Appendix A: V+D Mode

A.1 Logical Channels

The explanation given in Section 3.5 proves the importance of some logical channels. In fact, they turn out to be a crucial concept in TETRA. It is appropriate in this chapter to give a detailed explanation of how logical channels work and what their hierarchy is like. What it's not going to be detailed here, however, are the bits and headers of every single frame or the way logical channels interact with one another. After all, this is not a manual on TETRA, but rather a detailed discussion about its operation. For further information see again [7].

So, in order to understand the need of these logical channels it is necessary to go back to the OSI stack protocol in Figure 3.1. As far as we are concerned for the following reasoning, two things can be said about systems that meet the OSI model:

(a) the function of the second layer (the data link layer) is fundamentally to add coding in order to provide an error free link

(b) peer entities (e.g. both application layers) establish a link or connection between them in order not to break the stack protocol; that is to say, to make sure that each of the layers deal only with their own headers

However, in mobile radio dedicated communication these premises are not quite met; links between the layer 3 (network layer) peer entities do not exist. This implies that layer 2 must also provide some extra services, specifically control tasks. As a result, layer 2 is divided into two sub-layers: the Logical Link Control sub-layer (LLC) and the Medium Access Control sub-layer (MAC). The former interacts with layer 3 and provides reliable communication whereas the latter interacts with layer 1 (physical layer) and provides the necessary communication resources. Likewise, the MAC layer is divided into the upper and the lower MAC, as shown in Figure A.1, attempting once again to break down a complex task into smaller and simpler ones.

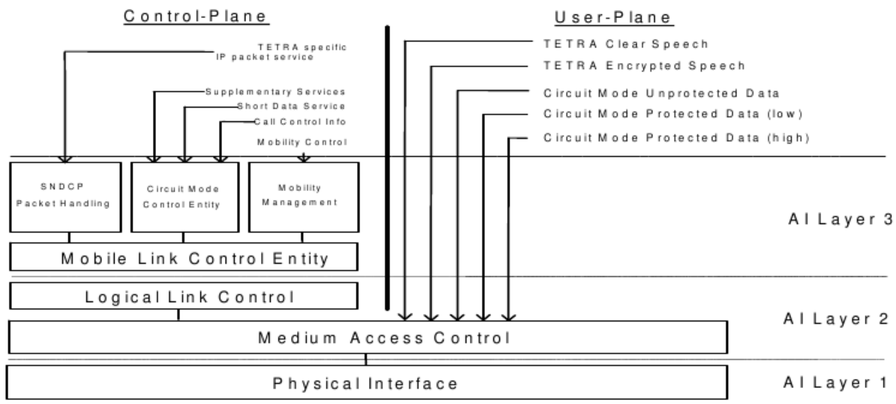

Figure A.1. Control plane and user plane division in the OSI model.

Note how layer 3 has been 'layered' too for equivalent reasons, something that within the current reasoning is of little interest and anyway beyond the scope of this project.

Once the subdivision of layer two is known, the question is how it communicates with both layer 1 and 3. In TETRA, communication between layers of the OSI model takes place via formalised interfaces known as Service Access Points (SAPs). This concept is illustrated in the next figure (Figure A.2), in which the functionalities of both the upper and the lower MAC are specified.

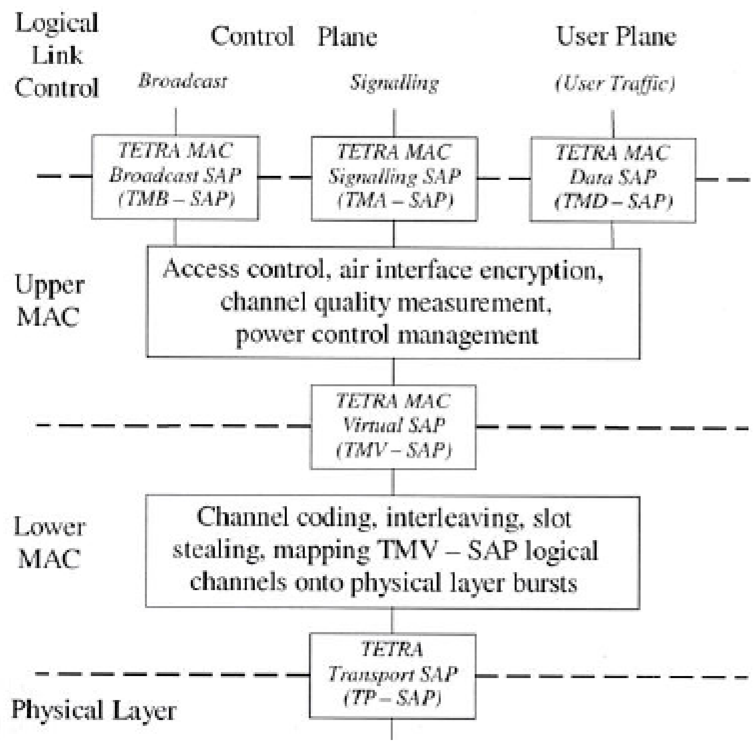

Figure A.2. Service access points (SAPs) in the TETRA OSI layered architecture.

Following the control and traffic channel separation previously mentioned, the protocol stack corresponding to the signalling traffic is usually known as the control plane (C-plane) and the corresponding to the user traffic is known as the user plane (U-plane). Information packets are passed to the MAC from the upper layers and the MAC also adds up its own information for peer to peer communication before sending then to the physical layer. There are three SAPs between the LLC and the upper MAC:

- C-Plane broadcast information, via the TMB-SAP (see Figure A.2) and destined for all mobiles[1].
- C-Plane signalling information, comprising two-way control information and packet data via the TMA-SAP, destined for specific mobiles.

[1] To all mobiles using the mode under study, the trunked mode. In other words, we're talking about base station - mobile communication. Direct mobile - mobile communication is therefore not included and belongs to the direct mode, that will be study in the next section.

- U-Plane user traffic comprising circuit mode voice and data plus end-to-end user signalling information, via the TMD-SAP.

So, each service access point, SAP, is provided with logical channels for transmission of information. Without looking at them in full detail, we will briefly introduce each of the logical channels employed.

- Broadcast Control CHannel (BCCH), passed via the upper MAC (TMB-SAP) from lower layers. The BCCH is a uni-directional channel (always downlink) that can be used by all mobiles with broadcast purposes. This logical channel is divided into two sub-channels called BNCH and BSCH, which will be later discussed when they come into play.

- Common Control CHannel (CCCH), passed via TMA-SAP from lower layers (see Figure A.2). This logical channel is bi-directional for transmitting/receiving control information between mobiles not actively engaged in a circuit mode call.

- Associated Control CHannel (ACCH), passed via TMA-SAP SAP too. ACCH is a bi-directional dedicated signalling channel associated with a channel which has been previously allocated for circuit mode traffic. Due to its importance, it'll be studied in a little more depth.

  In reality, the role played by this logical channel has already been studied; it just was not given a name. The ACCH is made up of three sub-channels: the Fast Associated Control CHannel (FACCH), the Slow Associated Control CHannel (SACCH) and the STealing CHannel (STCH). On the one hand, let's first say that the SACCH always uses slot 18. On the other hand, the FACCH uses traffic frames 1 to 17. Probably this rings a bell. As it was advanced a few paragraphs before, when a traffic channel is established some signalling is required before actually sending data.

  Note that this all might seem somewhat contradictory, but it's not. Wasn't it said before that they were used for traffic purposes? True, but that's only after all signalling exchanges have been made and established. In other words, when a mobile requests a connection and is first assigned a physical channel, the FACCH comes into play.

Once its signalling phase is completed, the assigned channel becomes a traffic channel (TCH) and is used for transferring data as we have already seen. At the end of the call (that is, when a end-call request is received) the channel reverts again to a FACCH to pass control signalling to the system. Therefore, TCH and FACCH can't exist at the same time and are mutually exclusive.

In addition, it's been stated that the SACCH always uses slot 18. But this slot is not exclusively used by the SACHH, for it can also carry signalling broadcast messages. The election is made by means of a flag, the Broadcast Block, transmitted on every single TETRA burst. As a matter of fact, this is the flag that indicates TETRA system whether a message is broadcast or not.

- Access Assignment CHannel (AACH), generated in the upper MAC and therefore not passed to the upper layers. It's a uni-directional channel (downlink only) that indicates access rights regarding control channels and also indicates the duties of the uplink and downlink slots on each physical channel.

- Common Linearisation CHannel (CLCH), which is also generated in the upper MAC, and is an opportunity for mobiles to linearise their transmitters. This means that it is used to adjust the shape of the signal. It can be seen as some type of regeneration process similar to the one carried out in repeaters. Since the technology is a 100% digital no noise is amplified. CLCH is an uplink channel shared by all mobiles.

- Traffic CHannel (TCH), passed from lower layers via TDM-SAP. As it was already advanced, this bi-directional channel for carrying user information (data) has different sub-channels defined depending on the application:

  - The Speech Traffic CHannel (TCH/S) carries digitalised voice information produced by TETRA voice codec, the Algebraic Code Excited Linear Predictive (ACEPL) at a rate of 4.56 kb/s. After the error protection stage, the rate is increased to 7.2 kb/s, exactly the full data rate of a user channel. Of course, that is not a chance result, but a deliberately conception to make data rates from different services match.

There are three different data rates depending on the amount of protection used. Each of these rates has its own traffic channel:

 - TCH/7.2, offering unprotected data at 7.2 kb/s net rate
 - TCH/4.8, offering low protected data at 4.8 kb/s net rate
 - TCH/2.4, offering high protected data at 2.4 kb/s net rate

 In order to obtain data rates up to 28.8 kb/s, 19.2 kb/s or 9.6 kb/s, a number of traffic physical channels may be allocated to the same communication. In order to achieve such rates, TETRA requires to allocate the traffic channels in consecutive slots on the same frequency. TETRA distinguishes the number of channels used by accommodating them with three different depths of interleaving (with N=1, 4 or 8)).

- Signalling CHannel (SCH), passed by the lower MAC to the physical layer via TP-SAP (see again Figure A.2). This channel is shared by all mobiles and there has to exist one, at least, in every base station.
- Main Control CHannel (MCCH), which is uni-directional (one for the uplink, one for the downlink). Its operation was already covered beforehand.

Other than those, there are more logical channels, but they all are sub-channels that belong to the previously mentioned and therefore not ultimately important to be aware of.

On a similar topic, we briefly mentioned how logical channels 'call' physical channels. However, we are not going to discuss here the mechanisms of how logical channels interact with the physical layer and, more importantly, how logical channels are 'accommodated' on the physical channels. This is known as the mapping of logical channels in TETRA.

A.2 Operation of the TETRA V+D mode

In this subsection some general concepts about the network under study will be discussed and therefore a more general point of view will be employed. The previous subsections in both chapter 3 and this appendix have covered how the system works at a low level, how logical channels play a vital role in the operation of TETRA and what type of services are offered. Now it's time for other important issues not addressed so far. For example, what about the location registers? In GSM, one of the first elements to be defined are both the Home and the Visitor Location Register (HLR and VLR, respectively). These are basically databases which contain information of the mobile phones operating in a certain coverage area, whether they are usual subscribers (contained in the HLR) or temporary subscribers (contained in the VLR). In either case, the aim is the same: storage handy user information such as account information, account status, user preferences, user's current location, etc.

These and other issues will be studied in this subsection. So, let's start on one of the ends of the entire system - the mobile terminal. In the V+D mode context, when a mobile is powered up, the first thing it needs to do is to establish some type of connection with the base station, process known as channel acquisition. But, since in this mode the TETRA network is in between any established communication, this means the MS first needs to 'talk' to the network (Fig. A.3).

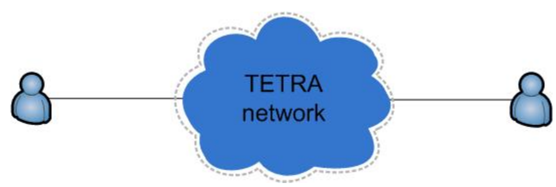

Figure A.3. Basic architecture of the trunked mode.

To start this communication process, there are two options: either a pre-established channel is contained within the MS memory or, otherwise, a search must be performed by the mobile to find a channel. Typically, the first alternative fits TETRA requirements best and so it is implemented by manufacturers, since when a channel is already established the delay is minimised.

Once the channel is established, the first step is to activate the mobile station (meaning to acknowledge the MS into the system, so that the MS is able to use the network[2]) is

[2] As a matter of fact, this whole process can be seen as a security mechanism, although it's not its original intent as there already exist a series of heavy security mechanisms in TETRA.

to acquire synchronisation before it can decode any of the messages broadcast by the base station. This is done by means of the SYNC burst (see downlink synchronisation burst in Figure A.4) which is broadcast by the TETRA network and sent over the Broadcast Synchronisation CHannel (BSCH). This burst is always transmitted in the first slot of the 18th frame of the Control Physical channel. Depending upon the circumstances, however, it can also use some of the slots of the 18th frames in the Traffic Physical channels, although we are not going to look into that.

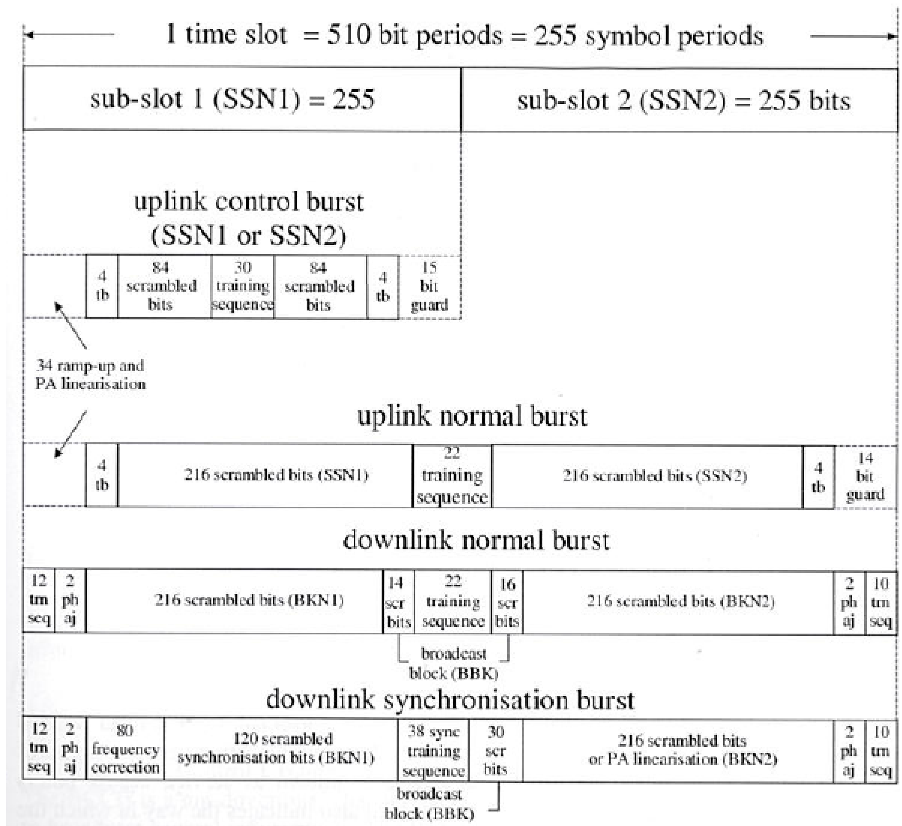

Figure A.4. TETRA burst types.

When synchronisation is achieved, the mobile then searches for the Broadcast Network CHannel (BNCH) on the current frequency and decodes information on the frequency of the main carrier, the number of Secondary Control CHannels (SCCH), power control information and some random access parameters.

Finally, once all this information is decoded, the mobile is able to decode the MCCH on slot 1 of the main carrier and the mobile is at this point potentially prepared to communicate with the system. A rough sum up of the steps involved in channel acquisition is given here:

1. The channel to be used for the first data exchange will be typically contained within the MS memory. If not, then a search to find a channel is performed by the MS[3]. In either case, this channel will be referred to as the pre-established channel.

2. The network sends a SYNC burst that contains synchronisation information. This burst is, of course, sent over the pre-established channel.

3. When synchronisation is achieved, the MS is capable of decoding the information that is sent by the TETRA network over the BNCH. The MS therefore searches for this channel and decodes this control information.

4. The MS decodes the MCCH on slot 1 and is ready to communicate with other mobiles by means of the trunked network.

The whole procedure just explained is automatically performed by the TETRA V+D system when the mobile is powered up, so that the only thing the user will notice will be a slight delay upon turning on the terminal.

The next paragraph explains how the system decides who can utilise the network.

Location Registration In a scenario where several base stations have been deployed, the coverage area is divided into a number of location areas known as cells[4]. For a MS to be paged within a particular location area, it must be first registered in that particular location area. Now, when a mobile needs to change its cell for any particular reason, say a cell change request or a call request, an implicit registration carry out by the network is performed provided that the request contains the identity of the mobile. This process

[3] This process is not commonly implemented anymore by manufacturers for delay reasons.

[4] In reality, some location areas may be composed of more than one cell, but as far as we are concerned here that's of little interest and thus skipped. Therefore, here the terms location area and cell will be synonyms.

is entirely carried out by the MAC sub-layer, starting with MS (MAC sub-layer) random access procedure to the BS.

Random Access Procedure When a mobile wishes to make contact with the system this is done by making a random access on a subslot of the MCCH. This is carried out by the slotted ALOHA access mechanism. The slotted ALOHA access is an improvement of the ALOHA mechanism that increases the maximum throughput that can be achieved. Simply put, the ALOHA protocol is an OSI layer 2 protocol for LAN networks with broadcast topology. A more well-known example of such a protocol is Ethernet, which is intended for wire-based topologies. All ALOHA protocols, however, are designed for wireless systems. There's a fully mathematical-based (statistical) explanation for slotted ALOHA, which basically sums up as follows:

- If you have data to send, you will have to wait until the beginning of the next time slot, reducing therefore the collision likelihood[5].

- If a collision occurs, the data is resent

ALOHA's operation is, in fact, not that different from the broadcast mechanisms used in Wi-Fi, and in terms of efficiency they are all about the same.

V+D call set-up procedure So far, the process that occurs when the mobile is powered up and how the mobile is identified into the system by means of a random access procedure has been studied. Notice how the random access is not a step, but rather a mechanism to achieve an aim (identifying the MS in this case). Now, the next question is: once he mobile is able to make use of the TETRA system, what occurs when a mobile makes a call? This procedure is known as call set-up, and this section will cover the sequence of events for individual (as opposed to group) call set-up. Figure A.5 illustrates this process.

[5] In normal or pure ALOHA the data can be sent anytime, and thus the probability is 'less controlled'. The factor in which this probability is reduced will depend on the period of time between time slots. See [19] and for further information.

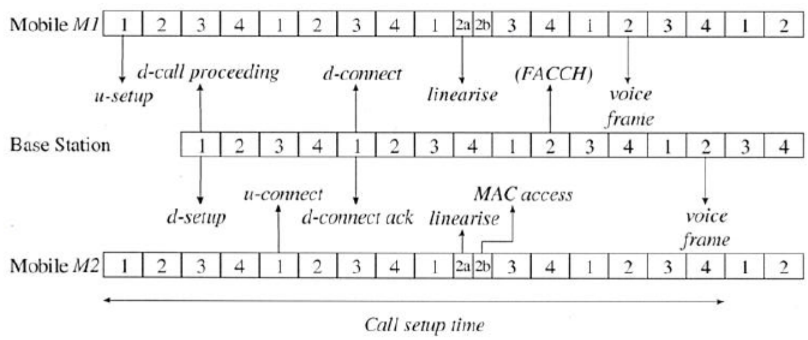

Figure A.5. Call set-up procedure.

The message sequence is started by the calling mobile M1 making a random access (known as *u-setup*) in slot 1. This message is sent in a single burst and is enough to establish the service. The slotted ALOHA procedure is in charge of resending this message if necessary (that is, in case of collision) as it's been explained beforehand. When the message gets to the base station an ACK message is sent back to the MS (*d-call proceeding*) and, at the same time, the BS pages the called mobile M2 with a message (*d-setup*) in its next slot 1. Once it's got the message, the M2 responds with a *u-connect* message in the subsequent slot 1. When the BS receives this message it assigns the calling mobile a channel using the *d-connect* message and the called mobile using the *d-connect ACK message* (see figure).

The rest of the figure (from linearise message onwards) shows how the rest of the procedure would develop and how first the signalling channel is established by means of the FACCH. This is just a graphical representation of what it was already covered in section 1.5.1 (see the ACCH paragraph).

The call set up time is defined as the time between the initial access request (u-setup) sent by the calling mobile (M1) and the first voice frame received to the called mobile (M2). In ideal conditions this time is about 230 ms, but it might be longer if several attempts are required due to propagation conditions. TETRA standard specifies a maximum call set-up of 300 ms.

Voice coding in TETRA The last important issue is the voice codec. Certainly, the speech needs to be digitalised at some point. Since TETRA is a fully digital system, this takes place in the mobile terminal (otherwise the analogue voice would need to be sent and thus the system would not be fully digital). The voice codec used is called ACELP. ACELP stands for Algebraic Code Excited Liner Predictive Coding. It is of no interest for this project to go into detail on how the coding process works, but rather look at it as a 'black box' whose input is analogue voice and the output a stream of digitalised voice (Fig. A.6).

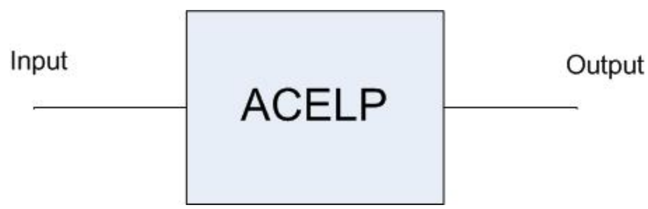

Figure A.6. Voice coding model.

1. INPUT. The input is human voice.
2. OUTPUT. The ACELP process implemented in TETRA produces 137 bits per 30 ms of speech:

$$173bits/30ms = 4,566.766666...kb/s \sim 4.567kb/s$$

Channel coding is added to these bits to produce 216 bits per 30 ms, which produces a bit rate of:

$$216bits/30ms = 7.2kb/s$$

Which is exactly the data rate of a single user channel. Of course, this is not a coincidence and ETSI designed the voice codec this way to ensure maximum compatibility and to avoid further 'patches' for the data rates to match.

A.3 Recap of the trunked mode

To help clarify all the important points explained in this section, they have been summarised here[6].

- TETRA is a cellular system, which means that a base station with an antenna provides coverage to a certain area. Figure A.7 represents an ideal case where all cells are hexagonal. In reality, cells have an asymmetrical, awkward shapes in order to adapt to the environment and achieve maximum efficiency.

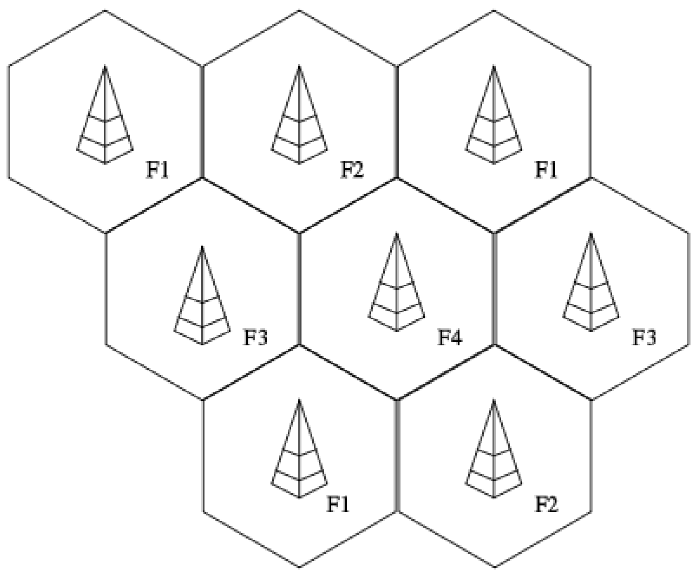

Figure A.7. Diagram of a cellular system.

- When a mobile terminal is powered up, it automatically establishes a connection with the base station in which it is located. This is totally transparent to users.

- When a mobile terminal requires some service from the network (e.g. a voice call), the network allocates a traffic channel (TCH) for the duration of the call, irrespective of whether that source is active or not. In other words, the traffic channel will always be saved no matter what occurs, taking up a piece of bandwidth (a specific time slot

[6] Recall the many terms to refer to this mode: circuit mode, trunked mode and Voice plus Data (V+D) mode are exactly the same thing.

in a carrier frequency). Prior to this, however, the call set-up procedure takes place, within a time lower than 300 ms.

- The allocated TCH is associated to a physical channel, which is nothing more than a time slot inside its corresponding carrier frequency (recall there are four time slots per carrier). Note that there are two different types of physical channels in TETRA: Control Physical channels (CP) and Traffic Physical channels (TP). All logical channels are mapped, when necessary, onto either the CP or the TP channels in the physical layer, depending if the data to be sent is data information or signalling information of the system.

- Each carrier provides four physical channels, one physical channel and three traffic channels. How so? By means of TDMA, which divides the 56.67 ms time frame into four different 14.167 ms time slots.

- Each TDMA frame (56.67 ms) is repeated 18 times in order to produce a multiframe of duration 1.02 s. We have already seen that some of these slots are used for information data and some other for signalling purposes.

- Likewise, the multiframe is repeated 60 times in order to produce a hyperframe of duration 61.2 s. These hyperframe is used by the upper layers for encryption and synchronisation purposes.

Now, on top of the carriers allocated for sending information data, once there's one terminal working inside the coverage area of a base station, some compulsory control channels are established:

- One pair of carriers per cell (up and downlink) are designated to carry the main control channel, called MCCH.

- In V+D mode, the MCCH is always present in slot 1 of every frame (see Fig. 5). The entire set of 'slots 1' make up what we have called the Control Physical channel (CP).

- Accordingly, the other 3 slots, used for traffic, represent the Traffic Physical channels (TP).

- Besides, in traffic channels, the 18th slot of a TETRA multiframe is used for signalling purposes which very slightly reduces the effective data rate, resulting in a 17:18 data ratio.

Concerning the special features provided by the V+D mode and that make this mode different from other public digital mobile radio systems, we can point out the following:

- Four types of calls are supported: individual, group, acknowledge group and broadcast.
- Multiple data rates can be supported over the air interface, with a maximum (unprotected) data rate of 28.8 kb/s.
- Transmitter pre-emption is supported in the V+D mode. MSs must continuously monitor the downlink AACH to check that transmit permission has been granted in the next uplink slot. This speeds up the re-assignment of the radio resources.
- Handover. MSs can decide to utilise an alternate cell if they detect better signal quality.
- Different simultaneous access priorities are supported by the V+D mode.
- High quality speech transmission at a gross net rate of 4.56 kb/s, and 7.2 kb/s after coding.

Appendix B: TETRA Direct Mode Operation

B.1 The Direct Mode Channel

The discussion and conclusions reached in section Section A.1 to justify the need of logical channels are completely valid here in the direct mode. The only differences are the name of the channels used along with some other details to solve the lack of a centralised network.

First of all, in this mode the DMO channels are programmed into mobile terminals, so that to start using the service the user has to select one of these channels for communication. From this point on, there are two ways to set up an individual call:

1. Two terminals have selected the same DM channel (e.g. they agreed to do it in advance somehow). Both parties tune in the same channel and by pressing the DM button can start a conversation, just as though they were using walkie-talkies. The calling mobile can perform a presence check on the called mobile within its coverage area. The transmission will start if a positive indication of presence is received, i.e. if the mobile is within the coverage area.

2. A mobile starts transmission without checking for the availability of the called mobile. This is the default method and is known as basic mode.

Coverage Since the trunked network is not involved in DMO conversations, group calls become more complicated, specially when it comes to synchronisation between mobiles.

To overcome the problem, when a channel is active (i.e. is being used) in a group call or individual call, one of the mobile stations acts as master and provides synchronisation by using Direct Mode Synchonisation Bursts (DSB) in frames 1 to 17. In DMO, there are only three possible bursts as shown in Fig. B.1.

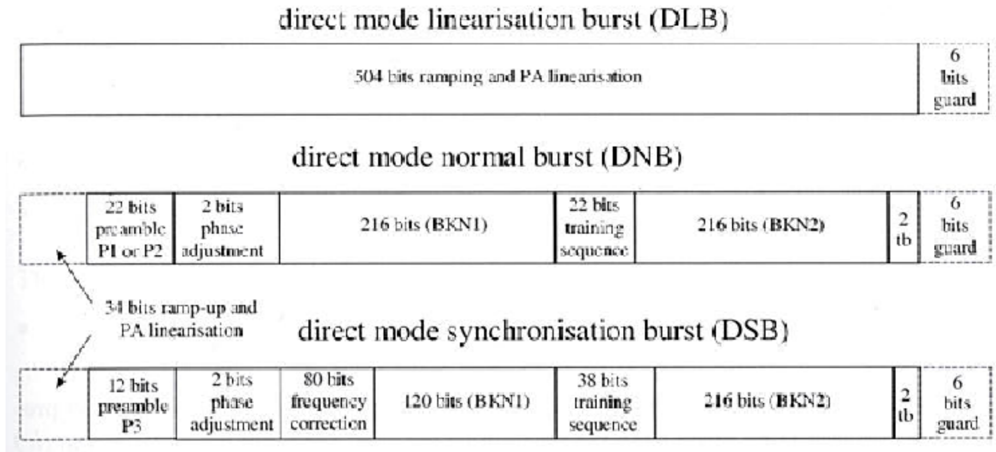

Figure B.1. Direct mode bursts.

B.2 Call set-up in Direct Mode

The main characteristics of the frame structure in the direct mode have been drawn up here:

- frame 18 is always used for synchronisation purposes and carries a DSB in both slots 1 and 3;
- frame 6 and 12 carry reservation information in a DSB in both slots 1 and 3;
- pre-emption[7] is permitted in slot 3 of frames 2, 5, 8, 11, 14 and 17;
- linearisation may be permitted by means of a Direct mode Linearisation Burst (DLB) in slot 3 of frame 3, during a call;

[7] In computing, pre-emption is the act of temporarily interrupting a task being carried out by a computer system, without requiring its cooperation, and with the intention of resuming the task at a later time. In TETRA it serves as a prioritising mechanism.

- frames 1 to 17 usually carry traffic in slot 1 in a DNB, during a call.

There are two different call set-up procedures: basic mode and presence check.

1. In the basic mode once a user selects a channel, the first thing the calling mobile check is the availability of the channel, i.e. whether the channel is occupied or not. This is done by checking the presence of synchronisation bursts in slot 3 of frames 6, 12 and 18. If the channel is occupied the mobile will refuse the procedure. If it's available, the mobile will linearise its transmitter (see CLCH in section 1.5.1) and then establish channel synchronisation and its role master by transmitting a sequence of synchronisation bursts using the DBS.

2. The call set-up procedure with presence check is very similar to the previous. The synchronisation bursts in this case contain a parameter which requests a response from the mobile which has been addressed as the recipient of the call. For the duration of this transaction the receiver is defined as slave and has to respond with an ACK to indicate that it agrees to accept the call. When the calling mobile (the master) receives this ACK it answers with its own ACK message and right after starts transmission.

Appendix C: Asterisk configuration files

The Asterisk configuration files are presented here. All files have the .conf extension. The ';' symbol at the beginning of a line means that that line has been commented out.

C.1 extensions.conf

```
; 2xxx : IP Telefone
; 4xxx : Rausrufen Sat
; 6xxx : Konferen
; 8xxx : Mobiltelefone (intern)
; 1xxx : Alternative mobiles (only to be used when 8xxx are not available)

[default]
include => for_everyone

; Make calls to TETRA terminals
exten => _1000X,1,Dial(SIP/${EXTEN}@tetra1)

; Make calls to GSM terminals
exten => _80XX,1,Dial(SIP/${EXTEN})

; Make calls to alternative GSM terminals 1xxx
exten => _10XX,1,Dial(SIP/${EXTEN})

; Lokale SIP-Telefonie zwischen IP Telefonen
exten => 2000,1,Dial(SIP/2000)
exten => 2001,1,Dial(SIP/2001)
exten => 2002,1,Dial(SIP/2002)
```

```
; Conference numbers. This is the begining of the configuration of the
; conference numbers, although tests dealing with this were not finally carried out
exten => 601,1,Answer()
exten => 601,n,MeetMe(600,asc,110112)

; Konferenzbeitritt als Normalo
exten => 600,1,Answer()
exten => 600,n,MeetMe(600,c,110112)

[for_everyone]

; Konferenzbeitritt mit PIN-Eingabe
exten => 602,1,Answer()
exten => 602,n,MeetMe(600,c)

; Service that states number of people conferencing
exten => 605,1,Playback(conf-thereare)
exten => 605,n,MeetMeCount(600)
exten => 605,n,Playback(conf-peopleinconf)



exten => 623,1,Answer()
exten => 623,n,Set(TIMEOUT(digit)=6)
exten => 623,n,Background(vm-enter-num-to-call)
exten => 623,n,WaitExten()
;exten => 623,n,Background(vm-dialout) ; einen Moment, ich verbinde...

; wenn eine falsche Nummer eingegeben wird
exten => i,1,Playback(pbx-invalid)
exten => i,n,Goto(default,623,1)

; wenn nix klappt
exten => t,1,Playback(vm-goodbye)
exten => t,n,Hangup()

; Play hello world at 6001
exten => 6001,1,Answer()
exten => 6001,2,Playback(hello-world)
exten => 6001,n,Playback(hello-world)
exten => 6001,n,Playback(hello-world)
exten => 6001,n,Hangup()
```

```
[incoming_calls]
; include => for_everyone
; incoming calls for number 1 or number 21
;exten => 1,1,Dial(SIP/10001@2000)
;exten => 1,1,Macro(incoming,623)
exten => 1,1,Goto(for_everyone,623,1)
```

C.2 meetme.conf

```
[rooms]
conf => 600,110112 ; room=600, pw=110112
```

C.3 modules.conf

```
;
; Asterisk configuration file
;
; Module Loader configuration file
;

[modules]
autoload=yes
;
; Any modules that need to be loaded before the Asterisk core has been
; initialized (just after the logger has been initialized) can be loaded
; using 'preload'. This will frequently be needed if you wish to map all
; module configuration files into Realtime storage, since the Realtime
; driver will need to be loaded before the modules using those configuration
; files are initialized.
;
; An example of loading ODBC support would be:
;preload => res_odbc.so
;preload => res_config_odbc.so
;
; Uncomment the following if you wish to use the Speech Recognition API
;preload => res_speech.so
```

```
;
; If you want, load the GTK console right away.
;
noload => pbx_gtkconsole.so
;load => pbx_gtkconsole.so
;
load => res_musiconhold.so
;
; Load one of: chan_oss, alsa, or console (portaudio).
; By default, load chan_oss only (automatically).
;
noload => chan_alsa.so
;noload => chan_oss.so
noload => chan_console.so
;
; CS deactivate MGCP
noload => chan_mgcp.so
```

C.4 sip.conf

```
[general]
language=en
t38pt_udptl = yes ;enable faxing
rtptimeout=15 ; after 15 seconds without RTP, hang up
register => user_ID:password@sipgate.de:5060/1
;qualify=5000
timert1=2500 ; default round trip time
timerb=5000 ; auto-congest after timerb in ms
nat=yes
;dtmfmode = info
dtmfmode=rfc2833
relaxdtmf=yes

[provider1]
type=friend
host=sipgate.de
username=user_ID
secret=password
```

```
fromdomain=sipgate.de
fromuser=user_ID
context=incoming_calls
disallow=all
;allow=ulaw
allow=g729
insecure=invite
canreinvite=no
qualify=5000

[mobiles](!)
; wir pollen interne Mobiltelefon-SIP-Accounts, um zu sehen, ob sie noch da sind
qualify=1500
context=default
type=friend
host=dynamic
secret=AsTeRi000
disallow=all
allow=ulaw

; the issuing of reinvites can cause buggy hardware to die
;canreinvite=no

; The TETRA base station
[tetra1]
context=default
type=friend
secret=TETRA_BTS_password
host=dynamic
qualify=yes
disallow=all
allow=alaw

; some SIP clients
[2000]
context=default
type=friend
secret=1234
host=dynamic
qualify=yes

[2001]
```

```
type=friend
secret=1234
host=dynamic

[2002]
type=friend
secret=1234
host=dynamic

; The mobiles
[8007](mobiles)
[8008](mobiles)
[8009](mobiles)
[1001](mobiles)
[1002](mobiles)
[1004](mobiles)
[1005](mobiles)
```

****