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Technical Report

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

1 Scope

This System Reference Document has been produced following a request from CEPT working group FM to ETSI and under the MoU between ETSI and CEPT.

The objective of the present document is to consider services, business and technical aspects of a CDMA system for PAMR operation in the following bands:

- 410 MHz to 420 MHz/420 MHz to 430 MHz;
- 450 MHz to 460 MHz/460 MHz to 470 MHz;
- 870 MHz to 876 MHz/915 MHz to 921 MHz.

This PAMR system is based on CDMA-1X technology, which employs direct sequence spread spectrum code division multiple access technology and a bandwidth of 1 MHz to 25 MHz, with added proprietary functions to support PAMR functions. For convenience, this technology is described in the present document as CDMA-PAMR; however, it should be noted that this does not exclude the possibility of other PAMR systems based on CDMA being proposed in the future.

The SRDoc analyses possible consequences of using CDMA-1X technology for PAMR operation, taking into account the number of potential operators in order to ensure competition and current PAMR services offered already in the relevant bands. The following information is included in the annexes to the present document:

Annex A: Detailed market information;

Annex B: Technical information;

Annex C: Expected compatibility issues.

2 References

For the purposes of this Technical Report (TR) the following references apply:

[1] APCO Report on Project 39, on Interference to Public Safety 800 MHz Radio Systems, an Interim Report to the FCC, December 24, 2001.

[2] Cellular Radio Interference to Denver's 800 MHz Public Safety Network, by Pericle Communications Company, Colorado Springs, June 10, 2003.

[3] CEPT/ERC/Recommendation 74-01E (Siófok 1998, Nice 1999): "Spurious emissions".

[4] ANSI/TIA -97-E: "Recommended Minimum Performance Standards for cdma2000 Spread Spectrum Base Stations".

[5] ANSI/TIA -98-E: "Recommended Minimum Performance Standards for cdma2000 Spread Spectrum Mobile Stations".

[6] TIA/EIA/IS-2000.1-C: "Introduction to cdma2000 Spread Spectrum Systems - Release C".

[7] TIA/EIA/IS-2000.2-C: "Physical Layer Standard for cdma2000 Spread Spectrum Systems Release C".

[8] TIA/EIA/IS-2000.3-C: "Medium Access Control (MAC) Standard for cdma2000 Spread Spectrum System Release C".

[9] TIA/EIA/IS-2000.4-C: "Signalling Link Access Control (LAC) Standard for cdma2000 Spread Spectrum Systems Release C".

[10] TIA/EIA/IS-2000.5-C: "Upper Layer (Layer 3) Signalling Standard for cdma2000 Spread Spectrum Systems Release C".

[11] ITU Radio Regulations 2001.

[12] Logical Strategy: "Business Demand for Next Generation PMR/PAMR Services", FM38(2002)43, 27 February 2002.

[13] EICTA Report EICTA/RSPC 01-0451: "PMR/PAMR development in Europe - A digital take off", contribution to FM38 by EICTA Radio and Spectrum Policy Committee, FM38(2001)32, April 2001.

[14] Logical Strategy: The Continuing Need to Supply PMR/PAMR Functionality to Europe's Business Community".

[15] TETRA Release 2 questionnaire results.

[16] TIA/EIA/IS-835-A: "cdma2000 Wireless IP Network Standard".

[17] TIA/EIA/IS-127 (and addenda): "Enhanced Variable Rate Codec, Speech Service Option 3 for Wideband Spread Spectrum Digital Systems".

[18] TIA/EIA/IS-893: "Selectable Mode Vocoder Service Option for Wideband Spread Spectrum Communication Systems".

[19] TIA/EIA/IS-707-A-2: "Data Service Options for Spread Spectrum Systems", Addendum 2.

[20] ANSI/TIA -683-A "Over-the-Air Service Provisioning of Mobile Stations in Spread Spectrum Systems".

[21] TIA/EIA/IS-725-A: "Cellular Radiotelecommunications Intersystem Operations - Over-the-Air Service Provisioning (OTASP) & Parameter Administration (OTAPA)".

[22] TIA/EIA/IS-801-1: "Position Determination Service Standards for Dual Mode Spread Spectrum Systems.

[23] CEPT/FM(02)176: "Systems Reference Document for CDMA-PAMR, submitted to FM PT 38 by Lucent Technologies".

[24] ECC/Report 025 (Stavanger 2003): "Strategies for the European use of frequency spectrum for PMR/PAMR applications".

[25] ITU-R Report M.2014: "Spectrum efficient digital land mobile systems for dispatch traffic".

[26] ETSI TS 100 910: "Digital cellular telecommunications system (Phase 2+); Radio transmission and reception (3GPP TS 05.05)".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

Base Station (BS): land station in the land mobile service

cellular: mobile system designed to operate on the principle of communications cells with handover of subscribers between each

CDMA-1X: TIA/EIA/IS-2000 Spreading Rate 1

CDMA-PAMR: for the purpose of TR 102 260, a PAMR system, based on TIA/EIA/IS-2000 Spreading Rate 1 specifications, with proprietary enhancements (note that this does not exclude the possibility of other PAMR systems based on CDMA techniques being proposed in the future)

dBc: decibels relative to the unmodulated carrier power of the emission

NOTE: In the cases which do not have a carrier, for example in some digital modulation schemes where the carrier is not accessible for measurement, the reference level equivalent to dBc is decibels relative to the mean power P.

downlink: unidirectional radio pathway for the transmission of signals from one Base Station (BS) to one or more Mobile Stations (MSs)

dBm: absolute power level relative to 1 milliwatt, expressed in dB

land mobile service: mobile service between base stations and land mobile stations, or between land mobile stations

land station: station in the mobile service not intended to be used while in motion

necessary bandwidth: for a given class of emission, the width of the frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions

out-of-band emissions: emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emissions

physical layer: part of the communication protocol between the mobile station and the base station that is responsible for the transmission and reception of data

point-to-point: communication provided by a link between two specified fixed points

point-to-multipoint: communication provided by links between one specified fixed points

Resource reSerVation set-up Protocol (RSVP): The RSVP protocol is used by a host to request specific qualities of service from the network for particular application data streams or flows. The network responds by explicitly admitting or rejecting RSVP requests.

soft handoff: A handoff occurring while the mobile station is in the Mobile Station Control on the Traffic Channel State. This handoff is characterized by commencing communications with a new base station on the same CDMA frequency assignment before terminating communications with the old base station.

spurious emissions: emission on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

unwanted emissions: consist of spurious emissions and out-of-band emissions

uplink: radio communication path for the transmission of signals from Mobile Stations (MS) to one Base Station (BS)

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AAA Authentication Authorization Accounting
ACCT Access Control based on Call Type
ACCOLC Access Control Overload Class
ANSI American National Standards Institute
AOC Access Overload Class
APCO Association of Public-safety Communications Officials
API Application Programming Interface
BS Base Station
BTS Base Transceiver Station
CC Call Control
CDMA Code Division Multiple Access
CEPT European Conference of Postal and Telecommunications administrations
DMO Direct Mode Operation
DNS Domain Name Server
ECC Electronic Communications Committee

EVRC	Enhanced Variable Rate Codec
FCC	Federal Communications Commission
FDD	Frequency Division Duplex
FDMA	Frequency Division Multiple Access
FER	Frame Error Rate
FPC	Forward Power Control
GPRS	General Package/Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile communications
GSM-R	GSM for Railways
IEEE	Institute for Electrical and Electronics Engineers
IOTA	IP-based Over-The-Air Administration
IPR	Intellectual Property Rights
IMS	Integrated Management System
IMT-2000	International Mobile Telecommunications 2000
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
LAC	Link Access Control
MAC	Media Access Control
MGCF	Media Gateway Control Function
MGW	Media Gateway
MPC	Mobile Positioning Centre
MS	Mobile Station
OTA	Over-The-Air
OTAPA	Over-The-Air Parameter Administration
PACA	Priority Access Channel Assignment
PAMR	Public Access Mobile Radio
PCB	Power Control Bits
PDSN	Packet Data Support Node
PDU	Protocol Data Unit
PMR	Private Mobile Radio
PSDN	[Packet Server Data Network]
PTT	Push-To-Talk
QoS	Quality of Service
RAN	Radio Access Network
RF	Radio Frequency
RPC	Reverse Power Control
RSVP	Resource reservation set-up Protocol
SCH	Supplemental Channels
SIP	Service Independent Protocol/Session Initiated Protocol/Session Initiation Protocol
SMV	Selectable Mode Vocoder
S/N	Signal to Noise Ratio
TDMA	Time Division Multiple Access
TETRA	Terrestrial Trunked Radio
TrFO	Transcoder Free Operation
TIA	Telecommunications Industry Association
UE	User Equipment
UIC	International Union of Railways
UMTS	Universal Mobile Telecommunications System
VoIP	Voice-over IP
VPNs	Virtual Private Networks
WG SE	Working Group, Spectrum Engineering

4 Executive summary

4.1 Status of the System Reference Document

This System Reference Document has been developed by ETSI following a request by CEPT working group FM, which had received a proposal from a single organization to consider CDMA-1X technology, as standardized by the TIA [4] - [10], for PAMR operation in the relevant bands.

The present document concentrates on the technical matters that are required to assist ECC/CEPT working groups FM and SE.

The following ETSI members identified themselves as proponents of the present document.

Association of Service Providers	Inquam (UK) Limited
Lucent Technologies Network Systems UK	Motorola S.A.S.
Nortel Networks (Europe)	Qualcomm Europe S.A.R.L.
BMWa	Norwegian P & T Authority
National Post & Telecom (Sweden)	

Statement from ETSI/MSG

MSG is the responsible Technical Body within ETSI for matters relating to the specifications for the GSM system. In response to an invitation from TC ERM to other ETSI Technical Bodies for comments on this system reference document, MSG has provided information on expected compatibility issues between CDMA-PAMR and GSM 900 at 915 MHz. This is contained in annex E.

Comments from Various ETSI Members

Comments from a number of ETSI members are contained in annex G.

Statements from Vodafone Group plc

i) The Vodafone principled position is that all issues should be handled in a fair and transparent process.

The absence of a market analysis consistent with the "Commission Guidelines on market analysis and the assessment of significant market powers under the Community regulatory framework for electronic communications networks and services" means that regulators will be at potential risk of discriminatory decisions should they permit the utilization of CDMA-PAMR in the 450 MHz and 900 MHz bands. Consequently, it has not yet been shown that it will be possible to make spectrum available for CDMA-PAMR, nor, if so, in which spectrum it would be permitted to operate.

ii) We are concerned that nowhere in the CEPT/ETSI process has the question been asked whether there are other technologies that might be a more appropriate solution to the PAMR e.g. more e-m compatible friendly technologies. Thus the conclusions on e-m compatibility may be deficient.

CDMA-PAMR is, at present, effectively a proprietary technology. Any regulatory actions by CEPT should not be restricted to this particular technology, but should also be applicable to other technologies having similar or better spectrum compatibility characteristics to those considered in the compatibility studies for CDMA-PAMR.

Statement from Vodafone Group plc, Orange SA, Telefonica Moviles, Nokia, France Telecom

General comment on this System Reference Document

We greatly regret that ETSI ERM was unable to reach a consensus on the majority of contributions relating to the technical description of CDMA PAMR in this System Reference Document. This was the case even when these changes were to remove ambiguities in the technical material or to provide additional information that would assist CEPT in its studies. The subsequent clauses and annexes A and B of the present document are therefore largely unchanged from the document originally received by CEPT Working Group FM (which was then forwarded to ETSI/ERM). Consequently, the additional information provided to ERM during its review of the present document is largely contained in the comments in clause 4.1 of this System Reference Document.

Comments on the technical content of this System Reference Document

Definition of CDMA-PAMR

In the present document, CDMA-PAMR is described as if it is a single system. However, if not standardized, the result could be a number of different and potentially incompatible solutions, using a variety of IP applications together with a CDMA-1X access network.

Expected output powers (clause 4.3.3)

The maximum power output is an important parameter for co-existence with services in neighbouring frequency bands. CDMA PAMR terminals are not widely available, if they are available at all(especially for the 870 MHz to 876 MHz /915 MHz to 921 MHz band). It is difficult to predict what the power output from commercial CDMA-PAMR base stations and terminals will be, especially as PAMR networks are expected to have lower subscriber densities than public mobile networks and would therefore benefit from larger cells.

The power output from a CDMA-PAMR base station will depend upon the radio planning and network configuration. TIA/EIA-98-E [5] specifies a number of power classes for the terminal, with an upper limit of 6,3W ERP (+38 dBm) for the 800 MHz band and 10 W ERP (+40 dBm) for the 400 MHz band. Note that a power defined in ERP is likely to result in a higher field strength than the same power defined at the antenna connector, because of the antenna efficiency.

Status of 400 MHz and 900 MHz bands within TIA specifications (clauses B.2 and B.3)

The use of CDMA-1X for PAMR is not "recognized" within the TIA/EIA/IS-2000 specifications. The titles given to these band classes are purely descriptive, as is clear from the titles for other band classes within these specifications. The specifications do not include support for important PAMR services.

Statement from Bolt Consult

The present document calculates the protection distances for CDMA-PAMR interference to SRDs. The calculated protection distances are 145 m and 97 m for interference by the CDMA mobile and Base station respectively. As the CDMA system does not have a significant restriction in the transmitter duty cycle the above mentioned protection distances are too high to protect social alarm and other SRDs. According to the calculations the guard band between CDMA-PAMR and SRDs shall be 2 MHz or more.

See annex D.

Statement from ANIE

In the SRDoc it is argued that CDMA-PAMR has a better power control mechanism than other system. That the average power is up to 10 dB lower due to that and that the interference is reduced in relation to the output power, and therefore CDMA-PAMR has less interference issues.(TR 102 260 v0.0.10 annex B, p.25 bottom section "Forward Power Control" and page 28 bottom).

It seems there is a flaw in that argument. It is correct that the CDMA-PAMR has a wideband spec which is relative to transmit power for smaller freq. offset of up to 4MHz (typically inside the CDMA band itself). However for offset larger than 4 MHz the spec change to be absolute and therefore no longer linked to the output power. This means that the interference will be reduced "inside" the CDMA band, but not for the adjacent services at larger offset.

Furthermore there is quite a big difference in a similar service specification such as TETRA that has a requirement for -100 dBc for freq. offset > 5 MHz (no req. more stringent than -70 dBm). For a 46 dBm (50 W) (highest BS pwr class) this correspond to -54 dBm in an 18 kHz filter. The requirement follows the BS power, so for a typical 25 W BS it would be -57 dBm, and for 10 W it would be -60 dBm 18 kHzBW. Only for powers less than 1 W the requirement become absolute and stays at -70 dBm.

The corresponding req. for CDMA-PAMR req. is -36 dBm (offset 4 MHz to 6 MHz) and -45 dBm in 100 kHzBW (offset > 6 MHz). Transforming to 18 kHz this is -43 dBm and -52 dBm 18 kHzBW. However this will not follow any reduction in output power.

For a 1W MS the TETRA requirement are -60 dBm 18 kHzBW (offset > 5MHz), where as the CDMA-PAMR also become absolute at 4 MHz to 10 MHz at -51 dBm in 100 kHzBW which transform into -58,5 dBm in 18 kHzBW. It has been not noticed any spec for > 10 MHz.

It can be seen that specifically for the BS there is a big difference in spec. The CDMA-PAMR is relaxed typically 17 dB to 8 dB for BS wideband noise larger offset. For smaller offset down to 750 kHz the difference is even bigger.

4.2 Technical Issues

The technical information about the CDMA-PAMR system contained in the following clauses and annexes A and B of this SRDoc is based on a document submitted to CEPT [23] and subsequently passed to ETSI - ETSI has not been able to validate part of this information about CDMA-PAMR, because some elements of this system are proprietary, and others are not fully specified in current versions of the TIA/EIA/IS-2000 specifications.

4.2.1 Short background information

4.2.1.1 System description

This System Reference Document provides details of CDMA-PAMR, which is a system that utilizes CDMA technology in order to provide PAMR services to users.

CDMA-PAMR is likely to be used as an extension or overlay to existing PAMR networks, and the system is also suitable for operation as a stand-alone network. For the purposes of this System Reference Document, CDMA-PAMR has been presented as a stand-alone system to avoid any confusion that may be caused by referencing other system technologies.

The approach that is taken for CDMA-PAMR is to utilize voice-over-IP technology running over a CDMA-1X radio network in order to provide voice-based PAMR services to users, in addition to data services with a range of data rates. This is implemented by means of a PAMR application running on a server connected to the CDMA radio network, which utilizes features and services of the underlying CDMA-1X network.

4.2.1.2 Applications

A typical application of the CDMA-PAMR technology will be for a wide area PAMR network operated by a network operator and covering the major parts of a country or region of a country. The proponents of CDMA-PAMR predict the number of subscribers for such a network would typically be expected to rise to a few hundred thousand, giving a user density (in urban areas) that is far lower than a typical public cellular network, but higher (on average) than for a wide-area PMR system (although without the concentration of user density exhibited by some localized PMR systems, e.g. those serving a single site or campus).

CDMA-PAMR is intended to provide a flexible environment for the creation of services and applications, and a combination of PAMR voice and data services. It is expected that system implementations will initially be driven by the need to provide data services for mobile workers, although other PAMR services may also be provided. Services available using CDMA-PAMR technology include, among others:

- Push-To-Talk (PTT) voice services.
- Group calls.
- Dispatch services.
- Prioritization and queuing.
- Status and short data messages.
- Packet data/IP services.
- Simultaneous voice and data.
- Dynamic group management.

- Over-the-air reprogramming of terminals.
- Location services.

In common with other current technologies, CDMA-PAMR will be able to support a wide range of data applications for users, including:

- Short data messages.
- Telemetry.
- Database access/interactions.
- Mobile office applications, e.g. email.
- Image and file transfer.
- Video.

Further information about user applications can be found in annex A.

4.2.1.3 New technology

CDMA-PAMR

CDMA-PAMR technology is based on the CDMA-1X technologies with extensions to provide PMR like services. These extensions are currently based on proprietary technology.

The services are based on the IP packet data service overlay of CDMA-1X and do not utilize the native voice services of that standard. This has the following implications for the services:

- All services must operate over an IP network with adequate quality of service.
- All services require an IP connection between the User Equipment and a central server providing those services.
- Individual speech call services require encapsulation of speech inside IP packets. Some slight loss of capacity will result when compared with native CDMA-1X voice services due to the overhead of the IP layer.
- Group speech services will require a separate IP connection for every member of a group engaged in group calls. This will result in significant loss of capacity when compared with a native group call service that allows many users to share the same downlink channel.
- IP packet data services will use the native IP data service of CDMA-1X. They may not need to make use of a central server.
- PMR data services such as Status and Short Data Services will operate over the IP packet data service via the central server.

Application services, such as location, store and forward and message retry may run over the native packet data service of CDMA-1X, or via the central server as is most appropriate, as they would for other PAMR technologies.

CDMA-1X compared with other technologies

There are a number of technologies that are applicable for the PAMR segment of the market. Please note that this clause only comments on key digital technologies, rather than older analogue technologies, and does not comment on all digital technologies.

There is an existing European Standard which has been developed to meet the PAMR market (as well as the PMR market). This is TETRA. Although CDMA-1X technology is a 3G technology in its cellular deployment markets, CDMA-PAMR aims to offer higher data rate services to the PAMR market.

In the United States, PAMR is known as Service Mobile Radio (SMR), and many systems are implemented using iDEN, a semi proprietary TDMA technology. This is deployed in many parts of the world, but is not common within the European Community.

The GSM specifications have been developed to include PAMR features. The GSM specifications including these features were adopted by UIC, as GSM/R for communication on railway networks.

With the advent of GPRS and newer technology, where a packet service is viable, many manufacturers have announced visions and product concepts for a "push-to-talk over cellular service" that operate in these GPRS networks. Push-to-Talk concepts can address some of the needs of PAMR.

It should be noted that these Push-to-Talk concepts - whether on top of CDMA-1X or GSM/GPRS - may not satisfactorily address the needs of mission critical PMR applications, such as Public safety agencies, due to mismatch with:

- call set-up time requirements;
- guaranteed access and availability of channels during incidents;
- guaranteed availability of radio service during network faults.

These users may therefore need a dedicated PMR network. These types of systems are already described in Report ITU-R Report M.2014 [25] (Spectrum efficient digital land mobile systems for dispatch traffic).

4.3 Short Market Information

The potential market for CDMA-PAMR is discussed in some detail in annex A (describing the PMR/PAMR market). From market research that has been conducted by Logical Strategy [14] it can be estimated that the total potential addressable market for PAMR/PMR in the EU is around 20 million (although it will not be possible for digital PAMR to penetrate the whole of this market). There is also an increasing trend towards the use of shared networks by PMR users. From these and other figures it can be seen that the potential market for digital PAMR is considerable, both in Europe and elsewhere in the world, with the numbers being counted in millions.

A harmonized standard would promote competition and free movement of such technology between countries, in conjunction with either pan European, national or local networks.

The proponents of CDMA-PAMR have claimed that CDMA-PAMR systems and equipment will be available from a number of different suppliers in the late 2003/early 2004 timeframe.

4.3.1 Market size, forecasts and timing

Substantial market potential exists for PMR/PAMR, both for CDMA-PAMR and for other technologies: Telecommunications consultants Logical Strategy [12] have estimated that approximately 50 million of Western Europe's 160 million workers can be classified as being "mobile workers", defined as those who are mobile for at least 20 % of the time. Of these, in the region of 20 million are blue/grey collar mobile workers with specialized communications needs. One quarter of these 20 million potential PMR/PAMR users are currently using PMR/PAMR solutions, with the majority being served by ageing analogue PMR networks that no longer meet user requirements in terms of cost and functionality. Market research indicates that these analogue PMR users would consider migrating onto a suitable PAMR network offering integrated voice and data services.

This issue is more fully addressed in clause A.2.

4.3.2 Spectrum requirement and justifications

The minimum spectrum requirement for CDMA-PAMR is 2 × 1,25 MHz per operator plus guard bands defined by WG SE. The ECC report 25 - Strategies for the European use of frequency spectrum for PMR/PAMR applications [24], expects the minimum requirement for general PAMR services to be 2 x 3 MHz per operator rising to 2 x 5 MHz in metropolitan areas. It should be noted that with CDMA-PAMR spectrum blocks would be 1,25 MHz, 2,5 MHz, 3,75 MHz and 5 MHz, plus guard bands.

CDMA - PAMR can be compared with IMT-2000 CDMA multi-carrier which is a member of the IMT-2000 family. The physical channel bandwidth is 1,25 MHz and the systems use both CDMA channel access. i.e. the user bit rates are equal.

Considering the same amount of spectrum available for both systems, it would result that both systems could provide the same services to the same number of customers. Only the frequency ranges would differ.

In technical terms CDMA - PAMR is only a different term for IMT-2000 CDMA Multi-carrier as seen under the aspect of being commercialized in a different way and addressing different customers (a niche market and not the public mass market).

4.3.3 Spectrum Parameters

The channel bandwidth of CDMA-PAMR systems is 1,25 MHz. I.e. in 2 x 5 MHz available bandwidth one could place a maximum of 2-3 carriers (depending on guard bands).

For example, TETRA defines in 2 x 5 MHz 222 duplex channels with 4 time slots giving 888 available channels. Every one of 888 available channels can serve 30 users with voice service per time slot giving the theoretical net capacity of 26,640 multiply frequency reuse factor.

This may be used as a benchmark for system comparisons of CDMA-PAMR versus TETRA.

The power density of wideband CDMA systems is low compared with conventional narrowband PMR/PAMR technologies. The typical power output of CDMA-PAMR mobile terminals is around 23 dBm. The power output from a CDMA-PAMR base station will depend upon the radio planning and network configuration, but base stations have typical output powers of around 44 dBm. The maximum power output is an important parameter for co-existence with services in neighbouring frequency bands.

4.3.4 Current regulations

There are no current European interface regulations for the CDMA-PAMR system.

Article 4.2 of the R&TTE Directive 99/5/EC states:

"Each Member State shall notify to the Commission the types of interface offered in that State by operators of public telecommunications networks. Member States shall ensure that such operators publish accurate and adequate technical specifications of such interfaces before services provided through those interfaces are made publicly available, and regularly publish any updated specifications. The specifications shall be in sufficient detail to permit the design of telecommunications terminal equipment capable of utilizing all services provided through the corresponding interface. The specifications shall include, inter alia, all the information necessary to allow manufacturers to carry out, at their choice, the relevant tests for the essential requirements applicable to the telecommunications terminal equipment. Member States shall ensure that those specifications are made readily available by the operators".

4.3.5 Compatibility issues

Compatibility studies should focus on:

- potential issues between different PAMR systems;
- how multiple operators in the same physical area will be affected;
- the effects on co-band narrow channel systems, particularly looking at potential changes in the noise floor. Studies in the USA have highlighted the problems of wideband CDMA interference into co-band narrowband systems at 800 MHz [1], [2];
- the effects on adjacent band services, such as GSM and UIC (GSM-R), for example CDMA base transmit into GSM base receive;
- the effect of overlaying wideband CDMA systems on top of already well developed and matured bands for narrowband systems;
- Required guardbands to protect adjacent services;
- potential intermodulation issue in introducing wide band technologies in narrow band spectrum.

Further information on compatibility issues can be found in annex C.

4.4 Issues raised by ETSI members

4.4.1 Existing allocation for PAMR spectrum

The current CEPT allocation for PAMR limits use to voice and data services. There is a question of whether changes are required to the allocation, or not. If no changes to allocation are required, it would mean that this is a standardization issue. If they are needed, the actual changes required to the allocation need to be determined.

4.4.2 Unwanted emissions and spectrum demand

Concern has been expressed that the occupied bandwidth may be larger than claimed and that spurious emission levels may be higher than allowed under CEPT/ERC/Recommendation 74-01E [3].

Concern has also been expressed from the proposal regarding spectrum demand as there is no clear specification for spectrum demand from the Lucent proposal.

5 Main conclusions

This System Reference Document has considered the application of CDMA-1X technology for PAMR usage in the bands 410 MHz to 420 MHz/420 MHz to 430 MHz, 450 MHz to 460 MHz/460 MHz to 470 MHz and 870 MHz to 876 MHz/915 MHz to 921 MHz.

In the area of compatibility and coexistence with other services, it was concluded that there exists a potential for interference due to the unwanted emissions of CDMA-1X technology into the receive bands of existing GSM, TETRA and other PMR/PAMR equipment, notably BTSs. This will be particularly relevant when deploying CDMA-1X technology spectrally and geographically close to a dense network of GSM BTS sites where sufficient physical separation distances may be difficult to obtain. Hence, appropriate unwanted emission limits for CDMA-1X technology may need to be considered, possibly following the generic principles established already for other comparable ETSI/3GPP mobile radio standards.

Issues of prominence in consideration of this SRDoc are the need for competition, harmonized spectrum and open standards.

Annex A: Detailed market information

Sources: Logical Strategy [12], EICTA [13].

CDMA-PAMR is targeted primarily at the mobile workforce market, and in particular at so-called "blue collar" and "grey collar" workers. Technological advances and operational demands are supporting a shift in working practices and lifestyles within businesses, and as a result the mobile workforce has in recent years emerged. The size of the mobile workforce and its associated communications needs is increasing strongly in Europe across almost all business sectors. Blue and grey collar workers form a substantial part of this large and growing mobile workforce.

Telecommunications consultants Logical Strategy [12] have estimated that, of the total of around 160 million workers in Western Europe, approximately 50 million can be classified as being "mobile workers", which are roughly defined as those workers who are mobile for at least 20 % of the time. Of these, in the region of 20 million are blue/grey collar mobile workers with specialized communications needs.

Market research demonstrates strong demand in the blue/grey collar sector for next generation mobile services, in particular high-speed data. The trend to using increasingly data intensive applications on fixed line networks will continue to be mirrored in the wireless world. Blue/grey collar business interest in mobile data services has grown strongly in the last few years. A range of efficiency-enhancing mobile applications are being demanded for blue/grey collar workforces, and many of these operate most efficiently over a high-speed data bearer. Current PMR/PAMR users foresee an upsurge in data usage, and higher data speed is considered to be the most important advance in data functionality.

A growing unmet demand for next generation services within the mobile workforce necessitates the consideration of alternative PMR/PAMR technology solutions. Logical Strategy [12] says that neither existing nor currently planned mobile radio or cellular systems deliver all of the functionality required by blue/grey collar mobile workers. Analogue PMR and PAMR provide critical specialized services for the blue/grey collar sectors, such as dispatch operation, push-to-talk and priority calling, but are hindered by technical limitations, and quality and coverage issues when used for wide area applications. Current generation digital PMR/PAMR solutions provide substantially improved service offerings, but do not satisfy all of the requirements of mobile workforces, in particular for high-speed data. Logical Strategy [12] says that public cellular operators are focused on the mass market and will find it difficult to cater to the specialized needs of the blue/grey collar business community.

In a report input to CEPT FM38 in early 2001 [13], EICTA identified the following trends driving the PMR/PAMR market forward:

- PMR and PAMR market growth driven by potential for new services and applications due essentially to the shift from analogue to digital technology.
- User productivity gains thanks to the availability of more efficient PMR/PAMR systems (data query, AVL, data transfer, fleet management, etc).
- Easier purchase conditions fostering growth in use of PMR/PAMR terminals through standardization of equipment and services.
- Shift from analogue to digital PMR and PAMR (primarily narrowband to date).
- Development of pan-European network operator, combining large area coverage and cellular features with PMR services. The scale of the network facilitates special application packages made available also on a large regional scale. The network is also expected to provide the basis for European high-speed data availability for PMR/PAMR users.
- Combination of user requirements (PAMR and PMR): the users are now more and more conscious that their operational and financial interests are to share large trunked networks and to leave conventional networks.
- Success of PMR 446 (satisfying needs for simple localized mobile radio).
- Conventional networks: the migration to digital for small conventional networks was expected to start around the year 2004. The user requirements will lead to replacement of conventional networks in the same organization by one large digital trunked network.

Although there have been developments in some of these areas since the EICTA report [13] was written, the majority of the underlying trends remain.

A.1 Range of applications

Sources: Logical Strategy [12, 14], TETRA Release 2 questionnaire results [15].

This clause provides some examples of the wide range of possible applications for CDMA-PAMR. The introduction of CDMA-PAMR is likely to be driven initially by the needs of PMR/PAMR users for data services, including high-speed packet data, and hence the clause focuses in particular on market analysis into future mobile data requirements for PMR/PAMR users. We begin, however, with a more general look at PMR/PAMR user needs.

Consultants Logical Strategy have recently analysed the needs for PMR/PAMR functionality within the European business community [14]. As part of this work, they identified the following categories of user requirements for mobile radio communications.

User need	Description
Enabling command and control communications	Give instructions on actions to be taken, places to go to etc Acknowledge receipt of instructions Commandee can seek clarification Communications kept brief to allow others to interact with employee/dispatcher Record of instructions available to commandee (e.g. addresses etc) Controller understands situation of controllee Users understand situational activity
Enabling remote discussions	Enable "normal" two-way conversation between parties in company Enable "normal" two-way conversation with parties external to company User can manage their calls Less intrusive/back-up communications methods available (SMS, voicemail)
Looking after employees and property	Immediate access to employee Employee/property able to make alarm call Know when employee is not available View/hear a condition remotely Equipment safe for environment to be used in Track employee and vehicle locations and activities
Dealing with organizational emergencies	Assemble mobile user groups at short notice Enable large number of communications in localized area All present understand situational activity
Helping remote resources to be more productive	Access/store information without returning to base Interact with required applications (e.g. personal productivity tools) Access third party information Link machines to machines, reducing human element of processes
Motivating employees	Provide communications capability consistent with status Enable non work-related communications
Managing mobile communications efficiently	Control user's ability to access specific services Receive information about service usage Self-management of service features

As part of the TETRA Release 2 work programme, a questionnaire was completed by a range of PMR/PAMR user organizations, including consideration of requirements for high-speed data. The following types of non-voice applications were identified, together with an indication of the approximate (net) data rates that it was believed would be required [15]:

- Real time short data (1 kbps to 40 kbps):
  - Location services;
    - Operation and control;
    - Biodynamic registrations (e.g. ECG);
    - People and vehicles;
    - Telemetry (real-time).

- Database interactions (8 kbps to 200 kbps):
  - On-line forms;
    - Database access;
    - Work management;
    - Data tasking (e.g. command and control);
    - Database enquiries;
    - WAP.
- Office applications (8 kbps to 400 kbps):
  - Web browsing
    - Emails and attachments;
    - Intranet;
    - Internet;
    - Mobile computing - office applications;
    - Connect to hospitals and national health networks.
- Image transfer (40 kbps to 500 kbps):
  - Image transmission/video;
    - Image (e.g. fingerprints, crime marks);
    - Image transfer (JPEG/compressed JPEG);
    - Picture and video;
    - Graphics, maps, location.
- File transfer (53 kbps to 1 280 kbps):
  - Email attachments;
    - Connect to hospitals and national health networks;
    - Content push;
    - Inter-agency communications;
    - Fingerprint data.
- Video transfer (128 kbps to 2 286 kbps):
  - Video conferencing;
    - Image transmission/video;
    - Video transfer;
    - Picture and video;
    - Video streaming;
    - Slow scan video;
    - Video clips.

Through careful application design it may be possible to reduce the net data rates that are required for some of these applications. Also, some of the application types listed may be subject to various interpretations. However the list serves as an indication of some of the data applications that are required by PMR/PAMR users, and the sorts of data rates that are needed to support them.

Logical Strategy has more recently also performed a similar market analysis, which gives examples of efficiency enhancing mobile applications that are being demanded by blue/grey collar workforces, and associated performance improvements and data rates. This information can be found in reference [12]. The Logical analysis concluded that, although some of these applications can operate using relatively low data speeds, many of the applications that are useful to blue/grey collar sectors will operate most effectively over a higher data rate wireless bearer.

A.2 Market size and value

Sources: IMS research [16], Logical Strategy [14].

Market researchers/analysts IMS have forecast the worldwide market for mobile radio (PMR/PAMR). Their 2001 report [16] concludes that the market at the end of 2000 was still dominated by analogue systems (80 % of users). By 2007, however, they forecast that digital will account for around 55 % of the total. The total number of mobile radio users during this period will vary in the range approximately 33 million to 35 million. Figure A.2.1 shows the projected growth in the digital user base.

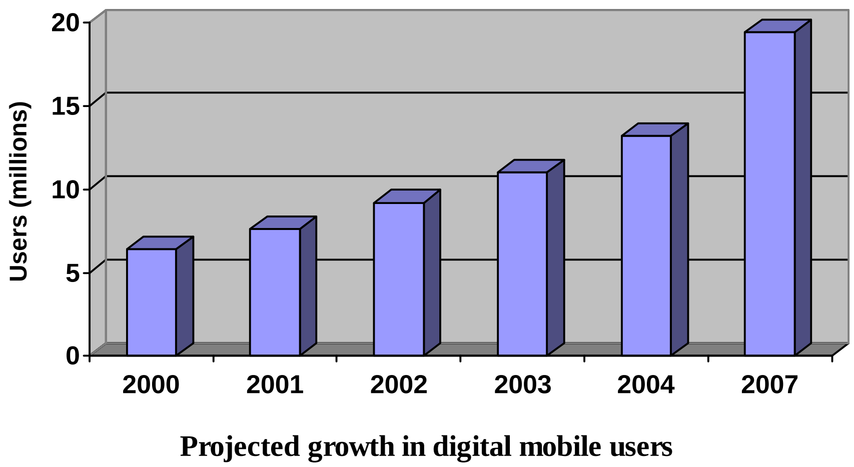

Figure A.2.1

These numbers are dominated by digital PAMR users on the Nextel network in the US, which uses iDEN technology. If iDEN is excluded from the above figures, the total number of digital PMR/PAMR users in 2004 reduces to around 3,6 million.

Focussing on Europe, Logical Strategy have analysed the market in the 15 countries in the European Union [14] in order to estimate the potential addressable market for digital PMR/PAMR. In each country they analysed the different industry sectors, in particular those with significant blue/grey collar mobile workers. These industry segments typically included transport, construction, utilities, services, manufacturing, retail/wholesale, public safety/security, government, and agriculture.

Logical's analysis concluded that the total potential addressable market for digital PMR/PAMR in the 15 EU countries was around 20 million users, which represents around 40 % of the mobile workforce and 13 % of the working population in those countries. These numbers are dominated by France, Germany, Italy and the UK, which account for 13,2 of the 20 million. The actual size of the digital PMR/PAMR market in the EU will be significantly less than this figure, however, since stiff competition from other systems and services, along with other factors, will mean that digital PMR/PAMR will be unable to penetrate the whole of this potential addressable market.

A.3 Traffic evaluation

The following is a list of CDMA-PAMR features and parameters relevant to traffic, capacity and spectral efficiency, which are used as assumptions in the traffic evaluation in this clause:

- The channel bandwidth is nominally 1,25 MHz with a spacing of 1,25 MHz between carriers.
- Voice and data applications co-exist within the same radio channel. One carrier can support up to 35 voice users. Assuming an Erlang B traffic model, that equates to 24,6 Erlangs/carrier at 1 % blocking or 26,4 Erlangs/carrier at 2 % blocking. The fundamental data rate per user starts at 9,6 kbps and can reach a maximum of 153,6 kbps. The total capacity for both voice and data is intermediate depending upon the mix of the two services.

- Data users are bursty and time-share a small number of high-speed "supplemental" data channels. Data requests are either serviced immediately or queued up. The time and rate of service are dictated by resource management, which considers issues such as RF conditions for the mobile, amount of data waiting to be sent, and when the mobile was last served.

- Data coverage is variable and data calls are automatically adjusted as the mobile location changes. Furthermore, data rates are automatically adjusted during the data session. Within the cell footprint, higher data rates are constrained to the cell interior since higher data rates require higher power.

- Data resource management: Data users first establish a fundamental channel of 9,6 kbps. Supplemental channels are then assigned for bursts depending on a number of factors. Supplemental channels are then set-up and turned down automatically to support data bursts. The average sector data throughput will vary with traffic characteristics and design configurations.

The following is an example traffic scenario based on a national PAMR network in the UK and the following assumptions:

- 500 000 PAMR users across the UK. This is around 16 % of the potential addressable market in the UK, based on the figures in clause A.2.

- 20 % of the subscribers are in Greater London = 100 000 users.

- Voice traffic in busy hour is 5 mErlang/user. This is based on experience with actual PAMR systems. This figure is doubled to 10 mErlang/user to include data traffic. Hence, the total traffic is 1 000 Erlangs.

- Because of the nature of the PAMR service, we assume that the traffic is uniformly distributed across a denser populated area of approximately 1 600 square km inside the M25 belt (the M25 being London's orbital motorway).

- Assuming an average cell radius of 3 km, 57 sites (171 sectors) are needed for coverage. With 24,6 Erlangs per sector per carrier (at 1 % blocking) and a 1:1 repeat pattern, a total of 4 206,6 Erlangs can be supported and this provides sufficient extra capacity even if an unforeseen peak traffic load should arise.

Annex B: Technical information

B.1 System description

CDMA-PAMR is a system that uses CDMA-1X access technology in order to provide PAMR services to users. The system uses Voice-over-IP (VoIP) technology running over a CDMA-1X radio access network, with a PAMR application utilizing services and features from the underlying CDMA and IP networks in order to provide the PAMR services and functionality.

The system essentially consists of the following two parts:

- The CDMA radio access network, together with the associated IP data network and components.
- The PAMR application, consisting of a mobile client part running on a mobile terminal, and a network server part running on servers connected to the network.

The features and functionality provided by CDMA-PAMR address essentially the same user needs as other PAMR technologies. CDMA-PAMR adapts the established and already deployed CDMA radio platform to provide both voice and data services in a PAMR environment. The CDMA-PAMR system has been developed for use in the European digital PAMR bands, and is based upon the CDMA-1X standards.

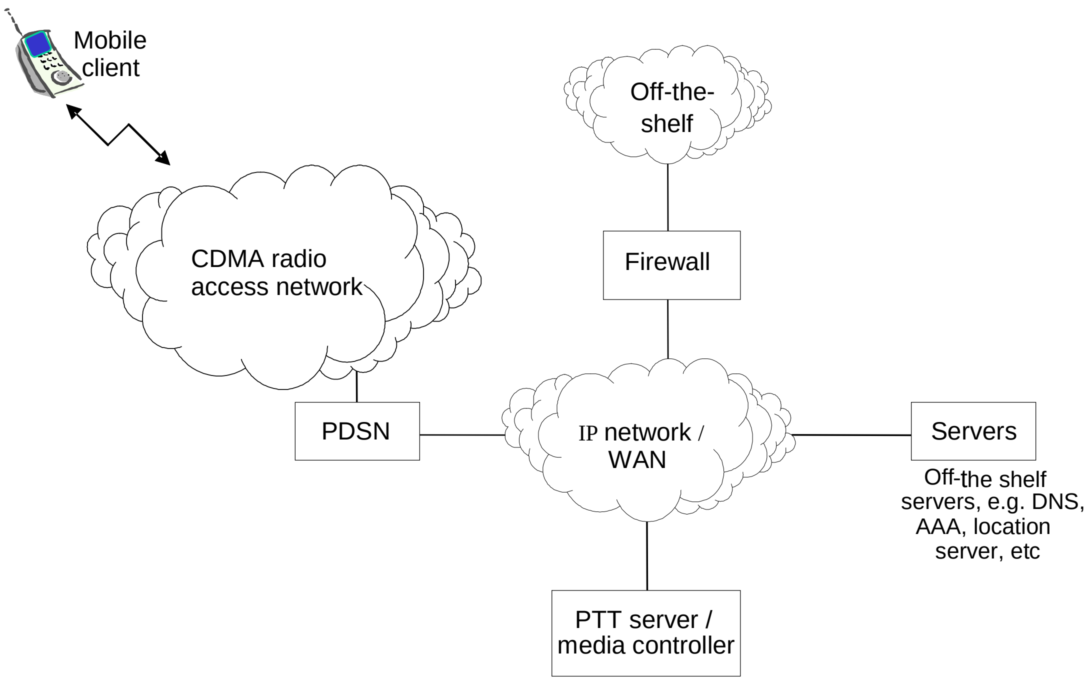

Figure B.1.1: CDMA-PAMR system architecture

CDMA-PAMR technology supports a multitude of service features, including high-speed data and the push-to-talk capabilities that are important for PAMR networks. The push-to-talk features utilize end-to-end voice-over-IP and the industry standard Session Initiated Protocol (SIP). The push-to-talk facilities may be integrated with related services such as instant messaging, and support the latest advances in standard vocoders, and both Mobile IP and Simple IP for mobile users. As the standards evolve, the push-to-talk features will evolve also to take advantage of the latest developments.

With the push-to-talk service, both point-to-point and point-to-multipoint connections are provided. When a member of a particular group requests a PTT call, the network sets up traffic channels for the group members, if the connections are not already active. The originator's speech is encapsulated in packets and distributed to all members of the group.

The service has a queuing capability that allows potential speakers to be placed in the queue for the "floor". When a potential speaker presses the PTT button on the handset, they will be placed in the queue and given the floor when it is relinquished by the existing speaker.

A number of additional network elements are used within the network in order to provide the capabilities necessary to support the push-to-talk services. These include a "PTT server" to provide call set-up and call control functions and a media controller to control the sending of content information to members of defined groups, together with a subscriber database to authorize the originating subscriber requesting push-to-talk service and to retrieve the current addresses of the desired destination parties.

The PTT server/media controller, a key element in the architecture, provides coordination of the push-to-talk call based on the originating member's requests and the associated response from the subscriber database. The functionalities provided by the PTT server/media controller include: subscriber registration; call processing via SIP; push-to-talk applications, including both point-to-point and point-to-multipoint services; sending out packets with the proper destination IP addresses of each available member for the call in progress; and dynamic activation and deactivation of group members during an active call. The associated subscriber database provides subscriber profile provisioning, group list administration, mobile based administration for end user updates to group lists, and web-based administration for updates to group lists.

The interface between the CDMA-1X radio access network and the IP packet data network/WAN is provided by a Packet Data Serving Node (PDSN), which is a standard product for such purposes. This node supports the use of a standards-based protocol that provides header compression to improve the efficiency of over-the-air traffic transmission and, therefore, to provide better voice quality.

In addition to the above-mentioned network elements, push-to-talk subscriber mobiles must be equipped with appropriate client software. The software allows the mobile to interface with corresponding software at the PTT server to effect push-to-talk features/functionality.

B.2 Radio aspects

CDMA-PAMR is provided by means of an application running over the CDMA-1X radio access network. CDMA-1X employs direct sequence spread spectrum code division multiple access technology and is standardized by the TIA. The system operates within a 1,25 MHz bandwidth.

The CDMA-1X air interface is defined in the relevant TIA standards ([6] - [10]). Its use for PAMR is recognized within the standards as Band Class 11 for the 400 MHz bands and Band Class 12 for the 870 MHz band. Additional references relevant to the structure and performance of CDMA-1X are listed in clause 2 of the present document.

- Further details of the radio spectrum parameters for CDMA-PAMR are provided below. The following are some of the points that should be noted.

- The carrier bandwidth of CDMA-PAMR transmissions is nominally 1,25 MHz, and a spacing of 1,25 MHz is employed between the centre frequencies of adjacent CDMA-PAMR carriers.

- Unlike FDMA and TDMA systems, CDMA-PAMR does not require that a "cellular" frequency reuse pattern should be employed for wide area networks, whereby the same frequency cannot be used at base station sites that are close to each other. With CDMA-PAMR, the same carrier frequency can be used by all the base stations in a network (i.e. the effective reuse factor is 1).

- The power density of wideband CDMA systems is low compared with conventional narrowband PMR/PAMR technologies. The typical power output of CDMA-PAMR mobile terminals is around 23 dBm.

- CDMA-PAMR employs power control on both the uplink and the downlink, with a large dynamic range. This means that both base stations and terminals in a CDMA-PAMR network will almost always be transmitting at output powers that are significantly lower than the maximum values.

- The limits for unwanted emissions from CDMA-PAMR transmitters operating in the European PAMR bands (Band Classes 11 and 12) are lower than those for other CDMA Band Classes identified for similar frequency ranges, reflecting the need for CDMA-PAMR systems to be able to co-exist with other systems and services that may be operating in these and adjacent bands.

B.2.1 Power and power control

B.2.1.1 Transmitted power

The power density of wideband CDMA systems is low compared with conventional narrowband PMR/PAMR technologies. The typical power output of CDMA-PAMR mobile terminals is around 23 dBm. The power output from a CDMA-PAMR base station will depend upon the radio planning and network configuration, but base stations have typical output powers of around 44 dBm.

The power transmitted from a CDMA-PAMR transmitter is spread over a wider bandwidth than with other (narrowband) PAMR systems. This means that the spectral power density (per Hz) is correspondingly reduced, according to the ratio of the CDMA bandwidth (nominally 1,25 MHz) to the narrower bandwidth under comparison.

CDMA-PAMR employs power control on both the uplink and the downlink with a large dynamic range. This means that both base stations and terminals in a CDMA-PAMR network will almost always be transmitting at output powers that are significantly below the maximum values. In addition, soft handover is a basic capability of CDMA technologies that allows use of lower power levels whilst improving the quality of the received signal through use of combining at the mobile terminal.

B.2.1.2 Power control

The primary objective of power control is to maintain satisfactory traffic channel quality and reliability with minimal required power while maximizing system capacity. The quality of each channel depends strongly on the ratio of signal power to the interference power, or E_b/N_t, E_b being the energy per signal bit and N_t the spectral density of the interference and noise. E_b/N_t is a function of vehicle speed, propagation conditions and the location with respect to the serving cell and other mobiles. This varying signal-to-noise ratio also influences the error rate.

The forward link power control algorithm in CDMA-PAMR operates at a rate of up to 800 Hz. Operating at such a high-speed, the power control mechanism facilitates an effective tracking of RF fades and provides a tight gain adjustment to satisfy only the minimum required E_b/N_t per call, thereby minimizing the power allocated to each channel.

The power level on the forward link is tightly coupled with the loading on the system (number of users generating interference), which determines the interference level, and RF conditions (user distribution, terrain, fading, etc) which dictate the path loss suffered on each channel. Network designs consider worst-case conditions such as the maximum number of users at the maximum allowable path loss (design cell edge). Amplifier ratings are chosen to accommodate even the unlikely occurrence of these conditions with a high probability. However, typical operating conditions will be significantly better. Interference levels in a network will drop if the number of users is less than the maximum or if not all of the users are at the cell edge. Since the power control algorithm minimizes the power to match the E_b/N_t requirement tightly, reduced interference will also lower the transmitted power levels. On the other hand, for capacity oriented designs, cell sizes are typically smaller than dictated by the maximum allowable path loss. Again, the power levels will be adjusted down to just meet the E_b/N_t requirement.

B.2.1.2.1 Reverse power control

The Reverse Power Control (RPC) algorithm used in CDMA-PAMR consists of an open loop as well as a nested closed loop with more generalized features. In the reverse open loop, the mobile estimates the transmitted power of the reverse link channels based on the measured aggregate received power. The RPC open loop function is performed in the mobile, using necessary operating parameters supplied by the base station via signalling messages in the forward link. The RPC is enhanced with more parameters for more complete control.

The reverse closed loop power control algorithms consist of nested inner and outer loops. The inner loop algorithm primarily determines and regulates the output power level based on the detected signal strength and the outer loop adjusted Eb/Nt set point value. This new Eb/Nt set point value is determined in the outer loop based on the monitored reverse Frame Error Rate (FER).

The inner and outer loops in the RPC algorithm allow the mobile transmit power to get down to levels below -50 dBm with a recommended step size of 1 dB. Consequently, while the maximum mobile output power is 23 dBm, typical power levels will be significantly lower in an operational network. Computer simulations suggest that average mobile transmit power in a cell with uniform mobile distribution could be as low as 10 dB below the maximum power. Furthermore, the average mobile transmit power in a cell is tightly coupled with the actual cell size, which is typically smaller in the field than that predicted by the maximum allowable propagation loss in the link budget. Generally, capacity considerations or one-to-one overlays with existing systems cause cell footprints to be smaller than the maximum that can be achieved by CDMA-1X. In such designs, RPC will lower the maximum mobile output power to a value smaller than 23 dBm, which corresponds to the signal level needed at the maximum allowable propagation loss. The reduction in maximum output power will roughly be in line with the dB difference between the link budget and the actual propagation loss at the real cell edge. The average mobile transmit powers will also scale accordingly. The spurious emissions (wideband noise) generated by the mobiles will also go down as the transmit power decreases. Therefore, the RPC algorithm will help mitigate interference caused by CDMA-1X mobiles into other systems.

Most of the RF designs also consider a building penetration margin, which shrinks the cell footprint further by significant amounts. In such networks, RPC powers down the outdoor mobiles accordingly, further reducing interference to other systems. While the indoor mobiles could still be transmitting at high power levels, interference they generate will also be mitigated by the building penetration loss.

B.2.1.2.2 Forward Power Control

The Forward Power Control (FPC) algorithm used in CDMA-PAMR is designed to compensate for the fast varying E_b/N_t and other cell interference via a fast tracking closed loop in a sub-frame interval. Thus a tight base station transmit gain adjustment can be achieved, and this results in a lower power requirement per call.

The forward closed loop power control algorithm consists of an outer loop and an inner loop and the algorithm is implemented effectively at a rate of up to 800 Hz.

Though the closed loop algorithm in the mobiles has not been standardized, the most common procedure for the primary inner loop is based on the Power Control Bits (PCB), which correspond to the Signal-to-Noise ratio (S/N) measured at the mobile.

The primary objective for the FPC for voice traffic is to maintain an acceptable voice quality while minimizing the power requirements. Frame Error Rate (FER) is a performance measure that well characterizes the voice quality, and maintaining an acceptable FER is an important part of the FPC. However, given that there is no direct close mapping between FER and the measured E_b/N_t, some adjustment in the inner loop is required in order to maintain an acceptable averaged forward link FER. Specifically, the E_b/N_t target value used in the inner loop function must be continuously adjusted based on the detected FER value. This FER detection is performed in the outer loop. In addition, the outer loop algorithm also includes estimating FER and dynamically determining the appropriate E_b/N_t target value.

The following are the required parameters for configuring the outer loop:

- Forward target FER.
- Initial Eb/Nt target value.
- Minimum Eb/Nt target.
- Maximum Eb/Nt target.

These parameters are passed to the mobile during call set-up.

The FPC algorithm is capable of lowering the total Base Station (BS) transmit power by as much as 24 dB with a recommended step size of 0,5 dB. The step size is adjustable and can be made smaller. Hence, depending on the cell size and the loading of the system, total power transmitted at the BS could be significantly lower than the maximum power rating of the BS amplifier. The maximum power is needed only in the unlikely scenario where the maximum number of mobiles is at the theoretical cell edge, corresponding to the maximum allowable propagation loss calculated in the link budget. Simulations have shown that required transmit power at the BS could be 2 dB smaller in a uniform user distribution at maximum capacity. Naturally, under typical conditions where the number of users accessing the system is not always as high as the maximum capacity, the FPC will lower power levels further. However, the most significant reduction in BS transmit power may come as a result of reduced cell sizes. Cell sizes in the field are typically smaller than that predicted by the link budget. The consequent reduction in total BS output power will roughly be in line with the dB difference between the link budget and the actual propagation loss at the real cell edge. Spurious emissions generated by the BS are expected to scale with the total output power. Therefore, FPC will help mitigate interference caused by a BS into other systems.

Furthermore, for designs utilizing a building penetration loss, power levels are likely to be lowered further since the probability of all the users being indoors at the same time is small. While indoor users may require strong signals from the BS, outdoor users will not, lowering the total BS transmit power.

In summary, both the RPC and FPC ensure that the minimum amount of power needed to maintain good voice quality is transmitted. The interference generated by a particular CDMA-PAMR system is always kept at the minimum and is not greater than that necessary to support the actual number of users accessing the system in a given cell footprint. Consequently, an important benefit of power control in CDMA-1X is the effect of reduced interference. For example, in the co-located scenario, where a CDMA-PAMR mobile is near the site, it will transmit less inference to adjacent non-CDMA-PAMR carriers and the CDMA-PAMR BS will transmit less interference to the non-CDMA-PAMR mobiles.

B.2.2 Frequencies

CDMA-PAMR technology is designed for use for PAMR networks, in particular in the following frequency bands that are designated for digital PAMR in Europe:

- 410 MHz to 420 MHz/420 MHz to 430 MHz;
- 450 MHz to 460 MHz/460 MHz to 470 MHz;
- 870 MHz to 876 MHz/915 MHz to 921 MHz.

These bands are encompassed within two specific Band Classes in the relevant standards:

- Band Class 11, which covers the 410 MHz to 430 MHz and 450 MHz to 470 MHz bands;
- Band Class 12, which covers the 870 MHz band.

Tables B.2.1 and B.2.2 indicate the channel numbers associated with the different possible centre frequencies for CDMA-PAMR carriers within these bands.

Table B.2.1: Channel number to centre frequency assignment for Band Class 11 (table 3.1.12-2 of [5])

Transmitter	CDMA Channel Number	Centre Frequency for CDMA Channel (MHz)
Mobile Station	$1 \le N \le 400$	0,025 (N-1) + 450,000
	$1\,001 \le N \le 1\,400$	0,025 (N-1 001) + 410,000
Base Station	$1 \le N \le 400$	0,025 (N-1) + 460,000
	$1\,001 \le N \le 1\,400$	0,025 (N-1 001) + 420,000

Table B.2.2: Channel number to centre frequency assignment for Band Class 12 (table 3.1.13-2 of [5])

Transmitter	CDMA Channel Number	Centre Frequency for CDMA Channel (MHz)
Mobile Station	0 ≤ N ≤ 239	870,0125 + 0,025 N
Base Station	0 ≤ N ≤ 239	915,0125 + 0,025 N

Unlike FDMA and TDMA systems, CDMA-PAMR does not require that a "cellular" frequency reuse pattern should be employed for wide area networks, whereby the same frequency cannot be used at base station sites that are close to each other. With CDMA-PAMR, the same carrier frequency can be used by all the base stations in a network (i.e. the effective reuse factor is 1), but with different pseudo-random codes. It should be noted that the use of different pseudo-random codes in adjacent cells increase the noise floor in a given cell.

B.2.3 Bandwidth and other radio parameters

B.2.3.1 Transmitted bandwidth

The channel bandwidth of CDMA-PAMR transmissions is nominally 1,25 MHz, and a spacing of 1,25 MHz is employed between the centre frequencies of adjacent CDMA-PAMR carriers.

B.2.3.2 Unwanted emissions

The permitted emission limits for CDMA-1X systems used for PAMR applications in Band Classes 11 and 12 is shown in table B.2.3 and table B.2.4.

NOTE: The requirements for CDMA-PAMR are more stringent than those previously designated for CDMA-1X for other Band Classes, and are consistent with the operation of other systems currently deployed in the European PAMR bands.

The base station emission limits for CDMA-PAMR (Band Classes 11 and 12) are as follows [4].

Table B.2.3: Unwanted emission limits for base stations

Separation from centre frequency	Emission limit
750 kHz	-45 dBc/30 kHz
885 kHz	-60 dBc/30 kHz
1,125 MHz to 1,98 MHz	-65 dBc/30 kHz
1,98 MHz to 4,00 MHz	-75 dBc/30 kHz
4,00 MHz to 6,00 MHz	-36 dBm/100 kHz
> 6,00 MHz	-45 dBm/100 kHz

The emission levels for frequency offsets between the above separations are derived by linear interpolation.

For some situations it may be necessary that additional filtering is applied at the edges of the "block" of carriers that are being used (i.e. at the lower side of the lowest frequency channel and/or the upper side of the highest frequency channel). The required emission limits in such cases will depend upon the particular situation in question: This is one aspect that should be considered as part of the compatibility studies to be conducted under the auspices of CEPT WG SE.

The emission limits for CDMA-PAMR mobiles operating in Band Classes 11 and 12 are as follows [5].

Table B.2.4: Unwanted emission limits for mobile stations

Separation from centre frequency	Emission limit
885 kHz	-47 dBc/30 kHz
1,125 MHz	-54 dBc/30 kHz
1,98 MHz	-67 dBc/30 kHz
4,00 MHz	-82 dBc/30 kHz
4,00 MHz to 10,0 MHz	-51 dBm/100 kHz

The emission levels for frequency offsets between the above separations are derived by linear interpolation.

The above emission limits apply at the maximum output power for a given mobile, however in practice this will not usually be the case, due to the advanced power control techniques used in CDMA-PAMR. When transmitting at lower output powers, the unwanted emission levels from a mobile will be significantly lower than those indicated above. As the output power transmitted by the mobile is reduced (e.g. as a result of power control), the unwanted emission levels will also fall by at least the same amount, and in many cases the emission levels will fall by significantly more than the transmitted power. This is due to the elimination of noise outside the occupied bandwidth that may occur as a result of the power amplifier being driven at maximum power.

The probability of interference from CDMA systems is further controlled through the use of power control in both mobile (uplink) and base station (downlink) transmitters (see clause B.2.1.2). The power control dynamically adjusts mobile or base station output power consistent with the needs to provide quality of service and limit interference. For example, the power level of mobile transmitters is substantially reduced when the mobile is close to the receiving base station and transmission is unimpeded by obstacles to propagation.

Please see annex G for comments from ETSI members.

B.2.3.3 Receiver performance

The minimum receiver performance requirements for CDMA-PAMR base stations and mobiles are described in IS-97 [4] and IS-98 [5] respectively.

Based on test parameters in these standards, the following indicative blocking requirements for CDMA-PAMR can be derived:

- for the MS, -72 dB Rx filter response at 900 kHz away from the centre of the CDMA-PAMR carrier;
- for the BS, -71 dB Rx filter response at 900 kHz away from the centre of the CDMA-PAMR carrier.

Tests described in the standards for the receiver sensitivity performance state that the signal strength at the BS input should be equal to or less than -117 dBm to achieve the FER requirements. Mobile receiver sensitivity tests use a -119,5 dBm signal at the UE input to meet the FER requirements. The actual equipment performance may vary from vendor to vendor.

B.3 Relevant standards

The CDMA-1X air interface that is used in CDMA-PAMR systems is described in the relevant TIA standards ([6] to [10]). The use of CDMA-1X for PAMR applications is recognized within the standards as Band Class 11 for the 400 MHz European PAMR bands, and Band Class 12 for the 870 MHz band. Additional references relevant to the structure and performance of CDMA-1X are listed in clause 2 of the present document.

Ongoing efforts in standards continue to develop requirements for new features that may further enhance the efficiency of CDMA-1X systems relative to their ability to support PAMR services. This includes Broadcast/Multicast Services, which will enhance the efficiency of use of the air interface and network resources to support the delivery of the same information to multiple users; and further mechanisms for Fast Call Set-Up that will help to further reduce delays involved in call set-up.

B.4 Technical overview of the CDMA-PAMR radio interface

B.4.1 Introduction

This clause provides additional detailed technical information describing the CDMA-1X air interface used in CDMA-PAMR systems.

The CDMA radio standards used in CDMA-PAMR were developed by a group of standards organizations, in particular the US Telecommunications Industry Association (TIA). The radio interface used in CDMA-PAMR is called CDMA-1X. The core network specifications are generally based on an evolved ANSI-41, but the specifications also include the necessary capabilities for operation with an evolved GSM-MAP based core network.

This radio interface is a wideband spread spectrum radio interface that utilizes CDMA-1X spread spectrum technology. The CDMA-1X system has a layered structure that provides voice, packet data (up to 307 kbps), circuit data (e.g. asynchronous data, fax), and simultaneous voice and packet data services (as shown in figure B.4.1). This radio interface provides protocols and services that correspond to the bottom two layers of the ISO/OSI reference model (i.e. Layer 1 - the Physical Layer, and Layer 2 - the Link Layer). Layer 2 is further subdivided into the Link Access Control (LAC) sublayer and the Medium Access Control (MAC) sublayer. Applications and upper layer protocols corresponding to OSI Layers 3 through 7 utilize the services provided by the Layer 2 and Layer 1 services.

Several enhancements have been incorporated in this radio interface and a generalized multi-media service model is supported. This allows any combination of voice, packet data, and high-speed circuit data services to be operated concurrently. The radio interface also includes a Quality of Service (QoS) control mechanism to balance the varying QoS requirements of multiple concurrent services (e.g. to support ISDN or RSVP Network Layer QoS capabilities).

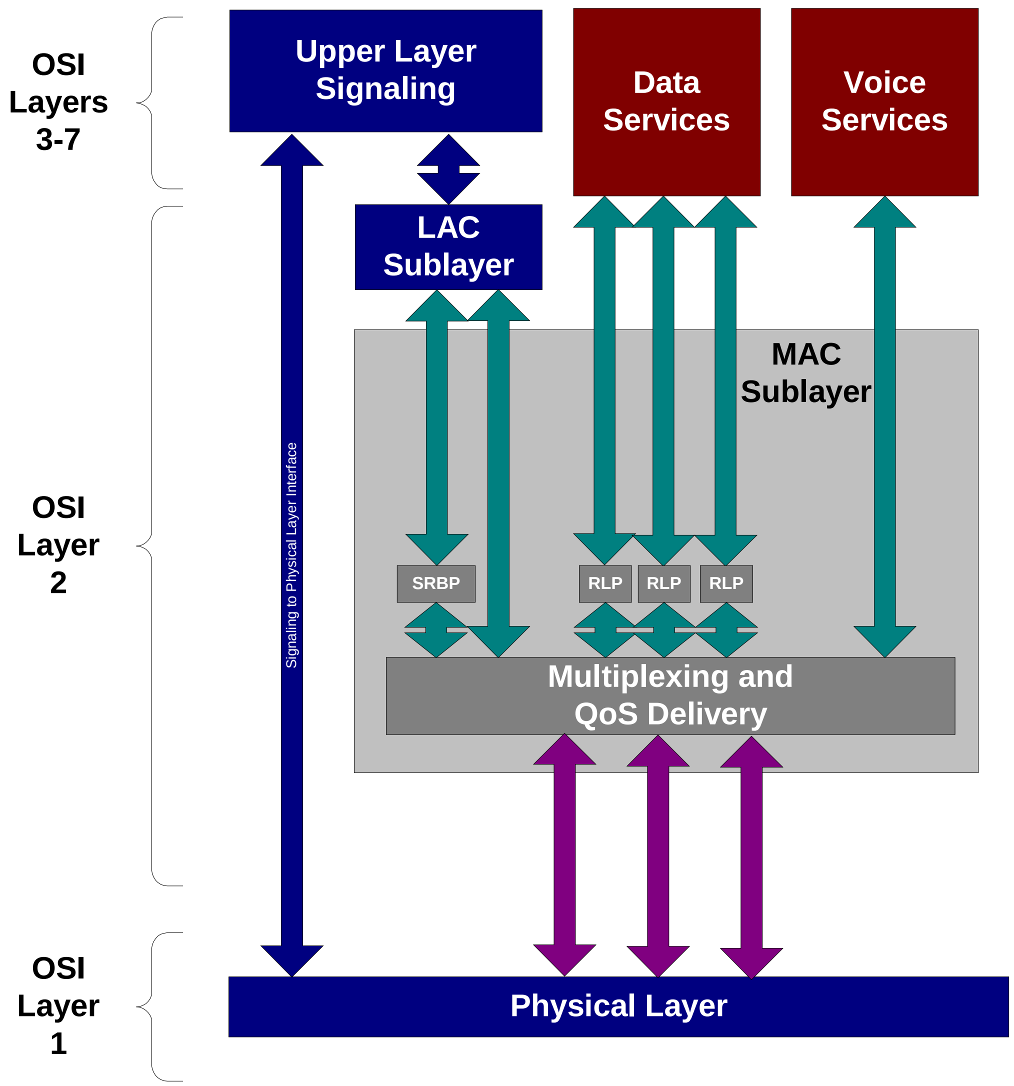

Figure B.4.1: CDMA radio interface architecture [6]

Figure B.4.2 shows the logical and physical channel relationships from the mobile station perspective.

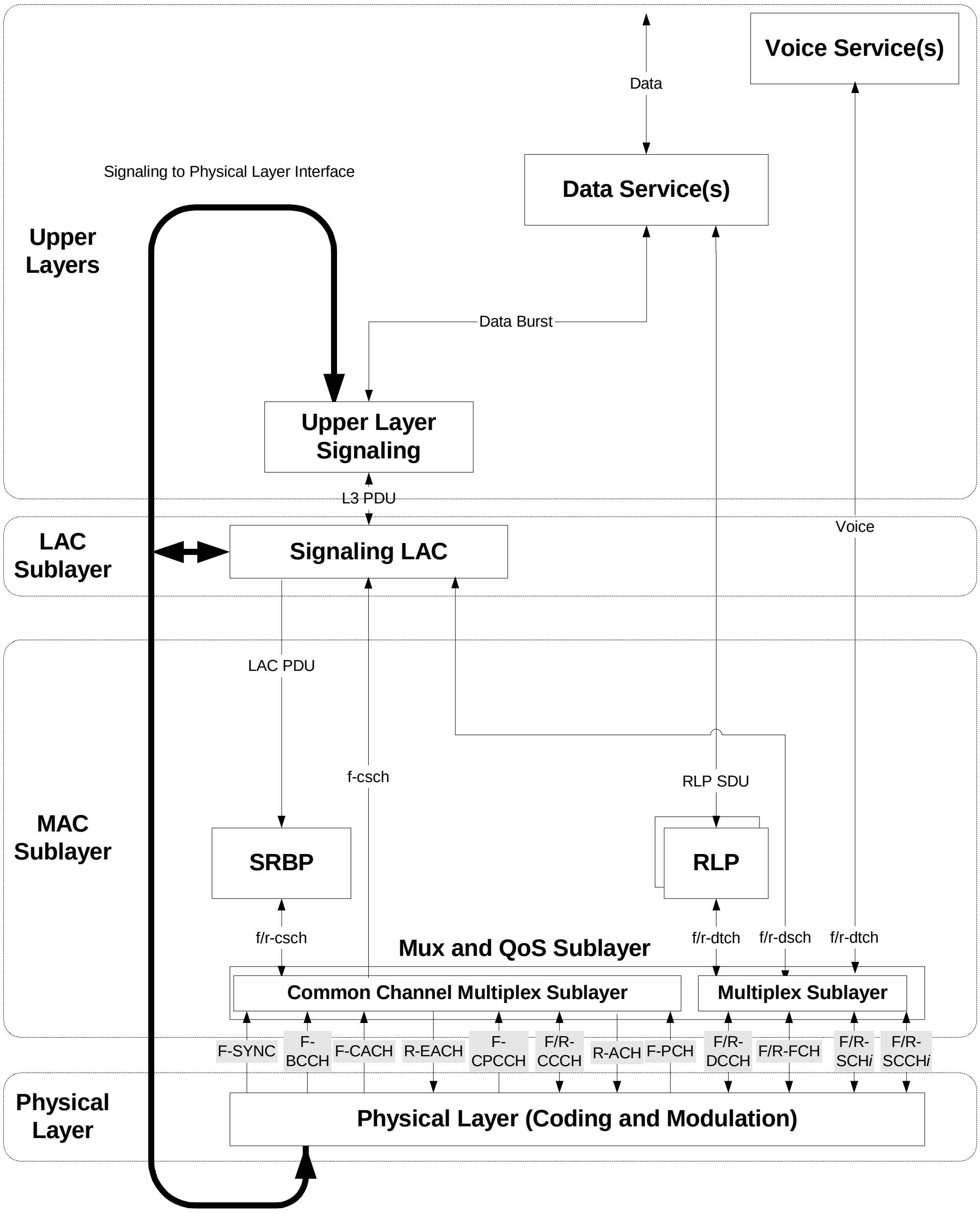

Figure B.4.2: CDMA radio interface architecture (mobile station) [6]

Table B.4.1 lists the physical channels currently used in CDMA-1X [6].

Table B.4.1: Physical channels in CDMA-1X [6]

Channel Name (see note)	Physical Channel
F/R-FCH	Forward/Reverse Fundamental Channel
F/R-DCCH	Forward/Reverse Dedicated Control Channel
F/R-SCCH	Forward/Reverse Supplemental Code Channel
F/R-SCH	Forward/Reverse Supplemental Channel
F-PCH	Paging Channel
F-QPCH	Quick Paging Channel
R-ACH	Access Channel
F/R-CCCH	Forward/Reverse Common Control Channel
F/R-PICH	Forward/Reverse Pilot Channel
F-APICH	Forward Auxiliary Pilot Channel
F-TDPICH	Transmit Diversity Pilot Channel
F-ATDPICH	Auxiliary Transmit Diversity Pilot Channel
F-SYNCH	Sync Channel
F-CPCCH	Common Power Control Channel
F-CACH	Common Assignment Channel
R-EACH	Enhanced Access Channel
F-BCCH	Broadcast Control Channel
NOTE: The notations "F/R" and "Forward/Reverse" represent two different physical channels (i.e. one forward channel and one reverse channel).	

To provide flexible voice services, this radio interface provides the framework and the services to transport encoded voice data in the form of packet data or circuit data traffic.

B.4.2 Physical Layer

B.4.2.1 Reverse link (uplink)

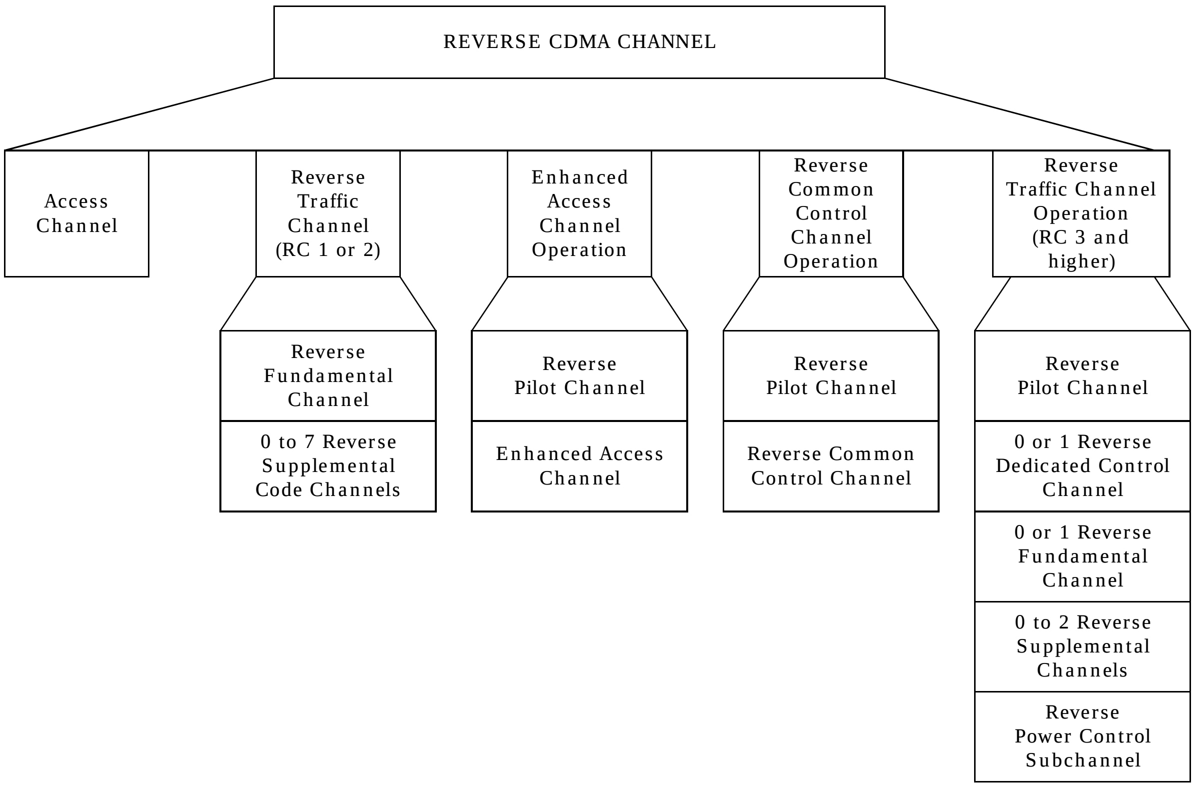

Figure B.4.3: Reverse CDMA channels received at the base station

Figure B.4.3 shows the reverse CDMA channels received at the base station. The **Reverse Pilot Channel** is an unmodulated spread spectrum signal used to assist the base station in detecting the mobile station transmission. The mobile station may also insert a **Reverse Power Control Subchannel** in the Reverse Pilot Channel. The Reverse Power Control Subchannel is used to transmit power control commands for forward link traffic channels. The **Access Channel** and the **Enhanced Access Channel** are used by the mobile station to initiate communication with the base station and to respond to paging channel messages. The **Reverse Common Control Channel** is used for the transmission of user and signalling information to the base station when Reverse Traffic Channels are not in use. The Reverse Traffic Channels with Radio Configurations 1 and 2 include the **Reverse Fundamental Channel** and the **Reverse Supplemental Code Channel.** The Reverse Traffic Channels with Radio Configurations 3 and higher include the **Reverse Dedicated Control Channel, the** Reverse Fundamental Channel**,** and **the Reverse Supplemental Channel.** The Reverse Dedicated Control Channel and the Reverse Fundamental Channel are used for the transmission of user and signalling information to the base station during a call. The Reverse Supplemental Channel and the Reverse Supplemental Code Channel are used for the transmission of user information to the base station during a call.

The mobile station supports three types of Forward Link power control based upon: 800 Hz feedback; the Erasure Indicator Bits (EIB); and the Quality Indicator Bits (QIB). The feedback is on the Reverse Power Control Subchannel. For the 800 Hz feedback mode, the outer loop estimates the setpoint value based on Eb/Nt to achieve the target Frame Error Rate (FER) on each assigned Forward Traffic Channel. The inner loop compares the Eb/Nt of the received Forward Traffic Channel with the corresponding outer loop setpoint to determine the value of the power control bit to be sent on the Reverse Power Control Subchannel every 1,25 ms.

Uplink soft handoff is achieved by performing selection combining at the base station.

B.4.2.2 Forward link (downlink)

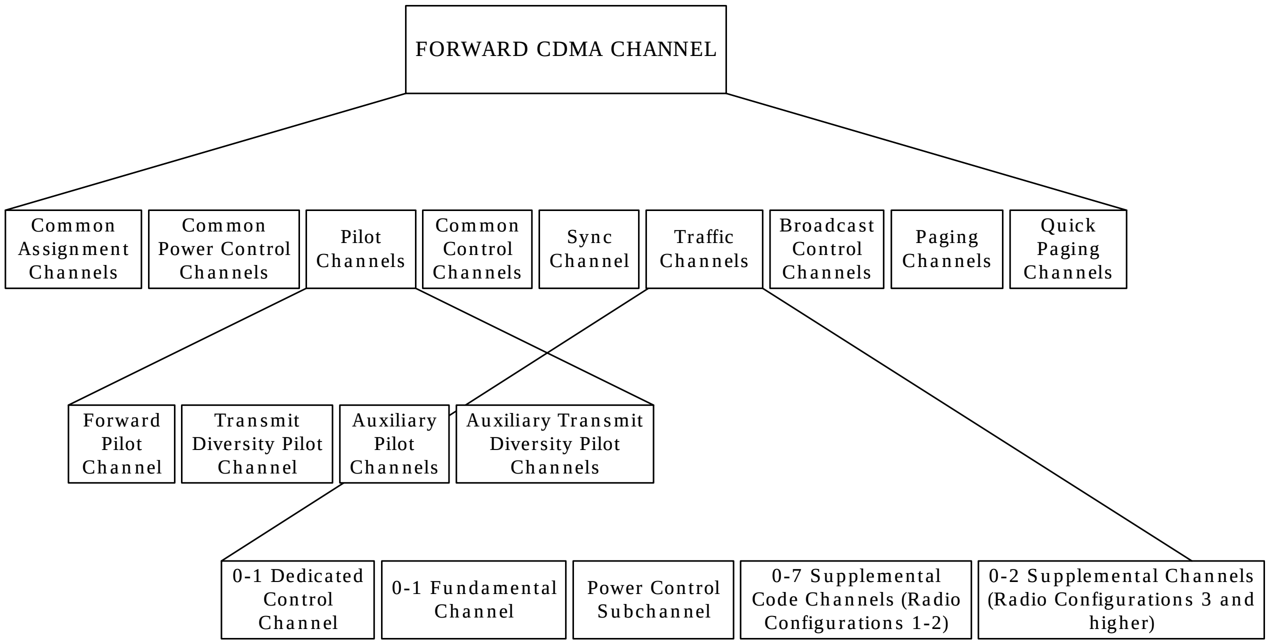

Figure B.4.4: Forward CDMA channels received at the mobile station [7]

Figure B.4.4 shows the Forward CDMA channels received at the Mobile Station. The **Forward Pilot Channel,** the **Transmit Diversity Pilot Channel,** the **Auxiliary Pilot Channels,** and the **Auxiliary Transmit Diversity Pilot Channels** are unmodulated spread spectrum signals used for synchronization by a mobile station operating within the coverage area of the base station. The Forward Pilot Channel is transmitted at all times by the base station on each active Forward CDMA Channel. The Auxiliary Pilot Channel is transmitted in a beam forming application. The Transmit Diversity Pilot Channel and the Auxiliary Transmit Diversity Pilot Channel are transmitted when transmit diversity is used. The **Sync Channel** is used by mobile stations operating within the coverage area of the base station to acquire initial time synchronization. The **Paging Channel** is used by the base station to transmit system overhead information and mobile station specific messages. The **Broadcast Channel** is used by the base station to transmit system overhead information. The **Quick Paging Channel** is used by the base station to inform mobile stations, operating in the slotted mode while in the idle state, whether or not to receive the Forward Common Control Channel, the Broadcast Channel, or the Paging Channel. The **Common Power Control Channel** is used by the base station for transmitting common power control subchannels (one bit per subchannel) for the power control of multiple Reverse Common Control Channels and Enhanced Access Channels. The common power control subchannels are time multiplexed on the Common Power Control Channel. Each common power control subchannel controls a Reverse Common Control Channel or an Enhanced Access Channel. The **Common Assignment Channel** is used by the base station to provide quick assignment of the Reverse Common Control Channel. The **Forward Common Control Channel** is used by the base station to transmit mobile station-specific messages. For Radio Configurations 1 and 2, the Forward Traffic Channels include the **Forward Fundamental Channel and Forward Supplemental Code Channel.** For Radio Configurations 3 and higher, the Forward Traffic Channels include the **Forward Dedicated Control Channel, Forward Fundamental Channel,** and **Forward Supplemental Channel.** Similar to the corresponding Reverse Traffic Channels, these channels are used for transmission of user and/or signalling information to a specific mobile station during a call. The Forward Traffic Channels also include the **Forward Power Control Subchannel.** It is used to transmit reverse power control commands and is transmitted either on the Forward Fundamental Channel or on the Forward Dedicated Control Channel.

The Reverse Traffic Channels utilize an 800 Hz feedback power control mechanism similar to that for the Forward Traffic Channel. In addition, the mobile station supports open loop power control.

Downlink soft handoff is achieved by performing diversity combining at the mobile station. Transmit diversity is achieved by transmitting modulation symbols on separate transmit antennas.

B.4.3 Layer 2 - Media Access Control (MAC)

The Media Access Control (MAC) Sublayer provides the following important functions:

- Best Effort Delivery - reasonably reliable transmission over the radio link with a Radio Link Protocol (RLP) that provides a "best effort" level of reliability.
- Multiplexing and QoS Control - enforcement of negotiated QoS levels by mediating conflicting requests from competing services and the appropriate prioritization of access requests.
- Sophisticated Reservation Access - capabilities to provide efficient high-speed low latency common channel access.

B.4.4 Layer 2 - Link Access Control (LAC)

The Link Access Control (LAC) Sublayer performs the following important functions:

- Delivery of Service Data Units (SDUs) to a Layer 3 entity using ARQ (retransmission) techniques, when needed, to provide reliability.
- Building and validating well-formed Protocol Data Units (PDUs) appropriate for carrying the SDUs.
- Segmentation of encapsulated PDUs into LAC PDU fragments of sizes suitable for transfer by the MAC Sublayer and re-assembly of LAC PDU fragments into encapsulated PDUs.
- Access control through "global challenge" authentication. Conceptually, some messages failing authentication on a common channel should not be delivered to the upper layers for processing.
- Address control for delivery of PDUs based on addresses that identify particular mobile stations.

The general architecture is presented in two planes: A Control Plane, where processing decisions are made, and a Data Plane, where PDUs are generated, processed and transferred. The Data Plane contains the protocol, and is layered.

As a generated or received data unit traverses the protocol stack, it is processed by various protocol sublayers in sequence. Each sublayer processes only specific fields of the data unit that are associated with the sublayer-defined functionality. The LAC Sublayer provides services to Layer 3 in the Data Plane. SDUs are passed between Layer 3 and the LAC Sublayer. The LAC Sublayer provides the proper encapsulation of the SDUs into LAC PDUs, which are subject to segmentation and re-assembly and are transferred as LAC PDU fragments to the MAC Sublayer.

B.4.5 Layer 3 Signalling

Layer 3 Signalling provides a flexible structure designed to support a wide range of radio interface signalling alternatives. In addition to supporting the normal mobile network features, Layer 3 Signalling also supports the following radio related features and capabilities:

- Radio Configuration Negotiation.
- Quick Paging Operation (to improve battery life).
- Handoff Capabilities (i.e. soft handoff, hard handoff, idle handoff, access probe handoff, and access handoff).
- Power Control.
- High-speed Data.
- Enhanced Access.
- Broadcast Control Operation.
- Auxiliary Pilot Support.

B.4.6 Summary of major technical parameters

Parameter	"Value"
Multiple Access Technique	CDMA
Duplexing Scheme	FDD
Chip rate	1,2288 Mcps
Inter Base Station Asynchronous/Synchronous Operation	Synchronous operation is required
Pilot Structure	Code division dedicated pilot (UL); Code division common pilot (DL); and Code division common or dedicated auxiliary pilot (DL)
Frame Length and Interleaving	5 ms, 10 ms, 20 ms, 40 ms, 80 ms frame and channel interleaving
Modulation and Detection	Data modulation: BPSK; QPSK; 8-PSK (DL); 16-QAM (DL) Spreading modulation: HPSK (UL); QPSK (DL) Detection: Pilot aided coherent detection
Channelization Code	Walsh codes and Long codes (UL) Walsh codes or quasi-orthogonal codes and Short codes (DL)
Scrambling (Spreading) Code	Long code and Short PN code
Channel Coding	Convolutional code with K=9, R=1/2, 1/3, or 1/4; Turbo code with K=4, R=1/2, 1/3, 1/4 or 1/5 (12,4) block code (UK)
Access Scheme (Uplink)	Basic Access; Reservation Access

B.4.7 Features relevant to PAMR

The following clauses briefly describe some of the features in the CDMA-1X standards that are of particular relevance for the delivery of PAMR services using CDMA-PAMR. The list of features described is not intended to be comprehensive.

B.4.7.1 Forward Quick Paging CHannel (F-QPCH)

When there is an incoming call for the mobile station (MS), the base station first pages the mobile station to determine the sector where the mobile station is currently located. The page is sent to the mobile station on either the F-PCH or the F-CCCH, according to which channel is deployed. These channels operate in slot cycles of length N slots (N=1, 2, 4, ..) where a slot is 80 ms in duration. Mobile stations can operate in Slotted Mode where each MS is assigned a specific slot in the slot cycle and the mobile station need only monitor its assigned slot for pages. Slotted mode reduces MS power consumption and hence increases MS standby time. But since the F-PCH/F-CCCH slots are 80 ms in duration, the mobile station needs to be awake 80 ms in each slot cycle.

The F-QPCH further minimizes MS power consumption. F-QPCH signals just one bit of information (Uncoded On-Off Keying). An 80 ms F-QPCH slot consists of numerous 1-bit indicators. Each 1-bit information is sent twice during each 80 ms slot. The bit position assigned to each MS is randomly hashed based on the MS identity. F-QPCH operates together with F-PCH or F-CCCH. Each slot of the F-QPCH corresponds to a slot in the F-PCH/F-CCCH. The F-QPCH slot is offset from the corresponding F-PCH/F-CCCH slot by 100 ms.

When a bit-position in the F-QPCH is set to ON, it indicates that there is a page in the corresponding F-PCH/F-CCCH slot for one of the mobile stations assigned to this bit position. When a bit-position in the F-QPCH is set to OFF, it indicates that there are no pages in the corresponding F-PCH/F-CCCH slot for any of the mobile stations assigned to this bit position. Thus, when its bit position is set to OFF, the MS can immediately go back to sleep. Since duration of a bit position in the F-QPCH is much smaller than the duration of a F-PCH/F-CCCH slot, MS power consumption can be considerably reduced by the use of F-QPCH.

B.4.7.2 Enhanced Access

Access messages on the reverse link are sent on the R-ACH (Reverse Access Channel). The R-ACH operates in slots of 80 ms to 520 ms in duration and with a data rate of 4,8 kbps. Access on the R-ACH is performed via a Slotted-Aloha procedure. In order to enhance reverse access performance, a new R-EACH channel (Reverse Enhanced Access Channel) was introduced. The R-EACH operates in much smaller slot sizes of 1,25 ms to 80 ms in duration and at much higher data rates of up to 38,4 kbps. This reduces the latency to transmit access channel messages.

The above mode of operation of the access channels is called Basic Access Mode. It is suitable for transmitting small messages. In order to increase the reliability of transmitting larger messages (e.g. Data Burst Messages), a new mode of access termed Reservation Access Mode was introduced. In Reservation Access Mode, only the (tiny) header of the message is transmitted via slotted-Aloha procedure on the R-EACH (i.e. similar to Basic Access Mode). Upon receiving the header, the base station sends a message on the Forward Common Assignment CHannel (F-CACH) to the mobile station assigning a dedicated traffic channel. Then the mobile station can send the body of the access channel message on the R-CCCH. Since Reservation Access Mode supports closed loop power control and soft-handoff, the reliability of message transmission is greatly increased.

B.4.7.3 Packet data dormancy

When a packet data session is first established, the session state information (e.g. PPP protocol state) is negotiated and maintained at both the mobile station and the base station. The packet data session may be in one of several different states based on the current status of the session. The main states are the Active State and Dormant State. When the mobile station and the network are actively transmitting packet data traffic, the packet data session is said to be in the Active State. In this state, radio resources (e.g. dedicated physical channels) are allocated to the packet data session. When there is no packet data traffic exchanged for an implementation-specific duration of time, the packet data session transitions to the Dormant State. In the Dormant State, the radio resources allocated to the packet data session are released but the session context information is still maintained at the mobile station and the network. Thus Dormant State allows the network to conserve radio resources when there is no active transmission of packet traffic. At the same time transition back to Active State does not incur excessive delay since the session context information is maintained.

Radio resource control can also be in one of several possible states. The two states of most interest here are the Mobile Station Idle State and the Mobile Station Control on the Traffic Channel State. In the Mobile Station Control on the Traffic Channel State, dedicated radio resources are allocated to the mobile station but while in the Mobile Station Idle State, the mobile station utilizes shared radio resources. Which of these states the mobile station is in is a function of the "state of all the services currently connected".

With respect to packet data service, if the packet data session is the only service connected and the packet data session is in the Dormant State as described above, then the radio resource control will be in the Mobile Station Idle State because the packet data session does not require dedicated radio resources while in the Dormant State. But when the packet data session transitions to the Active State, the radio resource control transitions to the Mobile Station Control on the Traffic Channel State since dedicated radio resources are required by a packet data session in the Active State. Furthermore, if another service (e.g. voice) is currently connected, the radio resource control remains in the Mobile Station Control on the Traffic Channel State even if the packet data session transitions to the Dormant State, since the voice service still requires the dedicated radio resources.

B.4.7.4 Data Burst Messages and supported services

Various services for data messaging are facilitated in CDMA-1X via the Data Burst Message. The Data Burst Message is a Layer 3 signalling message that can be used to transport data on behalf of data messaging services. Examples of such services are Short Message Service, Position Determination, and Short Data Bursts.

Data Burst Messages are supported on both the control channels and traffic channels. The mobile station can send a Data Burst Message over the reverse link channels, and the base station can send a Data Burst Message over the forward link channels. The type of information being carried by the Data Burst Message is indicated via the BURST_TYPE field of the *Data Burst Message*. Currently available services are as follows.

Burst Type	Designated Use/Type of Service
000001	Asynchronous Data Services
000010	Group-3 Facsimile
000011	Short Message Services
000100	Over-the-Air Service Provisioning
000101	Position Determination Services
000110	Short Data Bursts
111110	Extended Burst Type - International
111111	Extended Burst Type

Data Burst Messages may be used for customized services and applications, as well as for standardized services. Due to the design of the Data Burst Message, future services can easily be defined using a new BURST_TYPE value. Any enhancements to improve the reliability and/or reduce the latency of transmission of the Data Burst Messages benefit all services utilizing Data Burst Messages.

Broadcast Data Burst Messages are also supported. These are transmitted with broadcast addressing and are intended for a group of mobile stations. The Broadcast Data Burst Message is suitable for emergency announcements, etc.

B.4.7.5 Access Control based on Call Type (ACCT)

The ACCT capability allows the network to control origination attempts from mobile stations based on the call type (indicated via the service option number) being requested in the origination. For example, if the packet network is overloaded but the voice network is working well, then new packet call originations can be blocked via ACCT while voice calls are allowed to proceed. ACCT can be used to completely block originations of a certain call type or to partially control originations of a certain call type. Partial blocking implies a certain percentage of originations of a certain call type are blocked (e.g. allow 50 % of packet calls) and utilizes the ACCOLC (ACcess Control OverLoad Class) of the mobile stations to achieve this. Note that if a call is an emergency call, then even if the corresponding call type is being controlled, the emergency call can still go through.

ACCT works as follows: The base station indicates in the system messages transmitted in a given sector whether a certain call type is being blocked and if so at what rate. When a mobile station desires to originate a call, the mobile station checks the system parameters message to determine whether it is allowed to originate this call or not. Since the system parameter message is transmitted at least once every 1,28 s, the ACCT scheme is very flexible to dynamically control access. Furthermore, since a blocked call results in no access message being transmitted, access channel performance is not degraded.

B.4.7.6 Global emergency call

The CDMA-1X radio interface supports a global emergency call, which allows users to make emergency calls in different systems and countries where the local emergency number may not be the same. For example, the mobile user interface could support an "emergency button" which can be activated to trigger a global emergency call. Thus the user need not know the local emergency number. The message sent to the network will indicate this is a global emergency call and the network can take the appropriate action.

B.4.7.7 Priority Access Channel Assignment (PACA)

PACA allows users to have priority access to traffic channels on call originations. When traffic channel resources are not available to assign the requested call, the network queues the call origination. The network then indicates to the MS that the call request has been queued and also indicates the queue position and timeout value. Later when traffic channel resources become available, the queued call origination is served based on priority level and request time. This feature can be permanently activated or activated on a per origination basis. Each user is assigned one of N priority levels. The mobile station is also allowed to cancel an outstanding PACA request.

B.4.7.8 Access Overload Class (AOC)

AOC is used for system access control (e.g. for emergency calls, network overload). Mobile stations are assigned one of 16 overload classes (ACCOLC). ACCOLC 0 to 9 are used for regular mobiles; ACCOLC 10 is used for test mobiles; ACCOLC 11 is used for emergency mobile; ACCOLC 12 to 15 are currently unused.

Access to the system is controlled on a per class basis by using persistence values transmitted by the base station. One persistence value is specified for ACCOLC 0-9 and individual values are specified for ACCOLC 10 through 15. Based on the persistence value, access to the system can be completely blocked off or the access rate can be controlled. Furthermore, redirection to another frequency, band class, or system for load balancing, etc can be performed based on ACCOLC. There is also a persistence value for emergency call originations from normal MSs with ACCOLC 0 to 9. Thus access control for emergency and non-emergency calls can be controlled separately.

B.4.7.9 Vocoders

CDMA-PAMR systems utilize high quality, low average data rate vocoders in order to provide high system capacity at the same time as high voice quality. The vocoders used fall under the category of Source Controlled Variable Rate Vocoders. The basic technique used is that every 20 milliseconds, the incoming frame of speech is analysed for its characteristics, and an optimal choice for the encoding scheme is made from out of a set of FULL, HALF, QUARTER, or EIGHTH rate. These vocoders also support TTY/TDD transmission for persons with hearing disabilities.

The vocoders used in CDMA-PAMR systems are IS-127 (EVRC) [17] and IS-893 (SMV) [18]. EVRC is being used in initial implementations of CDMA-PAMR, while SMV provides enhanced optimization for the future. Both of these vocoders use highly sophisticated rate-determination techniques and CELP coding schemes to provide high voice quality at low average rates. The following highlights essential aspects of each of the two vocoders.

B.4.7.9.1 IS-127: Enhanced Variable Rate Codec (EVRC)

Channel-rates used per frame (bps): 9 600, 4 800, 2 400 and 1 200.

This is a high quality vocoder that has been used in CDMA-1X systems since 1996. EVRC provides equivalent quality as the 13 kbps vocoder defined in IS-733, but gives 50 % more capacity compared to IS-733. This is due to the use of Rate-set 1 that uses only 2/3 of the frame-rates as that of Rate-set 2.

B.4.7.9.2 IS-893: Selectable Mode Vocoder (SMV)

Channel-rates used per frame (bps): 9 600, 4 800, 2 400 and 1 200.

This is the latest vocoder to be standardized for CDMA-1X. Using state-of-the-art variable rate vocoder techniques that build on the rate-reduced mode techniques of IS-733, and advanced CELP techniques in IS-127 [17], SMV offers 5 modes of operation that provide network operators with high quality along with flexibility to significantly increase system capacity when needed.

B.5 Delivery of PAMR features

This clause describes how a CDMA-PAMR system provides the services, features and functionality that may be required for a PAMR network. The services and features that are provided for a particular CDMA-PAMR network will depend upon the nature of the PAMR network, e.g. whether it is a high-speed data overlay to an existing PAMR network, or a stand-alone PAMR network. The clause describes how the CDMA-PAMR application (combination of fixed and mobile parts) utilizes the services and facilities provided by the CDMA-PAMR radio access network in order to provide the services, features and functionality that are required by PAMR users.

The following PAMR features are covered in this clause:

- Push-to-talk (PTT) calls.
- Fast call set-up.
- Group calls.
- Dispatch services.
- Prioritization and queuing.
- Short data and instant messaging.
- Packet data services.
- Simultaneous voice and data.
- Full duplex telephony interconnect.
- Dynamic group management.
- Over-the-air programming.
- Location services.
- Numbering and addressing.
- Security.
- Direct mode operation.

B.5.1 Push-To-Talk (PTT) calls

CDMA-PAMR provides for PTT call processing independent of traditional cellular voice services. The CDMA-PAMR systems that provide this functionality are implemented at the application layer and therefore are largely decoupled from specific hardware in the programmable handset or the infrastructure. The PTT features are implemented on top of packet data services. This allows for a high degree of integration with other data applications, thus making it straightforward to deliver rich and robust services on a wide variety of terminal devices.

At the radio level, in addition to the dedicated radio channel allocated to a single mobile, CDMA-PAMR also provides broadcast radio channels that can be heard by multiple receivers, as well as signalling between the network and each mobile to support PTT calls for mobile users. Uplink speech is supported using standard traffic channels and speech coding over IP packet transport. The downlink speech can be allocated to a broadcast radio channel, or to a dedicated radio channel heard by a single mobile. The choice of the downlink environment can be controlled at the BSC/RNC to optimize the radio environment.

Arbitration among multiple users desiring to speak is accomplished within the core network according to priority rules that can be applied to specific PTT groups. As a result "first come, first served" and "dispatcher speaks first" priorities can be supported in the same network, as well as any variety of rule sets, tailored to the needs of the PAMR customer.

Through the use of IP routing techniques, including IP Multicast protocols, PTT group members do not need to be co-located, but can be dispersed over a wide geographic region. The system tracks the whereabouts of all members of the PTT group who are currently active, and distributes the downlink speech for the PTT group to the appropriate switch/base station for transmission in the most efficient manner.

When the user presses the PTT button to request to speak, a message is sent to the network as an IP packet. This IP packet is quickly routed to a central "moderator" which verifies the right of the user to speak and performs any arbitration necessary for simultaneous requests. The dispatcher can apply controls to mute one, several, or all of the PTT group. Assuming permission is given and there are no higher priority requests, a quick response is sent to the terminal in an IP packet indicating the right to speak, and the terminal notifies the user. In the meantime, the terminal and network have assured that an uplink radio channel is available to carry the speech from the PTT user. As the vocoded speech arrives at the network, it is carried in IP packets (VoIP) that are quickly routed to a media control entity, from where the voice packets are sent to all members of the PTT group, to selected members, or to a single recipient, as appropriate.

B.5.2 Fast call set-up

The call set-up time experienced by the user of a CDMA-PAMR network is kept short for all mobile services, in particular push-to-talk services, in order for the user to be able to use the services effectively. The following describes some of the features available in the CDMA-1X radio access network that can be used by the CDMA-PAMR system in order to optimize call set-up time.

Minimization of the number of messages that need to be sent between the Mobile Station (MS) and the Base Station (BS) is imperative in achieving fast call set-up. The CDMA-PAMR air interface contains a number of features that can be used to optimize the initial mobile station system access and traffic channel assignment process. Short Data Bursts can be used to deliver initial call set-up application layer signalling (e.g. SIP messages) so that call set-up time is removed from the critical path. These are described in more detail in clause B.4.7 of the present document.

The mobile station needs to be ready as quickly as possible to respond to paging activities from the BS. CDMA-PAMR provides the mobile station with the ability to return directly to the Mobile Station Idle State from Mobile Station Control on the Traffic Channel State upon call release. Thus, upon call release, the mobile station can immediately start to monitor the forward common channels in Mobile Station Idle State for pages, short data bursts, etc. The Forward Quick Paging Channel permits the mobile station to monitor for pages from the base station with low latency in an efficient manner without sacrificing battery life.

When a mobile is switched on, it establishes packet data service instances with the network. Upon reception of a page by a member of a PTT call, it is important to re-establish the service instances to that listener with minimal delay. To minimize or avoid any re-negotiation of the configuration parameters for the service instances, CDMA-PAMR provides the MS and BS with the ability to store service configurations in use upon release of the dedicated traffic channels. When re-establishing the dedicated channels, the MS and BS can use the stored service configuration and thus avoid performing service negotiation, which avoids the exchange of several messages over the air. For example, the MS and the BS can cache parameters that specify the service configuration for a push-to-talk traffic channel mode of operation (e.g. physical channel parameters, service(s) to be activated, and operational parameters for these services).

The Packet Data Dormant State provides a useful mechanism for use in PTT calls in CDMA-PAMR (i.e. using voice-over-IP), since it can be used to avoid having to initiate a new packet data session. Packet data dormancy is described in more detail in clause B.4.7.

Over-the-air signalling messages in CDMA-1X are highly optimized for small size to reduce latency, required transmission power, and message error rates. This optimization is emphasized for signalling messages that are exchanged on the common channels (e.g. system access messages to initiate calls). This reduces call set-up time and minimizes the amount of traffic that is exchanged without power control.

The CDMA-1X standards provide for the use of very short messages that carry the smallest possible number of minimally required fields for reconnecting a dormant packet data call. Due to the small number of fields that are carried, in many cases these messages fit in a single reverse access channel frame which results in short transmission time and reduced message error rate.

CDMA-PAMR provides dynamic assignment of a mobile station to non-slotted mode, in addition to the Quick Paging Channel discussed in clause B.4.7.1. When there is an incoming call for a mobile station, the base station sends the page message to the mobile station on the assigned paging slot of the mobile station if the mobile station is operating in slotted mode (battery saving mode). If the mobile station is operating in non-slotted mode (e.g. for time-critical applications), the base station may send the page message in any paging channel slot. The assigned paging channel slot of a mobile station occurs with a frequency determined by the selected slot cycle length. The shorter the slot cycle length, the shorter the delay to wait for the assigned slot of the mobile station, however there is a trade-off to be made with battery power consumption.

B.5.3 Group calls

CDMA-PAMR provides group and broadcast services in the application layer. By combining functionality of voice over packet data with group management services, CDMA-PAMR systems can provide group calls without any dependence on lower layer radio broadcast channels. Current CDMA-PAMR systems provide group calls by initiating individual data sessions to terminals involved in the group call and broadcasting information to those terminals. Group calls can also be configured at the radio level to take advantage of broadcast channels in order to further enhance the radio spectrum efficiency, whilst providing good downlink radio quality to multiple users in a given sector.

A group call is initiated by a user pressing his PTT button, triggering a group call initiation message to be sent. This will then be processed by the PAMR application using a combination of system elements (including PTT server, media controller, location server and group management database) in order to establish the group call. Users involved in the group can then press their PTT buttons when they wish to speak in order to "take control of the floor".

The broadcast radio channel in CDMA-PAMR is a basic building block that allows the creation of group, and broadcast and multicast of information to users. The broadcast radio channel is a uni-directional channel transmitting in the downlink (network to terminal) direction only. Multiple terminal devices can be provided with the configuration of such a channel in order to permit all of them to listen to a single channel.

Group calls can be thought of as a special application of broadcast or multicast because, in addition to multiple terminals listening to the same downlink radio channel, each terminal can signal to the network a desire to transmit on an uplink. This ability can be used in creating PTT group calls, moderated conference calls, etc.

B.5.4 Dispatch services, prioritization and queuing

Dispatch services in CDMA-PAMR are supported in the core network by designating one or more group members as being "dispatchers" with the ability to speak when desired, and to control the right to speak of other members. Dispatchers can be empowered to direct their voice to one or several members of the PTT group by designation of the users, or according to the geographic region to which the speech is directed.

When desired, priorities can be assigned to each member of the PTT group to control their interactions within the group communications. When multiple users are queuing for the right to speak, members with a higher priority will be given that right before members with a lower priority. Within priority levels, a first come, first served strategy can be employed. Users who have pushed the button on their mobile to obtain the right to talk will maintain their position in the queue until they have been given the right to speak, have dropped off of their own choice, or have been dropped due to timeout protocol strategies. Because of the flexibility of the CDMA-PAMR system, any, all, or a mixture of such priority and queuing strategies can be applied to each PTT group. Clause B.4.7 contains details of some of the features in the CDMA-1X radio network that are used for such purposes.

The VoIP-based approach that is taken for CDMA-PAMR has advantages for the implementation of dispatcher solutions. In CDMA-PAMR, dispatcher terminals are essentially terminals connected to an IP network, rather than having to be connected into the system via some more complex, less common or proprietary interface. For example, a dispatcher terminal may be connected into the system via the Internet and/or the user organization's LAN, or there may be a direct connection into the data network/WAN of the CDMA-PAMR operator network.

Emergency calls are supported in CDMA-PAMR through a combination of signalling and priority levels. An emergency call can be initiated from the mobile device through any variety of user interfaces, e.g. a "red button", a menu entry, etc. Signalling between the mobile and network conveys the "emergency" nature of the call, and results in an appropriate priority being attached to the request to speak.

In emergency situations, many users may try to speak at once, and may need to be overruled by a higher priority "dispatcher" who can choose the person who will be given the right to speak. This capability is part of the priority and queuing facilities built into the CDMA-PAMR system. Using the ability of a dispatcher to control which members or geographic regions receive the speech for the PTT group, the dispatcher can also influence and control use of the PTT group in emergency situations.

There is a range of options available for a CDMA-PAMR system in order to be able to handle emergency calls effectively, according to the requirements of the user organization. These may involve features in the network, such as priority access and emergency call flags, but equally important will be the way in which such calls are handled by the PAMR application, and the user interface that is provided in order to make sure that emergency calls are handled appropriately and effectively by/for the user organization according to the context in which they operate.

An advantage of the CDMA-PAMR system is the ability to "squeeze in" another call by simply allocating another walsh code in a sector, even though the nominal maximum capacity of the sector has been reached. Such an approach slightly reduces the quality of all calls in that sector on the given radio carrier by lowering the signal to noise ratio, yet allows additional calls to be served without pre-empting other calls. This technique can quite often satisfy the need to add one or two emergency calls in a sector. Pre-emption is still possible if required, and can be implemented in the RAN without requiring standardized solutions.

B.5.5 Short data and instant messaging

CDMA-PAMR provides a flexible range of facilities for short data messaging. These are based on the Data Burst Messaging facilities that provide a flexible and efficient low level mechanism for transporting short data messages of different types directly and quickly between users, using one of a number of different channel types according to which is most suitable. In addition, a number of different short messaging services are built on top of this, including Short Data Bursts (SDBs) and store-and-forward Short Message Services (SMS). The IP-based approach adopted for CDMA-PAMR also makes it relatively straightforward to integrate other IP-based messaging services (e.g. Instant Messaging) with messaging services provided over the CDMA-PAMR mobile network. Clause B.4.7 provides details of Data Burst Messaging and other facilities provided for short data messaging in the CDMA-1X radio network.

CDMA-PAMR provides instant messaging services for professional users. Instant messaging is in some respects the Internet analogue of the Short Message Service (SMS) on wireless networks, but differs in that SMS is a store and forward system whilst instant messaging occurs in real time. CDMA-PAMR provides instant messaging across the radio interface to the mobile user, taking advantage of presence and location services (see clause B.5.11) to know which other users are available for instant messaging communications.

CDMA-PAMR provides instant messaging services in an efficient manner by using features of CDMA-PAMR packet data such as dormancy and Mobile IP. Dormancy and Mobile IP provide an efficient "always on" service that allows mobile clients to maintain their IP-level attachment to an instant messaging server without actively using radio traffic channels. Because CDMA-PAMR data services serve as the transport for instant messaging services and are based on standard IP protocols, these messaging services can be readily used in conjunction with wired or pre-existing IP-based messaging services. Data Burst Messages on the radio interface provide efficient transfer of messages between mobiles and the network.

B.5.6 Packet data services

The CDMA-PAMR radio interface supports flexible data rates up to 307 kbps in the forward direction and 153 kbps in the reverse direction. At the packet data service level, Simple IP and Mobile IP are supported to provide both static and dynamic IP address environments, and support for Virtual Private Networks (VPNs).

Radio support for packet data allows efficient use of the radio interface by supporting dormancy of the radio channel when no traffic needs to be sent between the mobile device and the network. When data becomes present, the radio channel is quickly re-established using fast call set-up techniques and other mechanisms.

The ability to take advantage of the flexibility of packet data services and data rates in CDMA-PAMR has been available in standards since 1999, and available in actual products since 2001. The flexibility in data rates comes from the ability to use multiple Supplemental CHannels (SCH) on the radio interface to provide the bandwidth needed for a given mobile station and a particular packet session. In a given sector, multiple mobiles may be using packet data services, all at different bandwidths. Special mobile terminals are not needed, as all mobiles built to the standards and using packet data must support supplemental channels.

Packet data services provide the ability to send and receive IP packets, the basic capability of the Internet. Thus, the applications that can be supported extend across the full range of applications available and being developed for use across the Internet, in addition to other applications designed specifically for mobile workers. The mobile device, within the capabilities of its storage, processing and display technologies, is capable of participating in a wide variety of applications (see clause A.1 for some examples).

Specific applications for the PAMR community can be developed by the operator, by the PAMR customer, or by third party development houses, thereby allowing the greatest possible availability of applications at the lowest possible cost to the operator and user. With the increase in storage capacities on current data mobile devices, and given the ability to download new applications to the mobile device on an as-needed basis using common IP techniques and security mechanisms, the facilities available to the CDMA-PAMR end user are already broad and continually expanding.

B.5.7 Simultaneous voice and data

CDMA-PAMR is able to handle a full range of scenarios regarding simultaneous use of different services by a user, including simultaneous voice and data. For example, PTT calls can be made at the same time as a packet data session is active (due to the use of VoIP for PTT calls, this is effectively simultaneous packet data and packet data), and short data messages can be received at the same time by means of Data Burst Messaging over either a traffic channel or a control channel. Furthermore, full duplex telephony/PSTN calls can also be handled simultaneously with other services (provided that the user equipment is configured to allow this), since full duplex telephony will normally be effectively a separate application in the terminal (separate from the other IP-based services).

An initial requirement in the design of the CDMA-1X radio access network was for independent and simultaneous establishment, maintenance, and release of a voice call and a data call, but standards have gone further than this, supporting the concurrent connection of an arbitrary number of calls of various types. This includes support for simultaneous connection of multiple packet data calls.

Support for Concurrent Calls is achieved by separating the Call Control (CC) state machine from the Radio Resource Control state machine. As such, more than one instance of the Call Control state machine can be instantiated. This allows for independent and simultaneous establishment, maintenance, and release of multiple calls. This has also facilitated the addition of other call models in the standards. As a new call is added, a new instance of the appropriate CC state machine is instantiated; as calls are released, the corresponding CC state machine is terminated. Establishing a new call consists of both instantiating a Call Control state machine instance to handle the Call Control signalling messaging for this call, and setting up a Service Option Connection to carry the user traffic corresponding to this call.

Signalling support is available to originate, maintain, and release concurrent calls. Signalling messages have been created to request and assign new calls while on the dedicated channels (i.e. when another call is already established). Establishing the first call is done using standard processes. Subsequent calls are established as follows: for a Mobile Station (MS) originated call, the MS sends an Enhanced Origination Message. This message contains all the relevant parameters pertaining to this new call. The Base Station (BS) sends a Call Assignment Message in response to establish the call. For an MS terminated call, the BS sends a Call Assignment Message. Release of calls (other than the last remaining call) is achieved by performing service negotiation procedures to release the corresponding service option connection. The release of the last call is achieved via standard mechanisms.

In later releases, CDMA-PAMR systems are expected to evolve to provide a separate VoIP service option that will be used to distinguish the voice packets from other packet data, such as web browsing. This new VoIP service option will allow for advanced QoS techniques to be employed.

B.5.8 Full duplex telephony interconnect

CDMA-PAMR provides for a wide range of interconnect possibilities, including interconnection to the PSTN and packet data networks. PSTN interconnect for full duplex telephony is achieved via switches/gateways connected to the CDMA-1X radio access network. Interconnection for packet data services will generally be via an IP packet data network.

A number of vocoder options exist for CDMA-PAMR networks, namely the Enhanced Variable Rate Codec (EVRC) and Selectable Mode Vocoder (SMV) vocoder technologies (see clause B.4.7). EVRC is being used in initial implementations of CDMA-PAMR, while SMV provides enhanced optimization for the future. The CDMA-PAMR systems provide the ability to interoperate between the different vocoders if necessary.

Full duplex telephony interconnect is directly supported for both mobile to PSTN and mobile-to-mobile communications. When interconnection to the PSTN is desired, the network inserts appropriate transcoding capabilities into the voice path to fully interoperate with the PSTN. When interconnection to another mobile is desired, two situations exist:

1) both mobiles support the same codec; or

2) both mobiles support different sets of codecs.

The latter situation could arise as vocoder technologies improve and newer codecs take the place of those originally deployed.

In the first mobile-to-mobile situation, signalling within the network allows discovery of support for a common codec. In this case, the coded voice can be directly transported between the two mobiles without any transcoding within the network. This is referred to as Transcoder Free Operation (TrFO).

In the second mobile-to-mobile situation and in the mobile-to-PSTN situation, network signalling can discover these situations and insert appropriate transcoding devices in the voice path to allow proper interoperation. Such transcoders are normally situated in a Media Gateway (MGW) within the core network. A Media Gateway Control Function (MGCF) manages the MGW and provides interworking of the ISUP signalling of the PSTN with the SIP based signalling of the CDMA-PAMR core network. Incoming ISUP signalling is interworked to equivalent SIP signalling at the MGCF and forwarded on to other core network call control components. Interworking also occurs in the reverse direction for signalling to the PSTN.

B.5.9 Dynamic group management

As mentioned in clause B.5.3, CDMA-PAMR systems provide group calling services using voice over packet data. Because these services are implemented in application layers, CDMA-PAMR systems provide a wide variety of group management functions. Groups can be provisioned centrally, via mobile terminals, or via other integrated data services such as Internet directory services.

The approach used for group management in CDMA-PAMR provides a powerful and flexible approach to enable a user organization to manage their own communications in a way that is most suitable for them. Groups can be set-up and modified dynamically, either from a central terminal or distributed terminals, from fixed or mobile locations, via Web-based applications, etc. The longevity of a group can range from a fixed group corresponding to a particular operational unit that is relatively static, to an ad-hoc group that is established rapidly in order to provide effective communications for a particular temporary situation.

PTT group management is a peer-to-peer application between the PTT service and the mobile user or other associated wire line IP endpoints, allowing users (whether mobile users or administrators) to dynamically create, modify, or delete talk groups and/or membership. Group management in CDMA-PAMR in many ways parallels group management for chat groups in instant messaging. Security for dynamic group management is based upon IP security techniques such as TLS for privacy coupled with authentication and authorization schemes to ensure a given talk group is only modified by authorized persons.

B.5.10 Over-the-air programming

The CDMA-PAMR system provides the ability to the network operator to program the handset through radio communications between the network and the handset. This is referred to as "Over-The-Air Service Provisioning" (OTASP) and "Over-The-Air Parameter Administration" (OTAPA) [20], [21]. The procedures designed in the system create a secure and robust environment that includes authentication and abort procedures.

Network operators use these capabilities to remotely activate handset devices, administer authorized functions, and provide service support to the user. Ongoing standards work in this area is generalizing the existing OTASP and OTAPA capabilities to operate over standard IP messaging, and extending those capabilities to allow complete firmware reprogramming of the handset device, as well as downloading of new applications needed or desired by the user. This new feature is referred to as "IP-based Over-The-Air Administration" (IOTA).

Within the context of CDMA-PAMR, the "Over-The-Air (OTA)" capabilities provide the PAMR dispatcher the ability to dynamically reconfigure PTT capabilities, not only in the core network, but also at the terminal devices themselves. Thus when the PTT user, for example, invokes a menu on the handset, that menu may have been changed moments before using OTA programming.

Small client applications can be downloaded and installed on the handsets without central or regional customer care centres, thus simultaneously improving the customer experience, reducing customer care expenses, and improving the control level of the operator. Such client applications may include time accounting and expense accounting, taking advantage of both IP security techniques and the security capabilities of the CDMA-PAMR system.

CDMA-PAMR equipment that may need to be personalized to the user can be downloaded with the needed information, including specialized menus, phone books, diaries, specialized application clients, etc. Such facilities allow CDMA-PAMR equipment to be shared among multiple users, and provide a convenient way to upgrade or replace equipment in the field.

B.5.11 Location services

CDMA-PAMR will support a location services architecture that allows multiple location technologies to be deployed, including overlay systems and Global Positioning System (GPS) assisted systems. The accuracy of these services is increasing due to refinements required by the FCC for deployments of CDMA-1X radio systems in the U.S. Current deployments underway in the U.S. must provide:

Solutions	Accuracy	Percent of Calls
Network Based	100 m	67 %
	300 m	95 %
Handset Based	50 m	67 %
	150 m	95 %

The design of the architecture and messaging permits and supports not only triangulation and mobile assisted GPS, but a wide variety of other location technologies also. Signalling is sent from a Mobile Positioning Centre (MPC) through the Radio Access Network (RAN) to the mobile. That signalling can be recognized and intercepted by the RAN in schemes that are network based. The replies generated by the RAN are formatted to appear as if they had come from the mobile device. When the signalling is simply forwarded to the mobile device, such as in mobile assisted GPS schemes, the mobile will generate and format the response signalling. Once the MPC has the information requested, it can do any further calculations necessary to derive the desired geoposition information to the desired accuracy.

Handset-based, wireless assisted hybrid location determination technology uses measurements from the CDMA-1X network and a satellite network. This hybrid approach is best suited to support the most accurate location services. The TIA position location Standard IS-801-1 [22] fully supports the hybrid technique. It also supports MS-based and autonomous GPS technologies (where the MS uses little or no assistance from the wireless network).

The wireless assisted hybrid solution has the following advantages:

- Allows determining the MS position when fewer than four satellites are visible.
- Provides better availability, since it merges and expands the coverage areas of network-based and satellite-based approaches.
- Improves receiver sensitivity and permits operation in urban canyons and inside buildings.
- Takes advantage of the CDMA-PAMR terminal's knowledge of precise time.
- Makes it possible to use existing hardware correlators already implemented in the MS.
- Reduces the impact on battery life because the satellite signal can be acquired quickly.

The current signalling for location services takes advantage of the Data Burst Message that can be sent on either the traffic channel or on the paging channel. Future improvements under discussion include the use of IP packet data to communicate between the mobile and the location services functions within the core network.

The integration of location services and presence services provides a powerful capability for supporting, managing, and taking full advantage of PAMR services. Users of these services can take advantage of knowing the actual geographic location of other users automatically to the accuracy provided by the location technology chosen by the network operator and/or integrated in the terminal device. Such capabilities can be put to good use by managers of distributed taxi and trucking fleets, for example.

In addition, presence services allow individual users to note their status and availability in a programmatic manner. Thus, not only can the manager know where a group member is currently located, but can also know whether that the person is off duty, available for work, taking a meal break, etc. This presence information can be retrieved in an authorized, controlled manner by multiple applications through a standard Application Programming Interface (API), facilitating the development of PAMR software applications by multiple third party companies. This capability thus broadens the market for such software and can lead to reduced costs to the operators.

Examples of presence variables are:

- Whether the person has an IP address, which implies whether or not the user can receive IP based messages.
- Whether a person has registered for PTT service with the PTT server.
- User determined availability for members of a particular talk group, i.e. availability can vary per talk group or user in the sense that the user may be "available" for higher priority users.
- User determined availability based on spatial coordinates provided by the network location services.
- Dynamic state of a user's talk group, i.e. whether the user has enabled a particular PTT talk group.

A complete presence service provides presence information for many services, such as PSTN interworking. For example, the user may determine that they will accept a phone call from the PSTN, but not a PTT exchange.

Presence itself requires dynamic management, just as PTT talk groups, because a user may wish to change his/her availability rules for certain talk groups or users under various conditions or at various times of day. Such presence rules can be configured or modified from a mobile station or any IP endpoint that can access the "presence server".

Security for dynamic presence control management may be based upon usual IP security techniques such as TLS for privacy, coupled with authentication authorization schemes, to ensure a given user's presence rules are only modified by authorized persons.

B.5.12 Numbering and addressing

Through a clean architectural approach that separates circuit based voice calls from IP packet data, independence has been achieved in CDMA-PAMR between the telephone number of the mobile device and the IP address(es) supported by the device. The telephone number is assigned in the same manner as for existing technologies. The IP address can be allocated statically or dynamically, as suits the needs of the network operator, the user, and the user organization. Both Simple IP and Mobile IP are supported, as well as Virtual Private Networks (VPNs), providing flexibility to the network operator and value added capabilities to the corporate and individual user.

Separation of the telephone numbers or mobile identifiers from IP addresses provides a number of benefits:

- User addresses are not associated with a particular terminal.
- User addresses can be assigned to the users in an organization in the most user-friendly way, according to the needs of the organization.
- Enables an operator to make efficient use of scarce numbering resources (e.g. it avoids having to reserve a block of numbers for future expansion of the number of users within a particular organization).
- Global connectivity based on the Internet and other IP networks.
- Enables PTT users to have a PTT account that is independent of any device, for example for rental units.
- Enables PTT users that are not using CDMA-PAMR (provided those users can accommodate wireless codecs, or transcoding services are deployed). Examples of other users are 802.11 or wire line based users.
- Reuse of IETF protocols, driven by the Web and Internet standards bodies.
- Inclusion of commercial datacomm vendors in the carrier procurement process, as opposed to primarily or only telecomm vendors.

The CDMA-PAMR packet data architecture provides robust support for dynamic addresses and static addresses. These addresses can be either public or private. For example, it is possible for two or more mobiles with class 10 addresses to be on the same Packet Data Serving Node (PDSN) at the same time. Simple IP provides fairly wide connectivity in a metro; the connectivity is driven by operator configuration of the network. Mobile IP provides wide connectivity that crosses PDSN boundaries and technologies, i.e. 802.11. The CDMA-PAMR packet data architecture also provides a very low latency handoff while the mobile is active, i.e. engaged in a PTT exchange, thereby reducing interruption due to movement.

B.5.13 Security

CDMA-PAMR provides a full range of security features for both the user and the operator. The set of security features that are available is comprised of features implemented in both the network and the application. The network security features include air-interface encryption and authentication. The VoIP approach used in CDMA-PAMR provides for the convenient implementation of end-to-end security for PAMR voice services, as well as for packet data services and applications.

The enhanced encryption facilities available in the CDMA-1X radio access network allow 128-bit based encryption for both signalling messages and user data (e.g. voice or packet data) between the mobile station and the base station. There is also a unified encryption negotiation and encryption structure for both signalling messages and user data. The features of this enhanced air-interface encryption include:

- Signalling messages can be encrypted on both Common and Dedicated Channel.
- Uses 64-bit key from authentication process as the cipher key.
- Uses one of a number of 128-bit based encryption algorithms.
- User data encryption on Dedicated Channel (or on Common Channel Short Data Bursts, which are one type of Signalling message).
- Encryption algorithms are negotiated during Common Channel operation.
- Encryption can be turned on or off independently for each connected service.
- Recovery mechanisms when encryption is out-of-sync between the mobile station and the base station.
- Anti-replay attack mechanism.

The basic authentication facilities available in the CDMA-1X radio access network enable the base station to authenticate the mobile station and set up a cipher key for encryption. The enhanced authentication in the standards ensures the authenticity of the sender and the integrity of Signalling messages received over-the-air. Enhanced authentication uses one of two schemes to establish the integrity key of this purpose, one of which employs mutual authentication. The base station is able to set the cipher key size to either 64-bit or 128-bit according to the level of encryption strength required. The major features of this enhanced authentication include:

- Signalling messages are integrity protected on both Common and Dedicated Channel (by attaching a 32-bit Message Authentication Code to the message).
- Under one option to establish the integrity key, the base station authenticates the mobile station and sets up a 64-bit integrity key.
- Under the second option, known as AKA, the base station and mobile station authenticate each other (mutual authentication) and set up a 128-bit integrity key (and a 128-bit cipher key).
- Recovery mechanisms when integrity is out-of-sync between the mobile station and the base station.
- Anti-replay attack mechanism.

In addition to such network-based security features, CDMA-PAMR is also well suited to providing security features at the application level, including end-to-end encryption. As described previously, CDMA-PAMR implements voice services (such as PTT services) that are transported over packet data services of the radio access network. Such VoIP services can be architected to allow for complete end-to-end encryption of media (e.g. voice) without special support in the infrastructure. Such systems have already been employed commercially in the US for end-to-end secure voice services for government use.

B.5.14 Direct mode operation

Direct Mode Operation (DMO) is a facility that is not generally provided by PAMR operators. There are a number of good reasons for this, including: the difficulties in billing for and raising revenue from such a service; the issues associated with obtaining suitable spectrum and making it available for DMO usage; the problems associated for controlling and managing the usage of the facilities; and issues relating to the approval and circulation of terminals between different countries.

Nevertheless there are some radio users who value DMO services, in particular within the emergency services. DMO is essentially a simple facility, providing the ability to talk directly "back-to-back" between mobiles without the communications having to go via any infrastructure. Some emergency service organizations have extended the functional requirements for DMO to include additional complexities such as gateways and repeaters, however there is clearly also an additional cost that is associated with such complexity.

For CDMA-PAMR, the approach that would be taken for the provision of any DMO services is to utilize DMO radio modules that are essentially separate from the main PAMR network services (although they may be integrated into the same terminal equipment). Any integration/interactions between DMO and other PAMR services would most likely be implemented in the terminal, rather than in the infrastructure or the radio standards themselves. The solution would most likely make use of analogue PMR technology for the provision of DMO. Other possibilities for local on-site communications may involve the use of transportable base stations, cordless telephony, or local radio access technologies such as DECT or IEEE 802.11.

The DMO description given in this clause, leads to the conclusion that CDMA-PAMR systems do not offer the DMO capability. Just in case of emergency, the network infrastructure may be destroyed (natural catastrophes, terrorism acts or others accidents). For getting effective disaster relief support it is necessary to get effective telecommunication without dependency on central servers and other network infrastructure.

The CDMA-PAMR system description proposes a solution for terminals like the combination of CDMA-PAMR combined with additionally radio modules implemented in the same handset.

Annex C: Expected Compatibility Issues

C.1 Coexistence studies

CEPT WG SE7 are considering compatibility and the use of guard bands and separation distances between CDMA-PAMR and other technologies. If no account is made for filtering in equipment of other services, for example for duplex separation purposes, very large guard bands and separation distances would be necessary. SE7 are therefore considering compatibility with representative equipment that includes duplex filtering, where the duplexers in GSM, TETRA and PMR/PAMR equipment provides some additional attenuation against the effects of blocking and intermodulation, and the duplexer in the CDMA-PAMR equipment provides some additional attenuation of the wide band noise output of the CDMA transmitter.

It has been identified that duplex filters do not provide enough attenuation to avoid interference, and separation distances and coordination by the regulator will also be necessary. Additionally, as the separation distances to avoid interference can be large, and in some circumstances can exceed 1km, extra receiver filtering may be required by the other services to prevent interference.

C.2 Current ITU allocations

None.

C.3 Sharing issues

There will be a need for studies to be conducted into compatibility between CDMA-PAMR and other systems and services that may operate in adjacent frequency bands, with a number of issues needing to be explored in relation to such adjacent band compatibility. CDMA-PAMR is expected to have properties not dissimilar to those of TAPS, and will therefore need to be studied for the same adjacent bands and services. These adjacent bands and services are:

- UIC, GSM-R and the use of Direct Mode TETRA just above 876 MHz.
- Short Range Devices at frequencies below 870 MHz.
- PMR and related services in the 400 MHz bands.
- Broadcasting systems receivers above 470 MHz, both analogue and digital (DVB-T) (see note).

NOTE: This is a known problem for all radio services in the same bands as CDMA-PAMR and for those countries that use TV Channel 21.

- GSM BS receivers just below 915 MHz because of the transition at 915 MHz between the uplink and downlink.

For various calculations of the interference impact due to a nearby CDMA-PAMR system, an assumption regarding the maximum allowed interference limit falling into (or generated within) the GSM receiver has to be made. This then will also determine the resulting desensitization of the GSM receiver due to CDMA-PAMR.

The interference potential between CDMA-PAMR and GSM/TETRA/PMR/PAMR needs careful examination. Especially for the CDMA-PAMR - GSM 900 case the co-ordination between dense and frequently changing GSM sites with PMR network has never been attempted before. Spurious emission limits (similar to 3GPP) need to be examined with a view to minimizing the risk to GSM operators.

Annex D: Comment continuation from Bolt Consult

D.1 Protection distances for Short Range Devices

See clause 4.1.

D.1.1 CDMA transmitter data

The transmitter powers for the mobile and base stations are +23 dBm and 44 dBm respectively.

The proposed transmitter masks for both base and mobile stations are given in the draft TR and quoted below:

Quote:

"The base station emission limits for CDMA-PAMR (Band Classes 11 and 12) are as follows [4].

Table B.2.3: Unwanted emission limits for base stations

Separation from centre frequency	Emission limit
750 kHz	-45 dBc/30 kHz
885 kHz	-60 dBc/30 kHz
1,125 MHz to 1,98 MHz	-65 dBc/30 kHz
1,98 MHz to 4,00 MHz	-75 dBc/30 kHz
4,00 MHz to 6,00 MHz	-36 dBm/100 kHz
> 6,00 MHz	-45 dBm/100 kHz

The emission limits for CDMA-PAMR mobiles operating in Band Classes 11 and 12 are as follows [5].

Table B.2.4: Unwanted emission limits for mobile stations

Separation from centre frequency	Emission limit
885 kHz	-47 dBc/30 kHz
1,125 MHz	-54 dBc/30 kHz
1,98 MHz	-67 dBc/30 kHz
4,00 MHz	-82 dBc/30 kHz
4,00 MHz to 10,0 MHz	-51 dBm/100 kHz

Unquote:

D.1.2 Calculation of protection distances

Short Range Devices (SRDs) in the band 863 MHz to 870 MHz may operate in different bandwidths from 25 kHz to up to 600 kHz. An average victim bandwidth of 100 kHz is used here to calculate the protection distances for the case of out of band interference by CDMA-PMR to SRDs.

The following assumptions are made:

a) The calculation is using the Minimum Coupling Loss (MCL) method.

b) Assuming a protection distance > 10 m the following indoor propagation model is used:
PL= 51,2 + 35log d according to T.S. Rappport text book.

c) The urban outdoor propagation model is according to ERC Report 68.

d) The interference criteria used is I/N = 0 dB corresponding to a reduction of the SRD (victim) sensitivity of 3 dB.

e) The SRD victim receiver noise figure, N = 8 dB.

f) The SRD victim receiver antenna gain, G = 2,16 dB.

g) The interfering CDMA-PMR transmitter spectrum mask limits in different distances from the centre frequency of the carrier are re-calculated to 100 kHz equal to the bandwidth for selected victim receiver.

The calculations are made in an Excel spreadsheet copied below.

Interference by CDMA-PMR to SRD (victim 100 kHz bandwidth)

Interfering transmitter CDMA-PMR =>	Mobile	Mobile	Mobile	Mobile	Mobile	Base st
INPUT DATA lines below						
Distance from centre of carrier, MHz	0,885	1,125	1,98	4	>4,0	>45,0
Distance into SRD band, MHz	0,76	1	1,855	3,875		
TX output power radiated, Pt (dBW)	-7	-7	-7	-7	-7	14
TX power density radiated, Pt (dBW/30 kHz)	-54	-61	-74	-89		
TX power density radiated, Pt (dBW/100 kHz)	-48,8	-55,8	-68,8	-83,8	-81,0	-75,0
Input Building attenuation, (dB)	10	10	10	10	10	10
Input Frequency, (MHz)	868	868	868	868	868	868
Horizontal coupling loss factor, (dB)	0	0	0	0	0	2
Input RX ant. gain - feeder loss, Gr - Lfr (dB)	2,16	2,16	2,16	2,16	2,16	2,16
Victim RX noise = (10*log kTB)+NF (dBW)	-145,8	-145,8	-145,8	-145,8	-145,8	-145,8
Input Victim RX Noise figure, NF (dB)	8,0	8,0	8,0	8,0	8,0	8,0
Background noise in band (dB above system noise)	0,0	0,0	0,0	0,0	0,0	0,0
Relative interference level, I/N,(dB)	0,0	0,0	0,0	0,0	0,0	0,0
Input TX mod. Equivalent noise BW, BWt (kHz)	100	100	100	100	100	100
Input Victim RX noise bandwidth, BWr (kHz)	100	100	100	100	100	100
Input the shorter antenna height, Hm (m)	1,5	1,5	1,5	1,5	1,5	1,5
Input the taller antenna height, Hb (m)	1,5	1,5	1,5	1,5	1,5	10
Required Path Loss for main beam (Minimun Coupling Loss, MCL)						
Path loss, in-door to in-door, PL (dB)	89,2	82,2	69,2	54,2	57,0	61,0
Path loss, in-door to out-door units, PL (dB)	89,2	82,2	69,2	54,2	57,0	61,0
Path loss, out-door to out-door units, PL (dB)	99,2	92,2	79,2	64,2	67,0	71,0
Protection Distances for co-channel interference from main beam						
Indoor model, in-door to in-door, (m)	70,9	43,9	18,5	7,2	8,5	48,5
Indoor model, in-door to out-door units, (m)	70,9	43,9	18,5	7,2	8,5	48,5
Outdoor model, out-door to out-door units, (m)	145,1	89,4	37,3	14,2	16,9	97,1
h^2*h^2/r^4, (m)	453	303	143	60	71	231
a (Hm)	0,014	0,014	0,014	0,014	0,014	0,014
a (Hb)	0,014	0,014	0,014	0,014	0,014	21,540

Annex E: Comment from ETSI/MSG

E.1 Expected compatibility issues with GSM 900

Compatibility studies regarding specific systems are currently being undertaken in CEPT WGSE PT7, and a draft report has been developed. This report studies the compatibility between CDMA-PAMR and GSM at the upper edge of the GSM 900 band, at 915 MHz. The report considers two criteria for compatibility:

- 4,8 dB desensitization of the GSM base station, based on the GSM requirement for receiver blocking.
- 0,3 dB desensitization, based on the GSM requirement for BTS intermodulation.

However, most of the report is at present based on the criteria for 4,8 dB desensitization of the GSM base station.

The analysis below demonstrates that 4,8 dB desensitization would result in an unacceptable degradation in the performance. 0,3 dB desensitization is a more appropriate value.

The SE7 report concludes that coordination will be required between CDMA-PAMR and GSM base station. The effect of the different parameters for desensitization would be different trigger points for coordination. This coordination could take into account the specific characteristics of the GSM cell site. The consequence of adopting a coordination trigger based on 4,8 dB desensitization of the GSM base station would be that some GSM base stations could suffer unacceptable interference from CDMA-PAMR base stations, without a coordination process being triggered.

E.1.1 Performance criteria for compatibility studies with GSM 900

The critical scenario for compatibility between CDMA-PAMR and GSM 900 is interference from the CDMA-PAMR base station transmitter to the GSM 900 base station receiver (BS-BS interference). This will occur when a CDMA-PAMR base station antenna is installed in close proximity to a GSM 900 base station antenna. If interference occurs, it will be continuous, and the performance of the GSM 900 base station will be permanently degraded.

CEPT SE7 has developed a draft report "Adjacent band compatibility between GSM and CDMA-PAMR at 915 MHz". Recent drafts of this report have considered two different criteria for protection of GSM; 4,8 dB desensitization and 0,3 dB desensitization, both of which are taken from the specification 3GPP TS 45.005. The 4,8 dB desensitization criterion appears to be based on the GSM specification for receiver blocking, whereas the 0,3 dB desensitization criterion appears to be based on the GSM specification for BTS intermodulation.

The scenario used in TS 45.005 for receiver blocking is MS at MCL to BS (see for example, clauses A.8.5.1 or B.3.2.1 of TS 45.005). This scenario has a low probability of occurrence. The scenario used for BTS intermodulation is much closer to the scenario for GSM/CDMA-PAMR compatibility.

E.1.2 GSM Performance assumptions

The compatibility studies undertaken by SE7 have assumed that the receiver sensitivity of affected GSM base station is the Reference Sensitivity, as defined in TS 100 910 [26]. The reference sensitivity is the minimum performance requirement for the base transceiver station, and not for the complete system. The analysis by SE7 has taken account of one system factor - feeder loss - which reduces the effect of interference. However, other factors that lead to an increase in interference have not been included in the analysis.

The reference sensitivity is the worst-case sensitivity of a GSM base station. There are several factors which lead to all GSM equipment having a performance that is better than the reference sensitivity:

1) The reference sensitivity must be met under all environmental conditions, frequencies and for all equipments, taking account of production tolerances.

2) The reference sensitivity must be met for all configurations of base station. The simpler and more common configurations tend to have a slightly better performance.

3) Mast-head receiver amplifiers may be installed on some sites to improve the system sensitivity.

For any cellsite that has a system performance better than the reference sensitivity defined in TS 100 910 [26], the degradation in performance due to out-of-band interference from CDMA-PAMR will be correspondingly greater. This is illustrated in figure F.1.1, in terms of loss of coverage for a cell that is coverage-limited.

Protection Limit, as defined by SE7	Cellsite characteristics	Desensitization	Loss of coverage (% of area lost)
4,8 dB	Reference sensitivity (example used by SE7)	4,8 dB	47 %
	3dB better than reference sensitivity (typical cell)	7,dB	60 %
0,3 dB	Reference sensitivity (example used by SE7)	0,3 dB	3,9 %
	3dB better than reference sensitivity (typical cell)	0,5 dB	6,6 %

Figure E.1.1: Reduction in coverage of a GSM cell due to interference from CDMA-PAMR

It is clear that the loss of coverage that would result from a protection limit of 4,8 dB would be unacceptable to customers of GSM networks. The protection limit of 0,3 dB would also result in a significant loss of coverage. This loss of coverage would be the result of emissions within the GSM band from a CDMA-PAMR base station into an already-installed GSM base station. It is therefore apparent that it would be necessary to coordinate the location of CDMA-PAMR and GSM base stations.

E.1.3 Feasibility of installing extra filters in GSM base stations

Co-existence studies have shown that, as the separation distances to avoid interference can be large, and in some circumstances can exceed 1 km, extra receiver filtering may be required by the other services to prevent interference.

It is not clear that it will be feasible to retro-fit filters into already-installed GSM base stations. Most GSM base stations are now highly integrated, and do not have the space, or the connection points, to install additional filters within the equipment cabinet. Under the R&TTE Directive, any RF components installed within the cabinet of the base station would need to be supplied by the vendor of the base station, in order to preserve the manufacturer's declaration of conformity. It is frequently not possible to fit a filter in the antenna feeder, especially if the base station uses a duplexer.

Annex F: Comments from ETSI Members

No.	Clause	Comment	Author	Supporters	Discussion
V14					
V15					
V16					
N20	B.2.2	In this clause add the tables 3.1.12-1 (Band Class 11 Block Frequency Correspondence and Band Subclasses) and 3.1.13-1 (Band Class 12 Block Frequency Correspondence and Band Subclasses) of [5]. Add the text: "There are six band subclasses specified for Band Class 11. Each band subclass corresponds to a specific block designator as specified in table 3.1.12-1. There are two band subclasses specified for Band Class 12. Each band subclass corresponds to a specific block designator as specified in table 3.1.13-1. Each band subclass includes all the channels designated for that block. Mobile stations supporting Band Class 11 (12) shall be capable of transmitting in at least one band subclass belonging to Band Class 11 (12). For mobiles capable of transmitting in more than one band subclass belonging to Band Class 11 (12), one band subclass shall be designated as the Primary Band Subclass, which is the band subclass used by the mobile's home system".	Ministry of Economic Affairs NL		NL: There is currently no description of band subclasses in the SRDoc. This is needed for table B.2.4. See comments below (#58) on table B.2.4. Please note that there is some inconsistency within the TIA standards. Tables 3.1.12-1 and 3.1.12-3 of [5] are more complete than tables with the same title (tables 2.1.1.1.12-1 and 2.1.1.1.12-3 respectively) of [7]. Additionally [7] says that "the band class 12 block designators for the mobile station and base station are not specified" while table 3.1.13-1 of [5] does specify them. Table 3.1.13-2 of [5] is more detailed than table 2.1.1.1.13-2 of [7].

No.	Clause	Comment	Author	Supporters	Discussion
N21	B.2.2	Add tables 3.1.12-3 and 3.1.13-2 of [5] to this clause. Add the text: "A mobile station supporting operation in Band Class 11 with Spreading Rate 1 shall support CDMA operations on the valid channel numbers shown in table 3.1.12-3 within its block designator. A mobile station supporting operation in Band Class 12 with Spreading Rate 1 shall support CDMA operations on the valid channel numbers shown in table 3.1.13.3 within its block designator".	Ministry of Economic Affairs NL		NL: There is currently no information in this SRDoc on the valid and not valid CDMA frequency assignments. This information is contained in tables 3.1.12-3 and 3.1.13-2 of [5].
N29	B.2.3.2	Change the title of table B.2.3 from "Unwanted emission limits for base stations" to "Band Class 11 and 12 Base Station Transmitter Spurious Emission Limits (table 4.4.1.2-6 of [4])".	Ministry of Economic Affairs NL		NL: This change will bring the text more in line with that in the title of table 4.4.1.2-6 of [4].
N31	B.2.3.2	Add the relevant lines of table 4.5.1.3.1-1 "Band Class 0, 2, 3, 5, 7, 9, 10, 11 and 12 Transmitter Spurious Emission Limits for Spreading Rate 1" of [5] before table B.2.4.	Ministry of Economic Affairs NL		NL: According to [5], "when transmitting in Band Class 0, 2, 3, 5, 7, 9, 10, 11 or 12 with Spreading Rate 1, the spurious emissions shall be less than all limits specified in table 4.5.1.3.1-1". The values given in table B.2-4 are additional limits for certain subclasses of the band classes. Not all frequencies covered in this SRDoc fall within those subclasses covered by table B.2.4.
N34	B.2.3.2	Change the title of table B.2.4 from "Unwanted emission limits for mobile stations" to "Additional Band Class 11 (subclass 4 and 5) and 12 (subclass 1) transmitter spurious emission limits for spreading rate 1".	Ministry of Economic Affairs NL		NL: To align the text with [5].
N35	B.2.3.2	Under tables B.2-4, 3.1.12-1 and 3.1.13-1 of [5], add the text "For the separation from the centre frequency ranges in table B.2.4, additional emission limits for Band Class 11 Subclasses 0, 1, 2, 3 and also Band Class 12 Subclass 0 are not specified".	Ministry of Economic Affairs NL		NL: In line with table 4.5.1.3.1-5 of [5].

No.	Clause	Comment	Author	Supporters	Discussion
M01	New annex	Insert new annex on expected compatibility issues with GSM. See liaison statement.	ETSI/MSG	Vodafone, Telefónica Móviles, Ministry of Economic Affairs NL	VF: It is appropriate for ETSI, as the European body responsible for GSM specifications, to make observations on the expected impact of CDMA-PAMR on GSM networks. NL: We would prefer to have this annex incorporated in the already existing annex C "Expected Compatibility Issues".
NO13	B 2.3.2	Modify as follows: 1st paragraph The permitted out of band energy for CDMA-1X systems used for PAMR applications in Band Classes 11 and 12 is shown in the tables below. Note that the requirements for CDMA-PAMR are more stringent than those previously designated for CDMA-1X for other Band Classes (except for Band Class 6, for which more stringent additional transmitter spurious emission limits of -98 dBm/100 kHz are formulated, in order to protect co-located GSM 900 BS receivers), and are consistent with the operation of other systems currently deployed in the European PAMR bands, however, not with systems according to 3GPP standards such as GSM and UMTS regarding protection of the GSM 900 uplink bands. **Paragraph after table B 2.3 modify as** For some situations it may be necessary that additional filtering is applied at the edges of the "block" of carriers that are being used (i.e. at the lower side of the lowest frequency channel and/or the upper side of the highest frequency channel). The required emission limits in such cases will depend upon the particular situation in question: CEPT PT SE7 has assumed in its CDMA-PAMR <-> GSM compatibility studies that the unwanted emission levels from the CDMA-PAMR BS are by 45 dB lower than mandated in table B.2.3 for Band Class 12, please refer to figure F.1.1: Add figure as attached in figure for B.2.3.2.	ANIE, Deutsche Telecom, E-Plus, France Telecom, KPN, mmO2, Nokia, Orange, Siemens AG, Siemens Mobile Communications, T-Mobile	Telefónica Móviles	

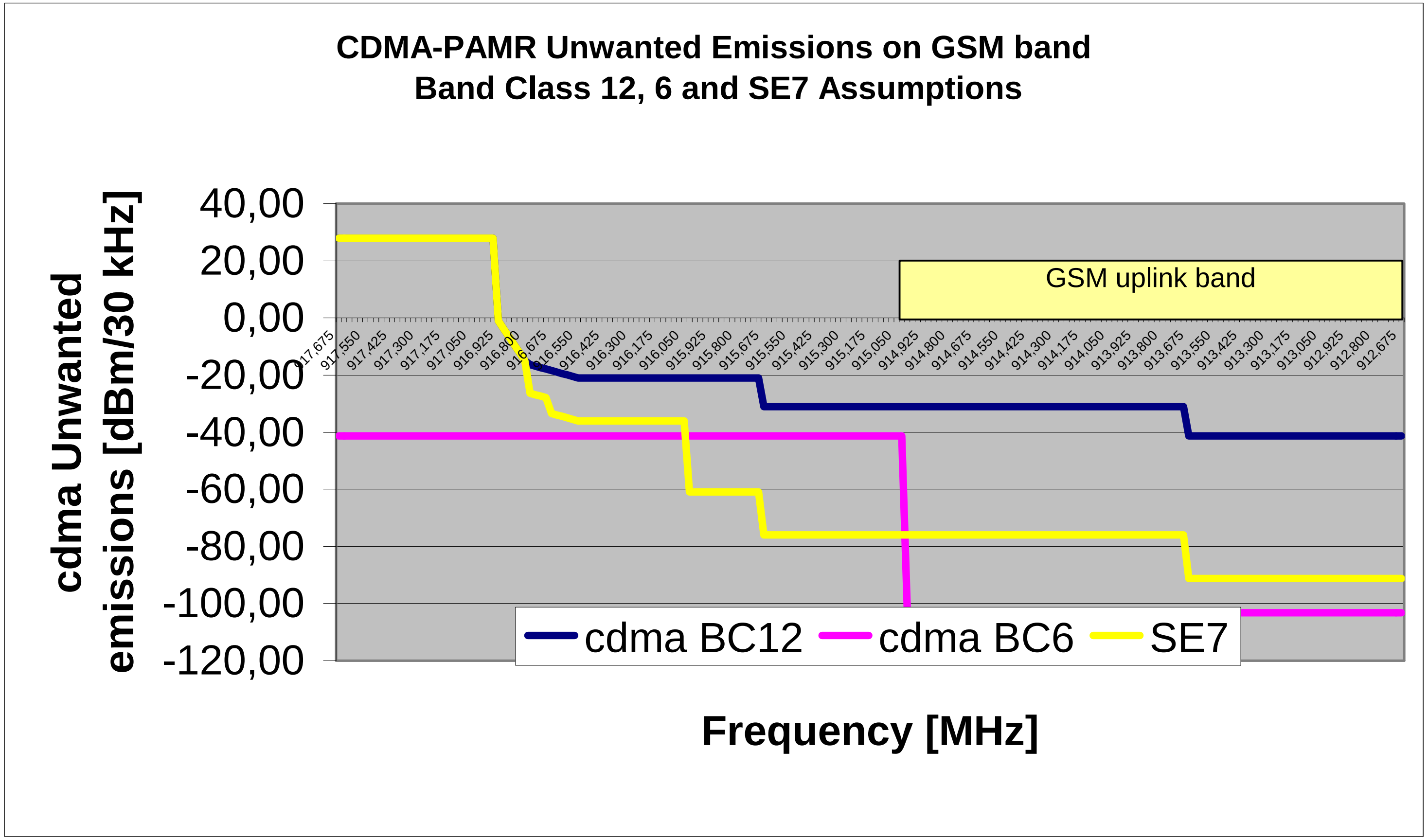

Figure F.1.1: CDMA-PAMR Unwanted Emissions on GSM band for Band Class 12, 6 and SE7 Assumptions

History

Document history		
V1.1.1	December 2003	Publication