

RECOMMENDATION ITU-R M.1033-1

**TECHNICAL AND OPERATIONAL CHARACTERISTICS OF CORDLESS TELEPHONES
AND CORDLESS TELECOMMUNICATION SYSTEMS**

(Question ITU-R 114/8)

(1994-1997)

Summary

This Recommendation provides the objectives and technical and operational characteristics for cordless telephones and cordless telecommunication systems. By summarizing and comparing the characteristics and providing associated references, the Recommendation provides guidance for administrations evaluating various cordless systems for their intended application.

The ITU Radiocommunication Assembly,

considering

- a) that new land mobile services, such as cordless telephones and cordless telecommunication systems providing communications in areas limited to a few hundred metres radius are becoming available to a large public;
- b) that in the longer term, International Mobile Telecommunications-2000 (IMT-2000) Recommendations will encompass future needs supported by digital cordless systems; however, in the interim, a Recommendation should include digital cordless systems;
- c) that these services can use consumer-type devices which may create difficulties to administrations, and may be misused;
- d) that the utilization of the radio spectrum should be as economical as possible and that the use of multi-channel access techniques conserves frequency spectrum;
- e) that highly flexible and economical systems can be achieved without using a central controller for setting up control of the radio path;
- f) that the widespread and increasing use of these equipments and the characteristics of their utilization may create operational problems;
- g) that certain administrations are encountering problems of mutual interference and inadvertent interaction between "cordless telephone" systems;
- h) that a number of systems have already been adopted by a wide range of administrations and can form the basis for a Recommendation,

recommends

that cordless telephones and cordless telecommunication systems (cordless systems) should conform to the following objectives and technical and operational characteristics:

1 General objectives

Cordless systems should be designed with the following minimum basic objectives:

- that the radio spectrum be used efficiently;
- that a system of high subscriber capacity be realized;
- that simple and miniature circuits be used to ensure that the weight and size of the equipment are comparable with ordinary telephones;
- that it can be provided economically and the cost of equipment can be reduced to be acceptable for a mass market;

- that the system provide good quality for public communication and that a flexible system of operation can be provided that does not require complicated frequency management;
- that the system provide as far as possible normal telephone features;
- that the system provide security of call charges.

2 Operational and management objectives

Cordless systems should allow operation and management procedures which ensure that:

- in system operation, it is only necessary to manage the number of cordless systems within the area determined by the distance at which interference occurs, while taking into account the subscriber capacity which is determined by the number of channels and the channel traffic;
- flexible operation can be provided, so as to permit the use of a greater number of portable sets than the subscriber capacity per zone, if the number of cordless sets in use in the adjacent zone is small.

3 Access techniques

Cordless systems should include the use of multi-channel techniques and appropriate protocols which do not require the use of a central controller for the detection of idle channels.

These techniques, also called self-trunking or dynamic channel selection, may employ FDMA-FDD, FDMA-TDD, as well as multi-carrier TDMA-TDD. Depending on the application the access technique should allow also in-call handover.

4 Features and areas of application

Since the start of cordless systems there has been an evolution in the areas of application which are covered. The services supported by cordless systems can therefore differ. Also, the service requirements can differ depending on the market segment to be served, for example, public, residential, business, etc. Therefore the importance of the different features of a cordless system depends on its application.

To facilitate the characterization of different cordless systems, the following description of features and applications should be used.

4.1 Cordless telephony (residential)

Cordless telephony in its basic form is provided by a cordless telephone, which consists in its simplest version of two parts:

- a fixed part which is connected to a subscriber line of the ordinary telephone network, and
- a portable set.

Each part uses multi-channel access techniques and can individually perform the following operations:

- search for idle channels;
- set up speech paths using the selected channel;
- check identification codes in the signals between the fixed part and the portable set in order to ensure that only associated units will lock to each other.

More advanced installations allow the use of more portable sets.

4.2 Cordless PABX

In addition to basic cordless telephony, single cell or multi-cell systems can serve the needs of small business or large business respectively for cordless extensions and on-premises communications networks.

4.3 Seamless handover

Seamless handover, which is an optional feature, allows systems to provide uninterrupted communications throughout the coverage area while the call is in progress. Handover may occur within a single cell or between adjacent cells.

4.4 Cordless local area networks (CLAN)

Cordless LANs or more general non-voice services, including those available in the ISDN, can be offered by fully digital systems. They are the replacement of a drop-cable connection from terminals to an ISDN or LAN backbone in order to support the "wireless office" concept.

4.5 Telepoint

In this application the system offers the portable set access to public base stations via a fully standardized air interface, including the necessary protocols for call set-up and authentication which should guarantee billing security. These systems may provide roaming, including international roaming.

4.6 Local loop replacement

In this application the system provides a replacement of the local loop (extension of the PSTN, ISDN into the customers' premises) by radio. Smooth billing should be guaranteed by secure authentication and the system should be capable of serving a large number of users.

4.7 Tandeming to cellular radio

The flexibility and high quality of cordless communications offers a means of enhancing other mobile services by cordless extensions (e.g. telepoint in trains, handhelds connected to a cellular mobile).

5 Existing systems

Cordless systems employing dynamic multiple access techniques and supporting varying subsets of the possible features and areas of application have been developed in many countries. Annex 1 provides information about existing systems.

ANNEX 1

Systems features and applications

This Annex gives information about ten existing cordless systems.

Table 1 shows the features and applications which can be supported by the different systems using the categories described in this Recommendation.

The major specifications of these systems are summarized in Tables 2 and 3 for analogue and digital systems respectively.

The main features of the ten systems and the references to the detailed specifications are described in Appendices 1 to 10.

TABLE 1

Features and applications	System No.									
	1	2	3	4	5	6	7	8	9	10
Cordless telephony (residential)	×	×	×	×	×	×	×	×	×	×
Cordless PABX	×		×	×	×	×	×	×	×	×
Seamless handover				×	×	×	×	×	×	×
Cordless local area network			×	×	×	×	×	×	×	×
Telepoint			×	×	×	×	×	×	×	×
Local loop replacement			×	×	×	×	×	×	×	×
Tandeming to cellular radio					×	×			×	×

NOTE 1 – × means that a particular feature or application can be supported by the system.

TABLE 2

System characteristics of analogue systems

	System 1 ⁽¹⁾ Japan, 1988	System 2 ⁽²⁾ CEPT, 1987
Class of emission	F1D, F2 (A, B, C, D, N, X), F3E	F3E or G3E
Multiple access scheme	FDMA	FDMA
Duplex type	FDD	FDD
Transmit frequency band (MHz)		
– fixed part	380.2-381.3	959-960
– portable set	253.9-255.0	914-915
Radio frequency channel spacing (kHz)	12.5	25
Number of speech channels	87 (adding two control channels)	40
Transmitted power, e.r.p. (mW)		
– fixed part	Maximum 10 ⁽³⁾	Maximum 10
– portable set	Maximum 10 ⁽³⁾	Maximum 10
Typical service range (m)		
– indoor	50	50
– outdoor	100	100
Voice signals		
– type of modulation	Angular	Angular syllabic compandor
– processing		ITU-T Rec. G.162 (suggested)
Audio signal-to-noise ratio (dB)	Minimum SINAD 20 ⁽⁴⁾	Minimum SINAD 20 ⁽⁵⁾
Identification code	3 × 10 ⁷ combinations	3 × 10 ⁴ combinations

FDD: frequency division duplex

(1) System 1 is in use in Japan.

(2) System 2 is used by several European countries.

(3) Antenna input power.

(4) Suggested value using an IEC Publication 489-3 standard input signal level of 10 µV.

(5) Ratio measured through psophometric weighting network (according to ITU-T Recommendation P.53 (same as O.41) using an input signal field strength of 30 dBµV/m.

TABLE 3

System characteristics of digital systems*

	System 3 ⁽¹⁾ (ETSI, 1992)	System 4 ⁽²⁾ (Sweden, 1989)	System 5 ⁽³⁾ (ETSI, 1992)	PHS ⁽⁴⁾ (Japan, 1992)	System 7 ⁽⁵⁾ (Canada, 1993)	System 8 ⁽⁶⁾ (United States of America, 1995)	System 9 ⁽⁷⁾ (United States of America, 1995)	System 10 ⁽⁸⁾ (United States of America, 1995)
Class of emission	F1EJT or G1EJT	F1W and F7W	F1W and F7W	G1W and G7W	F1EJT or G1EJT	F1EJW G1EJW or	G1WJT and G7WJT	300 KF7W
Multiple access scheme	FDMA	Multi-carrier TDMA	Multi-carrier TDMA	Multi-carrier TDMA	FDMA	FDMA	Multi-carrier TDMA	TDMA
Duplex type	TDD	TDD	TDD	TDD	TDD	TDD	TDD	TDD
Frequency band (MHz)	864.1-868.1	862-866	1 880-1 900	≈1 900	944.0-948.5	1 920-1 930	1 910-1 930	1 910-1 930
Radio frequency channel spacing (kHz)	100	1 000	1 728	300	100	100	1 250	300
Gross bit rate per carrier (kbit/s)	72	640	1 152	384	72	72	1 152	384
Number of speech channels	40	8 (per carrier)	12 (per carrier)	4 (per carrier)	40 (with 60 signalling/ control channels)	99	12 (per carrier)	128
Transmitted power, e.r.p. (mW)		Peak power over time-slot	Peak power over time-slot				Peak power over time-slot	
– fixed part	Maximum 10	Maximum 100	Maximum 250	Maximum 10 ⁽⁹⁾ (10)	Maximum 10	Maximum 30	Maximum 90	53
– portable set	Maximum 10	Maximum 100 Average < 6 ⁽¹¹⁾	Maximum 250	Maximum 10 ⁽⁹⁾	Maximum 10	Maximum 30	Maximum 90	53
Typical service range (m)								
– indoor	40	40	30	50	40	40	30	10-100
– outdoor	200	200	200	200	200	200	200	200
Voice signals								
– type of modulation	2 level FSK, Gaussian shaped	GFSK	GFSK	π/4 QPSK	2 level FSK, Gaussian shaped	2 level FSK, Gaussian shaped	π/4 DQPSK ADPCM (ITU-T Rec. G.726)	π/4 DQPSK ADPCM (ITU-T Rec. G.726)
– processing	ADPCM	ADPCM or CVSDM	ADPCM or CVSDM	ADPCM	ADPCM (ITU-T Rec. G.726)	ADPCM (ITU-T Rec. G.726)		
Identification code	1.5 × 10 ⁶ combinations	>10 ⁷ combinations	>10 ⁷ combinations	>10 ⁸ combinations	1.5 × 10 ⁶ combinations	15 × 10 ⁵ combinations	>10 ⁷ combinations	>10 ¹² combinations

Notes to Table 3:

- * Most systems indicate as audio quality that the mean opinion score (MOS), when tested subjectively, shall not fall below the MOS of 32 kbit/s ADPCM as specified in ITU-T Recommendation G.726.
- TDD: time division duplex
- CVSDM: continuously variable slope delta modulation
- (1) System 3 is used in the United Kingdom, Finland, France, Belgium, Germany, Italy, Portugal, Spain, The Netherlands, Singapore, Hong Kong, Malaysia and Thailand. International roaming for Telepoint operation may be provided between European countries with the possibility of extending this to the other countries listed.
 - (2) System 4 is used in Sweden, New Zealand, Malaysia, Thailand, Indonesia, Philippines, Hong Kong, Brazil and Saudi Arabia.
 - (3) System 5 is the digitally enhanced cordless telecommunications (DECT) system.
 - (4) System 6 is the personal handphone system (PHS).
 - (5) System 7 is used in Canada.
 - (6) System 8 is used in the United States of America.
 - (7) System 9 is used in the United States of America.
 - (8) System 10 is used in the United States of America.
 - (9) Antenna input power.
 - (10) Except for outdoor fixed parts.
 - (11) This average power assumes eight speech channels (duplex time-slots).

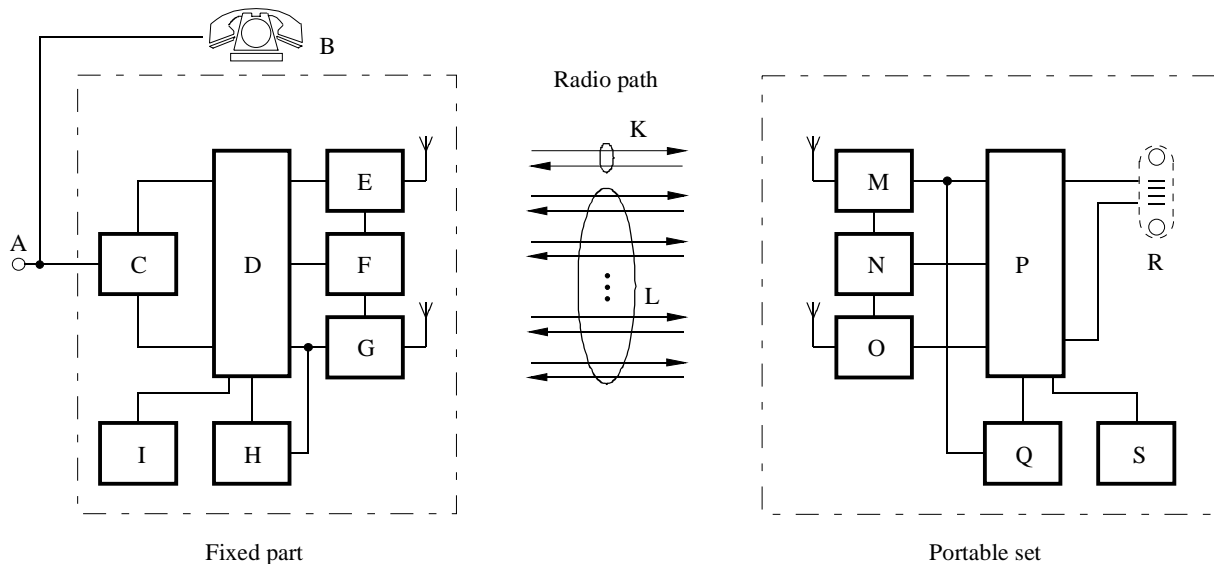
APPENDIX 1
TO ANNEX 1

General description of System 1 (analogue)

1 System configuration [RCR Standard, 1988]

The basic configuration of a cordless telephone System 1 employing the analogue multi-channel access technique is shown in Fig. 1.

FIGURE 1
**Basic block diagram of a cordless telephone system
using multi-channel accessing techniques**



- A: subscriber line
- B: ordinary telephone
- C: hybrid
- D: signal controller
- E: transmitter
- F: synthesizer
- G: receiver
- H: idle channel detector
- I: identification code ROM

- K: control channels
- L: speech channels
- M: receiver
- N: synthesizer
- O: transmitter
- P: signal controller
- Q: idle channel detector
- R: handset
- S: identification code ROM

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This system does not use a central controller. In the system, two dedicated control channels are assigned.

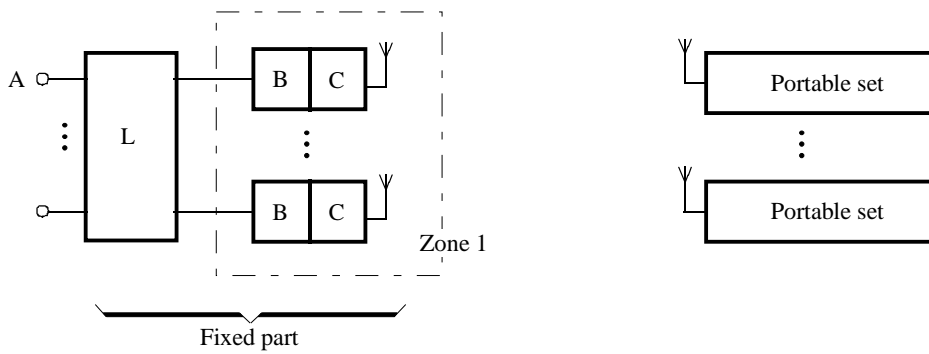
Each cordless telephone itself performs the functions of searching for idle channels and setting up a speech path over the selected channel.

Figure 2 shows the configurations of a multi-function cordless telephone.

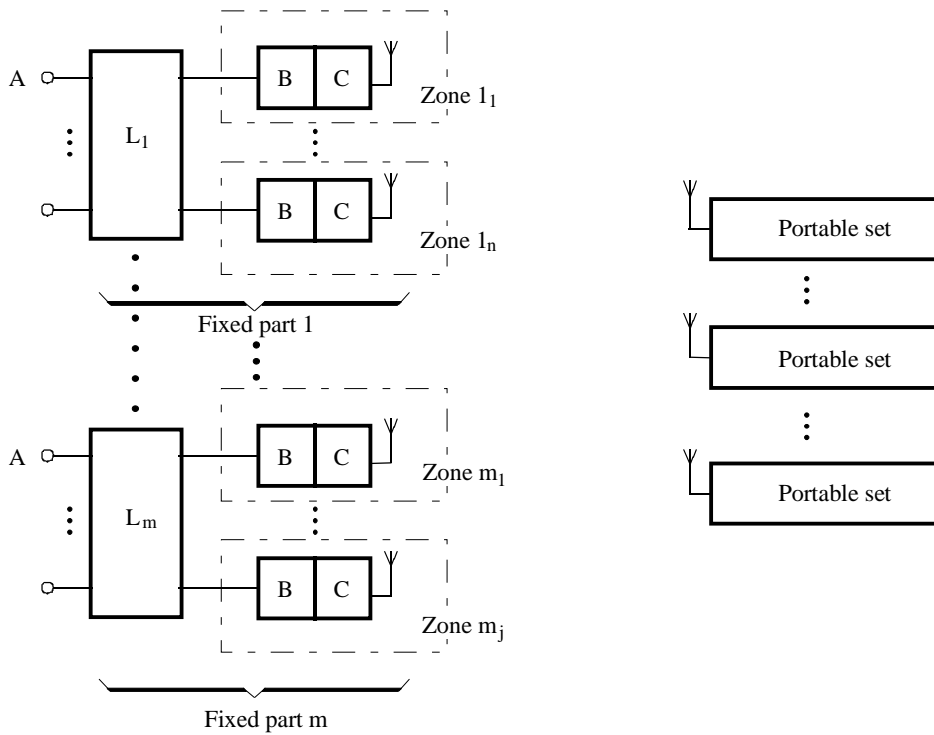
FIGURE 2
Configuration of multi-function cordless telephone



a) Block diagram of a multi-terminal cordless telephone



b) Block diagram of a cordless key telephone



c) Block diagram of a multi-zone cordless telephone

A: subscriber line
B: signal controller

C: transceiver
L: line controller

The following types are typical examples:

- multi-terminal cordless telephone,
- cordless key telephone,
- multi-zone cordless telephone.

2 Operational characteristics

2.1 Identification code

2.1.1 Only when its own identification code coincides between the fixed part and the portable set in the control channel, the fixed part and portable set shall switch to a speech channel. The length of the identification code shall be 25 bits.

2.1.2 Modulation methods and bit rates for an identification code are as follows:

Subcarrier MSK (fast FSK): 1 200, 2 400 bit/s

Direct modulation: 600, 1 200, 2 400, 4 800 bit/s

2.2 Idle channel decision

Carrier sense shall be performed immediately before transmission and if more than 2 μV is sensed, a radio signal shall not be emitted.

2.3 Occupied time of control channels

Considering the common use of dedicated control channels and easy introduction of sleep mode in portable sets, for originating calls from portable sets the occupied time shall be 1.3 s or less. For originating calls from fixed parts the occupied time shall be 4 s or less.

2.4 Transmitter power-off on disconnection

When disconnection is initiated, or when a radio signal is not received on any speech channel, the transmitter shall be turned off automatically.

2.5 Transmitter power-off in case of failure

When a failure in the radio equipment causing continuous transmitter power in the control channel is found, the transmitter shall be automatically turned off within 60 s.

REFERENCES

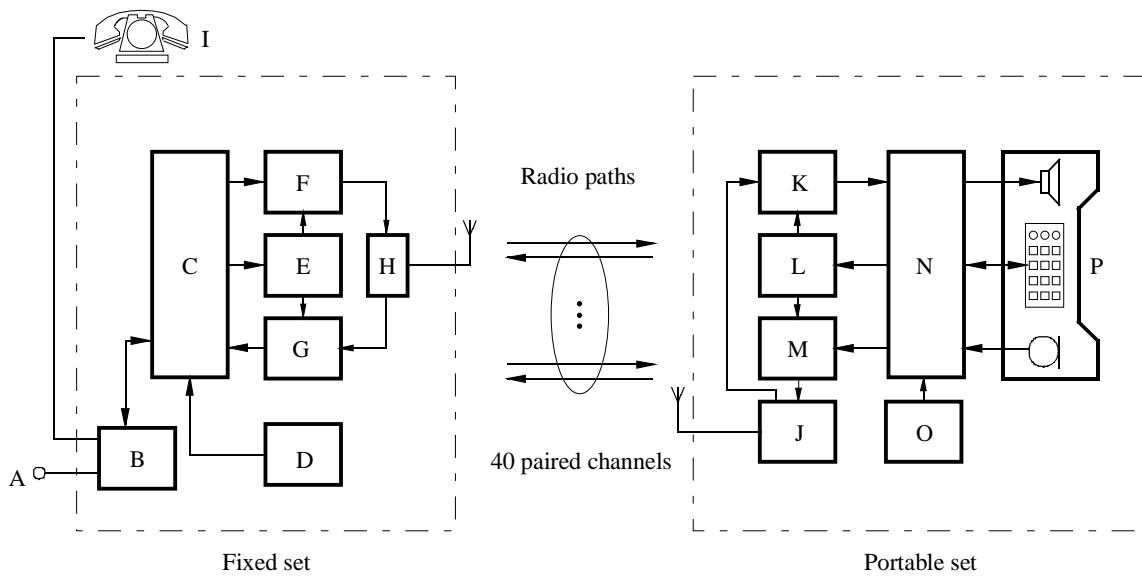
RCR Standard [December, 1988] 250 MHz/380 MHz Band Radio Equipment for Cordless Telephone. STD-13. Research and Development Centre for Radio Systems, Japan.

General description of System 2 (analogue)

1 System configuration

The configuration of an analogue cordless telephone of System 2 employing the multiple channel access technique is shown in Fig. 3.

FIGURE 3
System configuration



- A: subscriber line
- B: line interface
- C: signal controller and CPU
- D: identification code PROM
- E: frequency synthesizer
- F: transmitter
- G: receiver
- H: duplexer
- I: associated telephone

- J: duplexer
- K: receiver
- L: synthesizer
- M: transmitter
- N: signal controller and CPU
- O: identification code PROM
- P: handset

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The system configuration that has been adopted does not use a control channel to set up the RF connection between the fixed part and portable sets. Occupancy of an RF channel may be initiated by the fixed part or the portable set by following the same procedure.

2 Call setting-up procedures

The procedures for setting up a call are given in Fig. 4.

FIGURE 4a
Cordless originated call

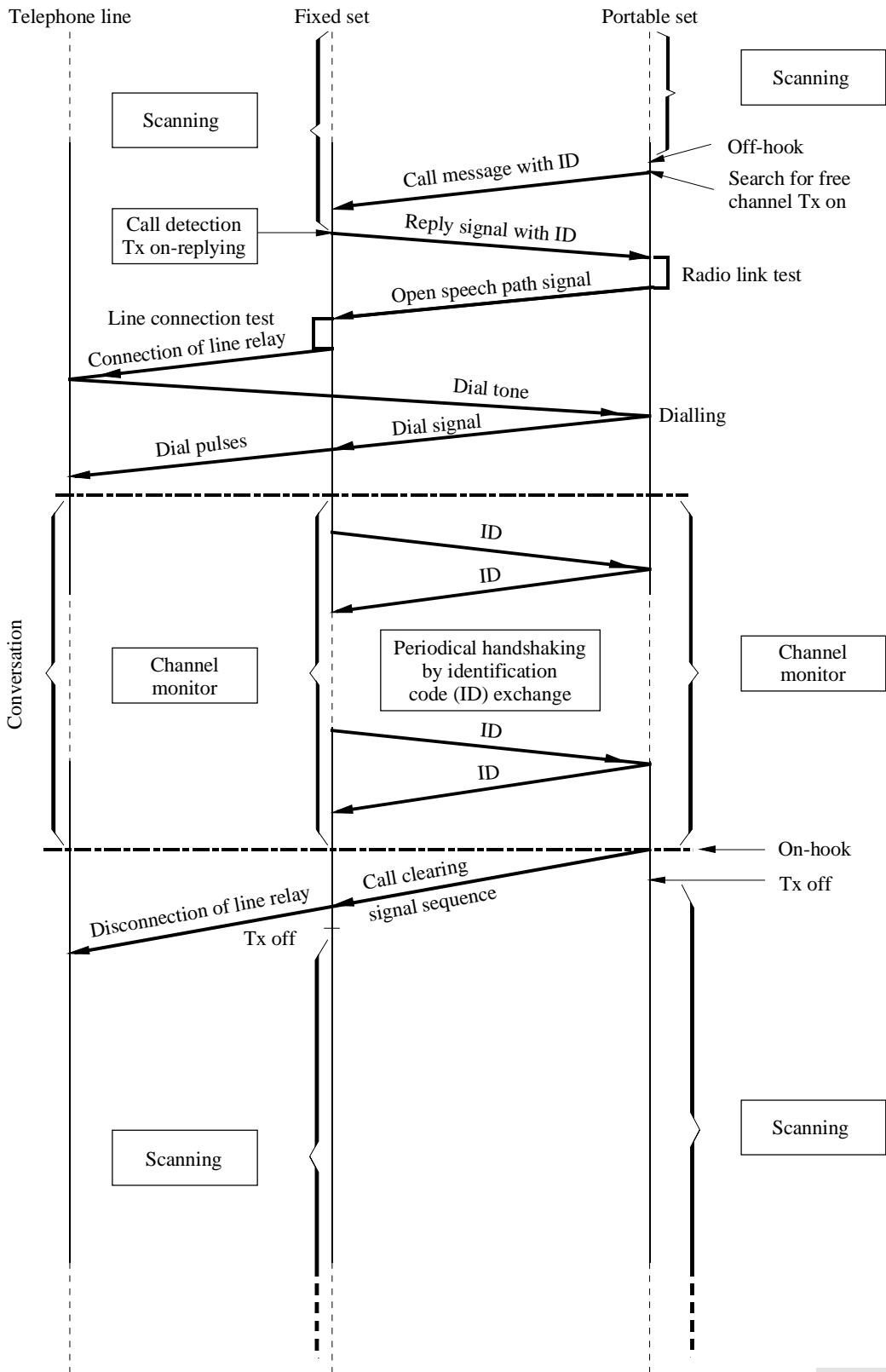
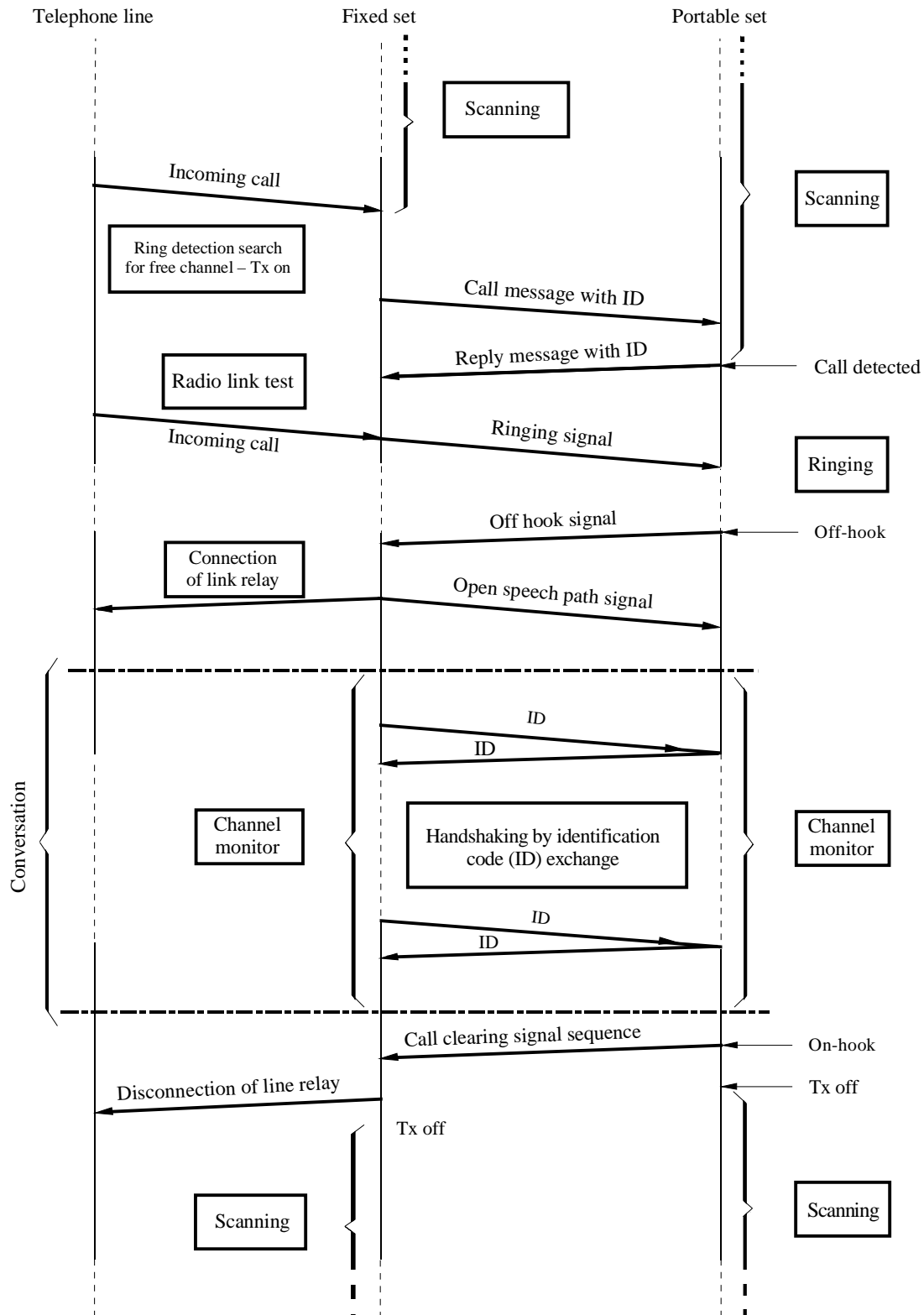


FIGURE 4b
Cordless terminating call



2.1 Waiting mode

In this mode, the receiver of each part of the cordless telephone set is constantly scanning the available RF channels, searching for a signal which contains its matching identification code.

2.2 Call originating mode

When the need for a radio-frequency channel arises in either of the two parts of a cordless telephone set, that part searches for an idle duplex channel by sensing the field strength on that channel.

On the idle channel, the initiating part starts transmitting its identification code. Upon detection of this code, the receiver stops scanning and initiates its transmitter to occupy the corresponding return frequency of the duplex channel and to transmit its identification code to the initiating part. As soon as the receiver of the initiating part detects its matching identification code on the return frequency of the selected duplex channel, the initiating transmitter stops transmitting the identification signals and the RF channel becomes available for the transmission of dialling tones and speech.

2.3 Conversation mode

To ensure continued locking during a call, the identification procedure is periodically repeated.

2.4 Call terminating mode

When the RF connection is to be terminated, the part of the cordless telephone set which initiated the termination procedure transmits a proper termination message including the identification code. The RF circuit is immediately disconnected and the cordless telephone set returns to the idle condition.

BIBLIOGRAPHY

ETSI [1992] Draft prI-ETS 300 235 Technical characteristics, test conditions and methods of measurement for radio aspects of cordless telephones CT1. European Telecommunications Standards Institute, Sophia Antipolis, F-06291 Valbonne Cedex, France.

APPENDIX 3

TO ANNEX 1

General description of System 3 (digital)

1 System operation

The digital cordless telephone of System 3 operates with digitally modulated, single channel per carrier equipment using time division duplex operation and frequency division multiple access (TDD/FDMA).

The system configuration does not require the use of a control channel to set up the RF link between the fixed part and portable sets. Selection of a suitable RF channel may be initiated by either the fixed part or portable set, the same procedure being followed in each case.

The basic characteristics of this type of digital transmission link are applicable to cordless telephones operated in residential, small business and telepoint services. In telepoint operation the portable sets are able to initiate calls within 100-200 m range of a public base station.

This TDD/FDMA approach is well matched to spectrum availability and network requirements. The 100 kHz channelling has no need for dispersion equalization, permits easing of frequency tolerances towards 1 part in 10^5 and allows the use of relatively simple filters. There is no necessity for an RF duplexer, less carrier-frequency sources are required and its moderate delay raises no echo control or absolute delay issues. With these attributes, the RF circuitry is simplified and the balance of implementation complexity shifts to baseband which is amenable to very large scale integration.

The above presentation of the digital cordless telephone is as a single base-handset combination. A wide range of situations can be accommodated with a capability of continuous growth.

For example:

- individual, independent, cordless extensions to a PBX;
- local concentrations of cordless base units in nests;
- central PBX-based multi-channel unit using a leaky feeder or discrete, distributed, antennas.

The last two clearly require synchronization between transmit and receive phases of the TDD signals within the nested unit, which is easily arranged. Another consideration is the need to exercise some control of intermodulation between multiple transmissions during transmission and reception. Although the need for intermodulation control is inherent in all such FDMA schemes and special measures may be required in combining RF channels, the effects can be contained without incurring significant cost penalties. The low power levels involved also make this aspect somewhat easier. Since PBX applications involve the provision of the PBX interface and control circuitry, any potential intermodulation control can also be incorporated.

In summary, for the digital transmission link there is a very high degree of common circuitry between handset and base hardware and a high level of commonality across all applications (including telepoint).

A common air interface standard has been developed that assures inter-working of all portable sets and base stations. Telepoint networks using System 3 will be required to implement this standard. This will allow roaming between the networks, so that any portable set will be able to be used with any network for which the user is a registered subscriber.

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ETSI [1992] I-ETS 300 131 Radio Equipment and Systems (RES); Common air interface specification to be used for the interworking between cordless telephone apparatus in the frequency band 864.1 MHz to 868.1 MHz, including public access services. European Telecommunications Standards Institute, Sophia Antipolis, F-06291 Valbonne Cedex, France.

APPENDIX 4

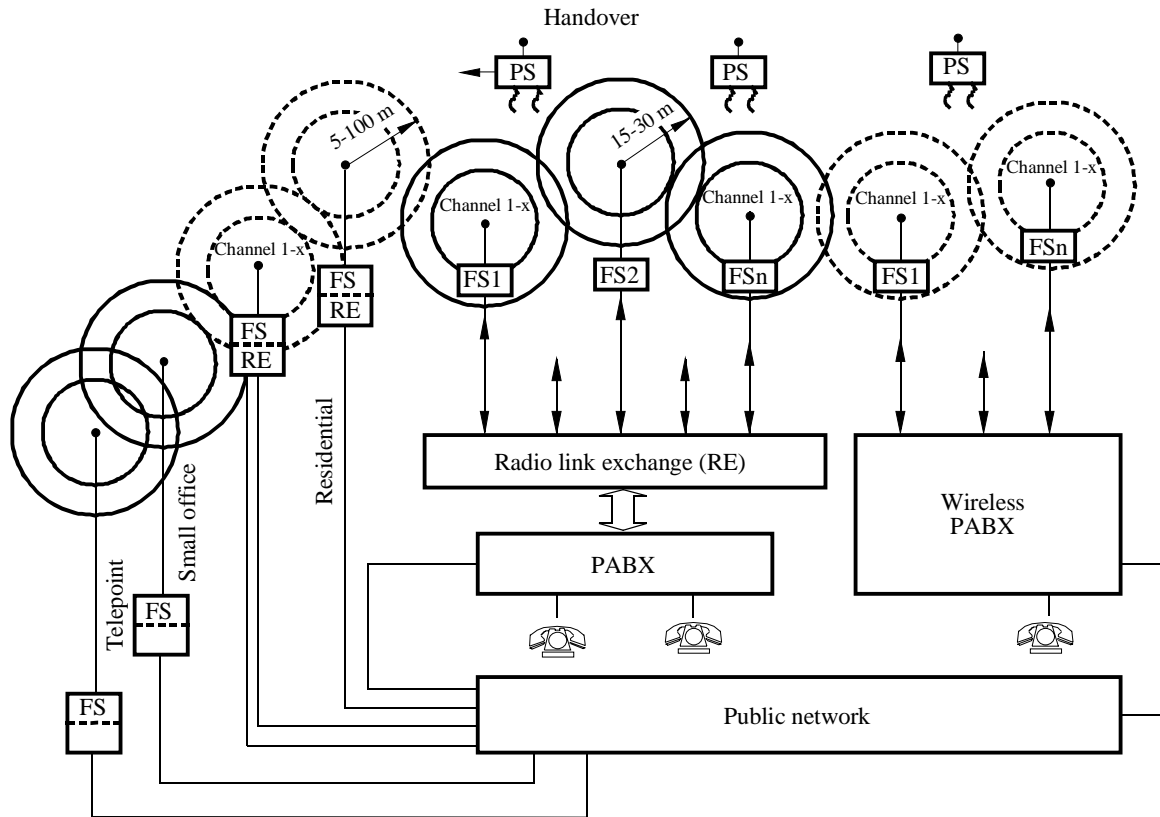
TO ANNEX 1

General description of System 4 (digital)

1 System configuration

Several configurations of digital cordless telephones of System 4 employing the time division multiple access technique (TDMA) are shown in Fig. 5. The multiple base station case provides a handover facility.

FIGURE 5
System 4 and System 5 families



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With one single radio transceiver, each fixed station (FS) can simultaneously communicate on all time slots that for each moment are allocated to that base station.

2 Call set-up procedure

The system configuration uses a time slot allocation which is dynamic and decentralized to each base station and each portable. When a traffic channel (time slot) is wanted, the portable station (PS) communicates with the fixed station (FS) having the highest field strength, and the channel is chosen with the least interference at the position of both the portable and the fixed station. For special services, it is possible to allocate temporarily more than one time slot to a portable station.

3 Interference limited capacity

For System 4 the range can be C/I limited rather than C/N limited. Thus the capacity in an operational area can be increased by denser and denser re-use by installing the fixed stations closer and closer.

4 Dynamic channel allocation and handover

Since all the stations (fixed and portable) have continuous information of the status on all slots due to the TDMA mode of operation, the dynamic channel allocation can be made very efficient and fast. Also, handover within and between fixed stations can be made efficient and fast. Furthermore, simulations have shown that this system is stable under heavy traffic conditions.

5 TDMA frame structure

Adjacent systems with differently specified TDMA frames and time slots can co-exist on the same frequency band as long as the frame cycle times are equal. Time slot synchronization is not needed between systems, provided that the frame cycle time is reasonably constant (± 5 ppm). Antenna selection at the fixed station provides diversity gain for both directions.

6 Applicable services

The system concept is applicable to large office, small office, telepoint and residential voice and data services.

BIBLIOGRAPHY

- ESPA [September, 1987] Publication 5.2: Business Cordless Telephones. Association of European Manufacturers of Pocket Communications Systems, Breda, the Netherlands.
- STA [1989] Specification 8211-A130: Technical requirements for connection of digital cordless telephones to the public-switched telephone network. Swedish Telecom, Stockholm, Sweden.
- TVTFS [1989] Regulations on Radio Technical Requirements on Digital Cordless Telephones in the Frequency Band 862-864 MHz. Swedish Telecom Radio, Stockholm, Sweden.

APPENDIX 5 TO ANNEX 1

General description of System 5* (digital)

1 System configuration

System 5 employs the TDMA time division duplex technique in such a way that various configurations can share the same spectrum resources. An overview of the System 5 family is given in Fig. 5. One configuration does not have to be synchronized with a neighbouring one, belonging to the same family, in order to operate in the same frequency band.

Proper synchronization though, would increase the capacity of both systems. Each fixed station can communicate simultaneously on all 12 duplex time slots and on any of the carriers, with one single radio transceiver. Handover facilities are provided in multi-base station configurations.

2 Services

The system concept provides for the following voice and data services:

2.1 Cordless telephone

DECT will provide this in its basic form, but can also support advanced features like connection to 2 PSTN lines, a system incorporating 2 or 4 handsets, intercom facility via the base station and call transfer between handsets.

* A list of abbreviations is given at the end of this Appendix.

2.2 Cordless PABX

The DECT system is designed to handle 10 000 E per floor, assuming a GOS of 1% and voice traffic with a peak of 0.2 E per terminal. A multicell system provides for fast in-call handover between cells according to interference conditions.

2.3 Cordless local area networks (CLAN)

DECT supports the “wireless office” concept. Terminals, connected to the backbone via the DECT system, can communicate at up to 256 kbit/s.

2.4 Telepoint

In its basic version, DECT telepoint supports outgoing calls only. When the infrastructure is prepared for it, extra features can be implemented including incoming calls (local log-on), and in-call handover to an adjacent telepoint base station of outgoing calls queueing for access to the radio interface. Hence, a Personal Communications Network (PCN) can be realized.

2.5 Local loop replacement

It is expected that the combination of cheaper digital transmission (via fibre) and larger private switches will result in a systems design wherein the radio part of DECT will be distributed, but the baseband processes, channel control and signalling will be centralized.

2.6 Tandeming of cordless systems with mobile radio

The protocols of DECT are designed to allow tandeming with the Pan-European digital cellular system GSM.

3 Grade of service

DECT provides a radio interface access to other networks and is designed to closely match wire-connected terminals to those networks from a point of view of grade of service (GOS). GOS here stands for the overall probability of a call not being set up or, worse still, being dropped during a call, in the busy hours.

Elements, contributing to a call set-up GOS are:

- the GOS for a PABX alone (in the range 0.1% to 0.01%);
- congestion in the radio bearer channels;
- loss of radiocommunication caused by poor radio signal coverage of the nominated communication area or cell.

The sum of the above contributions to the GOS for all applications of DECT shall not exceed 1%.

Dropping of a call will be far less acceptable than failure to establish a call, hence it is recommended that the probability of dropping shall not exceed 0.1% but 0.01% is preferable.

In spite of the above, however, a Telepoint service might have different characteristics due to commercial factors, independent of the DECT specifications.

4 Call set-up procedure

The system configuration uses a time slot allocation which is dynamic and decentralized to each base station and each portable. When a traffic channel (time slot) is wanted, the portable station (PS) communicates with the fixed station (FS) having the highest field strength, and the channel is chosen with the least interference at the position of both the portable and the fixed station. In the case of incoming calls, the base station chooses a free channel and uses its handshake to establish a communication link with the portable, preferably using the chosen channel, if it is free.

This method of dynamic channel allocation is efficient and fast because all (fixed and portable) stations have continuous information of the status on all slots due to the TDMA mode of operation.

The system concept includes the possibility of temporarily allocating more than one time slot to a portable station, in order to allow for special services requiring a high capacity communication channel.

5 Structure of the standard

DECT offers a concept for high capacity microcellular radio systems designed to operate in connection with the fixed PSTN, ISDN or other networks (e.g. office systems).

From the beginning, it was recognized that a highly structured approach to the design of the standard was crucial, due to the complex nature of the task. Also, a number of specialists in various fields would have to work on different aspects of DECT and an adequate structure would be advantageous for the organization of the work.

The OSI layered structure is basic to the DECT standard (Fig. 6).

- The physical layer (PHL) creates a set of “bit pipes” through the radio medium.
- The medium access control (MAC) layer chooses a suitable physical channel and prepares the information to be passed through the channel reliably. The MAC layer creates the possibility of activating multiple physical channels or to offer asymmetric throughput.
- The data link control (DLC) layer provides reliable transport of the data through the radio medium even when cells are switched during communication (handover).
- The network layer’s (NWL) function is to transport data between network nodes (data routes within DECT or to the outside world).
- In the DECT system, not only communication-type functions must be performed (for instance initiating a handover). Those functions can be found in the management entity, which interfaces to all layers in DECT.

6 Physical layer (PHL)

DECT is a multi-carrier time division multiple access time division duplex system.

In Europe, DECT operates in the frequency band 1880-1900 MHz. The standard defines 10 carrier frequencies from 1881.792 MHz to 1897.344 MHz, separated by 1728 kHz.

The RF modulation is Gaussian frequency shift keying (GFSK) with a relative bandwidth of $BT = 0.5$; the modulating signal is a bit-stream of 1152 kbit/s. Output power per physical channel is 10 mW. In the time domain, one frame of 10 ms consists of 24 slots of 416.7 μ s each, and so creates 12 duplex channels per carrier (see Fig. 7).

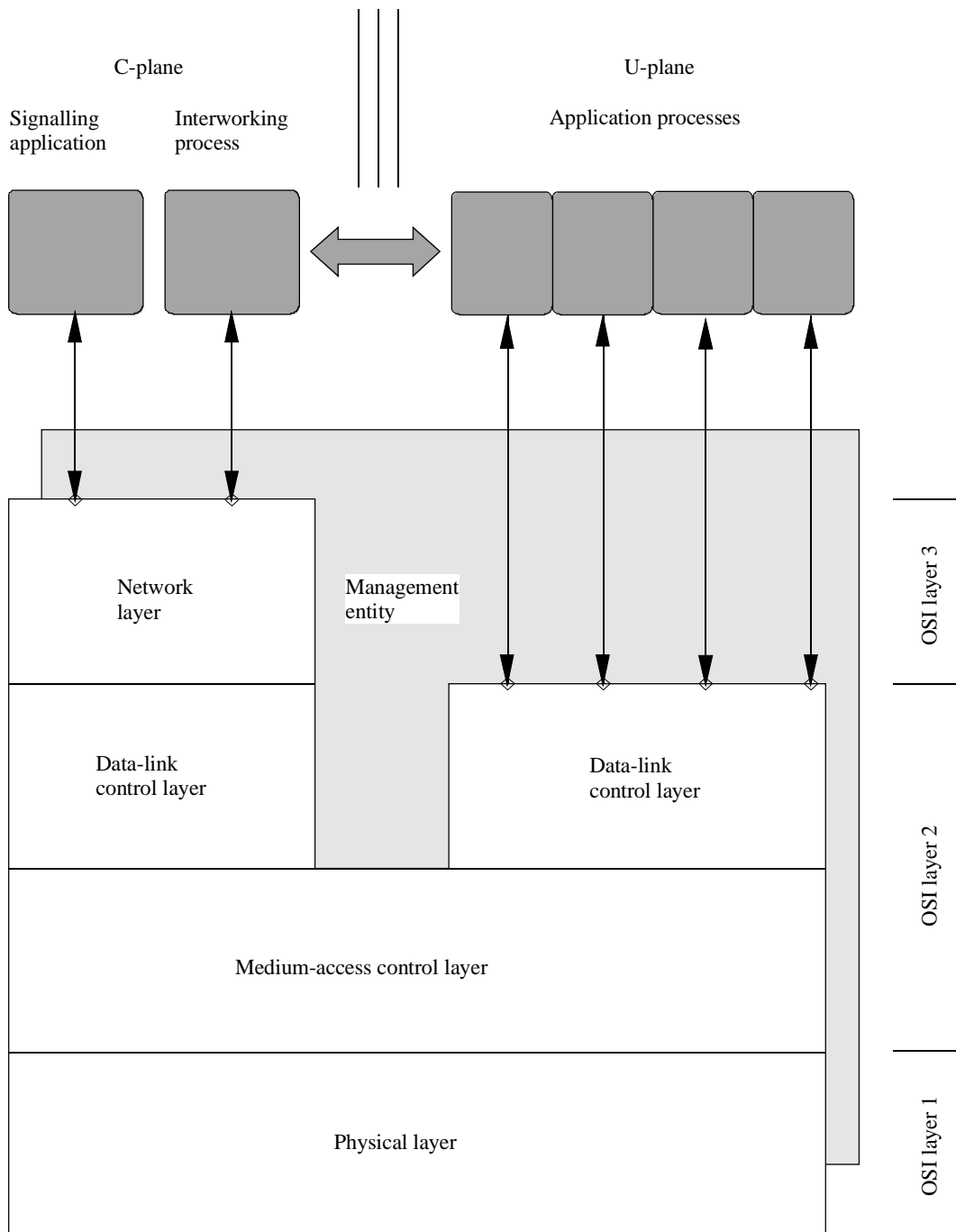
In each time slot, a burst of 364.6 μ s can be transmitted, so the overall throughput per slot is 42.0 kbit/s. This structure offers a MAC-layer data rate of 38.8 kbit/s for a duplex channel, enough to accommodate the bit-stream from and to the ITU-T Recommendation G.721 codec, used for DECT voice communication, as well as signalling information.

7 Medium access control layer (MAC)

In the MAC layer, radio resources are allocated by activation and de-activation of physical channels.

The process will take changes of bearer capacity needs during the connection, as well as the need to change physical resources (within a fixed station) during a connection due to unacceptable degradation of quality, i.e. intra-cell handover.

FIGURE 6
DECT layer structure

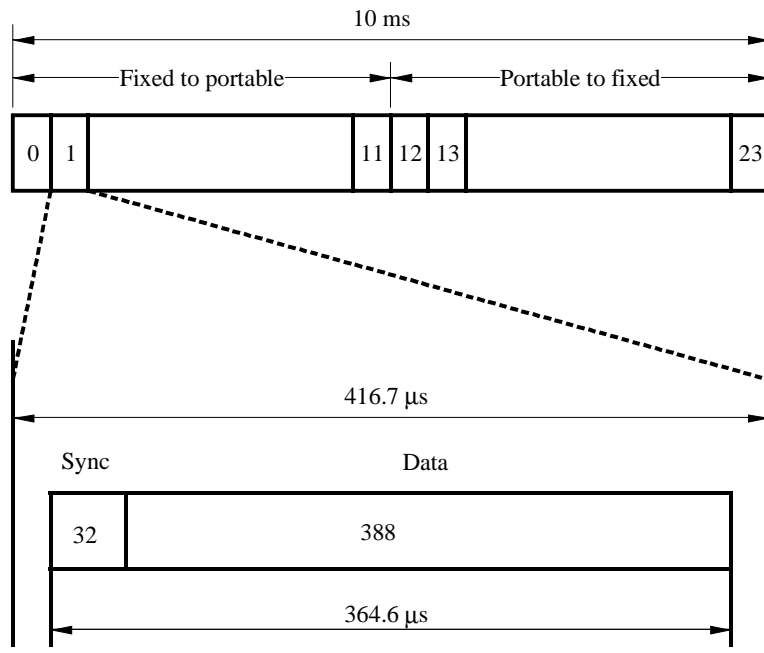


1033-06

Four logical channels are multiplexed onto these physical channels (see Fig. 8):

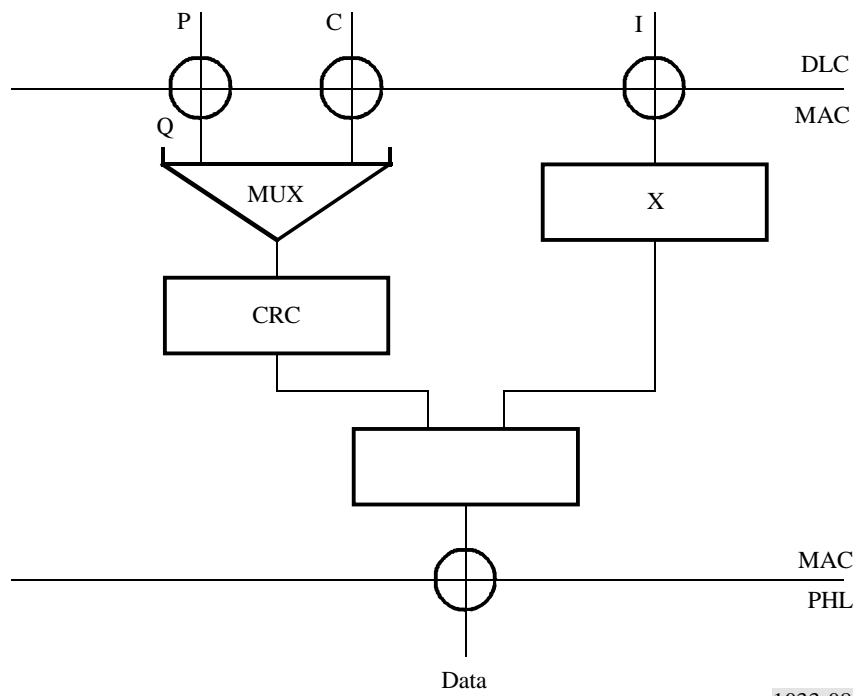
- the user information (I) channel;
- the signalling (C) channel, this channel contains MAC layer and signalling from higher layers;
- the paging (P) channel, carrying the data necessary to call portables from the network;
- the broadcast (Q) channel, which provides the portable repeatedly with information in order to recognize the network and its capabilities.

FIGURE 7
DECT physical layer PHL



1033-07

FIGURE 8



1033-08

Data streams originating in higher layers are segmented. If required, data segments may be transmitted, using more than one physical channel.

Data protection for the signalling data is provided for in the MAC layer by adding cyclic redundancy check (CRC) bits. User data may not be protected (in case of speech transmission) or protected according to service requirements.

In the MAC packet, 4 bits determined from some of the 320 I-channel bits are present (X). They are not to protect the I-channel against transmission errors but to detect partial interference with the burst independently from the user service.

Constant observation of the X bits allows early detection of interference of parts of the burst (e.g. when an unsynchronized signal of a similar system slowly drifts into the wanted signal) enabling adequate counter measures, e.g. by handing the connection over to another channel.

8 Management entity (MGE)

A number of functions in the DECT system involve only one side of the communication, hence they do not appear in an OSI layer.

Typically, the following functions are present:

- radio resource management, which includes the choice of free channels or the assessment of the quality of received signals;
- mobility management, which includes attachment (or change of attachment) to cells in idle mode, or the registration of portables into networks or location areas of this network;
- error handling, which includes the termination of a call in case of interruption of the radio link.

Although exchange to the outside world is not an issue with the MGE, the DECT standard will include some rules of performance requirements for it.

9 Data link control layer (DLC)

The data link protocol creates and maintains reliable connections between a portable and the central system. The DLC carries two types of traffic each with specific protocol requirements. Therefore, the DLC layer is separated into C- (for control) and U- (for user) planes (see Fig. 9).

9.1 C-plane protocols

- Connectionless broadcast service (Lb).
- Link access procedure for C-plane LAPC. This procedure uses variable length frames and the characteristics of it are closely matched to those of the underlying MAC service; segment sizes will be chosen so that frame boundaries always align with inherent MAC timing boundaries (this will secure synchronization).

9.2 U-plane protocols

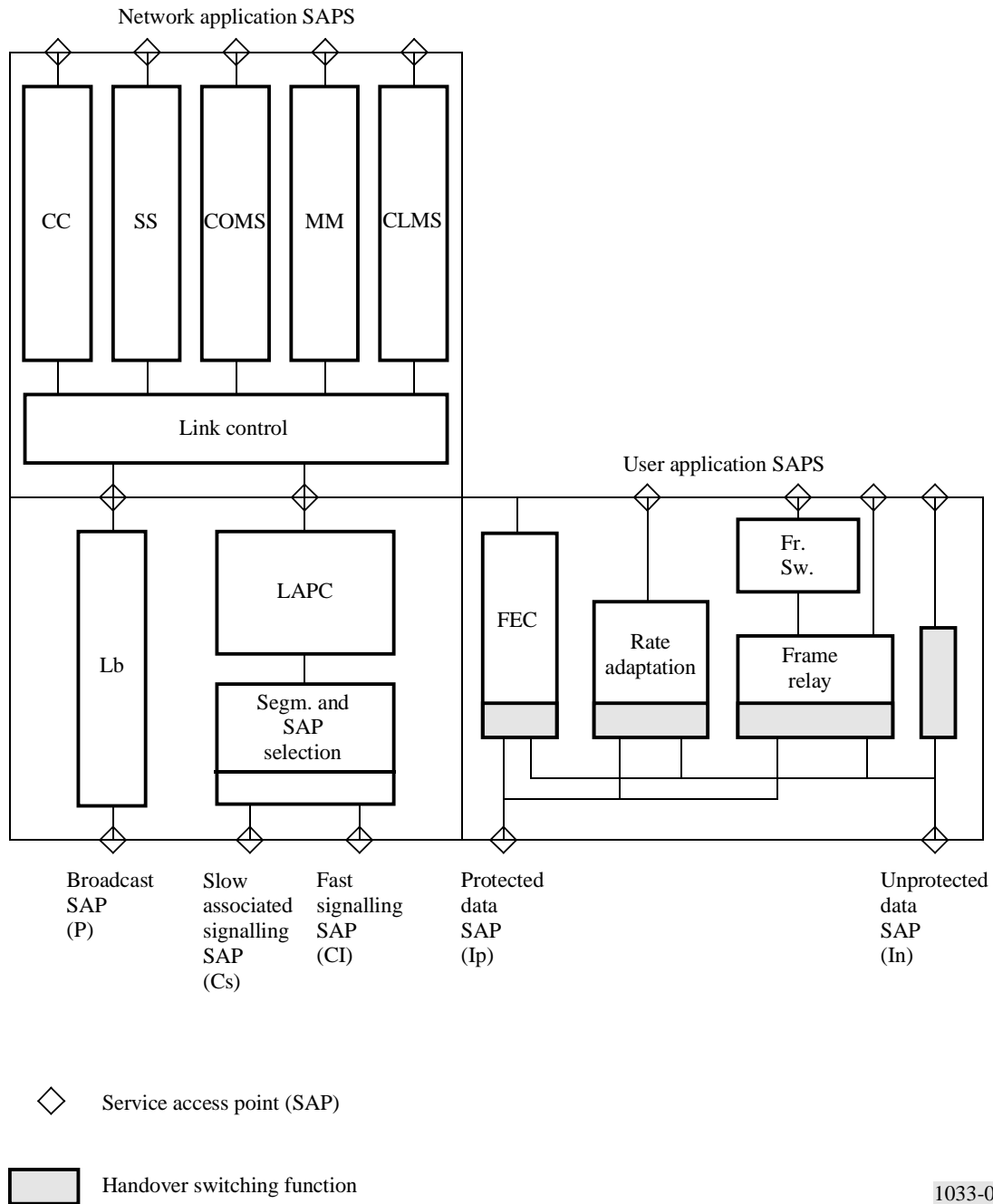
The protocols are defined according to the service, required by specific applications.

Among others, the following have been identified:

- forward error correction (FEC),
- null service, offering unmodified MAC bearers,
- frame relay for simple packet transport,
- rate adaption, for modem and serial-line substitution packet transport.

The simple cordless telephone service, however, does not require these protocols; they may be regarded as basic to value added services.

FIGURE 9
Overview of protocols
data link and network layer



10 Network layer (NWL)

The network layer protocol is structured as a group of connected entities (see Fig. 9). These are:

10.1 Call control (CC)

This protocol establishes and releases network connections, it negotiates connection capabilities, it activates and controls inter-working units and it transfers call related supplementary services.

10.2 Supplementary services (SS)

The SS protocol supports supplementary services like call forwarding, follow me, etc., which are call independent.

10.3 Connection oriented message service (COMS)

This protocol can be used, for e.g. data transfer through the DECT C-plane, by using a connection oriented DLC service.

10.4 Connectionless message service (CLMS)

The CLMS protocol applies in case a connectionless (multicast/broadcast) service of the DLC is used for a broadcast of network layer system information via the C-plane.

10.5 Mobility management (MM)

This element is crucial for interfacing DECT smoothly with networks such as GSM, Telepoint and advanced cordless PABXs.

10.6 Link control entity (LCE)

This entity matches and coordinates the various logical links provided by the data link layer to the needs of the network layer entities.

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- ETSI [1992] ETR 043 Digital European Cordless Telecommunications (DECT) Common Interface Services and Facilities requirements specification. European Telecommunications Standards Institute, Sophia Antipolis, F-06291 Valbonne Cedex, France.

List of abbreviations

- ADPCM: adaptive differential pulse code modulation
- CC: call control
- CLAN: cordless local area network
- CLMS: connectionless message service
- COMS: connection oriented message service
- CRC: cyclic redundancy check
- DECT: digitally enhanced cordless telecommunications
- DLC: data link control
- ETSI: European Telecommunications Standards Institute
- FDMA: frequency division multiple access

FEC:	forward error correction
FS:	fixed station
GFSK:	Gaussian frequency shift keying
GOS:	grade of service
GSM:	global system for mobile communications
ISDN:	integrated services digital network
LAN:	local area network
LAP:	local access procedure
LCE:	link control entity
MAC:	medium access control
MGE:	management entity
MM:	mobility management
NWL:	network layer
OSI:	open systems interconnection
PABX:	private automatic branch exchange
PCN:	personal communications network
PHL:	physical layer
PMR:	private mobile radio
PS:	portable station
PSTN:	public switched telephone network
RE:	radio exchange
SAP:	service access point
SS:	supplementary services
TDMA:	time division multiple access

APPENDIX 6

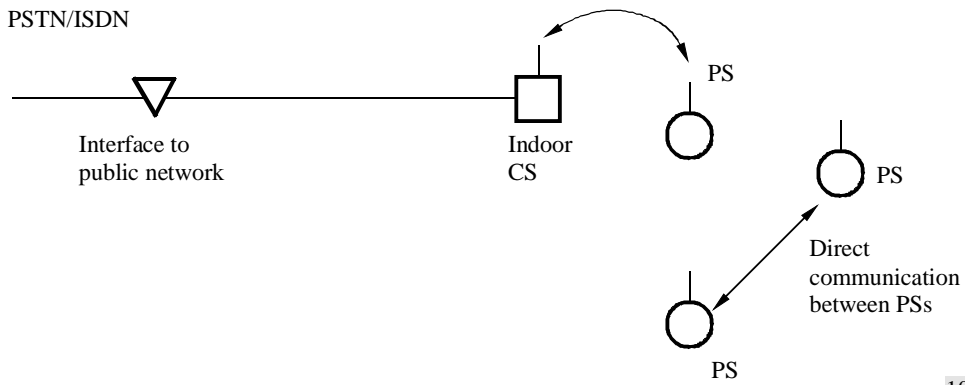
TO ANNEX 1

General description of PHS (digital)

1 System configuration

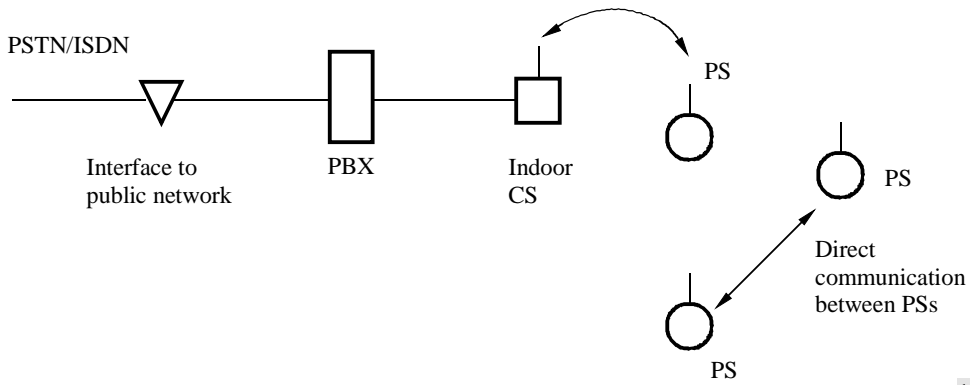
PHS is a digital cordless telephone system based upon a TDMA time division duplex technique. The basic configurations of PHS for use in homes, offices, and outdoors are shown in Figs. 10, 11 and 12, respectively.

FIGURE 10
System configuration in homes



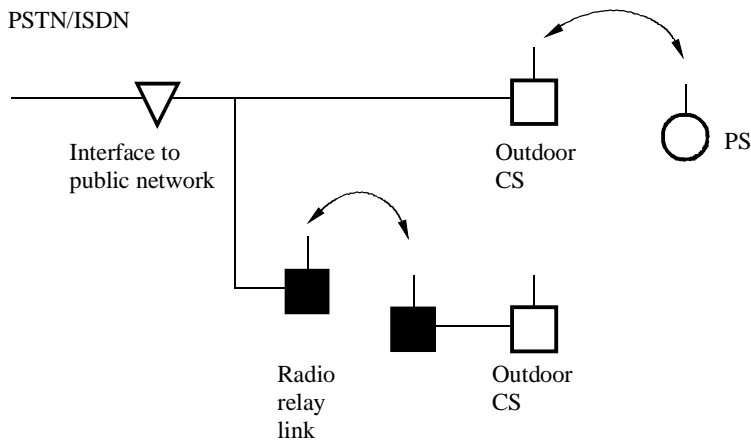
1033-10

FIGURE 11
System configuration in offices



1033-11

FIGURE 12
System configuration outdoors



1033-12

2 System concept

PHS, based on a common air interface standard, enables a personal station (PS) to access cell station (CS)s in a variety of areas such as homes, offices and outdoors. When the dynamic channel assignment is applied, the system allows the co-existence of multiple systems in an area. Microcell radio zone structure along with frequency re-use techniques would increase the system capacity and reduce the transmission power, leading to a decrease in PS size. The digital technology of PHS assures high communication quality and a high grade of security, and expands the service to relatively higher rates of data transmission or modem signal transmission. These features make it possible to apply PHS to, for example, OA (office automation) or FA (factory automation) systems. In PHS, direct communication between PSs is possible in case portables cannot communicate via CSs.

3 Access

3.1 Transmission scheme

PHS is a multi-carrier time division multiple access time division duplex system (TDMA-TDD) with multiplexing of 4 time slot channels per carrier. The modulation scheme is $\pi/4$ -shifted QPSK with a roll-off factor of 0.5; the modulating signal is a symbol stream of 192 000 symbol/s corresponding to a bit-stream of 384 kbit/s. Output power per physical channel is 10 mW, except for outdoor CS. In Japan, PHS operates in the 1.9 GHz frequency band with 300 kHz carrier frequency spacing. For voice coding, the 32 kbit/s ADPCM recommended in ITU-T Recommendation G.721 is adapted in view of lower processing delay time and voice quality requirements. Even lower rate voice coding techniques such as half rate, or quarter rate voice coding can be easily adapted, assisted by the flexibility of the TDMA-TDD frame structure.

3.2 TDMA-TDD frame structure

Figure 13 shows the TDMA-TDD frame structure. In the time domain, one frame of 5 ms consists of 8 slots of 625 μ s each, and so accommodates 4 duplex channels per carrier. As shown in Fig. 13, mainly two types of slot, the control slot and the communication slot, are provided. The control slot is accessed in common by a large number of radio station (CSs, or PSs) and provides the function to set up an individual communication slot between a CS and a PS. Accordingly, access to the control slot from one radio station should be made intermittently. The communication slot is individually assigned to each CS and PS pair and provides the control channel and the information channel to be used for individual call set-up control and transportation of user information respectively.

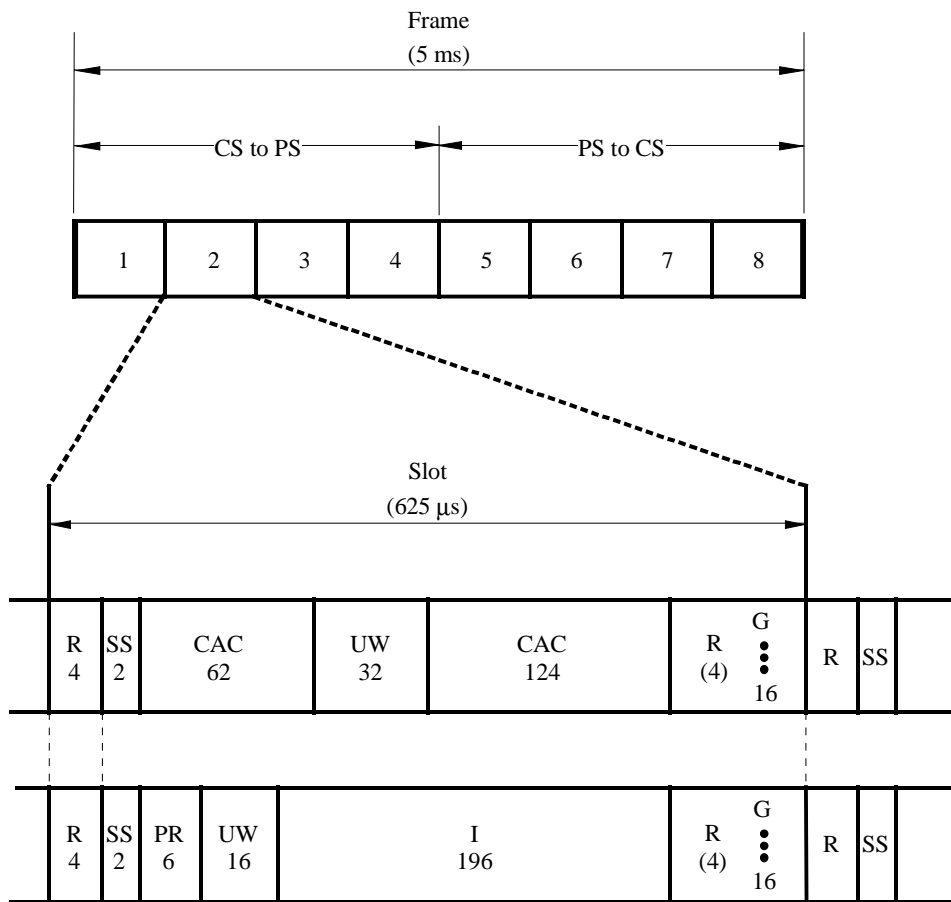
4 Basic principle of protocol

4.1 Protocol model

The protocol structure in PHS consists of three protocol phases: the link channel acquisition phase, service channel acquisition phase, and communication phase. The concept of this structure was introduced by taking into account that the protocol should provide:

- flexibility for various services, even over a degraded radio control channel, compared to fixed communication link;
- unification and simplicity to minimize the program size in the PS;
- ease in establishing local protocol to support the users original services.

FIGURE 13
TDMA-TDD frame structure

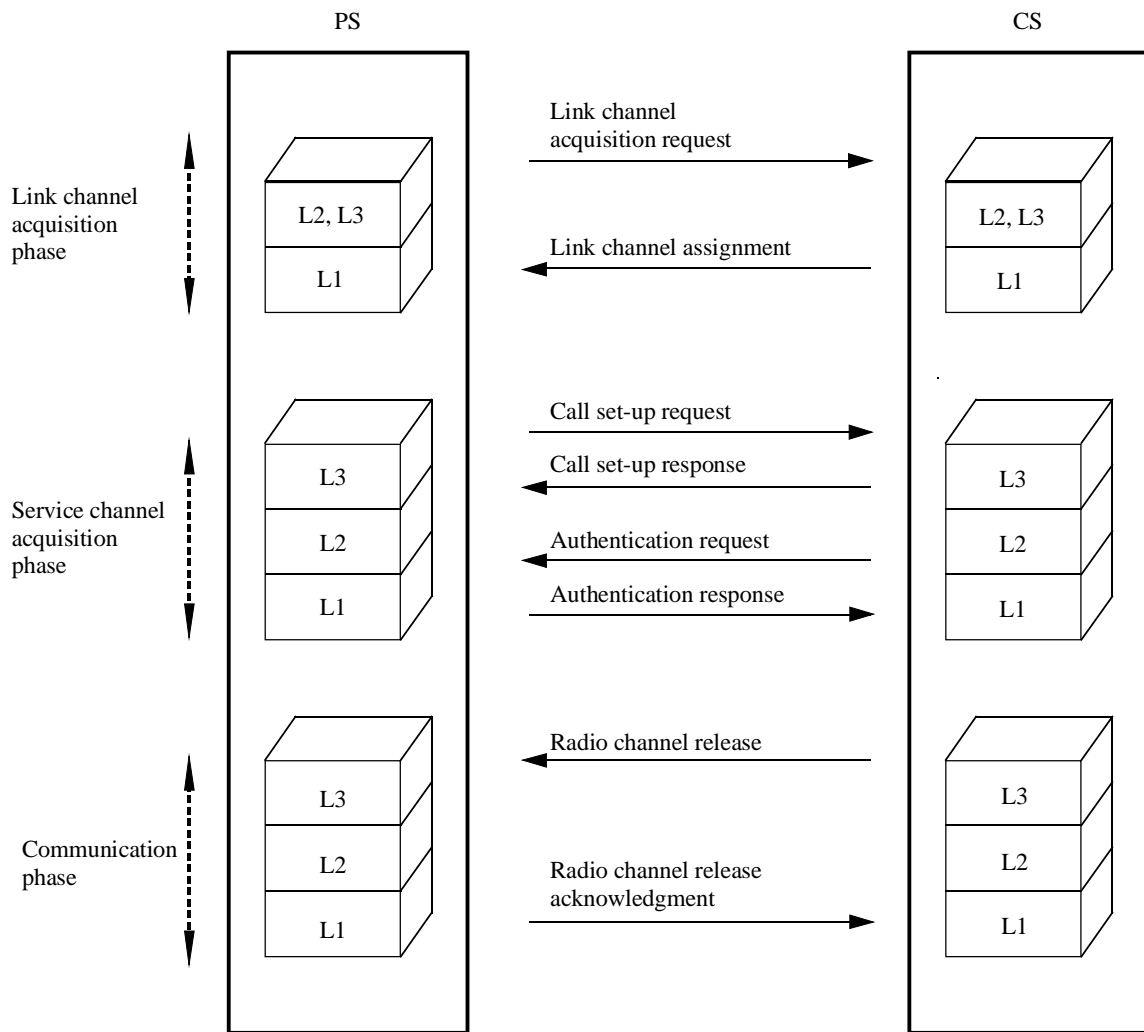


1033-13

The basic signal structure incorporating those three protocol phases is shown in Fig. 14:

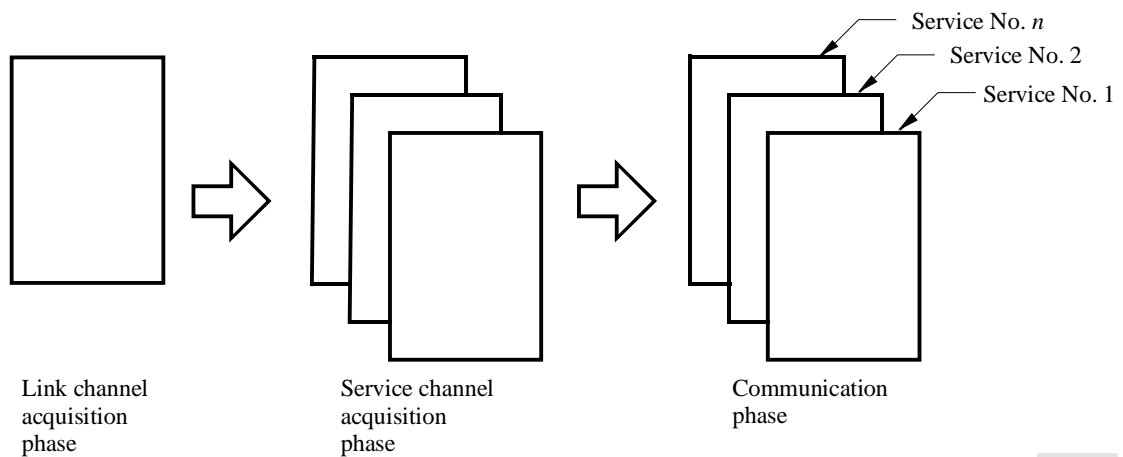
- *Link channel acquisition phase* – Through this phase, a link channel with required quality and capacity, and the proper protocol type for the call set-up in the next phase, are acquired.
- *Service channel acquisition phase* – Using the acquired link channel, a service channel with required capacity and the proper protocol type for the communication phase are acquired through this phase.
- *Communication phase* – In the communication phase, it is possible to select the optimal channel and protocol for each required service class. The concept of these service classes and protocol phases is shown in Fig. 15.

FIGURE 14
Basic signal structure



1033-14

FIGURE 15
Service class and protocol phases

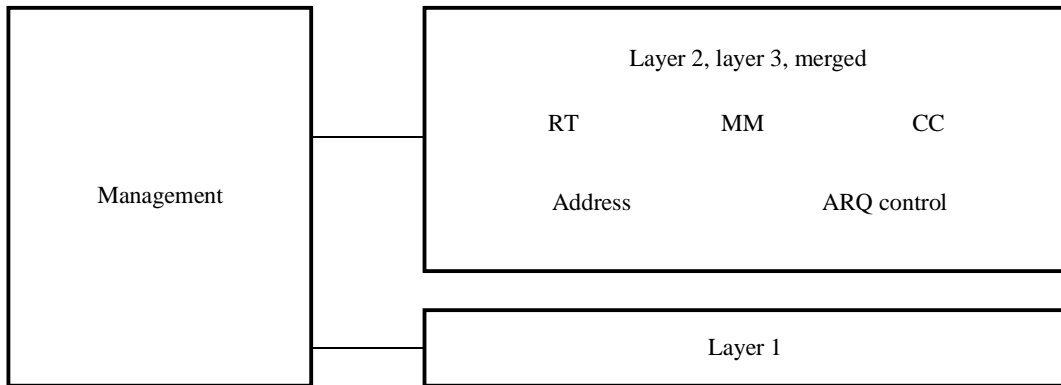


1033-15

4.2 Layer structure

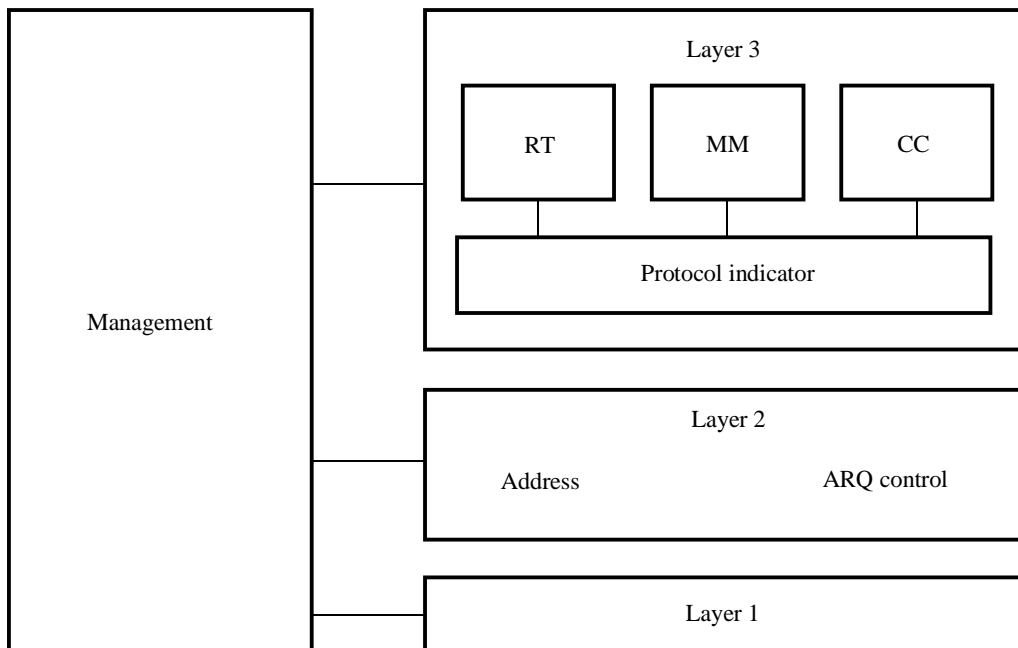
The control channel used in the link channel acquisition phase needs to be peculiar to the radio link characteristic. For this reason, the layer structure for link channel acquisition deviates somewhat from the OSI layered structure, with two layers, layers 2 and 3, being merged, as shown in Fig. 16. On the other hand, for both the service channel acquisition phase and communication phase, layers 1 through 3 from the OSI layered structure are adopted, with layer 3 supporting network functions such as RT (radio frequency transmission management), MM (mobility management) and CC (call control) as shown in Fig. 17.

FIGURE 16
Layer structure for link channel acquisition phase



1033-16

FIGURE 17
Layer structure for service channel acquisition phase and communication phase



1033-17

5 Layer 1 (physical layer)

Layer 1, the physical layer, provides and receives services to and from layer 2 and the management entity. Layer 1 provides layer 2 and the management entity with the following functions:

- transmission ability which includes synchronization and transmission of control signal and/or user information;
- establishment and release of the control channel and/or communication channel;
- maintenance of the radio link;
- signal transmission for operation and maintenance of the system;
- indication of layer 1 status to the management entity;
- radio link error detection, which is output slot by slot.

The channel structure applied to layer 1 is based upon ITU-T Recommendation Q.1063 and Report ITU-R M.1156 – Digital Cellular Public Land Mobile Telephone Systems (DCPLMTS).

6 Layer 2 (data link layer)

Layer 2, the data link layer, creates and maintains a control link between the CS and PS. The features of LAPDC (Link Access Procedure for Digital Cordless) which constitutes this layer are as follows:

- this procedure uses the HDLC (High level Data Link Control) subset for its protocol in order to maintain data link quality against degraded radio link. The basic protocol class is BAC (Balanced operation Asynchronous balanced mode Class) with a sub-function of I (Information) response deletion;
- a UI (Un-numbered Information) command, which transmits information without link set-up procedure, is available for quick on-line control during communication;
- an address part, consisting of a SAPI (service access point indicator) and a command/response indicator bit;
- a frame synchronization function supplied from layer 1, releasing the LAPDC from generation/deletion of the flag sequence and “0” insertion/deletion process for succeeding transmission data “1” s;
- an error detection function also supplied from layer 1, using CRC (cyclic redundancy check). This releases the LAPDC from generating/checking the FCS (frame check sequence).

7 Layer 3 (network layer)

Layer 3, the network layer, offers the functions of establishment, maintenance, handover and release of network connection set-up on the common air interface. It also supports the functions of PS location registration, and authentication procedure for security. The layer 3 protocol applies to the environment, procedures and messages required for the entity of network functions both on the link channel and service channel. Those functions are:

- RT (Radio frequency Transmission management), which supports radio resource management including radio zone assignment, radio link establishment, maintenance, handover, and release;
- MM (mobility management) which supports PS mobility, providing the functions of PS location registration into a network and the authentication procedure for security;
- CC (call control) which supports network connection control including call set-up, call maintenance, and call release.

BIBLIOGRAPHY

RCR Standard (Draft) [December, 1992] Second generation cordless telephone system (RCR STD-28). Research and Development Centre for Radio Systems, Japan.

List of abbreviations

BAC:	balanced operation asynchronous balanced mode class
CAC:	common air channel
CC:	call control
CRC:	cyclic redundancy check
CS:	cell station
FCS:	frame check sequence
G:	guard time
HDLC:	high level data link control
I:	information
ISDN:	integrated services digital network
LAPDC:	link access procedure for digital cordless
MM:	mobility management
OSI:	open systems interconnection
PR:	preamble
PS:	personal station
PSTN:	public switched telephone network
QPSK:	quadrature phase shift keying
R:	ramp time for transient response
RT:	radio frequency transmission management
SAPI:	service access point indicator
SS:	start symbol
TDD:	time division duplex
TDMA:	time division multiple access
UI:	un-numbered information
UW:	unique word

APPENDIX 7
TO ANNEX 1

General description of System 7 (digital)

The CT2Plus system used in Canada for cordless telephone services has been designed to provide a wide range of capabilities and yet maintain efficient use of spectrum and inexpensive portable handsets. The system is designed for residential (cordless telephone), public access (“telepoint”), and commercial and business (wireless PBX) applications. The system specifically addresses the complete range from low-end residential systems to high functionality business systems on a fully compatible basis and in a cost effective manner.

The Canadian system is derived from the CT2 CAI which is defined in the European standard ETSI ETS-300-131. The CT2 CAI has also been underwritten by a memorandum of understanding as a standard for public service applications in many areas of the world. CT2Plus is based on the CT2 CAI with compatible enhancements to meet Canadian spectrum and service requirements. The system has been implemented in Canada in the 944-948.5 MHz band however extensions are provided to readily accommodate spectrum allocations of 8 MHz or more. Other spectrum bands can be easily accommodated.

The system can be interconnected to both analogue and ISDN networks and support features such as calling line identification and "D" channel data services. CT2Plus supports a wide range of basic and optional features. These include, for example, alerting functions, alphanumeric display, telepoint authentication and registration, handset registration to multiple service providers, emergency calling and two way calling features. In addition, signalling layer 3 includes areas of the message space for expansion in order to accommodate future services and features.

The voice quality provided by the system meets the Canadian network requirements for PBX/Centrex, local metropolitan and long distance connection for both two-wire and digital connections. In particular, the low delay inherent in the FDMA multiple access technique meets the delay requirements for connection to the public switched telephone network without the need for additional echo control devices.

The system uses time division duplexing (TDD) and digital modulation to achieve high spectral efficiency and robust operation within buildings. Dynamic channel allocation techniques further assure the efficient use of spectrum. Traffic densities as high as 10 000 E/km²/floor may be achieved (at 0.5% grade of service blocking).

The system fully supports in-call handover. Well-defined procedures were provided for handover as a result of interference or as a result of changes in location. The system also includes provision for cases in which communications fail and alternative procedures must be called upon. The system fully supports location tracking and roaming of subscribers. Through the use of signalling channels (occupying the band 948.0-948.5 MHz), portable units may readily locate the nearest fixed part (or base-station) and register for active service. These signalling channels also may be used to announce call delivery to the portable part and thereby improve the standby life of the portables. There are five signalling frequencies each of which supports 12 signalling channels through time division multiple access.

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- DOC [1993] Radio Standards Specification, RSS-130, Annex 1, CT2Plus Class 2, Specification for the Canadian Common Air Interface for digital cordless telephony, including public access services. Department of Communications, Slater Street, Ottawa, Ontario, Canada.

APPENDIX 8

TO ANNEX 1

General description of System 8

1 Introduction

The personal communications interface (PCI) standard [ANSI TIA/EIA, 1995] was developed to meet the need for an inexpensive cordless communications system primarily for voice traffic. PCI is intended to provide personal communications services in residential and business environments. It is particularly targeted at the following applications:

- cordless business telephone systems (PBXs),
- residential cordless telephones,
- public access services.

The PCI standard ensures the interoperability between devices from different manufacturers. It may be used for the two-way interworking between fixed and portable radio devices operating in the isochronous unlicensed frequency band allocated for personal communications services in the United States of America (1 920-1 930 MHz). The equipment is intended to convey digitally-encoded speech and data with associated digital signalling, via a radio channel, to and from a nearby fixed station, or network of fixed stations.

Applications for the PCI standard include wireless access to business and residential services. The standard is designed to allow a user to move from one personal communications environment (domestic, private branch exchange, key system, Centrex) to another with a single portable device.

The PCI standard outlines the technical requirements to ensure that:

- minimum interference is created to other users of the shared unlicensed radio spectrum and the interference from other systems has a minimum effect on the operation of equipment so that coexistence is possible;
- there exists a defined degree of interworking between the portable and fixed devices following the PCI standard, allowing users in possession of compliant portable devices, to make and receive telephone calls from compliant fixed devices.

To these ends, the PCI standard specifies the essential requirements for:

- monitoring, accessing and relinquishing an RF channel,
- the means by which the data structures are modulated onto the channel,
- the means by which the two ends of a radio link become and remain synchronized,
- the provision of signalling or marker channels,
- generation and interpretation of digital control,
- generation and interpretation of digital speech and data.

2 General description

The PCI standard has as its basis the common air interface for equipment standardized by ETSI (I-ETS 300 131), described as System 3 (CT2) in the present Recommendation.

In addition, PCI has enhanced the following capabilities: automatic handover, location tracking, roaming, rapid call set-up, and increased battery life for the portable devices. Because of the additional constraints required to follow the United States Code of Federal Regulations (CFR) 47 Federal Communications Commission (FCC) Rules Part 15 subpart D “etiquette” for sharing the spectrum in the unlicensed band, compatibility or interoperability is not maintained between equipment conforming to the PCI standard and equipment conforming to the I-ETS 300 131 standard.

The principal changes added to adhere with a spectrum etiquette (outlined in the FCC Rules Part 15 subpart D) and to facilitate sharing of the spectrum among different systems are the requirement to always listen during the intended transmit interval before transmitting to be sure the channel is free; not transmitting on a channel if foreign signals are detected above a threshold; and not beginning any transmission by a portable device unless the fixed part transmissions can be received. In addition, there are a number of RF parameter changes dealing with power levels and allowed levels of in-band and out-of-band emissions.

The basic technical characteristics of the PCI radio system are shown in Table 3. PCI is a multicarrier frequency division multiple access (FDMA) time-division duplex (TDD) system. The standard defines 99 carrier frequencies separated by 100 kHz. The RF modulation is two-level frequency shift keying (FSK) with a Gaussian shaped filter ($BT = 1/2$). The modulated bit stream is 72 kbit/s. The maximum output power is 30 mW per channel. The time-division frame period is 2 ms (1 ms in each direction of transmission). This bit stream accommodates speech coded as per ITU-T Recommendation G.726 and associated signalling information.

REFERENCES

ANSI TIA/EIA [1995] Personal Communications Interface Interoperability (PCI) Standard. Standard 663. American National Standards Institute/Telecommunications Industry Association/Electronic Industries Association.

APPENDIX 9

TO ANNEX 1

General description of System 9**1 Introduction**

The Personal Wireless Telecommunications (PWT) standard [TIA/EIA, 1995] was developed to meet the need for cordless communications, primarily for voice traffic, and also to provide support for a range of data traffic communications.

The PWT standard is designed to support a wide variety of voice and data applications at a cost that encourages wide availability. It is envisaged that PWT will provide personal telecommunication services in residential, neighbourhood and business environments. It is particularly targeted at the following applications:

- cordless business telephone systems (PBXs);
- residential cordless telephones;
- public access services;
- packet data services;
- laptop/palmtop services;
- wireless video services; and
- cordless local area networks (CLANs).

One primary objective of the standard is to provide for interoperability between devices from different manufacturers, and so offering users a family of telecommunication services for voice or data, either as basic services, or with optional (and compatible) extensions.

While providing for interoperability, the standard also provides escape protocols that allow manufacturers to develop new applications not yet supported in the basic standard. In addition, reserved codes have been included in the PWT standard to provide mechanisms for evolutionary development of the standard.

The PWT standard also has the objective of coordinating the use of two shared resources:

- the RF spectrum which is used for the operation of the communication system,
- the networks for which the PWT provides a telecommunications connection.

It is the objective of the PWT standard to ensure that conforming devices will be able to use the radio and network resources efficiently and with the minimum degree of interference (i.e. avoiding adverse affects to existing, or future, users of those resources).

2 General description of the system

The PWT standard is based on a micro-cellular radiocommunication system that provides low-power radio (cordless) access between portable parts and fixed parts at ranges up to a few hundred metres. The PWT standard is a derivative of the DECT standard (System 5 in the present Recommendation) with modifications to suit the United States Code of Federal Regulations (CFR) 47 Federal Communications Commission (FCC) rules Part 15 subpart D. The principal changes to adhere with these rules are the requirement to always listen during the intended transmit interval before beginning a transmission to be sure the channel is free, not transmitting on a channel if foreign signals are detected above a threshold, and not beginning any transmission by a portable device unless a signalling channel can be received from a coordinated fixed base station. In addition there are a number of RF parameter changes involving power levels and allowed levels of in-band and out-of-band emissions. Alternatively, it may also operate under FCC Part 24 Rules. The basic technical characteristics of the PWT radio system are shown in Table 3.

PWT is a multi-carrier time-division multiple access (TDMA), time-division duplex (TDD) system. In the United States of America PWT operates in the sub-band 1 920 to 1 930 MHz, and optionally, in the sub-band 1 910 to 1 920 MHz. The standard defines 16 carrier frequencies separated by 1 250 kHz. The RF modulation is $\pi/4$ shifted differential quadrature phase shift keying (DQPSK) with a relative bandwidth of 1/2. The bit stream is at 1 152 kbit/s. The RF output power per physical channel is 90 mW. In the time domain, the frame period is 10 ms. Each frame consists of 24 time slots of 416 700 ns in duration. With this arrangement there may be 12 duplex channels per carrier.

Each time slot provides an overall throughput sufficient to accommodate speech coded according to ITU-T Recommendation G.726 and for associated signalling information.

A connection is provided by transmitting bursts of data in the defined time slots. These may be used to provide simplex or duplex communications. Duplex operation uses a pair of evenly spaced slots: one for transmit and one for receive.

The basic duplex service uses a single pair of time slots to provide a 32 kbit/s digital information channel capable of carrying coded speech or other low rate digital data. Higher data rates are achieved by using more time slots in the TDMA structure, and a lower data rate may be achieved by using half-slot data bursts.

PWT is able to support a number of alternative system configurations ranging from single cell equipment (e.g. residential cordless telephone) to large multiple cell installations (e.g. large business cordless PBXs).

The protocols are designed to support uncoordinated system deployment, even where the systems coexist in the same physical location. Efficient sharing of the radio spectrum (of the physical channels) is achieved using "dynamic channel selection".

In addition, the PWT protocols provide two internal mechanisms to support rapid handover of calls in progress (both intracell and intercell handover are supported).

REFERENCE

TIA/EIA [1995] Personal Wireless Telecommunications (PWT) Interoperability Standard. Standard 662. Telecommunications Industry Association/Electronic Industries Association.

APPENDIX 10

TO ANNEX 1

General description of System 10

1 Introduction

This Appendix describes the two unlicensed TDD modes [ANSI J-STD-014A and J-STD-014B] of personal access communication systems (PACS-UA and PACS-UB). The intended applications of PACS-UA and PACS-UB include low mobility indoor (up to 30 km/h) such as wireless PBX, wireless Centrex, wireless keysets and cordless telephony. PACS also has an FDD mode of operation [ANSI J-STD-014].

PACS-UA and PACS-UB, common air interface standard adhere to the United States Code of Federal Regulations (CFR) 47 Federal Communications Commission Rules Part 15 subpart D. These rules are intended to ensure that minimum interference is created to other users of shared unlicensed radio spectrum and interference from other systems has a minimum effect on the operation of equipment so that coexistence is possible.

PACS offers a common air interface which is applicable to a wide range of venues and environments and which can support interoperability between public and private access. PACS has been designed for easy integration into an existing PSTN and maximizes the use of existing network elements.

The PACS standards were developed to ensure that a single handset could be used for residential cordless telephone access in the home, licensed wireless access in public venues and wireless PBX, Centrex or keyset access in the workplace.

PACS supports local loop replacement application where a wireless drop connection may be preferable (for economic or other reasons) to a wireline connection. In this application, subscriber units (SUs) provide a standard interface (e.g. RJ-11 jack) to the user allowing access from standard telephone equipment.

The PACS air interface is designed to support voice, voiceband data, and digital data services along with related intelligent network services.

The supplementary services that are available include: call forwarding, three-way calling, call waiting, call completion, advice of charge and call restriction. Since PSTN infrastructure can be used, many other AIN-based supplementary services can be easily provided to subscribers.

PACS has been designed to ensure a high level of security designed to protect the access to services and the privacy of user-related information.

2 General description

The PACS-UA and PACS-UB standards are low power radio access technologies which use $\pi/4$ DQPSK modulation. They use TDMA/TDD techniques with a maximum of 53 mW RF transmit power on both the forward and reverse links. The bit rate over the air interface is 384 kbit/s at a symbol rate of 192 ksymbol/s. The RF channel spacing is 300 kHz and the 99% power bandwidth is 288 kHz.

Both PACS unlicensed techniques have a frame structure with four forward link time-slots and four reverse link time-slots which are paired to support full duplex connections. PACS-UA has a 5 ms frame duration and PACS-UB has a 2 500 μ s frame duration.

The systems are able to support full-rate channels of 32 kbit/s as well as subrate channels. The speech coding uses Recommendation ITU-T G.726 32 kbit/s ADPCM and provisions are included for lower-rate speech systems when such encoding systems are practicable.

Handover is controlled, directed and initiated by the subscriber unit and is initiated on the new link. Such handovers are more reliable and result in fewer dropped calls and much faster set-up times than conventional network directed handovers.

Network directed handovers are supported to meet network management requirements such as load shedding to relieve congestion.

REFERENCES

ANSI J-STD-014. Personal Access Communication System Air Interface Standard. American National Standards Institute. (See also Recommendation ITU-R M.1073.)

ANSI J-STD-014A. Personal Access Communication System Unlicensed – Version A Air Interface Standard.

ANSI J-STD-014B. Personal Access Communication System Unlicensed – Version B Air Interface Standard.
