typical Cell Diameter	0.2 miles	0.2 miles		

† Industrial Scientific and Medical

1 Based on Table 2, *Overview of Wireless Personal Communications*, IEEE Communications, January 1995

2 Telecommunications, December 1990

_____ Notes _____

Assignment Questions

Quick Quiz

1. CT0 is an analog cordless system while CT1 is digital. [True, False]
2. CT0 uses separate transmit and receive frequencies. [True, False]
3. The frequency allocation for CT0 is the same everywhere around the world. [True, False]
4. The CT2 system uses [the same, different] frequencies for transmit and receive.
5. The CT2+ system [allows, does not allow] a user to maintain a conversation while moving between two basestations located near to each other.
6. The typical digital cordless systems vocoder uses [16, 32, 64] Kbps ADPCM.
7. The channel bit rate in digital cordless systems is always at least twice the vocoder bit rate because of time division duplexing. [True, False]
8. CT2 has more end-user channels than CT2+ because it has a more efficient modulating scheme. [True, False]
9. Inbound calls can be received on CT2+ but not CT2. [True, False]
10. The CT2 time frame is [1, 2, 4] mSec long.
11. CT3 has [2, 4, 8] full duplex channels per carrier.
12. CT3 is also known as [PCS900, DCT900].
13. DECT [can, cannot] be used as an ordinary home cordless phone.
14. It is estimated that DECT can handle a subscriber density of 10,000 erlangs per square kilometer. [True, False]
15. The DECT time frame is [2, 10, 20] mSec long.
16. Each DECT carrier can support [8, 10, 12] mobile users.
17. DECT [can, cannot] support high-speed data.
18. Some ISM systems will use spread spectrum techniques. [True, False]

Composition Questions

1. Why do you think TDD is used on digital cordless phones?
2. Which of the digital cordless standards do you think has the best chance of gaining worldwide acceptance? Why?

For Further Research

Pahalavan, Kaveh and Levesque, Allen H.; Wireless Information Networks, Wiley, 1995

IEEE Communications, January 1995, a special issue on Wireless Personal Communications

www.dect.ch

www.ericsson.com.au/BN/dect

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www.pcsi.com

http://www.phone-guys.com/

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