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# CHAPTER 6

## 6.1 Introduction

In Part 1, "Disaster Comunications-Global" ( required reading) we have discussed the problems facing a disaster or aid team wishing to communicate with their office back in their home country. In this part we will turn to the problems of communications with and between members of the same team or group of teams in an area of about 100KM or so around a given point. So how complicated can that be? Well, it can be very simple if you wish, but also there are some cases where a more complicated set-up is justified.

I will try to mention just about every practical system we at DRCF have ever heard of. Just because we mention (or don't mention) a system, **this is not an endorsement of the idea**. We merely acquaint you with the facts and leave you to decide what you think is best for you. Reading this won't make you an expert, but it will help you and your experts to come to a better understanding

The Disaster Relief Communications Foundation (**DRCF**) is a Non Governmental Organisation (NGO), a small registered charity, and we admit that our resources are limited. However we do try most conscientiously to make sure that what we say is generally agreed to be true, or at least valid opinion, by experts in the relevant fields. However if you know of something better that we do, we most sincerely welcome input, for future revisions of the book.

### 6.2.1 For field telephones

Field telephones are ruggedised telephones often designed to be left outdoors during use. Before you roll your eyes upward and 'tut' at this section consider something. No lesser organisations than the BBC, and most armies of the world still use field telephone systems in 1996 though they could easily afford radio systems. To see why, let's look at what a field telephone system is and what its advantages over, say walkie-talkies are.

An ordinary telephone system relies on power from a central switchboard or Private Automatic Exchange (PAX). This scheme is called the central battery system. (CB).The problem is that if you lose the power to your switchboard, you lose all of the phones. For this reason, though the BBC has PAX telephones laid out in, for example, a commentary box at an Outside Broadcast (OB) they do not totally trust to this system. Engineers would find that when they needed it most, when some kind of problem occurs, it would let them down.

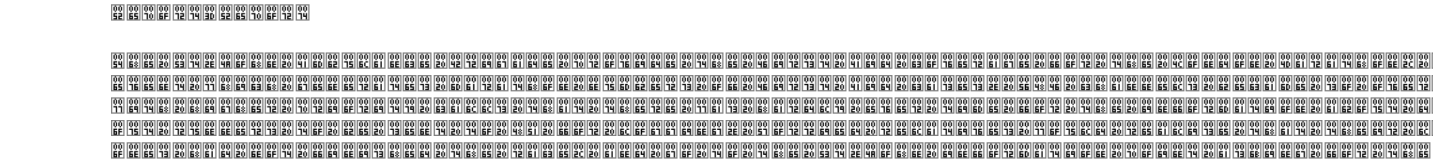
An alternative system is called the Local Battery system (LB). Incidentally this was the type of telephone first used by the Edison Bell telephone system in 1876 or so. They are usually distinguished by a rather comical looking crank handle sticking out of the front or side. This handle is called the Magneto handle, so the system is sometimes also called the Magneto system, though more modern designs are electronic and have a button marked 'call' or 'ring'. When the crank is turned (or the button pressed) the bell on the other phone rings.

The phones are connected up by wires. Just about any wire in existence is suitable, field telephones are not fussy. Large reels of Jumper wire or field telephone wire are very cheap, you can even use wire fences and an earth return . The phones are totally self contained, they don't need power or any kind of control system from anything else. This makes them very reliable indeed. To power the microphone in the telephone, there is a built in 3v battery called the polarising battery. The very good news it that this battery can be just about any disposable battery you can buy from anywhere, such as a bicycle or torch battery, it is not special in any way and even the voltage is not critical. They are switched on either when the phone is lifted off the hook, or by pressing a button on the handset labelled 'press to talk'.

How long do the batteries last? Well that depends, but as a guide, I have a collection of field telephones at home. My two boys age 5 and 3 play with them, and rather roughly. Not only have they never been able to break them, but the batteries have to be changed only about once per year, and only then because of ageing. I have one phone which had the same battery in for 3 years, and still worked perfectly straight from storage when it was needed.

Field telephones are tough and totally reliable. You will never loose sleep over charging up the batteries every 8 hours as with a walkie talkie. In any case, you may not trust your generator or mains supply enough to be sure that there will be power to charge your radios, whereas the field telephone batteries will work even when nearly totally flat, so they won't let you down without warning. They are also immune from interference and channel overloading, which often dog 'walkie talkies'. Privacy is enhanced because listening in would involve line tapping which is much more trouble to do without being caught. This deters the casual listener who may be allocated the same channel, or the person with a scanner.

Walkie talkies have the problem that if put behind or inside a building or in a dip in the terrain, they will not work. Furthermore, you may not get any warning of this until you try and it doesn't work. Whereas field telephones will work anywhere that you can get a cable to. The range of field telephones is rather academic, but over 100km is possible. The limiting factor will be how much cable you can bring to the site and have time to 'string up'.



Field telephones can be readily and cheaply purchased from Army surplus or via magazines for about one tenth of the cost of a walkie talkie. They are also simpler in that you will not need a licence for them as they don't use a radio channel, neither do the operators need licences.

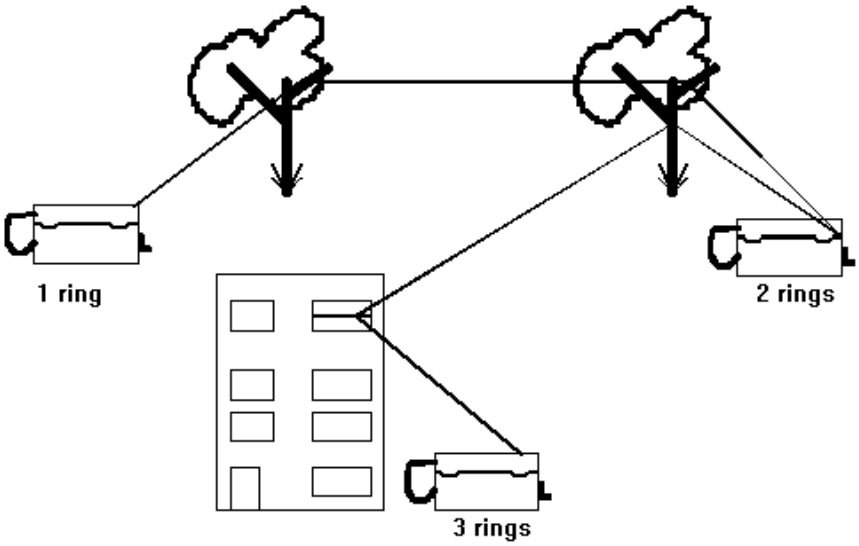



*Fig 17 Field telephone systems lend themselves to improvised cabling schemes*

### 6.2.2 Against field telephones

With all these selling points, why does everyone buy Walkie-talkies? The reason is , wires. The cost of wire of the type needed is actually very little - that is not the problem, the problem is the laborious task of stringing out the wires, a process called 'cabling'. This process does take some hours so it is unsuitable for anyone constantly on the move.

Here we need to make a clear distinction between the cabling techniques, each has its own style.

- Temporary cabling.
- Semi-Permanet cabling.
- Permanent cabling.

Temporary cabling is what your first response will be. This means getting the cable from A to B with the least effort, therefore the least time spent of rigging up. I can lay and fix one reel of line (about 500m) in about half an hour in this way. Sometimes you may just lay the wires on the ground, if out of the way of footpaths and roads, and then use handy trees or buildings as makeshift telegraph poles when a road crossing is required.

Inside buildings, the wire can be fed into a window and then loosely tied to light fittings or taped to corners until a suitable position for the phone is reached. The reliability of the link now depends on keeping the line out of harm's way, so this is where imaginative improvising comes in. The line will probably be broken a few times while the best route is found, but the lines can be rejointed without any special tools if this is the case.

If you do this in an urban environment, you must remember to look out for adjacent power cables and never cable over them, always well under. This is so that if your cable comes undone at one of the verandas you tied it to, it will go slack and not touch the power cable, maybe electrocuting the person using the phone.

Despite being in a rush, you must take care to tie the line securely over paths and roads to avoid trip or strangulation hazards. On the other hand, you would want to use few enough knots that when the operation is over, or if the phone's position is to be changed, you can quickly reach and undo all the knots you tied, allowing the cable to be easily reeled in without damage and re-used. Recovering a reel of cable takes about half an hour.

Sooner or later someone is going to complain about the scruffy wiring and the fact that they can't close the windows or doors properly. Then you will have to smarten things up with a semi-permanent scheme. This means tidying up the wiring by clipping or taping it to the skirting board or door frames of the rooms. You may have to drill a small hole in the door frames and window frames to let the cable pass through unseen and let the doors close properly. All of this will take much more time, about 1 or 2 hours per 100 m. You would do this when the line is established and the panic is over, (unless there was not immediate panic in the first place), in which case you should do a neat job the first time.

By the time the installation becomes semi-permanent and if the line has to cross someone else's property, the owner will soon complain if your wiring over or past his place is scruffy. Worst of all, when the immediate crisis is over, the local officials may complain about the wiring crossing public land and in particular public roads, (on the other hand, seeing the state of some overhead wiring in urban areas, no one may notice

unless you are really bad). If things have got to the stage that the locals can worry about such things, then probably you can go home anyway, but if you are in for a longer term commitment, then you can't expect to do this for very long, and therefore field telephones will be best used on your own camp, building, area of responsibility or compound.

In many cases, where law and order has broken down, wire may be very valuable and so will be cut down and stolen for the copper. Even if the wire is not copper, they will cut it down and strip it to find out. This is a major problem in Africa for instance. Another problem is that in some countries, the government has a monopoly of communications of all sorts and so you will meet zealous opposition to unauthorised wires crossing public land.

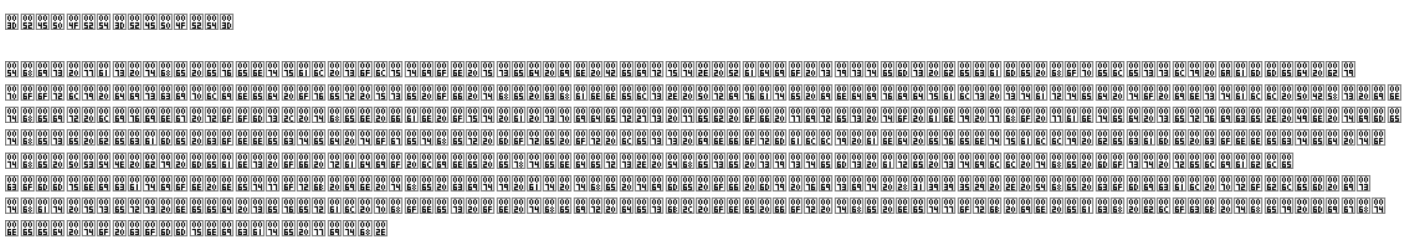
### 6.2.3 Private Wires

If your installation is becoming more permanent, there is something else you may find worth while, a **Private wire**. If there is a telephone system in the town and if it is working, you should naturally use the phone to call the other offices that you need to contact. If the local phone system is not working or is not reliable, or the waiting time for connection is very long, you can make a special arrangement. In a 'private wire' scheme, one of the telephone lines around the area which would normally be connected to the local exchange, are diverted between the points you specify. If there is spare local cable capacity, then this is very easy and quick for the local engineers to do ( the work will take about 2 hours once the administration is out of the way). You can now connect your LB phones to the wire and you have your own private hot line from point to point. Your system will work even if the local exchange has failed, and of course the line can never be blocked or busy.

Another good reason may be economy. Most companies charge for Private wires on the basis of distance from point to point, a fixed charge per quarter. If you make more than say four calls to a nearby place per day, you may find it much cheaper to install a private wire and LB phones, a sort of 'Hot Line'. You can talk all you want now, it won't cost any more than the fixed cost of renting the line.

### 6.2.4 PAX and PBX systems

These are private telephone exchanges. A Private Automatic eXchange (PAX) means that you can dial any phone wired up to the exchange, but not make calls to any phone outside of your system. A Private Automatic Branch eXchange (PABX or PBX) gives the same service as a PAX, but in addition also gives access to the PSTN. The advantage of a PBX is convenience. Everyone instinctively knows how to use a phone, so no training is needed for the users. The only major problem is typing out a good directory and keeping it up to date, and the laborious cabling needed.



You don't have to connect a PBX up to a PSTN line, but if you do then this will give access to PSTN by any phone on the network. If no PSTN lines exist in the area then you have the option of providing one by satellite service, such as Vsat, INMARSAT, or by a radio line extender. This means greater convenience as users can share this resource without going to the terminal, which can then be placed in a good position. Of course this will not improve the reliability of the PSTN line, but perhaps you can 'leap frog' a broken Exchange and connect to a line which is working better this way. HF radio Phone patches can also be arranged, but a radio operator would have to operate the radio, and a special phone patch system needs to be installed on one of the extensions. This is the system adopted on ships, for example.

Against PBXs, they depend on reliable power to the exchange. If your exchange power fails, or the exchange fails, you will lose all of the phones until service is restored. You will also have the same problems as with field telephones, namely that you need to carry out cabling to each and every phone separately. In fact the situation is worse than with Magneto phones because you cannot 'daisy chain' on phone from another. You have to provide a separate line to each phone.

PBXs vary in size and weight. DRCF has a 10 line PAX which is shoe box sized and weighs 5KG, but some designs are quite large and heavy. Older electro-mechanical designs are heavier but use no power at all when on standby, electronic ones use the same power whether idle or in use. It is unusual to find a design intended for portable use. The laboriousness of installation and the non-agility of PBXs means that they are best suited to longer term and shorter range applications rather than fast response disaster communications. It will take about half a day to install 10 lines, and when you move on, it will take half a day to dismantle the system.

### 6.2.5 Cordless PBXs

Cordless PBXs are like a small scale private Cellular Phone system. In addition to having wired extensions, there are also small, shoe box sized 'base stations' for mounting on the wall inside or your building. The user uses special phones looking like cellular phones. There are many versions of this, such as the international standard Digital European Cordless Telephone (DECT) system. The advantage is that because cabling is much simpler, set up speed is much quicker. Also the users have the advantage of total freedom within the coverage area of the system. My employers use such a system at our office and I wouldn't go back to being chained to my desk again at any price.

In fact the theoretical range is around 500M, but experience shows that 300M is the best practical range provided base station site is good

enough (which is the critical factor). To cover a large area may require the installation of many base stations. One per floor per building is recommended.

Against them is the old problem of getting permission to use the frequencies .The DECT system is unlikely to be affected by another service, it is self-organising, but it would effect another existing service on the same frequency. Also they are more expensive than the wired line alternative, certainly much more expensive than a VHF simplex radio system. If money is no problem, go for this, but if it is then you have a hard task to justify it over 'walkie talkies'.

## 6.3 'Walkie-Talkies

The term 'Walkie Talkie' is a trademark of the Motorola Corporation. Around the late fifties very physically small valves were devised for fighter aircraft, to the point where a radio transceiver could be fitted into a box small enough to be carried in the hand. This was in contrast to earlier designs which were microwave oven sized, and had another ammo box for the batteries. To make them a bit more user friendly, they cleverly designed them with cups at the ear and mouth position so that they would automatically be used like a telephone handset. They first saw use in the Korean war and then later in the Vietnam war, when 'grunts' would direct helicopter gunships to their positions with them.

Today, as with the term 'Walkman', or 'PC', which are really trademarks, 'Walkie-talkie' has come to mean a hand held two way radio system. This history shows why experts curl their lips up when you say walkie talkie, and prefer one of several alternative names. Englishmen in particular hate to use the term, it sounds like baby talk to their ears and you can see them visibly shudder when they hear the words.

Here are some preferred names that you will hear in conversation to refer to walkie talkies, and an explanation of where they have come from and what they mean.

**R/T or R/T set.** This stands for Radio Telephone. This term was invented to distinguish this from a Wireless Telegraph (by morse code) in the 1920's, when valves were invented and this made modulation practical. In Regulations and laws, this is still what your set is called. In fact your signals may be called' emissions by radio telephony' in your licence. Today this term is completely obsolete because of the Public Land Mobile Network (PLMN) better known as the Cellular Phone system or Mobile Phone system. Today the makers of very small cellular phones make their terminals look like telephones and indeed act just like them too. This is to help users to identify with the concept , thus boost sales. You can see there is plenty of scope for confusion with the term Radio Telephone, that is why it is avoided these days (except by legislators).

**Two-way radio**. To many, the term 'radio' means a wooden box with ornate fretwork standing in a commanding position on grandads dressing table. This is actually a broadcast receiver. The word 'broadcast' is borrowed from a farming technique, where a farmer would sew a field by walking casually around it with a sack of seeds in his hand, and literally throw handfuls at random. This was of course very inefficient and has been replaced by seed drilling. Radio programmes from such organisations as the BBC are figuratively just cast out from the transmitter, to land any which way they will, with no attempt to control the reception at all.

Today, the meaning of Broadcasting in law is that a signal is sent over an area without controlling the receivers. There are special frequencies and laws covering Broadcasting, so be very careful never to say that you are 'Broadcasting' from your station, or the result could be an angry visit from a government inspector wishing to close you down. Two way radio is an unofficial but highly effective term by which laymen will not visualise Broadcasting.

**P.R.set,** Stands for Personal radio set. This is a Police term because an individual radio is issued to an individual PC for his care ( and he is answerable ). Many people from a services or Private radio background use this term.

**Portable radio.** This means it is designed to be used while carried in the hand. In contrast to this term, a **Transportable** radio means one which can be carried from place to place, because it has handles on it and an internal battery, but is designed to be placed on the table when in use. You may wonder why anyone would do that if they had a portable set, but all will be explained later. One thing to watch out for is that in law, there is no distinction between portable and transportable, they both conform to the same regulations. You must take care with some people that they understand the difference between portable and transportable equipment when talking about it.

**CB sets,** CB stands for Citizen's Band and refers not to a type of radio as such, but to a set of laws and regulations regarding their use. CB sets are technically just like any others, but there are both advantages and disadvantages to their use, which we will discuss later.

**Amateur Radio** or **HAM Radio**. Again, like CB, this refers to a set of rules and regulations and not to radio equipment as such. However there are some interesting points about Amateur radio that need expanding on, so this is another subject that we will return to.

**Handie Talkie or HT**, A new buzzword used by many manufacturers and much beloved of the buzzword loving amateur radio fraternity. A person using this word probably has an amateur radio background, which is a good thing.

**Handset.** This really means the part of an ordinary telephone that you hold against your ear. Someone using this word is giving away that he has a background in Telephones,(which is no bad thing). Some radios have 'telephone lookalike' handsets instead of fist mics. This is good because it forces you to hold the mic at the right place, and provides a clear sound right into your ear.

**Handheld.** Good word.

Whatever its name, nearly everyone has seen or used a handheld. Because of their small size, convenience and ruggedness, they have found nearly universal acceptance by all serious organisations who can justify the expense of them, they are a completely mature product now, and modern designs are more similar than they are different.

### 6.3.1 Procedures

One off-putting thing about them is that it seems that no one who uses them can resist the urge to speak fluent martian gobbledygook when they pick one up. For some this is all part of the excitement, and knowing your 'rogers' from your 'wilcos' is all part of the rights of passage into the elite world of the airline pilots and other glamourous folk, but for others it is at best a turn off or at worst very intimidating. I have seen very intelligent and articulate mature professionals reduced to stuttering wrecks for fear of not incanting the right spells to make the thing work.

I want to tell you right now, that in most cases, ordinary language is quite good enough. There are quite elaborate procedures for some services such as Marine radio or Aeronautical service, and they do help a great deal when there is pressure to be clear and concise in the presence of many languages. But if you are not planning to organise much international air sea rescue on your handsets, don't bother.

There are however a few things you should not forget. First, unlike a telephone, it will not ring when someone wants to talk to you, so you must have it switched on all the time, and be listening to the channel all the time to hear if a message is for you. Sounds silly to say this, but we have come across cases where the system was not working because users had their sets turned off, thinking they would ring like a Mobile Phone.

Another point is that for historical reasons, most handhelds use what is called the SIMPLEX system. The technical details are not important but you can always tell a Simplex system because of a button, or bar, on the handset labelled 'PTT' or Press To Talk. You must hold down the PTT all the time you are talking, and remember to let go when you want to listen. Sounds simple but I have spent many frustrating hours with highly educated people before this becomes instinctive. You must say something when you have finished talking so that the other person knows when to talk and when to shut up. Usually this is done by saying 'over' before you let go of the PTT, but anything that makes it clear who should talk next is OK.

Don't forget that the Simplex system is a 'round table' or 'party line' discussion, but for technical reasons which aren't very interesting, only one person at a time can talk. The usual way of fixing this is for the previous speaker to clearly state who should speak next just before he says 'over'. Another way is to have a person called the 'Net Controller' to act like the chairman at a meeting, and decide who the next speaker will be.

By the way, this apparently annoying side effect of simplex, that all stations can hear everything said, is actually a great bonus. If you keep an ear open to what is going on, it is like having a rolling briefing constantly going on. In fact, sometimes someone may just say something to no one in particular just so that everyone can be informed, and understand the whole situation by the time they are called personally for comment. This is one reason why police, fire and ambulance services don't use mobile phones though they could easily afford them.[66]

### 6.3.2 Callsigns

Just as every car needs a number plate, so every radio has to have a Callsign, for the same reasons of tracking and administration. One example of this is in aircraft. You will see painted on every aeroplane, something like G-AVIR. This is not the number plate of the aircraft but its radio callsign. To avoid confusion if the line is a bit muffled, there is an agreed list of words that stand for each letter of the alphabet, called the international phonetic alphabet. The words had to be carefully chosen so that every race and culture could pronounce them and not get them confused. That is why a pilot of the aircraft just mentioned would call up the tower and say " Woodvale tower this is Golf Alpha Victor India Romeo, taxi clearance".[67]

Why did I mention this when I promised you could use ordinary language? The reason is that some administrations will issue a licence on the condition that every message starts and end with the callsign that they will decide upon. It will be printed on the licence document. So you may get stuck with "Lima Delta one five zero this is Whiskey Alpha three three five" when you would rather say " Hello Fred this is Bill, over". Your technical expert or administrator will probably tell you what callsigns to use. Having said that, you soon get used to it and I have many friends such as G0FTU, who's name I can not always remember!

You will recall that I said that the other person you wish to call should be listening to his radio. Actually this is not always the case, and he may be holding another conversation or doing something else just with the radio in earshot. You will first have to get the attention of his conscious brain, make his 'ears prick up', by what you say before waffling on with the question you were wanting to ask. The best way is to call his callsign and/or his name twice, then give your callsign and wait for him to call you back. If he doesn't, then try again a few moments later. You may say "Aidman one, aidman one, are you there Brian? this is aidman two, over".

Because you have a virtual party line, you should obviously not call until you have listened long enough to know that there is not already another conversation going on. Simplex is a very unforgiving one-at-a-time system and you will rudely bring the other conversation to a halt ( unless of course your business is more urgent, in which case, do explain this by starting with the words 'Priority!,Priority!' or 'Break Break'). While you are talking, unknown to you, there may be other users impatiently hopping from foot to foot saying " get on with it you gas bag", so keep things as to-the-point as possible, and always make it clear when you have finished the conversation by saying something like 'over and out' or 'clearing the channel'.

This is not an instruction manual but I mentioned these points because it shows that you do need to think of training for your users if you expect to get value for money for your handhelds. Encourage your people to try them out, the moment of crisis is too late for them to become familiar with them.

### 6.3.3 What is the range of them?

This is the favourite question for users and the most dreaded one for the experts, who roll their eyes upward, draw a deep breath and then don't really answer the question at all. To find out why, lets take a closer look at our handheld.

The bulk of the handheld is probably the battery, in a clip at the bottom. Then there is the transceiver itself, with knobs and switches on it. Then sticking out of the top, is a part physically small and unglamourous, but at least as important as the other parts, a 'rubber duck'. This is actually not rubber but a helically wound steel antenna protected by a plastic outer sleeve. It happens that lower frequencies need bigger antennas, so in fact, to make the antenna of a size sensibly proportional to the radio, VHF or UHF frequencies are used in handhelds. Otherwise you would end up with floppy fishing rods which snag on everything and break the radio.

In theory a VHF or UHF radio signal has an infinite range, after all, the astronauts on the moon in 1969 told us of their 'giant leap for mankind' using VHF radios very similar to the handhelds in use today. You are not in space, but on the ground, and if I may make a point, quite close to the ground too, as many users clip the handheld to their belt when not in use. It happens that VHF and UHF don't penetrate through thick walls very well, and not through earth at all. This means that the range is 'line of sight' only.

You know as well as I do that this is not at all true, so what is the explanation of the fact that UHF radio works so well in built up areas when it should not? VHF radio waves have the property that they bounce off objects they encounter rather well. UHF is even better yet, so this explains why UHF is preferred for handhelds.

Imagine you lived in a chateau where every room was a copy of the hall of mirrors, except that the mirrors where badly tarnished and the windows nearly opaque. You can see that you could communicate from room to room by a flashing lamp very easily, especially in the dark. This is how the world looks to a UHF radio.

Now you can see why defining range is so difficult. You may have a lucky spot at both ends and have a range of tens of kilometres, but you may also get a disappointing few hundred meters. Finding out what the range is, is a matter of trial and error. Every time you change position, you should call up someone else to see if you are in a 'dead spot'. Sometimes just putting the radio to rest on a window shelf is enough to fix the problem, sometimes a more elaborate solution is needed. In any case, regular radio checks are a good idea as you will have no warning when you or the other party does move into a dead spot. Happily there are plenty of tricks for improving this situation and we will now move on to explain them.

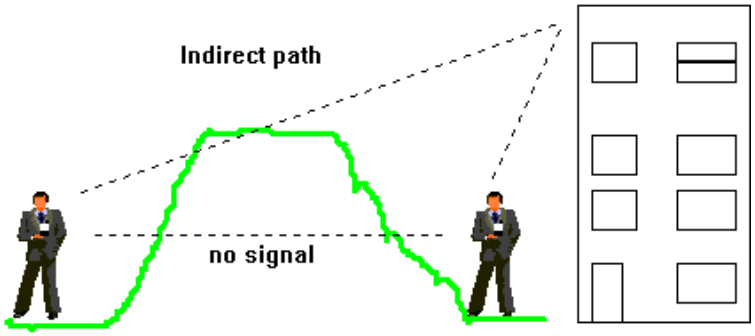



*fig 18 Direct paths to handhelds can become blocked, but if you are lucky, an indirect path may also exist*

By now you realise that the secret is not in the electronics, rather in the humble but very important antenna. The simplest thing to do is to ask someone to talk for a few moments, say count to 10, then move the radio around until the signal is strongest. This may put the radio in an awkward position for speaking into it, so an extension microphone can be used to make using the radio more convenient.

**VHF radio;**

**The Secret is in the position of the Antenna**

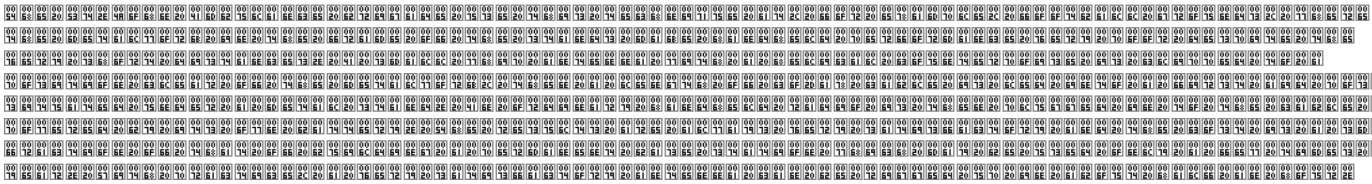
### 6.3.4 External antennas

If that doesn't work, you can try extending the antenna out of the room altogether. This is only possible where the antenna can be unplugged from the radio, or an extension lead can be plugged in. An extension lead can then be plugged into the socket where the antenna just came out, and the extension lead, (specially made from 50 ohm co-ax cable and fitted with co-ax sockets of the correct type and gender), can be lead out of the room and to the highest point it will reach, (or the point with the clearest view towards the place you want to communicate with). However the extension lead will have some loss of signal, which will get worse as the cable gets longer. In fact the cable should be only about 100m long at the most, unless you use special (more expensive) so called 'Low Loss' cable.

You cannot use the antenna that just came off your radio. You must use a special design intended to work away from the radio. However there are many good designs available 'off the shelf'. Suitable models include, the dipole, the base loaded whip, the ground plane radial, the Slim Jim or the helical counterpoise whip and very many more.

There are as many opinions as their are experts about which is best, but the bottom line is that you are trading size and weight for efficiency. Remember that you have to personally carry this antenna on the 'plane and across rubble for days in order to fix it up, the shop won't deliver it for you. I recommend the lightest, easiest quarter wave whip with helical counterpoise, Ideally, these should be supplied with a large, strong clip, so that they can be quickly clipped onto a pipe or veranda rail, or failing that, they can be taped into a good position or tied with string.





In any event, I can assure you that it is worth the effort, the difference of even modest height is like night and day. The losses in the cable are more than compensated for by the better antenna position. The problem is that you have now sacrificed mobility. You can easily use your ordinary handheld to connect to the external antenna, no problem. There is then no security problem as when the room is left unattended, the radio can be just clipped to someone's belt and carried off. But as it will take a few minutes to fix up the antenna again, you may decide to leave the antenna fixed up in position until the location is no longer needed.

The next obvious logical step is to rig an external antenna system up and leave the radio connected and in the room all the time. This has the advantage that any user has reassurance that the equipment will always be there when needed. However this is only practical where security is assured, or there is usually someone there. However if this is so, then the set-up could be in place long enough to be worth investing some hours in siting the external antenna in a really good spot. What you now have is a **Base Station,** this is a theme to which we will return later.

If you have a really good spot for your antenna, with a good view over the area, then you are really on to something good. Whereas individual handhelds may be out of contact with each other, they could well be in good contact with you at your base station. If there is someone at the base station, then they can write down messages from one handheld, and repeat them to another, overcoming some of the serious limitations with handhelds.

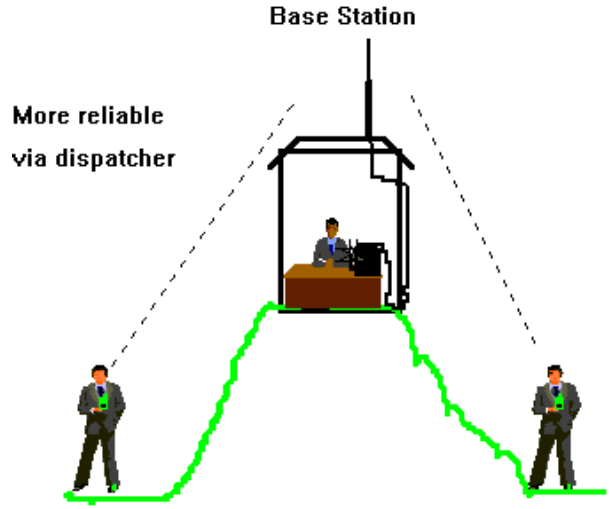



*fig 19 If you can install a Base Station in a good position and have reliable manning, this is much better.*

I want to stress here that the **secret is in the position of the antenna, mostly its height**, and not the power of the transmitter or anything else. A perfectly ordinary handheld connected to the antenna by an extension lead is just as good a base station as a more elaborate set up. However, there may be justification for something more elaborate and I promise to explain all as we go. I am going to come back to the subject of base stations, but now I think it is time to change subject to that of a Mobile station.

## 6.4 Mobile Stations

A rather funny name this, as mobile means moving and station means not moving. The reason for this odd name is that the licence for a radio transmitter is called in law a Radiocommunications Station licence, so legally at least you have a mobile radio station. A mobile station means that the equipment is mounted in a vehicle and is designed to be operated while driving and on the move. (or else it should be called Transportable).

I make no apologies for saying again that the **important thing is in the antenna**. Vehicles have the advantage that weight is less critical a problem so a much bigger and heavier antenna can be fitted to a vehicle. The antenna will have a greater 'gain', meaning signals will sound stronger. Furthermore the metal in the vehicle itself helps the whole effect to be even better, but this is only so if you install the antenna in a good position and bond it well to the earth of the vehicle.

A further point is that as vehicles tend to be on the open road and in clear open spaces more than a person is, then the range of line of sight from the antenna is probably going to be much, much more than from a handheld. Whereas a handheld may give 2km range, a mobile can have a 20km range.

You don't have to have a permanently mounted radio in the vehicle to gain these advantages. In the case of an emergency there may not be time to install a mobile radio into the vehicle, or security aspects may go against the whole idea. You can use a so called 'Magmount' antenna. This is a quarter wave or three quarter wave antenna with a powerful magnet on the bottom. The antenna is mounted on the roof of the vehicle and right in the centre of the roof. It is held in position by the magnet, only direct brushing by trees will dislodge it.

The feeder cable can then be let into an open window in the vehicle, and an ordinary handheld can be connected to the magmount. The radio can then be connected to the cigarette lighter of the vehicle to draw power. This then gives the flexibility that you have a charged handheld to use when you get out of the vehicle. You should then disconnect the magmount, locking it up in the car, and connect the rubber duck to the radio for portable use. This arrangement is used by many radio amateurs for example, and is highly effective and secure.

## 6.5 Power Output

Up to now, I have been saying that power doesn't matter very much, and antennas are the secret, but now I will have to say more about power levels. As mentioned before, handhelds have such poor antenna positions that the range will be limited more by topography than anything else. Even though the signals do bounce as I have said, there is a loss each time this happens, so the signal gets weaker as it bounces each time to reach the other unit. You might think the solution would be to simply raise the power of the transmitter in the handheld, but there is a problem.

About two thirds of the size, and certainly the weight of a handheld is its battery. This needs to be big enough to power the radio until the user can get back to base and recharge the battery. Recharging can take from 4 hours to 16 hours depending on the design of the charger, but usually the battery in a handheld is designed to be used during a working day of about 8 hours, and charged in the rest of the night. If your day is longer than 8 hours then a better alternative is to use batteries that can be unplugged from the bottom of the handheld, and replaced with another one which was charged earlier. (obviously you need to have enough chargers to charge both at night).

Actually if your battery does go flat, you may get no warning of this and be missing vital messages , so in practice it is good to change a battery about half way through the day, during lunch break. This means carrying your spare battery around with you to do this, or arranging a fresh battery for pick up at the place you have lunch.

Handhelds use very little power when just listening on the channel for a call, but very much more when the user talks. Typically, a battery life may be quoted at 8hrs standby time (listening without speaking) or 30 minutes 'talk' time, or sum of the two.

Therefore to make the batteries last longer, they would have to be much bigger and heavier. The irony is that they would soon get bigger than the rest of the whole handheld. There is only one way to reduce battery size, that is to reduce transmitter power.

However we have just seen that a mobile station may have a greater range because of a better antenna, and thus because of that, it will be worthwhile having a higher power transmitter. This in turn will be possible because a vehicle battery has much greater capacity than a handheld one, so the extra current drain is not a problem.

## 6.6 Transportable units

We need to think of this at our base station. If you think you will ever want to communicate with a mobile station, then you should use a higher power transmitter at the base station, or you may be able to hear the mobile calling you, but the mobile won't be able to hear you replying. This is where your transportable unit comes into it's own. Transportables have higher output power than handhelds, so in addition to being larger, they also have larger and heavier batteries. This is why the resulting unit looks so ungainly. In addition, they also often have their battery chargers built in to the unit. This is important because it will prevent the all important charger being forgotten or put on the wrong truck and sent in another direction (which has happened).

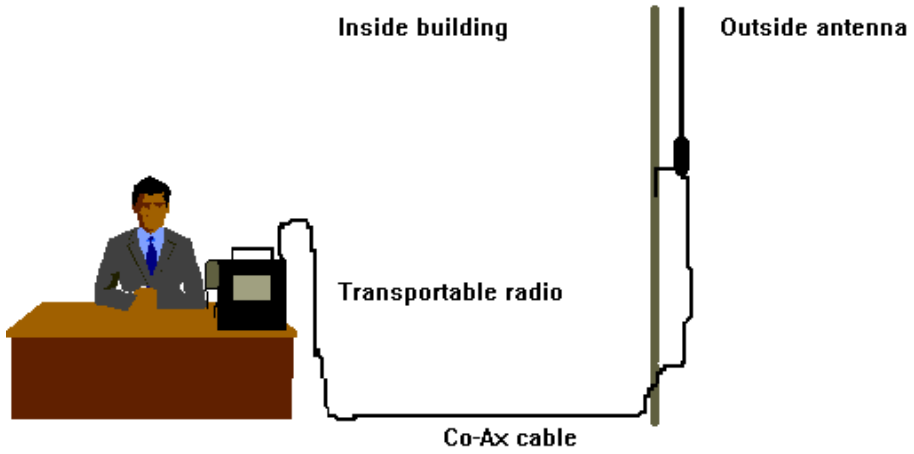


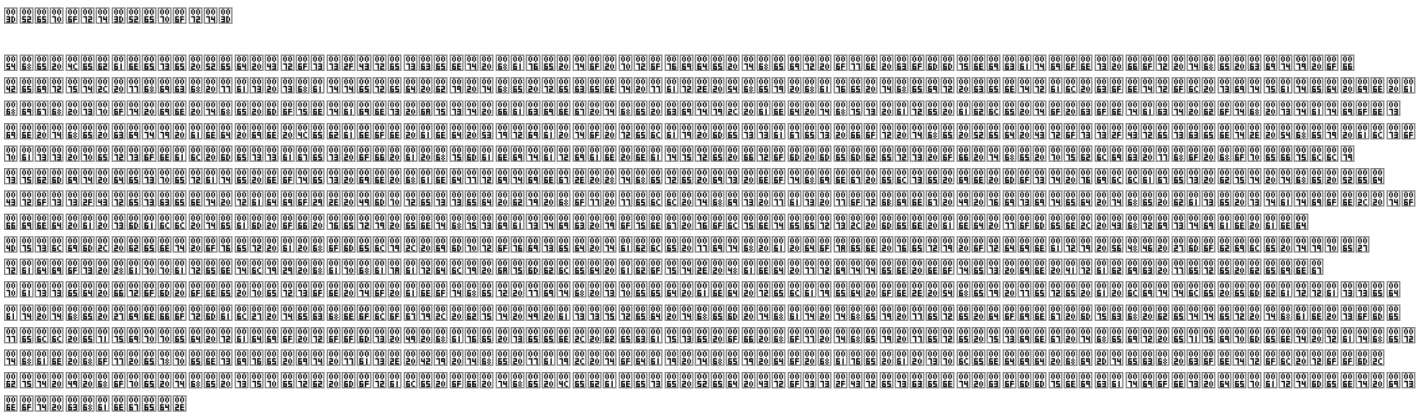

*fig 20 A transportable unit should be used with an external antenna.*

Transportables usually come with a rubber duck helical antenna built in, intended for use while on the move, but to use this when stationary would be to throw away the advantages of them. You should use a transportable in conjunction with a temporary external antenna, such as one that can be clipped to a fitting in a good position.

## 6.7 Base Stations

If you are in the happy position of being in a good spot all day, then it will be worth while the hours it will take to put the antenna in a really good spot and even use or improvise a modest mast to improve the height. If you now have such a base station you would be using it frequently to repeat messages for handhelds, so you would perhaps assign someone to permanently keep an ear on the channel at all times. However you may have the problem that the spot which is good for a base station is not ideally where staff would be in attendance at all times, so the site for a base station may turn out to be a compromise between these two factors.

By the way the term **base station** refers to the way you use the site, not to the type of equipment installed there. You do not have to install an imposing panel looking like Heathrow approach radar to make it a base station. You may find that the base station is a rather disappointing sight, a scrawny looking radio rather like the one you have seen in the vehicle that brought you. No matter, it is how it is used and where it is sited that makes the difference, not what the equipment is.



One solution to the problem of having to have the Base Station in an inconvenient position is a 'remote controlled' Base station. In this arrangement, the base station itself is placed in a position which is best for the antenna system. While the controls are placed at a position where you can expect staff to be present. This is done by using specially made basestations which can be remotely controlled. There then has to be a cable from the basestation to the remote controller. In most designs, ordinary telephone cable can be used, then temporary cabling rather like that used in field telephones can be rigged, enabling the placing of the base station on the top floor of an adjacent building, while the controller is in the office, perhaps at street or basement level.

For a more permanent arrangement, a private wire can be arranged from the local telephone administration, connecting the two points. This will however cost you a installation fee plus a quarterly fee for the maintenance of the line. This is the method used by HM[68] Coastguard and the Air traffic control authorities among others. This explains their fantastically long reach as they select towers on top of high hills for their basestations, while the air traffic controllers headphones are connected to them by telephone lines (private wires).

If a private wire is not practical, or there are not staff at any location to handle traffic, then another alternative can be tried. The repeater.

## 6.8 Automatic repeaters

Usually called simply Repeaters or sometimes Relay Stations, these automatically repeat messages just as the radio operator would do at the base station, (if he were not having a break). Naturally it does not do it by writing the messages down and speaking them out but another way.

The receiver at the repeater receives the incoming message as usual, but instead of putting the voice out on a loudspeaker, the output is connected straight into the 'microphone' socket of the transmitter. The receiver has circuits to detect when someone is talking, and switches on its transmitter, boosting the signal and putting it out of its own transmit antenna, (which is obviously in the best position you can possibly find). The other handhelds receive this strong signal from the repeater transmitter, and so hear loud and clear signals from the sending handheld, giving the impression that the handheld itself has a greater range. This is the system used by for example police forces, which explains why their handhelds seem to have such a good range.

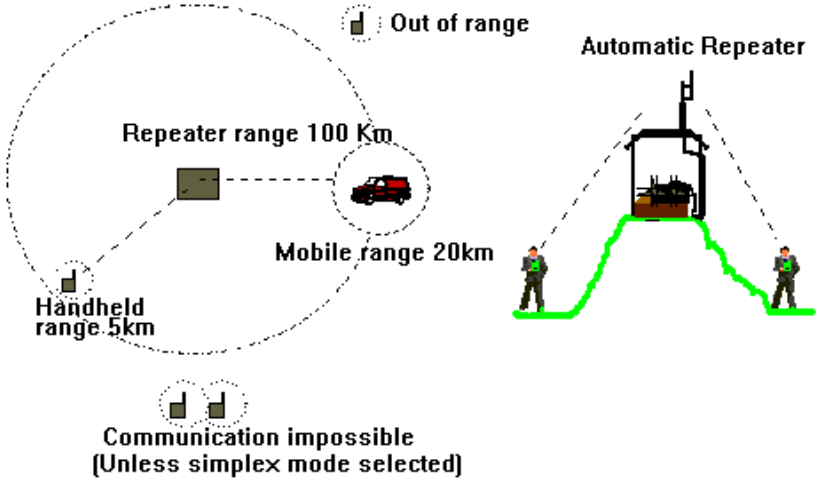



*Fig 21 Repeaters boost range but need fallback schemes in case of failure*

However their are some snags with repeaters. For technical reasons that I will have to explain later, if you set your radios to work with repeaters, they then cannot work without them. Therefore if your repeater is not working either because of a fault, loss of power, it has been stolen, or it never seems to have made the right truck somewhere, all of your radios will not work until you fix your repeater.

Also, if your handhelds stray out of the area of coverage of the repeater, say by driving to another town on the other side of a hill, they will not work with each other, which will confuse the users no end. If you choose to use repeaters you must guard them with zeal. Someone will have to check them to change the batteries or top up the fuel in the generator at least every 8 hours. You have just put all your eggs in one basket, so you must take extra care with the repeater.[69]

Because of the vulnerability of repeaters, you will need to have a fall back strategy, but in order to understand the problems and solutions with them, I will have to get more technical about channels.

## 6.9 Channels

Probably somewhere on your handheld or transceiver there will be a control marked CH or Channel. Typically it will have some positions marked A-B or 1-6. It may seem that contacting another radio would be as simple as just selecting the right channel, unfortunately this is not so and there are many complications. To examine them lets just take a short step back and look at how radio works.

In the days before radio, carrier pidgeons were used to carry messages. When the pigeon arrived at the destination, it was ignored. The important thing was the message strapped to its leg. When radio first came in, the term carrier wave was often used as an analogy with the pigeons. The carrier wave transports the message to the receiver, where the carrier wave is discarded and the message is extracted and read.

However, here the analogy ends. For one of the useful things about radio, is that the carrier can be at various frequencies. A part of the transmitter will set the frequency of the carrier before the message is put on, by a process called Modulation, in another unit called the Modulator. In the receiver at the other end, a special part of the receiver called the Tuner, can let in only the frequency wanted by the operator. The allowed in carrier then has the message removed by a unit which does the opposite to the Modulator, called the Demodulator.

If we set the tuner of the receiver to the same frequency as the carrier at the transmitter, and if we use the same type of demodulator as the transmitter had modulator, then the radio link will work. Actually there is only one modulation system commonly used in handhelds today, the FM system (12.5khz separation or 25khz separation) so you would be unlucky to have a modulation system mismatch. Frequency is another thing.

Apart from some exceptions which I promise to come back to later, you will likely have applied to the host government in the country you are operating in for a (PMR) or (Private Mobile Radio Licence). You will then be allocated a frequency by the government, rather than your choice. You may be lucky enough to have permission for more than one frequency, but again, they will be set by the government. To stop people illegally using frequencies for which they do not have a licence, most governments forbid the use of radios in which the user can select any frequency, but rather, specify channellised equipment.

Prior to the introduction of Synthesizers, a crystal would be fitted into the radio, one for each frequency used, by a technician in a workshop. Today this is done by computer or diode programming, but it means that the user can not select the frequency directly, only select the ones fitted into his radio. There are several problems with this.

One problem is that if your radios were programmed by different technicians, they may have been programmed in a different order to other sets. Therefore the frequency on channel 1 for one set, may be channel 3 on another, and channel D on another. Never assume different handhelds will work together until you have checked every channel. If they don't work, don't assume that they are not programmed, but test all channels until you know which are which. The best thing is not to let this happen to you by carefully controlling who programmes your radios and having some kind of plan to standardise things. If you have the luxury of having the frequencies written on a plate on the back of the radio, this is better, but some organisations insist that the actual frequencies be kept secret.

If you are working with a different organisation, then very likely their sets will be on different frequencies to yours. There is no point in saying, call me on channel two, because their channel two may be a different frequency to yours. On the other hand, if you are going to be working with another organisation a lot, you will have to tell them the frequency of your channels so that their engineer can programme their sets accordingly.

You would then need to arrange that the common frequency appears on the same position of channel knob in the sets of both organisations, as people are sure to say, 'call me on channel 2' rather than '165.475MHz '. Interworking is not always possible. Sometimes regulations or jealousy prevent this information from becoming available so you will need to check that this is OK before doing it. Sometimes the technical details of the radios do not make it possible, for example if one organisation has VHF and one has UHF.

There is a further complication regarding repeaters. Remember I said that the repeater listens to a handheld then transmits it out by its own transmitter. But this should be impossible because the receiver would then become jammed by its own transmitter, and never hear another word from the handheld. Quite true, so a tricky trick is used. The transmitter puts the signal out on a different frequency to the one the receiver is tuned to. This is called the Duplex system.

The upshot is that the handhelds have to know to listen to the output frequency, but when the PTT button is pressed, re-tune to the repeater input frequency. Because the repeaters antennas are usually higher than the handhelds, the repeater output frequency, or handheld input is called the downlink. The handheld output frequency which is the repeater input is called the uplink. It would be too much to expect operators to remember all of this, so the channel selector knob is programmed to arrange this automatically when you select a certain channel number. So you can see that **some channels are two frequencies!**

The bad news is that if the repeater were faulty, or not put up yet, then the handhelds would not hear each other because they would not be set to listen to the transmit frequency of each other. There are two solutions to this problem. The best one is to apply for a simplex frequency in addition to your duplex pair. This means that you manage without a repeater if you didn't have one by simply changing to the other channel. The problem is that everyone would have to know this and change accordingly.

Another idea is to programme one of the channels to the output frequency of the repeater, but arrange simplex programming on that channel. This could cause confusion because someone would be sure to hear the repeater when flicking channel knob, then wonder why no one could hear him when he calls. If you have only one licence for one duplex channel , but have two channel radios, then programme simplex mode on the downlink frequency. This has the advantage that users can be warned to switch to the other channel when the repeater's failure is learned of, because they will still be listening to the downlink frequency in receive mode.

Again, you would need to explain what you had done to your users, so some form of instruction is needed or your investment will be wasted.

A further complication is that the government may not allocate a duplex channel to you, in which case you cannot use a repeater. In that case, you have the option of a remote base station arrangement. Remote basestations also offer the advantage that if they fail, handhelds that are in range can still talk to each other, and to mobiles or transportables, so the problems of working in failure mode are less severe.

### 6.9.1 Trunked repeater systems

Another problem with repeaters is that a handheld could quite easily stray out of the area of coverage of the repeater. If the area of operation is larger than the area of coverage of the repeater, then another repeater will have to be built on a site suitable for coverage of the new area. There are two problems with this, firstly the users will have to know what the coverage areas of the respective repeaters are and they will have to know of and have their radios programmed with the frequency for the other repeater. The other problem is that it is not possible to communicate with users on the other repeater.

One solution to this problem is to couple or link the two repeaters together, either by a landline link or by a radio link.

To overcome the problem of users having to keep re-tuning the radios, more ambitious trunked radio systems are in use. With these, the radio automatically scans for the strongest signal and re-tunes to it. This does mean that the radio has to have the appropriate control systems built in, and it has to be correctly programmed.

In multi-channel 'pool' systems, each repeater station has not just one channel, but several channel available for use. The same repeater can then be used by different unrelated services, all of whom benefit from the repeater's coverage. When a user presses the push to talk button on the handset, a short data message is sent from the handheld requesting an uplink channel to the repeater. If there are no spare channels available at the repeater, then the user hears a low pitch 'boop' sound, followed by a 'pip-pip-pip' sound when a channel has become free and been allocated. When the 'pip-pip-pip' has been heard, the user can now speak.

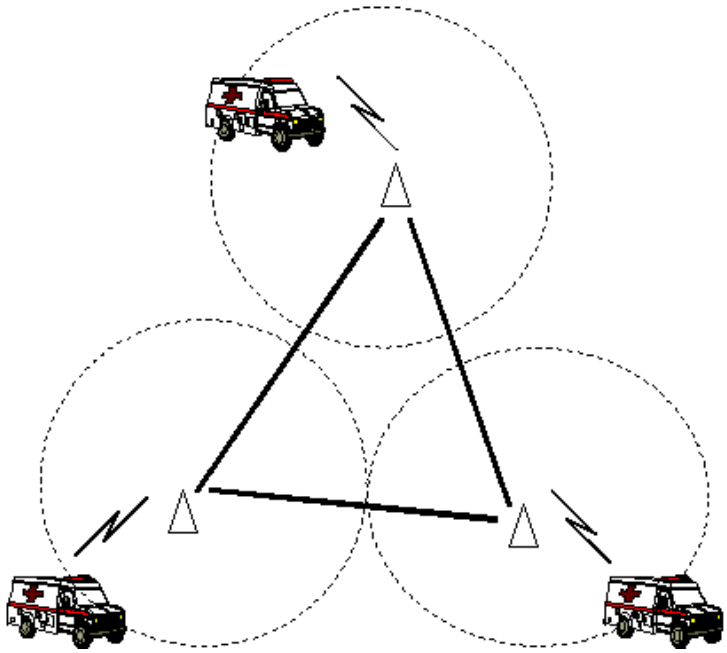


*fig 22 A trunked system links repeaters together to provide a wider area of coverage while keeping operaton of the radio as simple as a simplex system. This method also retains the benifits of point to multipoint communications.*

In the mean time, all the other handsets which are programmed to be in the same group as the sending handset will have been 'paged' by the system, and will have tuned in to a downlink frequency on the repeater who's service area they happen to be in.

More advanced versions such as the Ericsson/GE EDACS system are digitally scrambled, making unauthorised overhearing, by journalists for example, impossible. EDACS also offers the possibility for a handset to 'join' and 'unjoin' groups as the needs requires. For example, a Red Cross unit would be only in the Red Cross group normally, but once on the scene, may decide to join the same group as the local fire/police /medical services are on in order to co-ordinate their efforts better.

The advantage of this is that there is virtually no limit to the size of the area that can be served by such a system, while there is no knob twiddling to be done by the user and so it feels just like a simplex walkie- talkie to him.

The disadvantage is that 'ordinary' radios will not work with a trunked system unless they are specially programmed to do so. This means in fact that you have to be given radios by the operators of the trunked network. This could present a problem as they are quite expensive and so it is unlikely that there will be many floating spares at very short notice.

Also, the system needs to be set up by engineers and so is unsuitable for use in the first phase of a disaster. However it is ideal for the case where regional planning policy provides for such a system for the local emergency services, for instance. If you are planning ahead for disaster communications in a known area, try to get permission to use the local administration's trunked network and obtain handsets and mobiles on their system.

## 6.10 CB

Citizens band as it is called in the USA, UK and other countries, refers to a band of frequencies which have special rules. Any private citizen is free to go to the Post Office and purchase a CB licence, renewable annually, entitling him to set up a radio transmitter provided it conforms to certain rules. So far, this is really not different to anything else mentioned above. The result is that there is such a large mass market for sets which conform to these rules, that the prices of the transceivers on these bands tends to be about one quarter of that for any other band. If cost is your priority, then this may be for you. However there are some things that you need to be aware of.

For one thing, not all countries have a band allocated to citizens personal radiocommunications, so it could be illegal to use them. Some countries have their CB frequency band on a different frequency to the 27MHZ used in the UK and the USA, so the price advantage may be lost as cheaper equipment will not work. Additionally, the USA specifies AM modulation whereas the UK specifies FM.

Another problem is the frequency itself. 27MHZ is a frequency with big problems. Most of the time it acts like VHF, as a purely line of sight mode, but not bouncing off walls of buildings very well, reducing its effectiveness in built up environment. However it does perform well at

rolling over gentle and smooth terrain. The problem is that due to the influence of the sun, every 11 years it becomes liable to long distance 'skip' causing its signals to bounce off the Ionosphere and giving the band fantastic ranges. Well what is wrong with that, you ask quite rightly? The problem is that now you will have strong interference from USA and S America which will make the channels hard to use for local messages as they will be swamped by strong signals from excited (and illegal) high power stations.

A further problem is to do with the wavelength of 27MHz. It is about 11 meters long, as opposed to about 70cm for UHF. This apparently boring detail has a profound effect on antenna size. For example external antennas have to be about 5 meters long, making them much larger heavier and more expensive than the titchy UHF equivalents. The biggest effects though are on the handhelds. A whip on a handheld would have to be at least 2.5m long, like a fishing rod, in order to be efficient. Even if you try helicals, the sizes become like horse whips and are not really handy.

By far the biggest problem is the popular success of the band. Many thousands of ordinary people, and in particular young operators having their first taste of communications technology are on the CB. As they are not required to pass an exam in procedures, this means that discipline on the band is notoriously bad.

To add to that, many CB users feel that their band should be used only for personal use, and greatly resent the use of the band for 'serious' use. You can see why; commercial users would block it all day with traffic that should really be sent on the proper commercial frequencies set aside for that purpose. Therefore you may find yourself subject to hostile 'jamming', and a great deal of intimidation designed to make you move over to a proper commercial frequency.

On the other hand, if you are operating in an area where a disaster is in progress, CB users are unlikely to feel that way, and on the contrary, you may find may useful local contacts who are in a position to be of help to you . Nearly all countries supporting CB have disaster relief networks such as 'React' to help you in this way.

Whether legal or not, you may find that the CB band is the only one which is common to all agencies working in some areas. We saw before that interworking between agencies can be fraught with technical difficulties, but you may have CB in common with them, in which case the channels are the same frequencies for both organisations. Unfortunately, repeaters are forbidden on the band as duplex working is not allowed.

CB equipment is so relatively cheap that it is not a bad idea to pack at least one transportable with external antenna, and perhaps a handheld too, just in case it comes in handy. If it doesn't, you can always use it for shopping trips.

### 6.11 Amateur Radio

Amateur radio, (or Ham radio) is another set of international laws enabling private individuals to operate radio stations for their own self training and entertainment(see part 1, 3.4) In this respect it is like CB. But there are also many differences, many of which are very important to know, so without giving an exhaustive lecture about amateur radio, let's look at some of the more important points.

Let me return to the theme of handheld radios again. You will recall that some of the problems with CB are associated with the large antennas and liability to jamming. Amateur radio does not suffer from these problems because there are many frequency bands allocated to amateur use, one of which is in the VHF band and one in the UHF band, both of which are ideal for handheld units.

Amateurs are required to sit an exam before being allowed to take to the air, and are required to keep good behaviour or they risk losing their licence. All of which adds to greater discipline on the amateur radio bands. A further plus is that repeaters are allowed on these bands, and furthermore, a large network of them already exists.

Local amateurs are probably well drilled in the arts you need for communicating in the local area. They will understand the local topology, for example, and already know what is possible and how. They will also know about the coverage of the local repeater system and packet nodes. Even if you decide to deploy your own system, Amateurs can advise you about what to deploy where and even be able to help you with some of the hardware you may need. Best of all, it won't cost you anything!

Another advantage is that the Amateur radio bands are defined by international law, so you will have a common pool of agreed frequencies to use for interworking with other organisations. This has the advantage that there will be no need to wait for a frequency to be allocated to you, you could start to use the channels immediately.

With all these plus points, you may wonder why everyone does not use the amateur bands. The reason is that in law it is strictly forbidden for any person who does not have an Amateur radio licence to operate on the band. So you would need to either take a Radio Amateur with you, or get the users to obtain their own licences.

In practice the situation is much better. The International Telecommunications Union (ITU) is very well aware of the practical problems faced by disaster and aid organisations in moments of crisis, and are also well aware of the benefits that radio can bring. In Resolution 640 (see 5.2), radio amateurs are encouraged to 'meet the needs of international disaster communications'. There is a full consideration of all this in chapter 5, but here is a brief summary.

The British regulations, for example, say that a licensee can allow a 'representative of a user service organisation' to use his equipment, but only under his ' presence and direct supervision'. As to what is the definition of a 'User service organisation' and what constitutes 'direct supervision' depends of the interpretation of the rules by the government in who's territory you are working.

In the case of breakdown of authority in the area concerned, this may provide you with a way of circumventing red tape and getting equipment into the area as you won't be intruding on any existing users frequency. This fact alone may be enough to allay fears from existing users, and create less barriers to get you on the air as soon as possible. Invoking resolution 640 provides you with a legal framework for operating, which will keep you out of trouble, provided you obey the locally applicable regulations but you must demonstrate absolute maturity in how you exercise the privilege so provided.

It would be illegal to use the Amateur bands for an extended period for a long term aid operation. Another point is that you have absolutely no right to hog any channel, or to cause interference to any other Amateur operator. Whatever the case, finding someone in your organisation or team with the will to obtain an Amateur licence is obviously no bad thing.

There are however security implications in using the Amateur service, I have covered this before in part 1, but I thought this a good time to repeat it again. The Amateur Radio Operators working with you are unlikely to embarrass you, but many others will be listening in with great interest. It will be like doing your laundry in the town square, with passing strangers looking on. Ideally you would like to solve this problem by using data systems such as packet radio, in which case you would want to scramble the data before sending. The problem is that it is strictly forbidden for an Amateur station to send messages in anything other than 'plain language'.

By contrast, your organisation rule book may insist that you preserve the confidentiality of those you are serving, making passing such information in such a public forum out of the question. This issue means that the use of Amateur radio may be limited to logistical matters, but in any case this will depend on what the policy of your organisation, the policy of the host nation regarding sending coded messages by amateurs, and how urgent your need is.

A further problem is that amateur networks are designed to relay written messages from net to net until they arrive at their destination. It takes quite some minutes for even a simple message to be spoken over the air, written down, checked, and spoken again to the next net controller etc. until the message arrives at the addressee. If this requires, for example, four repetitions of the message, then it can take 20-30 minutes to ask a question and get a reply. Again, packet operation improves this situation.

### 6.12 HF Radio

Whatever we do, the range of VHF and UHF radio systems will be about 50-100km at best, so what if we either don't have a high spot to rig our antennas, or the range to the next base is more than the range of our equipment?. One answer is HF Radio.

There is another better book dealing with the setting up of HF radio stations for aid organisations, "**Where There Is No Telephone**", (see bibliography) so I will not repeat the fine work covered in its material. However, while you are waiting to get your copy, I will go over some of the main points.

For a fuller discussion of how HF radio works, see the **Appendix " How HF Radio Works"**. Basically we need to remember that we are reflecting our signals off the underside of the ionoshpere,our marvellous shield, protecting us from radiation in space and making life on earth possible. However the shield is built to keep radiation out, not radio in. It is different under the day part where the sun is stronger and the shield is higher and more active, than it is under the night time part where it is lower. As we rotate under it, the frequencies that will work well by day will not work well by night.

The bottom line is that you will need to have at least two frequencies or more, (at least 2MHz apart), to give reliable HF radio contacts. It then depends on the skill of the operators to decide which frequency to use, but it is always better to use the higher one by day and the lower one by night. The best thing would be if we could get our experts to predict the best frequencies for us, and then apply for licences at frequencies near to the best ones selected by our experts.

### 6.13 Allocations

The sad fact is that this will not be the case. We will have to apply for a licence for a frequency from the government of that country, but we will be just one of many applicants. The result will be that we will be stuck using the frequencies that the government issues. Therefore we may find that our frequency is only any good at certain times of day, leaving us cut off the rest of the day. If this is so, it is important to carry our regular radio checks with the other stations in our organisations to see that they are still in contact with us. Over a period of a year, the pattern will emerge of how our network is performing.

Further bad news is that your licence may insist that you share the frequency with other users, and specify a time for you to use the frequency. If you are in a skip zone (dead zone) at that time, you are out of luck, and should re-apply to the government explaining your problem.

Whereas with VHF, the secret is the height of the antenna, in HF radio, **the secret is in the frequency you use**. You should get expert opinion about what frequency band to apply for.

# frequency

Once the licences are issued and their terms and conditions are known, only then should the equipment be ordered and purchased. The licence may specify certain technical restrictions on the radios and antennas to be used, so you should get an expert to look over the details for you before you purchase to make sure that the equipment will meet 'type approval'. Type approval varies from county to country, and is different from Europe to Africa for example. Pester your salesman until you are quite happy that the equipment meets the type approval for the country in which it will be used , there are lots of bad stories about this.

### 6.14 Antennas

See 3.1.3

The type of antenna you buy will depend upon the frequency you are intending to use, the physical space that you have to erect it and the range and direction of the other station or stations you are intending to call.

There is more information on this in "Where There Is No Telephone" and in part 1 CH 3.1.3 of this book, but here is a summary of the main points.

Once the frequency has been decided upon (by the host government) you now must specify this to the supplier of the antenna. If you have been allocated more than one frequency, then it is possible to have the same antenna designed to work with several frequencies, in which case you must specify this to your antenna suppliers.

Another alternative is to use Broadband antennas, or Long Wire antennas with an automatic or manual Antenna Tuning Unit.(ATU). Or you can use temporary 'bobbin type' antennas which are physically wound out to the right size when the frequency is chosen. This is better for those on the move as it is very compact.

In any case you may end up with an antenna which is physically about 50M long, so you may have to take this into account when selecting antenna type.

If you are communicating to another place, the direction of which is known, then a beam is better, concentrating your power in that direction. If you are working mobile stations then an 'inverted V' might be better, offering both vertical and horizontal polarisation.

Good installation of HF antennas is very important, especially with respect to their height, bearing and earthing. Make sure that whoever installs the antenna has the instruction manuals from the maker and has access to advice about the installation of it.

The choice of make and model of radio is much less important than the frequency and the antenna, but you should choose something that your people can understand, and has a reputation for reliability and prompt maintenance in your area and is **type approved** in the country you are working in. One way of simplifying things is to buy locally.

### 6.14.1 Scanners

If you have been allocated more than one frequency, then a scanner, allowing you to listen to the frequencies one at a time, at say one second intervals, is a very good idea. Then if callers don't get through on the higher frequency, they might try the lower one. The problem is that if you don't know that the higher one has faded out, you may be listening to a dead band without knowing it.

Scanning receivers can be programmed to switch from frequency to frequency so that you can listen on all the frequencies that you may be called on. Naturally this means that the calling person needs to make a call at least 15 seconds long in order for the scanner to visit that frequency and open the speaker long enough for the person to recognise his callsign. Separate scanners have to be connected in such a way that they will be disconnected from the transceiver when transmit is selected, by connection to an external RX antenna socket on the back of the transceiver.

A much better way is to specify a transceiver which is capable of scanning by itself, not all models offer this but it is highly recommended.

### 6.15 HF Amateur Radio

The Amateur service can be used in a disaster, provided the Host government has given its permission. By invoking ITU Resolution 640 and the Tampere convention, you can use the HF radio bands allocated to the Amateur service ( see ch 5). This will also solve the problem of interworking with other groups in the area. Amateur bands in the 3.5, 7 and 10 MHZ band are all excellent for local contacts, but as usual you must organise who listens to what frequency and when.

Amateur radio transceivers can be purchased which can also be used in a general coverage mode and thus be used both on amateur and commercial frequencies. This will enable the same radio to be used for local calls and for long distance phone calls via a coast station such as Portishead Radio. Another important point is that Amateur bands are not restricted to just voice communications. Other more advanced data communication modes are very common, indeed were developed on the Amateur bands. To see why you would want to get an already complicated situation even more complicated. Let's look at them on the next section.

## 6.16 Data by radio

There are many radio data systems, but by far the most common in 1996 are:

- Packet
- Tor

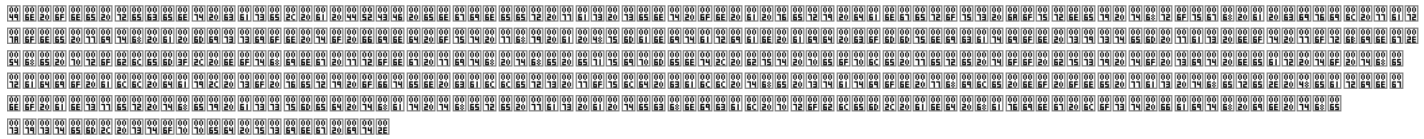
Before we look at them, we must ask, why spend time and money on them when we can make do with something simpler? Perfectly good question. Technical whizz kids just love gadgets, so they are likely to insist on their indispensability sometimes for reasons less than logical. Data communications systems will cost you more to purchase. Not only because you will need special, (but not too expensive) extra circuits, but because you will need a computer or terminal to process the data.

Now, I have used computers every day for many years, in fact the whole of this document was written on various lap top computers. I would never be without one on my travels around the world, but I still can't decide weather I love them or hate them. A fixed desk top computer connected to the mains is one thing, but when you start to travel with a computer it is quite another. Is it robust enough to handle the bad knocks?, did you remember to charge it? Where is the charger? Yes, computers are not totally reliable yet. If your PC won't do the business for any one of a hundred reasons, you will have egg all over your very red face Trust me, I know.

Never trust techno-wizzgadgets. If you are really serious about reliable communications, then always have a back up plan, preferably a simpler system, to fall back upon if your flagship sinks. For example you may arrange a voice check on the link say two or three times a day at a scheduled time convenient to both operators. If the data system has failed, you will learn of this at the 'sked' and be passed any missing traffic.

Now that I have said that, I still think that Data communications systems are a very good idea, why? Because if they can be connected to a regular radio, and if they are working, good. If not, then you have not lost anything **provided you take the kind of precautions just mentioned.**

### 6.16.1 The problem

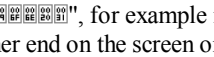
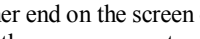


Wouldn't it be nice if you could just write out a message for the station at the other end at a printer on their desk, or in their car. Then they could read it when they had time, a kind of do-it-yourself Internet. Of course you would want something that told you if the message got through or not, but think, you could write your message and get on with your very important work instead of wasting time with knobs, dials and roger-wilcos.

You may smile and sigh at this fanciful dream from the far future but don't. Its here now, it definitely works, and its relatively cheap.

### 6.16.2 Packet Radio

The Packet radio system ( I will discuss AX25) is most suitable for VHF and UHF systems. It gets its name because of the way it converts your data into 'packets' with an address on the outside and the contents on the inside. You connect a small box called a Terminal Node Controller (TNC) to your ordinary radio's microphone and headphone socket, you don't even have to open up the radio. Then you connect either a computer or a 'terminal' to the box. Terminals can take the form of a small thermal printer with a keyboard attached, such as the famous TI703, or some portable electric typewriters can be adapted for this job.

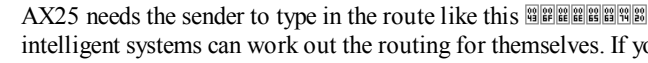
To use the system you just type "  ", for example into the keyboard. Then it writes "  ". From then on anything you type comes out at the other end on the screen or paper, perfectly simple. If the other person is there at the time, you can even hold a two way conversation. At the end of the message you type "disconnect" and it replies "disconnected". There are many advantages to having messages in text, and we have covered them in chapter 1.2.3 , so if you have not read that, please do so now.

You may wonder what if the station is out of range of your VHF set. Normally, if you do not have a repeater, you would be out of luck, but packet radio has another very pleasant surprise up it's sleeve.

### 6.16.3 Digipeating

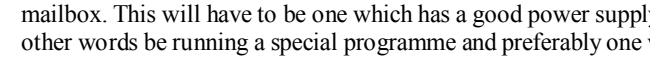
TNC's talents don't end at just connecting as in our first example. They can also take in messages and then pass them on to someone else who is in range of it, but out of range of the sender. This is called Digipeating (digital repeating). Any or all stations can be digipeaters. You can pass

messages over thousands of miles, if you know the routing to send it.

AX25 needs the sender to type in the route like this  , then all is the same. However some more intelligent systems can work out the routing for themselves. If you are using digipeaters which are usually in the same position, and which are normally switched on, then digipeating is ok, but otherwise some other ideas are worth looking in to.

### 6.16.4 Mailboxes

Suppose my equipment is out of range of the sender or the other station is not always switched on, or I am a mobile station and my route via the digipeaters is different from the usual, then I won't get anything, so what now? The most common fix is to designate one of the stations to be a mailbox. This will have to be one which has a good power supply as a computer will now have to be on all the time to act as a mail server, in other words be running a special programme and preferably one which is in a position of good radio coverage.

To send a message to the mailbox is also simple, the sender types "  " instead of the usual command. To retrieve messages, you just connect to the mailbox via the digipeaters as usual, then after typing in a password, you can privately read your mail.

There are many exciting ways of using packet radio, but this is not an exhaustive manual on all modes so time to ask another question. What if you are out of range of any VHF working digipeaters? There are two methods, satellite systems, and the HF radio equivalent of packet, TOR.

## 6.17 Satellite Packet Radio

This system, called 'Satellife' (see appendix) was invented especially for aid organisations by volunteer communications experts at Volunteers in Technical Assistance (VITA). A packet radio Digipeater/mailbox is built aboard a Low Earth Orbiting Satellite (LEO). The satellite passes low over the earth about four time per day. You type your message into your TNC, then it waits until the satellite passes over next time, and beams the message up. At the same time, messages become beamed down by the satellite. It is rather like a global roving mailman.

The plus side to this is that not only is the equipment very inexpensive to purchase, but the service is free. The system has access to Internet in order to traffic messages to users not so equipped. There are more details about this in the appendix.

## 6.18 Teleprinter Over Radio (TOR)

Teleprinter Over Radio (TOR) can also be known as Simplex Teleprinter over Radio (SITOR) or Amateur Microprocessor Teledata over Radio (AMTOR). They are more similar than they are different.

In most ways, TOR is used just like packet radio is, but there are some differences also.

There are in fact packet radio systems that work over HF radio. These have the advantage that they can send the full ASCII character set, making it possible to send messages generated by computer mail programmes. However straight packet is much less reliable over HF radio and so a special version called PAKTOR has been developed and I will come to that later. For now we will stick to TOR.

TOR is used in a way very similar to packet. The user first types into the keyboard the receiving station's selective callsign, then waits for a 'connected' indication from the terminal. From then on, you can type out information that is guarantied to arrive just as you typed it, on the other station's screen or paper. This is achieved automatically, by sending the letters you typed three at a time, and then checking that they are OK at the other end. If they are not, then they are repeated until they are correct. All this is done automatically so there is no need for the users to know about any of this. A big plus is that it can work even if the equipment is un-attended, thus freeing people for more important jobs. Tor is very mature now and is used by such organisations as the CICR(Comitee International Red Cross). There are also mailboxes available for TOR just as there are for packet.

The disadvantage of TOR is that for reasons of history, it can only transmit letters of the alphabet, numbers and a few punctuation symbols. You can therefore not transfer ASCII coded computer data over it directly, but of course programmes exist for filtering out unsupported characters, if you do write the message on a computer and forget.

### 6.18.1 Pactor

The Pactor system is a highly successful development from the TOR systems just mentioned. It took the best of the TOR and Packet systems and combined them into one. It was invented by a group of German radio amateurs who wanted to exchange computer data files and found the limited character set of AMTOR too restrictive for their liking. There are three big advantages of Pactor.

1) It can transmit the whole ASCII character set, in other words upper case and lower case letters, and can transmit all of the symbols appearing on your computer keyboard. At first this may seem like only a small victory, but it means that pactor can carry files generated by electronic mailing systems, for example. Another less obvious advantage is that it can transmit computer files which are not messages at all, such as spreadsheets, or even programs themselves.

2) It transfers data much faster than TOR, four times faster, at a rate of 200 Bauds for Pactor as against 50 for TOR. there is also a version transferring data at 800 Bauds. (However this is still reletively slow compared with PSTN line and modem).

3) More advanced error correction systems are used so that the chances of the message arriving without corruption, even over a bad circuit, are better.

The Humanitarian aid community soon showed interest in this mode and a special version was developed for them, known as Swiss-PTC (Pactor Controller). It was a big hit and generated high demand for traffic. It is not exactly the same as normal amateur pactor in order to discourage unintended listners from copying information not intended for them .

To improve speeds still further took much more effort from the experts. More advanced modems and dedicated data coding chips were then added to the system in order to develop a faster and yet more reliable system which would have a speed of 800 Bauds. However with so many stations already using pactor and Swiss PTC, it was arranged for the new system to automatically recognise the correct system and select that one, while remaining compatible with ordinary SITOR as well. The new system became known as PTC-2.

Pactor is now the favourite system for use by Humanitarian aid organisations at time of writing in June of 1996, and such as the ICRC, IFRC, UNHCR etc. use it as standard. In fact it is part of the IFRC automated electronic mail system. It enables Red Cross offices in areas where there are no data services, to access the electronic mailing system in Geneva and all without the aid of radio operators in the radio room. The main advantage is that, because the Red Cross have private frequencies, there are no costs to pay other than the first cost of the equipment.

## 6.19 CTCSS

Continuous Tone Controlled Squelch System (CTCSS) is offered on most VHF and UHF sets. It often happens that you have to share a frequency with another user, and their constant chatter is bothersome to listen to, leaving you to turn your volume down so low that you can't hear your own people calling you.

In a CTCSS scheme your sets emit a continuous tone while the PTT is pressed, but this is not heard in your loudspeaker. Instead, a circuit inside your set checks to see if the signal is one of yours, and if so, switches on the speaker. If not, then the speaker stays silent and your nerves are spared.

There are however some rather disturbing down sides to CTCSS. One of them is that if you recall, only one user at a time can use a frequency, so how can you tell that another user is not on the frequency? You can't, neither can they. They might be blasting across your calls and wiping you out without knowing it, and you likewise.

Hopefully they are fitted with a system which will not let them transmit unless the channel is not occupied, but if you are also so fitted, there is potential for a problem. If you press and talk, but the channel is occupied, you will transmit nothing but think you are transmitting. Actually there will be a light or beep indication on the control panel of the radio, but will all of your people think of that? They might either think a message has got through that hasn't, or lose faith in the system when it doesn't work.

```
=Report=Report=

The volunteer St.John Ambulance brigade in London, England are a front line ambulance group. They supplement the London
Ambulance Service and are often faced with a busy day of calls from the public, needing vital life saving assistance at
once. The Ambulances are dispatched from the HQ near Baker St., in the west end of London, by simplex radio system in
the VHF band. Suddenly without warning, a very powerful station, callsign 'Zero Base', started to come on the same
frequency as was used for ambulance dispatch. It often happened that urgent messages to ambulances were lost, garbled
and delayed when this new station just transmitted across the weaker ambulances. Pleas to the dispatcher of the
intruding station were ignored. In time it was discovered, by St.John engineers, that a private security company had
been allocated the same frequency as the brigade, but were using CTCSS in order to have 'privacy'. CTCSS does not give
real privacy and you must understand what is actually happening when you use it.
```

A further problem is, suppose another organisation needs to contact you urgently and tunes to your frequency expecting to contact you. You won't hear them unless they also know of and have programmed in the CTCSS tone.

Frankly I think it isn't worth using CTCSS in simplex mode given the problems, unless the interfering stations are always weaker than yours.[70] However it is used by the UNDHA for example in their repeater systems. We must make sure that our repeater will not pick up random

interference (of which there may be plenty) and block our repeater by holding it in the transmit position. By using CTCSS, the repeater will only open when our mobiles are transmitting. The repeater downlink should be stronger than any adjacent signals so the problems are much smaller than the advantages.

**Warning**

CTCSS and SELCALL do NOT provide real privacy as some salesmen claim,
it is an illusion. You cannot hear other stations on the same frequency,
but they can easily hear you.

## 6.20 SELCALL

Selective Calling (SELCALL) is another scheme to overcome the problem of having to listen to other people's chat. There are various methods of it but the basic idea is the same. Each station has a built in circuit board with a unique code. Only when the code is heard will the speaker be switched on. The sender of the message must first send the SELCALL code before trying to call the other station. SELCALL produces a very distinctive sound, like dyslexic pan pipes.

There are however two features that SELCALL offers that are different from CTCSS. One is that you can call all or only one station. You can arrange it so that when the SELCALL is received, a bell sounds in the building or the horn sounds on the vehicle. This could alert the staff to an incoming call without them having to be in earshot of the radio at all. Another feature is called revertive calling. With this, you will get an indication of some sort at the sending end if the receiving station received the code and has set off its alert horn. This can give you reassurance that the system is working.

However there is also a problem with SELCALL. It often happens that key leaders are doing more than one job in on going emergency. Suppose for example that the Duty officer has the SELCALL 101. When you call this SELCALL his personal radio and only this one will switch on. This is fine if he is carrying that particular set. Suppose that same person is also acting as first officer of the Disaster Action team at the same time. To call the First officer the SELCALL would be 102, for example. This would mean that the officer would have to carry both handsets in order to receive both calls. The situation would become more complicated if he then got in a vehicle and found that his handheld will not work so well inside the metal of the car, as the car mobile station does with its much better antenna.

Given time, some quite bizarre scenarios can occur resulting in people having to carry several handsets around. and despite all that, have to remain near to a transportable set to receive calls intended for him in a supposedly fixed position. With SELCALL it is possible to bring back some of the bad old problems with phones and mobile phones.

The solution is for a person who is away from the radio which is normally assigned to him, to defeat the SELCALL system so that he can hear calls for him. This is done by pressing a 'def' button on the radio or, via a menu, defeating the SELCALL system. It also means that callers need both to SELCALL him and give a spoken call so that he will hear the call if listening by ear.

Another solution is for the sender, upon not receiving a response from the called mobile, to then send the group call SELCALL. A group call SELCALL means that the sender enters in a code which is recognised by all of the mobiles in a certain group. Having opened the speakers on all mobiles, the sender can then speak out the callsign and name of the person required. When the person answers, he can state the SELCALL of the radio he is using, and the call can be set up again thus closing the other radios off during the conversation.

### 6.20.1 Pagers (Beepers)

A pager is a small and light radio receiver. It's size and weight mean that it is far more convenient to carry personally than, for example, a mobile phone or a two way radio. They are designed for optimum battery life, so that they can last about one month before the battery has to be changed. They are usually powered by an ordinary disposable battery of the type that can be purchased from nearly any general store. To add to that, they are much cheaper to buy and about one fourth of the cost to run than for example a mobile phone.

A typical use for them is for callout alert. In some models, there is a loud tone when the pager is called, in some there is the option of a vibration alert so that the user will not be embarrassed if in a meeting or sound sensitive area. In this case the user will have to have pre-arranged the meaning of the alert, and either go to a pre-determined meeting point or call a phone number. Some models of pager have more than one paging sound in order that several different predetermined messages can be sent.

More expensive models feature a small screen which may have either numbers or letters and numbers on its screen. In that case, a message can be left on the screen for the user to read later should he not hear the beeper. The pager usually remembers the last 10 messages. The sender can now send a phone number to be dialled, or a radio callsign to be called, or even leave a message (usually of up to 255 characters) giving further details of the reason for the alert.

These days pagers have become the backbone of many organisation's callout plan, with most emergency services depending on pagers to alert key staff quickly in the case of emergency. However there are some disturbing aspects to paging that you have to be aware of and have prepared for before you trust them totally. First though, lets review how they work.

Pagers are radio devices usually working at frequencies around 160MHZ. The area of coverage of them will depend entirely on the coverage of

the radio base station network to which the user has subscribed. If the user roams out of the area for which he has paid a subscription, then the base stations in that area will not be programmed to call the pager and the call will be lost. If the radio waves become blocked to the user, for example if the user goes underground or in a screened place in a building, then the call will be lost. The problem is that if the alert did not reach the user for any reason, the sender will not know this. Pagers are usually one way devices and so the sender does not know if the call succeeded or failed. If the user fails to respond, the sender just has to keep paging and re-paging until the user answers.

If the base station has been disabled by a disaster, for example by having the mast knocked down by a storm, then the signal will not be transmitted at all. Like all radio base stations, Paging transmitters do not stand alone but need two vital services from the ground, Power and Line. A typical Pager station has enough battery back-up for about 8-16 hours operation without mains power. A long power outage will stop that station from working.

The paging stations have to know what pagers to call. To do this, the paging station receives a so called 'Paging list' from a control computer, usually situated very many miles away. This paging list in turn must come to the station usually by telephone line private wire. If the lines are down to the station then the station will have no paging list to send.

The sender has to alert the paging computer system by phoning the office of the paging company and either speaking to an operator, or typing the message from his phone pad. If the telephone system is out of order, then you cannot call the paging centre.

For a small area of operation, say over a 10KM radius, a 'stand alone' private paging system can be installed. The coverage area of the system will now depend entirely on the position of the antenna of the transmitter. These systems are usually basic tone only systems but have the advantage that they are independent of the local telecom net, have no running costs apart from the initial cost of the equipment, and are usually very quick to install. On the down side, You do need a radio licence for such devices unless the government has allocated a special general paging frequency for such private systems.

Apart from the same vulnerability to disaster as other conventional systems suffer, paging systems often only cover areas where there are concentrations of business users, that is, not rural areas. This is so because the profit margins on paging operations are quite small, whereas the cost of a paging station may be just as high as for any radio base station. There may be future systems operating from satellites to offset this problem, when installed, users would have global availability. However if the user cannot call his office to ask for instructions, the usefulness of these global pagers is much reduced, so in fact paging may be best used in conjunction with another mobile communications system.

In the future it seems that paging will have competition from the mobile phone sector. The latest mobile phones are only slightly bigger and heavier than a pager, and the user has to carry a phone anyway in order to reply to the page. As the latest mobile phone systems are digital, there is little complication in building in paging capability into the phone itself. In the Short message service (SMS) offered by the GSM (Global System for Mobilecommunications) system for example, messages of under 255 characters are passed over the call set up channels, so that the message charge is very low.

The message is stored in the phone as numbers or text in much the same way as a pager, including a helpful beep. The big advantage is that the GSM system positively knows if the message was received or not, and is able to notify the sender. It is even possible for the user to reply to the sender to acknowledge what action he will take. It seems that there are no complications to adding such a service to the future satellite services, and so they all plan to offer such a service.

In the future this will mean that the sender can call the message centre over a satellite link, and have the paging message sent down on a satellite link also, meaning immunity from ground disaster at last!

## 6.21 Line extenders

Line Extenders, also called 'Radio in the local loop',', these are a method of extending a telephone line by radio. A station is set up in a town where there is working telephone system, and a line is connected to the station. At the other end, a telephone is connected to a special device, which carries out the conversion of signals automatically. Versions also exist enabling many mobiles to access the line, thus enabling telephone service to be extended to them.

Line extenders are a mature and reliable product now, and they are used all over the world to provide telephone service to areas where the wiring does not penetrate. The equipment is compact and fairly cheap. The problem is that it is only as good as the local telephone exchange that you have connected to. If international connections in the area are poor, you will have not gained much over the other global methods, except perhaps cheapness. In a disaster, the local phone system will be either destroyed or severely overloaded, so it may be best not to trust only to this method. Long term aid missions though can benefit from this arrangement very cheaply.

## 6.22 Mobile Phones

Many users of the communications systems mentioned so far are heartily fed up with what we have provided. They are very unhappy with the fact that they almost always have to read a complex looking manual and spend hours by trial and error before they can use the system which their engineer is so satisfied with.

What seems so much like second nature to engineers is actually hostile to users who feel that they are much too busy to fiddle with such irrelevancies. We are living in a new era, the 'customer is always right' attitude means that users are much less likely to put up with us techno-

people if we don't deliver what **they** want.

Just about everyone can use a telephone. That is why the mobile phone service is so popular. This is a great technical achievement. Behind the scenes, millions of dollars worth of computers and a huge network of base stations are invisible to the user. That is why when asked what they would really wish for, nearly all aid workers rock their head to one side, sigh, and confess that they want a mobile phone.

The public mobile phone system, also known as the cellular phone system is properly known as the Public Land Mobile Network (PLMN). Mobile phone systems work in a way similar to the other systems we have described. They need base stations to connect to. In the case of a disaster, they are not likely to be working. This is because few base stations have diesel generators, and usually have battery backup for only 8 hours of service once the mains goes off. Also, they rely on lines or microwave links going to a parent computerised switching system called the Base Station Controller (BSC) or Mobile Telephone Switching Office (MTSO). If these lines are disrupted, or the BSC has failed, then you are out of luck.

Even if the PLMN survives the disaster, one big problem is that most base stations have capacity for less than only 30 calls per cell. In a disaster, the working stations are sure to be busy with calls from local people, and you may have to wait a long time before there is a free channel at the base station to carry your call. You also have the problem of finding someone to sell you the mobile phones for the system in operation, and setting up a valid subscription to the service. This will be very hard as the local people will no doubt have beaten you to it.

The operator of the system has a different perspective. When asked "is your system still working", he will look at his toll ticket tape, recording the money earned, and reply with a smile of satisfaction that it is working very well indeed, thank you. They rarely remember to mention that the control channels that set up the calls are completely overloaded, and in fact users are finding the system nearly useless because there is rarely a free channel when anyone tries to call them, the call then fails.[71]

Other users in the cell may have bottomless pits of money at their disposal, and so having seized a channel, they hold it sometimes for days in order not to lose contact with their office. In fact, most systems offer the capability for the operator to allow only calls from 'emergency services' to get through. In practice this is seldom switched on because of the loss of money this would involve. This is a sensitive subject and one which operators are often reluctant to discuss.

If the area has the Global System for Mobilecommunications (**GSM**) operational in the area, you are in a much better position. GSM phones are standard over the whole world, so you could bring GSM phones from Britain, and use them in Beirut or Siagon without a problem. If people in Britain phone you **on your usual number**, the system will find you wherever in the world you are, and put the call through even if the caller has no knowledge of where you are. This is called International Roaming, and is a great triumph of GSM.

Unfortunately there are still some snags. It may be that the operator of the PLMN in the disaster area has not signed a Roaming agreement with your operator at home, in which case roaming will not be possible. A bigger problem is that the GSM system is not by any means universal, so there are many places where incompatible systems are in use, so your phone can't be used. Also, in may countries, mobile service is provided only in cities, leaving no service at all once outside well populated areas.

## 6.23 Emergency Mobile Phone systems

Several manufacturers make quick fit emergency mobile phone systems. They consist of a kind of advanced base station, and special mobile phones for use with them. The problem is that they usually only offer connection within the area that the base station covers. Sometimes an outside line connection is available by satellite connection by dialling a number but usually not. The big problem is that to do this they require several duplex frequencies, one for each simultaneous call plus one for the control frequencies. You could not use it unless the government authority in the area agrees. This could take quite some time. In addition, it is much more expensive than the conventional systems just described but not any more effective, so you would need to justify the cost.

Another solution is the DECT system, a self organising mobile communications system rather like a mini mobile phone network. This has been described in ch 6.2.1.

## 6.24 Position finding systems

At first, position finding may seem to be an unnecessary complication to an already expensive and complex operation. but consider for a moment the kind of problems faced by field staff. In the first phase, a 'rec' team will have to assess the needs of the prospective clients. Often, the team are driving in a place where they have never been before, and often without the aid of road signs because they have been destroyed by the disaster, are in an unreadable script, or have never been provided. Even a map is useless unless you know your present position. Upon reaching the scene of the greatest need, they will now have to find the name of the place that they have found, but again, will they be able to do that, or unambiguously pronounce the name of the place?

Having compiled their report and moved on, the main supply vehicles must now find the same place, so that the 'clients' identified by the 'rec' team can be helped without delay. Finding and then re-finding places becomes so difficult that many operations leave this job of distribution to local militias or other 'helpful' persons. The result is often that the supplies end up in the hands of 'sergeant Bilko' types and find their way into the black market economy rather than to the needy victims. Clearly, delivering the supplies that you have paid for to the users that you have intended is much better.

Safety is another factor. Should your field staff get into trouble and urgently need help, the rescue teams cannot help unless they accurately know the position of the distressed field team. This is why, at sea, the very first thing a ship must send over the radio during a mayday call, is its position. If the radio then fails, the rescue ships at least know where to go to find out what is wrong.

These then are among the many reasons why a humanitarian aid field unit may want quite accurate position fixing. Until about 1995, such devices were much to expensive and impractical for use by such small NGO's with small budgets, but by 1995 all that has changed. By that time, hand-held battery powered units with all the desired capabilities were about USD 300-500, which is about the same size weight and cost as one handheld radio. The dominant system is use at the time of writing, at the end of 1996 is the Global Positioning System (GPS).

By the turn of the century it is expected that most of the new LEOsat satellite phone systems will offer position fixing as a standard part of the service and so very soon position fixing will become an indispensable part of the many new products and services. For the moment though, let us look at some of the ways of using GPS.

GPS was developed for position fixing at sea in the air, and for the positioning of missiles. The GPS receiver on the ground finds its range to two or more satellites that could be in view of him. A computer inside the GPS unit computes its position based on the range to those satellites and the position of the satellites at the time the ranges were made. For the satellites to know their position, they have to have accurate clock, so a further bonus of GPS is very accurate time.

At sea or in the air a latitude and longitude position is very useful. There are few other relative landmarks to reference to anyway. On the ground however we want to find our way along a road network to reach a certain town or village, so for the position information to be any use at all, we would need to have maps with the lat and long grid printed over them. I have to tell you now that most useful road maps do not offer this, whereas most useful lat and long maps are not much good at showing ground detail and in any case cannot be purchased at an airport petrol station.

The alternative is to use 'relative positioning'. Suppose that you arrive at a city in the disaster zone, and are given a road map, that you purchased at the airport petrol station, to find your way to the next rendezvous. What you would do is go to a place on the map which is very distinct. Go there (or send someone there) and Using the GPS, find the exact position of this place. It will now become a WAYPOINT. Record this waypoint in your book and agree with other members of your organisation the name of this waypoint and its absolute (lat and long) position. You will have to do this because other teams may have a different map with a different scale, colour code scheme, icon scheme and grid system to the one you are using.

Your map will hopefully have a reasonable scale printed on the border, and an indication of which way is north, though this is usually (but not always) the direction pointing straight up. Now mark the position of the place you want to go next. This will be another waypoint, you can name it what you like but the place name on the map is best (provided you can read and pronounce it!). Using a ruler and divider, you can draw a line between the two places and measure the line. You now know the direction and range of the other waypoint. You can now type this information into your GPS, and it will remember the location of the two waypoints, and even calculate the absolute lat and long of the other waypoint for you.

Well, that was jolly good schoolboy fun, but why did we do that? As you drive down the rutted roads in the bad weather for hours, you will probably wonder where you are and if you are going in the right direction at all. Your GPS will probably be battery powered, so rather than leave it on all the time you should switch it on only when you need position information. You would then switch on your GPS, and ask it what is the range and direction, from where you are now, to any of the waypoints you have entered into its memory. You will get a readout saying, "270 degrees 7Km". Now you can pinpoint yourself on the rather sparse map you have, even without any grid marks on the map and even if there is no landmark at that point. Furthermore, if you have a compass, you can use the direction for steering, provided the road system is simple enough. However you must be clear if the baring shown on the GPS screen, is the baring FROM the waypoint or TO it (or you could be driving the wrong way.. it has happened).

When you arrive at the scene of some obvious need, you can ask GPS for the position, and create a new waypoint at this spot. You can then use the relative information about how far away from another known waypoint this is, to draw its position accurately on you map. You can also use the absolute lat and long position to send to the other teams by radio, so that they can mark it in on their maps and find their way more easily. They will also know if they have got the right spot.

Used wisely, GPS can give a great deal of time and money saving help, and all at very modest outlay. GPS will probably be in service for many years to come and so you can invest without fear of the equipment becoming obsolete very soon. However it is important to remember to ask for a model that can calculate waypoints and give relative positions, or GPS will be useless without lat and Long maps, which you can bet will not be available to you. You should also share waypoint information with other teams, and collect positions from them. This not only saves misunderstanding, but adds a significant safety factor, you never know when they will fail to report and you will have to find them without being able to communicate with them. You should likewise report to someone else what waypoints you are expecting to be visiting before your next communication.

There are other systems than GPS for position finding, some based on ground based transmitter stations, such as Decca, Omega and Loran. However these are vulnerable to the user straying out of the range of the system, and to the failure of the ground based radio base stations providing the signals. The advantage of spaced bases systems such as GPS, Transit and Glonass, is that they are immune from land based disasters, and have global coverage.

## 6.25 The Future

In the future we could have advanced satellite systems offering global mobile phone systems at a very reasonable cost. When that happens, then the users will at last have what they think they really need. It is also thought that there will be a kind of satellite version of packet radio, giving access to Internet. A world wide library system called World Wide Web will make it possible to for example fetch maps and photographs of a place together with a detailed guidebook about it instantly on your screen. You will be able to read this book on your screen as it too will be on the WWW (it is hoped).

However this will not make your investment in the conventional systems obsolete because the future systems may be just as prone to overloading as the present ones are. Therefore you should consider them to be your secondary system until they mature, well into the first decade of the 21st century. It is an exciting future for the communications industry, but also a confusing one, that is why DRCF is here to help you. Future revisions of **Disaster Communications** will include anything promising that comes up. To do this we need your help, both financially and with information.

There is also excitement on the legal front. Remember all the legal hurdles to getting even a simple system set up? Well in 1996 there will be an International Convention on Emergency Telecommunications, which, it is hoped, will clarify and simplify the situation. The aim is to make moving equipment across borders easier and setting up emergency communications systems rapid and efficient by bringing in new legislation. It is hoped that many countries will sign up for an agreement to allow a waiver of the usual red tape in the case of an acute emergency, but of course there will be many terms and conditions to be met by prospective foreign rescue teams. The DRCF will be here explain them.

## 6.26 Training

Everyone realises the need for better training of key staff in the arts of Emergency Telecommunications. Not just techno- waffle for the boffins, but down to earth clear grounding for the decision makers in our business.

Many of the decision makers in aid and disaster work are intelligent, experienced and highly motivated people. Few however have any kind of telecommunications background and this often results in the application of technology which is sometimes less than appropriate. These are busy people who need courses that will fill their needs for keeping up to date with todays can-do technology but keeping the language at popular level.

The DRCF and several other groups are actively working on establishing a framework for defining target groups for training and developing such courses. It is hoped to be able to offer theoretical and practical courses covering all aspects of this work, from a co-operative and co-ordinated base, within a time scale of about two years.

This book will be updated and expanded as experts submit more input to it. In addition it is proposed to add smaller booklets about topics which attract popular attention.

We have a lot to do before the International Decade for Natural Disaster Reduction (IDNDR) is out!

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[66]In fact they go to the trouble of arranging 'talk through' systems on their duplex base stations to give this effect.

[67]See Appendix for the full International Phonetic Alphabet.

[68]The antennas for Liverpool Coastguard's Marine Rescue Centre at Bootle are on top of Blackpool Tower, giving a commanding coverage of the Irish Sea.

[69]The UNDHA portable repeater for use at a disaster site has enough self contained battery power for 24hrs sustained operation.

[70]A personal opinion, your experts may advise otherwise.

[71]During the Koybe earthquake disaster, the mobile phone system survived in tact. The operators claim that service was provided without overload throughout the rescue period- Ericsson.