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Communications Equipment for Public Safety Communicators

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Answering the Call

COMMUNICATIONS EQUIPMENT FOR PUBLIC SAFETY COMMUNICATORS





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Chapter 1: A Brief History of Telecommunications

Development of the Telephone

The word telephone originated from the Greek words *tele*, meaning far, and *phone*, meaning sound.

A Brief History of the Telephone

- 1876 Alexander Graham Bell is credited with inventing the first telephone in Brantford, Ontario and patenting it in Boston, Massachusetts. In August of the same year, the first one-way long-distance call was made over an eight mile span between Brantford and Paris, Ontario.
- 1878 The first telephone exchange was constructed in New Haven, Connecticut. Total customers: 21.
- 1892 First commercial switchboard.
- 1896 Dial telephones invented.
- 1915 New York and San Francisco integrate the first transcontinental phone service.
- 1927 The first transatlantic radio-telephone service between New York and London, England.
- 1960 Communication satellites were brought into existence by the United States. These satellites were huge silvery balloons that reflected radio signals to ground stations.
- 1970 Overseas dialing between New York and London could be done directly, without operator assistance.
- 1982 Mobile telephone systems in operation after licences granted by the Canadian Radio Telecommunications Commission (US Federal Communications Commission). Mobile units included car phones, cellular and radio telephones.
- 1997 Entry of Personal Communication System (PCS) on the public market.

- Today we have an explosion of personal communications devices to stay in touch including wireless systems, picture phones, blackberry, etc.

Not only has the telephone changed visually in the past 120 years, but the way calls are carried over distance has advanced as well. Copper wires were originally the only means for transferring information from one phone to a commercial switchboard, to another phone. With the advance in technology came communication satellites, which reflect signals from one ground station to another. Now, airwaves can also be leveraged to play an important part in telephone communication.

Early Systems

In the early days, telephone systems were entirely manual. The person who wanted to place the call would have to crank a handle on the side of the phone set. This cranking action would alert the operator who was sitting in front of a small console. The operator would question the caller to obtain call information. If the operator could connect the caller to the desired destination through the local switchboard, he/she would do so using a combination of patch cords and switches. At the termination of the call, the operator would manually disconnect the caller by unplugging the patch cords. If the call could not be completed locally, the operator would have to access other switchboards in other parts of the community.

If the call involved a destination that was long distance from the caller, more switchboards were connected. Since everything required a wire connection, these calls used hundreds of miles of twisted copper wire, and international calls used thousands of miles. This process produced poor audio quality. As telephone service was extended to more and more customers, it became apparent that a better method of handling calls was needed. Equipment that could be automated in some way had to be developed.

Telephone Exchanges

The first user switchable equipment was for the operators who had to answer and interrogate callers. They could then connect to other operators at other switchboards using a new device: a rotary dial wheel.

Operators kept a directory of locations and could determine call routing based on their own knowledge of geography and the telephone systems of the day. The use of the rotary dial for operators had minimal impact on the callers, but paved the way for the domestic dial telephone set. For the operators, calling was only slightly less labour intensive. Callers still had to be interrogated, a switchboard dialed up, and calls manually connected and disconnected.

Automatic Switching

The next leap of technology was the connection of telephone subscribers to equipment that could be switched automatically according to the signals sent by the caller. This was achieved by providing telephone sets equipped with a rotary dial wheel. Just like today, callers dialed a series of numbers that were interpreted automatically by the telephone switching equipment located in a central office. The first *switched* exchanges could only complete calls in a specific geographic area defined by the locations of telephones directly wired to the telephone exchange. If a caller needed to reach someone outside the local exchange, operator intervention was required. As technology advanced, adjacent exchanges could be called without the assistance of an operator. If the call was determined to be long distance, operator assistance was again required. Now, long distance calling can be routed through microwave systems and orbiting satellites. As technology improved, so did the audio quality and the speed of establishing the communications connection.

Convergence

Convergence, as it applies to technology, implies moving towards one point or moving towards one another. In this case it is the rapidly moving enhancement of technology and merger of the previously separate communication sectors through the advancement of computer technology and digital technology.

Convergence makes it possible for one element to provide multi-service. An example of this is in the mobile phone, which was initially designed for voice communications. Today cell phones offer more functions: They offer print and text media as in the Short Message

Service (SMS); they provide reception links to radio stations and access to broadcast information, they provide links to access the web, they capture, send and receive pictures and a new generation of cell phones are designed to capture video images. They can be used coast to coast and fit easily in pocket or purse.

The changes in telephone technology include digital technology for cleaner sound that is free of interference. The arrival of digital processing of sound has enabled personal computers to replace telephone sets through Voice-over Internet Protocol (VoIP). Phone, fax, e-mail, and television can all be operated simultaneously through personal computers. This convergence of equipment compatibility is heading us to an age of universality and better connections for our communication.

Chapter 2: Modern Telephone Equipment

How Call Information Arrives

Callers may contact an agency through a multitude of sources. The most common means of contact is the telephone. Callers may come through the switchboard at the agency, be redirected from another extension in the agency, or come directly through the emergency or 9-1-1 line. Callers may also contact the agency through the telephone operator or be connected from another agency.

Direct information can be passed on to the communicator through the agency radio system from another agency sharing the same channel, or they may use the same system to pass on second hand information from a citizen who contacted their agency in error. Inter-agency memorandums or correspondence from support or outlying agencies are another source of information that may lead to a call being processed. The agency may also be contacted on their Canadian Police Information Centre (CPIC) terminal or by message form through an automated system (Computer Aided Dispatch, [CAD] such as Versadex CAD using BC- PRIME, Computerized Integrated Information Dispatch System [CIIDS] or another type of software).

Citizens may approach a field unit with information that will be passed on to the call taker, through the radio or a mobile data terminal (MDT). It may take the form of e-mail, fax, or direct communication. Callers may make contact with the agency in person by attending the front counter, knocking on a secure door, or buzzing on an exterior intercom system. They may pass on information to another employee of the agency or through regular mail or a courier service.

In short, caller information can come to an agency through both the most obvious and the most unlikely paths. Communicators need to be familiar with all the equipment utilized within their agency, as well as systems used by neighbouring or support agencies. The following equipment is often found in public safety communications facilities:

- Telephone system (regular, switchboard, 9-1-1, direct lines)
- VoIP phones through a third-party call centre

- Pagers
- Intercom
- Radio base station
- Trunk system
- Repeater system
- Radio/telephone headset interface
- Portable radio
- Mobile radios
- Facsimile
- Computer Aided Dispatch (CAD) system
- Computerized Integrated Information Dispatch System (CIIDS)
- Police Information Resource System (PIRS)
- Police Records Information Management Environment (PRIME)
- Canadian Police Information Centre (CPIC)
- Logging recorder
- System alarms

Not every agency will have all, or even a few, of these systems in place. There may be equipment specific to agencies not included in the list given. It is the communicators' responsibility to learn the systems and equipment at their agency and be able to perform with them in a competent and professional manner.

Modern Telephone Systems

Modern telephone systems include *manual, semi-automated and fully automated systems*. Effective call takers are familiar and proficient with all technical equipment in their work environment. Each agency or department has equipment unique to it. Experienced call takers make themselves aware of any equipment in their agency. The call taker should be masterful in the use of each piece of standard equipment, aware of its back up capabilities and whom to contact when it fails. They are also responsible for knowing how to perform their duties

professionally and proficiently manually, in the event of apparatus failure. Call takers should also be aware of the location and the uses of any manuals associated with the equipment, and keep up to date on any changes or updates relative to the operation of the equipment.

Manual Systems

Manual call taking systems consist of the minimum equipment necessary to take calls and record information received. This is usually a simple telephone set without the means of transferring calls or sharing information with other operators or equipment.

Semi-Automated Systems

Semi-automated systems consist of more advanced equipment and usually include multi-line telephone sets that have the ability to switch calls between operators and interface with other electronic equipment.

Fully Automated Telephone Systems

Modern telephone systems use computer technology and high speed data channels to route calls, with reduced need for the intervention of human operators. Audio voice signals are converted into digital signals, compressed and multiplexed, and can be sent off into the international telephone system at the speed of light. Voice signals are accompanied by toll and system control information on the same line. Other information can accompany the voice signal or data being transferred by the customer. This additional information might include toll data and/or signals to verify accuracy of the transmission.

9-1-1 Communications Systems

There are three types of 9-1-1 communications systems and equipment:

- Basic
- Semi-enhanced
- Enhanced

Basic

A basic 9-1-1 system consists of either a simple telephone set that rings when a 9-1-1 call is placed, or of a set of multi-line phones with certain lines dedicated to incoming 9-1-1 calls, and a system for recording

incoming information with a pencil or pen on paper forms. Paper forms are an integral part of a call taking operation and are usually simple and straightforward. Call takers need to obtain sufficient information to allow for a safe and appropriate emergency response by the agency(s).

Semi-enhanced

A semi-enhanced 9-1-1 system usually consists of a basic phone system plus some kind of a Computer Assisted Dispatch (CAD) program. Such systems print or display the telephone number of the set from which the 9-1-1 call was placed, within seconds of the call taker answering the 9-1-1 line. This feature is known as Automatic Number Identification (ANI).

All CAD systems have pre-formatted screens that enable public safety communications operators to enter caller information through a keyboard. (These caller information screens parallel the forms used in the basic system.) The added benefit of semi-enhanced systems is the creation of an electronic archive of some kind. The call is electronically time and date stamped, and a paper record outlining the nature of the call can be produced. If the CAD system has a multi-terminal capability, the dispatcher may have a dedicated terminal that presents caller information. Delivery of ANI information is the only feature of a semi-enhanced system.

In a semi-enhanced system calls are answered at random by whoever is available to pick up the call, at the time the call comes into the Communication Center.

Fully enhanced

Fully enhanced 9-1-1 systems (E9-1-1) consist of a semi-enhanced system with the added feature of Automatic Location Information (ALI). ALI is the database of telephone subscriber information held by the telephone company. Together with ANI, ALI information is either printed or displayed to the call taker within seconds of answering the call. Display units consist of video display terminal (VDT) screens or liquid crystal display (LCD) units. ALI information *must* be confirmed during a 9-1-1 call.

Some systems allow for the automatic loading of ANI/ALI information directly into an incident screen. Most systems have an incident coding system that automatically establishes the priority of the call and can even send the call to the appropriate zone dispatcher.

Automatic Call Distribution (ACD) is telephone switching software that has the ability to queue incoming calls in order and to distribute them to available operators. It is an effective method of ensuring all available lines in a Communication Center are utilized effectively. A Fully Enhanced 9-1-1 system will often contain this feature; however ACD is also a stand alone system and may exist in Centers that do not have a 9-1-1 system. Archiving software such as the Genesis Call Management system can produce a variety of statistical information such as call volume, number of rings before answer, number of calls per operator, etc. This software is compatible with a number of call answering systems, including 9-1-1.

Fully automated systems may allow for the direct querying of persons, vehicles, etc., from the occurrence screen. Systems may include several keyboards, large color monitors, printers, and so on.

There are many types of emergency dispatch systems, which vary significantly in functionality and user-friendliness. Large complicated systems provide superior capability, but require greater commitment to maintenance, user training, training systems, etc.

One of the main problems associated with fully enhanced systems is the reliability and currency of the database that feeds the ANI/ALI information. Human error can result in the entry of incorrect or dated information. In addition, sometimes the information presented to the call taker is not the actual location or phone number of the calling party. Calls originating from wireless telephones such as cellular, personal communications devices, autotel, marine radio telephone often do not contain correct ANI information and usually never contain ALI information. This is also a problem when other relaying – such as call forwarding – is used.

Next Generation 9-1-1 (NG 9-1-1)

In the Next Generation 9-1-1 environment, the public will be able to make voice, text, or video emergency "calls" from any communications device via Internet Protocol-based networks. The PSAP of the future will also be able to receive data from personal safety devices such as Advanced Automatic Collision Notification systems, medical alert systems, and sensors of various types. The new infrastructure envisioned by the NG9-1-1 project will support "long distance" 9-1-1 services, as well as transfer of emergency calls to other PSAPs, including any accompanying data. In addition, the PSAP will be able to issue emergency alerts to wireless devices in an area via voice or text message, and to highway alert systems.

(Source: wikipedia.org)

Commercial 9-1-1 Terminal Equipment

NORTEL (Northern Telecom)

Nortel equipment uses 14 inch VDTs to display ANI/ALI information. Typically, call taking and dispatch consoles are already crowded with keyboards and other VDT devices, so the addition of these large display units creates further crowding of workstations.

Positron

The Positron system displays ANI/ALI information on small (7") monochrome VDT screens or on small narrow Liquid Crystal Display units. The small size of this equipment is beneficial, in that it can be installed in a console quickly and efficiently and does not take up a great deal of space.

Both NORTEL and Positron systems display the ANI/ALI information in a common format.

Computer Network Systems

Computers are the norm in most public safety agencies. For most effective communication, they are connected to both phone and dispatch systems as well as other equipment via networks. Fully automated systems traditionally operate with the use of a mainframe computer. The mainframe computer could be located in a remote

location and could have other functions besides supporting the call taking and dispatch operation. Such systems require backup power in the form of uninterruptible power supplies and/or stand-by generators, in order that power failures not affect the operation.

Local Area Network (LAN) systems

Typically, automated call taking and dispatch systems are supported by a Local Area Network (LAN). Such a system of computers enables the sharing of information between workstations and the routing of communications into and out of the communications centre. The heart of a LAN is its server.

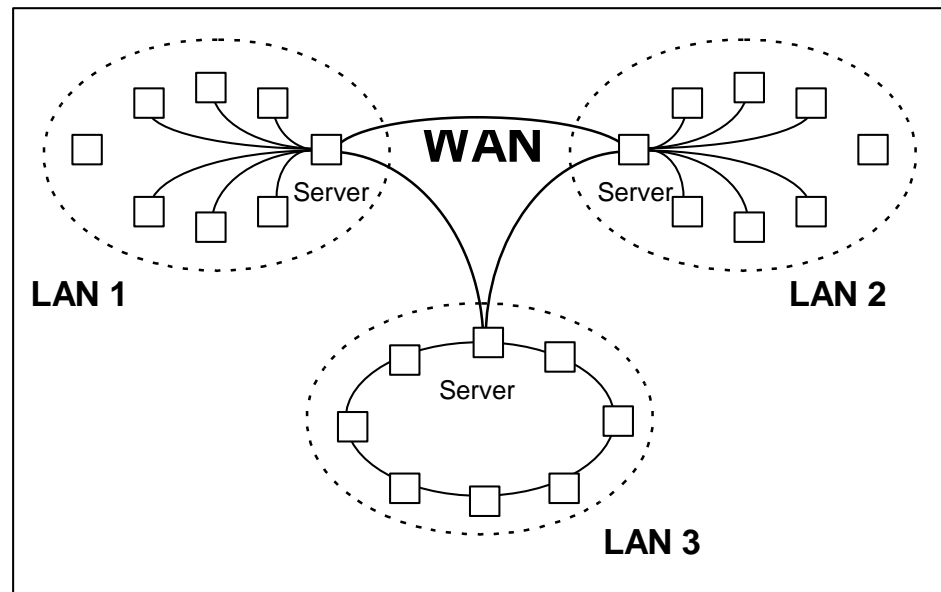
The server consists of *multiple computer processors, high capacity hard drives, and a large RAM memory*. The server stores shared programs, archives and logs system activity, and backs up the files of individual workstations. Most business establishments use LANs to run word processing, spread sheet and other programs. LANs allow employees to communicate with each other and simultaneously work on the same projects.

Wide Area Network (WAN) Systems

Systems that connect LANs to each other are known as Wide Area Networks (WAN). WANs may operate over a large geographic area, and may be province- or country-wide. The Internet is a type of WAN.

The Kwantlen computer network system has both systems. The Richmond campus has a LAN that supports its in-house communication. Similar LANs exist at the Newton, Surrey and Langley campuses. All four locations are tied together using a WAN. All college terminals can communicate with each other no matter where they are located. The servers also enable staff to communicate with the system from off site through modem lines.

The following diagram shows three LANs connected to form a WAN.



Three LANs connected to form a WAN.

The RCMP operates two types of computer networks: the RCMP Office Support System (ROSS) and the Computerized Integrated Information Dispatch System (CIIDS). In British Columbia, police use a province-wide system (BC-PRIME) that links all departments together on an information sharing system. This allows all departments to collect and view information in real time.

The CPIC and PIRS systems are types of WANs. The ROSS system can be set up as a LAN in one location. Other jurisdictions have other ROSS LANs. They are connected together to form a WAN system, which allows each to communicate with the others nationwide.

The biggest single problem with large, wide scale, computerized systems is that they are subject to larger problems, especially when they fail. Theoretically, a system could be supported and operated over a WAN environment. This is possible, but not necessarily a good idea without built-in redundancies. The problem is that a single processor failure could bring the entire system down. Every public safety communications operation must have a contingency plan to fall back on (pen and paper) when their systems fail.

Specialized Equipment

Telecommunications Device for the Deaf (TDD/TTY)

Telecommunications devices for the deaf (TDD/TTYs) are used by hearing and speech impaired people to communicate over telephone systems. These are also referred to as TTYs (teletypewriters). These devices normally consist of a modem, a keyboard and a visual display. Some units can be connected directly to a telephone line, while others have cups into which the user must insert a telephone hand set.

The user dials a known TDD/TTY number, and the two devices are connected. Communication takes place as the users type messages back and forth. As the caller types the keys at the sending unit, the letters appear on a display screen or printer at the receiving unit. When a message is received at the receiving unit, the operator at the receiving end types a reply, which is transmitted back to the originating unit and appears on the caller's display.

Usually, calls from a TDD/TTY sound very much like a call received from a facsimile machine, with a series of tones and beeps. Sometimes, there may be a prolonged silence. This can create a problem in that an operator may assume it is a crank call or an abandoned 9-1-1 call, and may disconnect it. This causes consternation on the part of the speech or hearing impaired caller and causes potentially critical delays in response.

Since some agencies do not have TDD/TTY equipment, emergency calls from the deaf are relayed through a third party who then phones the emergency service agency. This service is commonly provided through telephone companies in Canada.

In the NG9-1-1 environment, the deaf will be able to place emergency calls by sending a text message from their cell phone. They will be able to carry on a text conversation with a 9-1-1 operator, and even send pictures or video when necessary

Hearing-impaired people often have less warning of crimes and other emergency situations due to their inability to detect auditory clues.

Crimes such as forced B&Es might be detected only when visual clues

are available. Timely response by the public safety agency is even more critical due to the initial delay in detection. A third party answering service further delays the process.

Another problem with TDD/TTY calls is that sometimes they appear as silent calls, that is, no one appears to be on line, when in fact a TDD/TTY is waiting to receive synchronization tones. Often, operators do not understand the nature of the call, or treat the call as abandoned or prank, which inevitably causes problems for the communications centre.

The Americans with Disabilities Act (ADA) has generated a great deal of publicity regarding the TDD/TTY. This act does not permit discrimination against disabled persons when accessing public service providers and states that disabled persons should have the same access to emergency services as those who are not disabled. For 9-1-1 operations, this means that third party answering of emergency TDD/TTY calls is discriminatory and is not permitted.

Such legislation does not exist in Canada.

Formats

Two types of formats are used by hearing-impaired people to communicate over the telephone: BAUDOT & ASCII. The two are not compatible, yet American Public Safety Answering Points (PSAPs) are expected to be able to handle both types of calls directly on their 9-1-1 trunks. This has resulted in a new line of telephone interface equipment especially designed to detect TDD/TTY devices and to correctly identify the format of communications.

Optional equipment, which can detect and decode the tones of either TDD/TTY format, is available and can be installed.

Operators working in a communications centre equipped with a TDD/TTY must ensure that they are adequately trained in the use of such a device, and that they are sensitive to the fax-like noises made by TDD/TTYs.

Facsimile (Fax)

The evolution of the telephone brought with it the development of equipment such as the facsimile and (fax). Inventors in Europe and the US began working on the fax in the late 1800s and early 1900s as a method of transmitting text and pictures over telephone systems. With the fax, an electronic scanner moves across the page and converts images into sets of electric signals. These signals travel over telephone lines to the machine receiving the fax; the receiving fax then converts electric signals back to the original document. The popularity of the fax increased dramatically in the 1980s as they became smaller, faster and less expensive.

One of the biggest problems with facsimile devices is the authentication process designed to ensure that you are actually communicating with the facsimile machine that you want to communicate with. In short, it is not that reliable and is subject to tampering. For the public safety communications operator, this raises two issues:

1. First, when someone sends the agency an important fax, there is no positive way of knowing from where it is actually coming. It is possible for someone to intentionally send an agency false information.
2. Second, there is no real way of knowing that information you are sending out is going to the right place. Communications operators must be very careful about faxing information, and must also be very careful about receiving information. Whenever possible, an agency must have a way to confirm whatever information it receives by fax. This responsibility may not fall on the communicator, but may be delegated to an investigator.

The information that passes by fax is not secure. Someone with the intent and the technical expertise can intercept faxed information. The only way to circumvent this is to use facsimile equipment that sends transmissions via secure data lines.

When information received over a facsimile appears to be legitimate, it would be treated and processed as any other call for assistance.

Modems

A modem allows computers to communicate with each other over telephone lines. (The word *modem* stands for modulator/demodulator.) A modem translates sound into tones that represent binary numbers, and sends these tones over telephone lines to other computers. The modem at the receiving end turns the signal back into numbers for the receiving computer. The modem makes it possible to talk from one computer to another directly or through an on-line service.

With the advent of the Internet and the interest in emergency services being involved on the net, there is a trend to encourage the public to send information to public safety agencies. This requires computers and modems to hook into the telephone system and make the connection. As with faxed messages, one cannot be certain who is sending the message. Information sent and received over the Internet is not secure and therefore should be verified by telephone contact before it is acted upon.

With the Internet comes an increased risk from hackers. A hacker is someone who has the intent to penetrate a computer system and to cause problems with the computer. Hackers are often the source of computer viruses, and they also take great delight in erasing hard disk drives and generally disrupting and destroying data. When information received over the Internet appears to be legitimate, it would be treated and processed as any other call for assistance.

Personal Alarm Systems (PAS)

A personal alarm system is an emergency communication system which allows the user to be mobile, and which can transmit the user's exact location to a monitoring centre. Elderly and/or disabled persons may use such systems. A large percentage of calls from PASs are false; somehow the button on the device gets pressed without the owner of the alarm realizing that the system has been activated. When a personal alarm system is triggered, a call taker at the monitoring centre will call the user to confirm that an actual emergency exists. On the basis of the information received, the call taker will contact emergency services as needed.

Some personal alarm systems connect directly to public safety communication centres. Call takers are required to take all such calls. If a call turns out to be false, the subscriber may be embarrassed and the responder upset, but ignoring any calls is not an option.

DVERS Alarms

Domestic Violence Emergency Response System (DVERS) alarms are personal alarm systems installed in the homes of victims who have been considered to be at very high risk of domestic violence, sexual assault and criminal harassment, often by an estranged partner.

Chapter 3: Wireless Telephones

One of the main thrusts of new telephone technology, and certainly the most visible, is the development of personal wireless equipment. While wireless equipment has been available for the connection with remote locations for many years, the advent of the *cellular phone* system has brought true phone portability to most people in our society. These modern wireless telephones transmit clean voice and data signals, and eliminate the clumsy one-way conversations punctuated by “over”, “over.”

Cellular Telephone systems

Wireless telephone equipment comes in several varieties, the most common being cellular telephones. Cellular telephone systems consist of small mobile radio transceivers, and radio transmitting and receiving towers that provide small, concentrated *cells* of signal coverage area. Cells are located in relatively close proximity to one another and are designed to provide service to specific coverage areas such as cities or high volume highways. The system works well in the designated service areas; however, outside of the designated signal area, the coverage vanishes quite suddenly.

Every digital or analog cellular system is comprised of four parts.

1. Cells and cell sites (base stations)
2. Switching station (mobile telephone switching office or MTSO)
3. System operator and its local office
4. Cellular telephones

Cellular *mobile* telephone services are systems that involve equipment located in cell sites and in mobile units, and in a mobile telephone switching office which controls the operation of the entire system.

Cell Sites

All cell sites contain a radio transmitter, a receiver, and an antenna which together form a *base* station. Each cell site covers a specific geographic area.

The cell sites are connected by wire or fibre optics to the mobile telephone switching office for phone signals and data and system control.

Mobile Units

Mobile units, such as cellular telephones, are in constant contact with the cellular system. Even in stand-by mode, the cellular telephone unit is communicating with the computer equipment at the cell site. The cell site senses whether or not the signal strength from the cell phone is increasing or decreasing. If the signal is being picked up by more than one cell site, the system monitors which signal is stronger, and will *hand off* a telephone set from one site to the next by commanding the cellular telephone to switch to another channel. The cell site also can command the cellular telephone to increase or decrease the power output to the transmitter. Cellular subscribers who are mobile in a city or traveling down a highway may be handed off several times during the course of a conversation without realizing it. The system is transparent to the user, and very simple to use.

When in operation, mobile units are in radio contact with a base station. Since mobile units roam from cell to cell, they need to change the frequencies used in transmitting and receiving because their distance from various base stations changes. To enable a mobile unit to change frequencies, its location must be determined so assignment of the change in frequencies can be relayed to the unit. When in use, the unit determines which base station receives the strongest signal. A *hand-off* (the transfer from one radio channel to another) is determined by signal strength. When frequencies must be changed, the information is sent through the voice channel to the unit, which in turn changes the frequencies of the unit.

Mobile Telephone Switching Office (MTSO)

Mobile Telephone Switching Offices (MTSOs) are connected to base stations by telephone lines (land lines). Each office is connected to another switching office in the telephone network. A signal is transmitted by a mobile unit, received by the Cell Site (or base station), and is sent from the base station to the MTSO, from where it is sent to

its destination, thus completing the call. The following diagram represents the process that a cellular telephone uses.

Cellular System Basics

Making a Call

When a cellular user makes a call from a cellular phone, radio signals are transmitted to the cell site. The cell site alerts the Mobile Telephone Switching Office (MTSO) switching station. The MTSO, in turn, provides an open channel (frequency) and connects the call to the Public Switched Telephone Network (PSTN). The PSTN put the call through to the number to be reached. This process takes the same amount of time that it takes to make a call from a land line phone.

Receiving a Call

A call placed to a cellular phone may come from either a land line phone or another cellular phone. Regardless of the source, the MTSO is notified that a call has been placed to a specific cellular telephone number. At this point, the MTSO searches for the correct cellular phone by sending out data over the radio waves. Cellular phones that are in standby mode (i.e., turned on but not being used in a call) continuously scan the radio waves being transmitted by the MSTO. If a phone "hears" its telephone number, it sends back a signal that informs the closest cell site of its Electronic Serial Number (ESN) and its telephone number (Mobile Identification Number or MIN). The cell site passes this information to the MTSO, where the ESN and MIN are verified and a channel (frequency) is assigned for the call. The cellular phone receives the message directing it to tune to the correct voice channel. The cell site makes the voice channel available, and the call is completed.

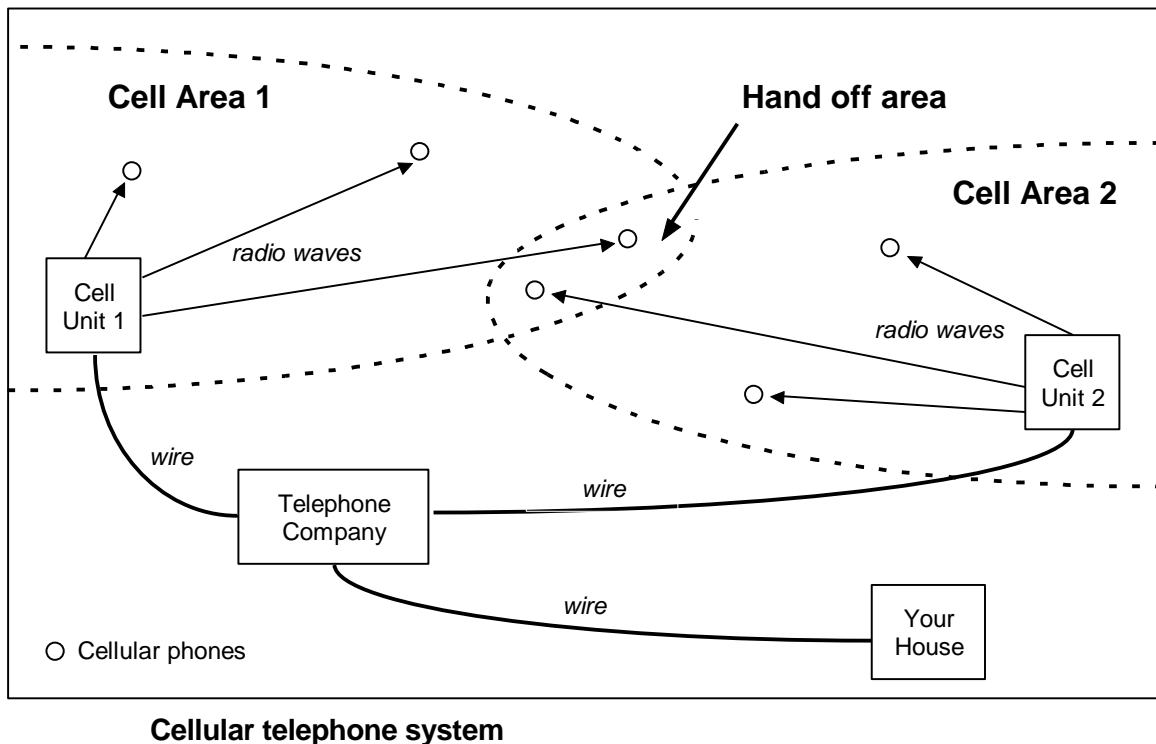
Hand-off

Hand-off is the transfer of a call from one cell site to another as the cellular phone moves through the service coverage area. The cell site warns the MSTO that the mobile's signal strength is falling below a predetermined level. The MTSO then alerts all cell sites bordering on the first one. They measure the mobile's transmitting signal and report

back to the MTSO. The MTSO, which is programmed to select the site receiving the strongest signal, switches the call from the weak cell to the strongest cell without interrupting the call. The entire process takes a fraction of a second, and the caller usually is unaware of it. Such hand-offs may occur several times during a single conversation as the caller moves through the coverage area.

Roaming

Roaming is a service offered by most cellular service providers that allows subscribers to use cellular service while traveling outside their home service area. When they come within range of another cellular system, the ROAM indicator on the cellular phone will light to show that they are in range. When they roam (operate outside their home system), their cellular phone will seek service from the same type of cellular system as the one they subscribe to at home. There is usually an extra charge for calls placed while roaming.



Marine coverage

Commercial and recreational boaters require communication equipment for a variety of reasons, but most importantly for emergencies. Cellular

phones provide an easy way for boaters to contact emergency services quickly and safely.

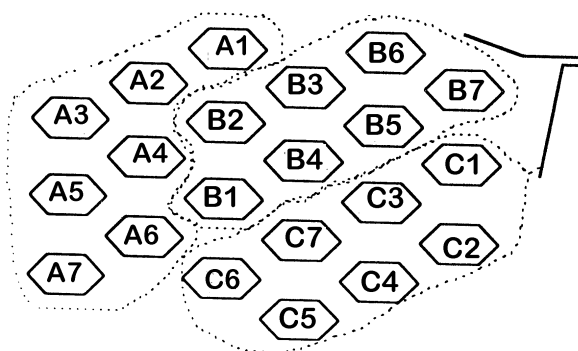
Land coverage

Cells are designed to provide service to specific coverage areas such as cities or high volume highways. The system works well in the designated service areas; however, once a subscriber gets outside of the designated signal area, the coverage vanishes quite suddenly.

In highly populated areas, problems such as congestion can occur. This problem can be minimized by subdividing or splitting cells into smaller ones and using lower-powered transmitters. The ability to be mobile with a cellular phone is achieved by extending the transmission across cells, and changing frequencies as needed. To change to other frequencies effectively requires cellular phones to be tracked. Dynamic tracking is a feature in cellular telephone service that involves the use of sophisticated technology to track cellular phones for the purpose of changing frequencies.

Organization

Cells are organized into clusters. Clusters consist of seven cells. Each cell contains approximately 95 channels, which provides 665 two-way radio channels to a cluster. The clusters are repeated over a geographic area, providing unlimited frequency use within a boundary.



**Cells A1, B1, C1 would share the same frequencies,
cells A2, B2, C2 would share the same frequencies
cells A3, B3, C3 would share the same frequencies, etc.**

A major problem with cellular telephone equipment is the absence of ANI/ALI information. Call takers must ensure they gather enough information about caller location and call back details on incoming cellular calls. Another problem is the volume of calls. With a cellular system, the communications centre might get 20 or 30 calls for the one situation, compared to one or two calls on the regular telephone system.

Professional organizations such as NENA and APCO have been lobbying the legislators and commercial providers of cellular equipment for solutions to problems created by this technology. Professionals believe the answers to cellular ANI/ALI problems will be found in cellular signal triangulation and location determination technology. If the geographic position of a cellular telephone can be determined, the information can be processed into an address or a location anywhere on the surface of the planet.

What is Wireless 9-1-1?

In most areas of North America, citizens have basic or enhanced 9-1-1 service from their landline, or wireline, phones in their homes or workplaces. Basic 9-1-1 means that when the three-digit number is dialed, a call taker/dispatcher in the local public safety answering point (PSAP), or 9-1-1 center, answers the call. The emergency and its location are communicated by voice between the caller and the call taker. In areas serviced by Enhanced 9-1-1, the local 9-1-1 centre has equipment and database information that allow the call taker to see the caller's phone number and address on a display. This lets them quickly dispatch emergency help, even if the caller is unable to communicate where they are or what the emergency is.

However, when 9-1-1 calls are made from wireless phones, the call may not be routed to the closest 9-1-1 centre, and the call taker doesn't receive the callback phone number or the location of the caller. This presents potential life threatening problems due to lost response time, if callers are unable to speak or don't know where they are, or if they don't know their wireless phone callback number and the call is dropped.

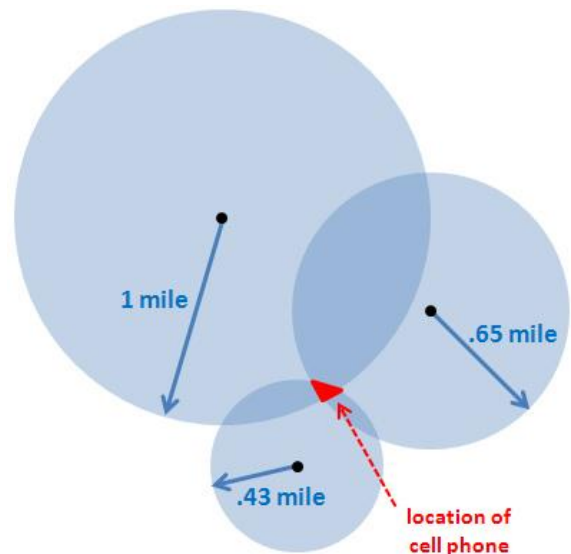
Three Phases of Wireless 9-1-1

There are three phases that are referred to in implementing Wireless 9-1-1. The most basic of these, sometimes called Wireless Phase 0, simply means that when you dial 9-1-1 from your cell phone a call taker at a public safety answering point (PSAP) answers. The call taker may be at a local PSAP, in a city or up to hundreds of miles away, depending on how the wireless 9-1-1 call is routed.

Wireless Phase I is the first step in providing better emergency response service to wireless 9-1-1 callers. When Phase I has been implemented, a wireless 9-1-1 call will come into the PSAP with the wireless phone call back number. This is important in the event the cell phone call is dropped, and may even allow PSAP employees to work with the wireless company to identify the wireless subscriber. However, Phase I still does not help call takers locate emergency victims or callers.

To locate wireless 9-1-1 callers, Phase II must have been implemented in the area by local 9-1-1 systems and wireless carriers. Phase II mandates that the wireless carrier must provide the PSAP with more precise location information based on handset or network-based location triangulation technology, or a combination of the two. The location information is provided is the approximate X, Y (longitude, latitude) location of the handset making the call. Phase II allows call takers to receive both the caller's wireless phone number and their location information.

Source: <http://www.nena.org>



Triangulation - cell phone detected within a certain radius of each of 3 cell towers – the area where each cell tower overlaps the phone is where it is pinpointed.

Personal Communications System (PCS)

Another form of cellular telephone technology is the *personal communications system* (PCS). It is like a cellular telephone system, but operates on a smaller scale. PCS systems are installed in large office buildings. The people who work in offices in the building use a small, battery-powered, cordless telephone. There are no telephone sets connected to wall telephone jacks. Everything operates in a cordless environment. If a person changes offices, the telephone moves with the person. Workers can move freely throughout the office building and take their phones with them. The phones are small, inexpensive and simple to use. The PCS system operates like a cellular network, with the exception that the network exists only in the office building – for now.

Eventually, as more and more buildings are equipped with these systems, people with PCSs will be able to roam around the downtown core of a city and never be out of touch with their offices as long as they are within range of a building equipped with a PCS system. PCS systems will be interconnected. There are plans to have pods of PCS coverage in high traffic areas, such as Automatic Teller Machines.

PCSs will operate under Code-Division Multiple-Access (CDMA) technology. With CDMA, a phone call is assigned a code instead of a certain frequency. Using the identifying code and a low-power signal, a large number of callers can use the same group of channels. When a user travels from one cell site to another, there is a soft hand-off, which means one connection is not dropped until after it is picked up from another cell site, resulting in fewer lost calls.

Time Division Multiple Access (TDMA) is a communication technique that uses a common channel for communications among multiple users by allocating unique time slots to different users. This is the preferred technique under Project 25 of APCO International, and the engineering method adopted by the majority of radio manufacturers in support of Project 25.

Personal Communication Systems have a wireless modem, which enables subscribers to connect the handset to a laptop or a fax machine

and access the Wireless Intelligent Network System (WINS). This system will eventually allow people access to information about traffic congested areas to avoid, or about the location of the hospital nearest to them. These phones will have better clarity than cellular phones, making it easier for emergency dispatchers to communicate with the caller. Fewer calls will be lost as it will be possible to use these phones in places such as tunnels and parking garages. It is not yet known if ANI/ALI will be able to pinpoint a caller's location from a PCS.

Companies in today's competitive market are researching ways to develop this feature; therefore, it will likely be available soon. When one considers the impact of conventional cellular telephones on 9-1-1 operations, the prospects for widespread PCS systems are overwhelming

Mobile Telephone Systems

Several mobile telephone systems are in use throughout the world. In North America, these systems are known by a variety of names such as mobile telephone, mobile, autotel, aurora, marine telephone, and so on. These systems are quite different from cellular telephones in that they are designed for long distance communications. These systems existed long before cellular telephones, and still have their application in areas where there is no cellular coverage. These systems have no ANI/ALI capability. Since they operate in a mobile radio environment, communications occur in what is referred to as *half-duplex*. This means that only one person can speak at any one time, like on an emergency service radio system. Usually, people will say the term "over" at the end of their conversation, giving the cue to the person to whom they are speaking to go ahead with their conversation.

Mobile telephones are generally operated in the following sequence: The radio user selects the channel that carries the repeater's frequency, then *keys* the microphone to activate the repeater, and dials in their personal access number, starting with the star key.

When access has been gained, the user will hear a dial tone over the radio and is then able to key in the telephone number they wish to

connect. When the telephone is answered, the user may carry on a conversation. The connection is:

Mobile Radio $\Rightarrow \Rightarrow$ Repeater $\Rightarrow \Rightarrow$ Phone System $\Rightarrow \Rightarrow$ Telephone

Most mobile radio services offer some privacy in radio conversation. Privacy is acquired by separating the two sides of the conversation. The radio will transmit on one channel and receive on another. This is preprogrammed into the user's radio. Anyone trying to listen on a scanner or their own radio phone channel would hear only one side of the conversation and a continual tone during the other side. However, someone with a scanner may find the frequency for the other channel and flip back and forth to listen to the whole conversation.

When the connection has been made, the repeater turns the extension number into a series of tones that are sent over the radio waves to activate the corresponding radio. (Each radio responds to a unique set of tones.) Then the caller dials a number for the repeater system and is then prompted to dial an extension number that corresponds to the radio they wish to contact. Once received, the tones activate the radio to ring. Some radios will beep, and others have been set up to have the vehicle's horn beep to signal the owner there is an incoming call. The radio user then dials in the access number and is able to converse with the caller.

Like an emergency dispatch radio system, squelch tails can be heard when the mobile party terminates the conversation and stops transmitting. Large areas of North America still have no cellular coverage. In these areas, however, the chances are very good that a form of mobile telephone coverage exists. All public safety communication centres should be prepared to deal with calls from mobile telephone systems particularly if the Public Safety Communication Centre is located in remote areas of the country, near the ocean, or near large bodies of fresh water.

To disconnect once the conversation is over the user re-dials the same access code only this time begins it with the pound key instead of the star. The repeater having received the *hung-up* code then sends out a

series of tones to confirm the disconnection. The sequence is:

Telephone $\Rightarrow\Rightarrow$ Repeater $\Rightarrow\Rightarrow$ Mobile Radio

Some mobile telephone services offer the ability to receive incoming calls. This is usually adapted into a vehicle mobile radio.

Chapter 4: Electrical Power Systems

Power Requirements

An alternate source of uninterrupted electrical power during a power failure is critical to the continuous functioning of communication systems for emergency services. During power failures, many people call 9-1-1 with inquiries or emergency situations. In order to deal effectively with crises or disasters, communication operators need access to all the equipment and systems available to them in their particular agency.

In modern public safety communication facilities, there are three main types of emergency power systems.

- Uninterrupted power supply (UPS)
- Standby power supply
- Powerline conditioners

The ability of the communications system equipment to withstand brief power failures will determine which emergency power system will best integrate with it.

Uninterrupted Power Supply (UPS)

An uninterruptible power supply is an essential part of any operation that is supported by computer operated systems. The UPS performs two functions:

- It provides continuous power to an electronic or computer device for a limited period of time.
- It senses a power fail situation and initiates the orderly shut-down of an electronic or computer device.

The UPS device uses batteries to supply power to an *inverter*, a solid-state circuit device that converts the direct current battery power to standard alternating current. When the external power supply fails, the UPS produces power for the equipment connected to the UPS. The UPS continues to supply power until the main power is restored, a stand-by power plant activates, or the batteries go dead. How long the

UPS will last on its own depends on how much power it must deliver, and the storage capacity of the batteries connected to it.

When purchasing a UPS for a communications centre, it is wise to purchase a good unit which will serve the agency's current needs and will allow for future growth and expansion.

Systems that are absolutely essential to the continuous processing of emergency calls are usually plugged into the UPS. Such systems include the telephone system, the ANI/ALI display units, the call processing terminals, the voice logging recorder, call check recorder, and the call dispatching terminals.

Equipment that can withstand a brief power failure (under 30 seconds) such as the radio and the CPIC and PIRS terminals will probably be connected to a standby power system. All other equipment can be connected to a powerline conditioner within the UPS to provide basic protection to the equipment from power surges.

All employees must be cautioned against operating appliances and other non-essential devices on a UPS circuit. Coffee makers and heaters will exceed the operating parameters of the UPS and will cause serious damage to the unit.

UPS systems can be hooked up to an emergency system two ways: *off-line*, and *on-line*.

Off-Line Systems

An off-line UPS system powers the load continually from the public utility and only switches to the UPS or inverter mode (battery) upon sensing a power failure. Off-line systems are unacceptable when associated with a sophisticated computer system as data loss may occur using this system.

On-Line Systems

An on-line UPS system continuously powers the load from the inverter. The advantage of the on-line system is that UPS output can be briefly operated in parallel with public utility during transfers from by-pass (public utility) to inverter. The result is an uninterrupted transfer of the

power load from one source to another. An on-line system also provides power conditioning and regulation.

A UPS system has three components:

- a rectifier/charger
- a battery bank
- an inverter

Rectifier/Charger

A *rectifier/charger* device converts AC into DC. The rectifier receives 110V AC (110 volts alternating current) from the AC's main supply. It will absorb the surge if the incoming voltage is over 110V. The rectifier then converts the voltage from 110V AC to 12V DC (direct current). This enables the battery to receive the power and become charged.

Terminology:

Alternating Current (AC)

The form of electrical power supplied to their customers by utility companies. The flow of the electrical current alternates directions very quickly.

Virtually all non-mobile electrical equipment connects to this form of electrical energy.

Direct Current (DC)

The electrical current flows in one direction only.

Battery

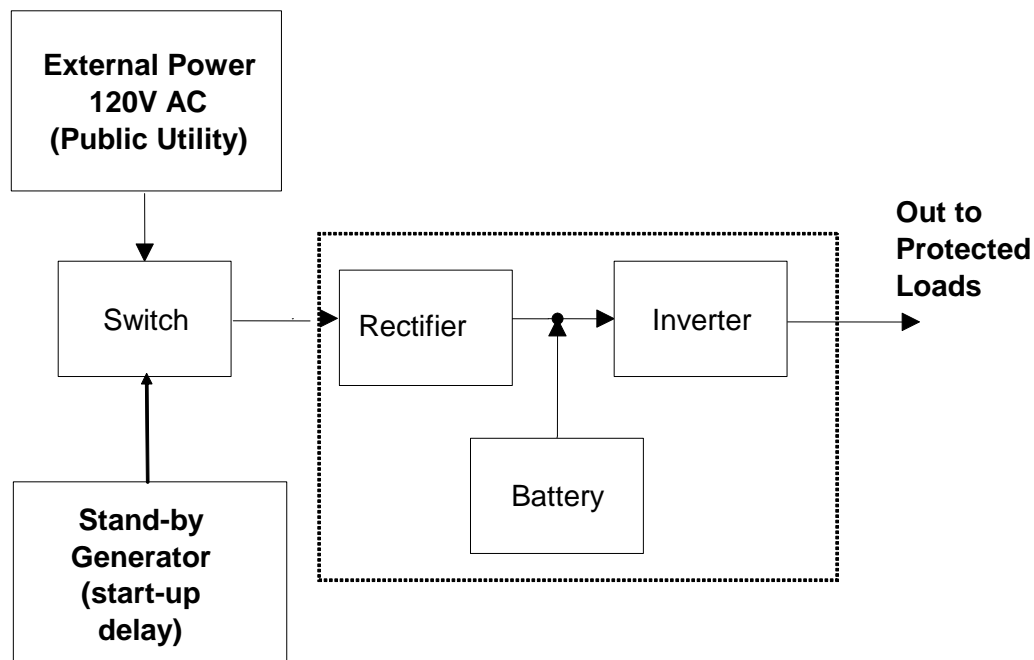
A battery is a source of DC electrical power. The battery is kept charged by the rectifier when the utility is providing a healthy supply of power. It discharges when the public utility power is disrupted. It also has the ability to stabilize voltage and current fluctuations.

Batteries can hold a charge from a few minutes to many hours, depending on the capacity, age and condition of the battery. As batteries get older, they become harder to charge fully and must be tested regularly. In a UPS system the batteries are in constant use; it is therefore important that they are in good condition and have sufficient capacity.

Inverter

An inverter is a device that converts DC to standing AC. The batteries supply power to a solid-state circuit inverter, which feeds power to the equipment connected to the UPS when in a power failure.

The following diagram shows an uninterrupt power supply (UPS).



Uninterrupted power supply (UPS)

Stand-By Power Supply

A stand-by power supply is a power source that activates when the public utility power or prime power source fails. It is necessary to have a standby power source so that information and data is not lost when the main power source fails.

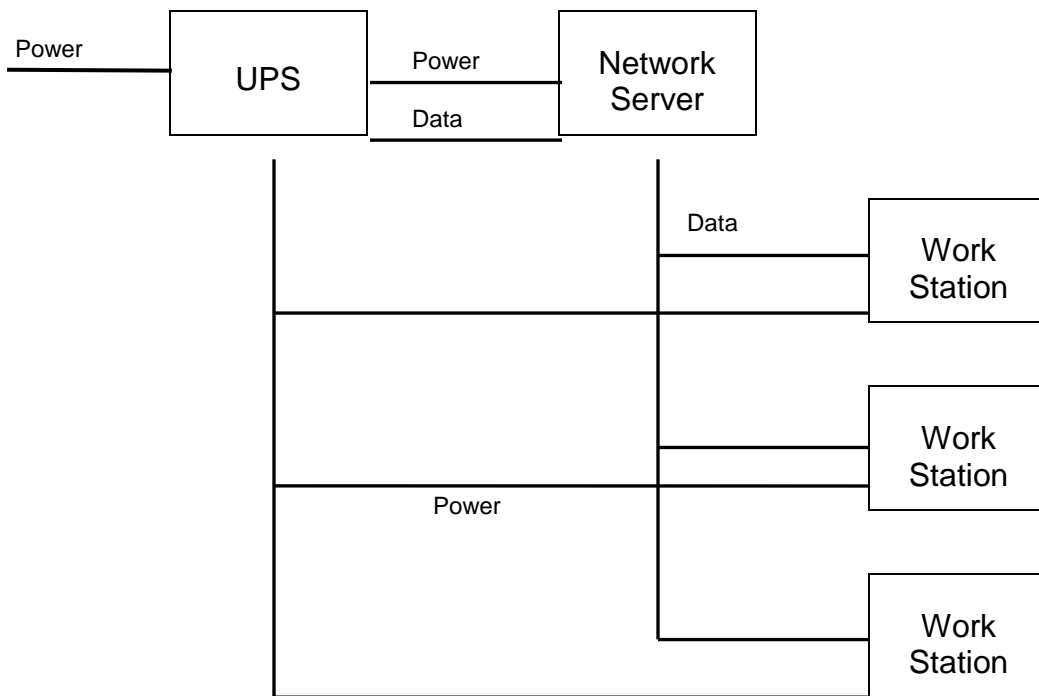
Stand-by power is usually supplied by engine- or turbine-driven generators (fueled by gasoline, diesel, propane, or natural gas), which produce AC electrical energy. Generators are designed to start after the main power source fails and will last as long as their fuel supply. When the system detects a definite power failure, the generator's starter is

activated. The generator is allowed to come to full operating speed and output, at which point a switching system cuts in designated power circuits from the main supply to the generator.

The generator operates until the main power is restored. When the system senses that the prime power source has been restored, the stand-by power circuits are switched back to the main AC supply, either manually or automatically, and the generator shuts down.

Secondary essential equipment is usually plugged into the stand-by power source. Such equipment includes the radio system, CPIC terminals, PIRS terminals, and other items that can afford to be out of commission for up to 30 seconds and can re-boot after the stand-by power system is activated. In modern public safety communication facilities, the power protection and emergency standby systems are interconnected and most often operate in conjunction with each other.

The following diagram shows a UPS for computer equipment.



UPS for computers

UPS for Computers

In a modern public safety communications facility, the UPS is connected to a network server (the system brain) with both a power line

and a data line. Work stations are connected to the UPS with a power line and to the server by data lines. Should the power fail, the UPS automatically begins supplying power from the generator to the network server and the work stations.

The data line to the server notifies the server that the power is out, and the server notifies the workstations of the situation so they can save or exit the programs that are running. Meanwhile, the generator would be started so that work can continue normally when full power from the generator becomes available.

A UPS system provides the additional benefit of protecting the equipment it supports by acting as a huge power filter and regulator. It filters out power spikes, and temporary power fluctuations appear to go unnoticed. Fifty percent of all blackouts last less than six seconds, but an outage of only 4/1000 of a second can have serious repercussions to agency systems.

Power Line Conditioners

Power line conditioners are devices that provide rudimentary protection against the problems associated with electrical power fluctuations, either of an internal or external source. Internal problems may be created by systems within the building environment, such as elevators, air conditioners and industrial equipment. Lightning, accidental damage to power lines caused by flooding, car crashes, earthquakes and utility grid switching are a few examples of external power problems.

A power line conditioner prevents voltage from sagging below the minimum or peaking over the maximum standard the system is designed to operate under. Power line conditioners are built into equipment and are usually passive in design, in that they are always working. They react automatically to voltage problems within a system or piece of equipment, and do not have to be activated manually.

Power line conditioners come in a variety of sizes and are usually located next or near to the equipment they are protecting (when they are not built into it). All computer equipment or systems that could be damaged should have some form of built-in protection.

During a power failure, the UPS supplies power to the network server and the work stations, and the generator takes over and supplies power as soon as it is running at full capacity, allowing work to continue uninterrupted.

Power fluctuations that may affect communications equipment take the following forms:

Spike

A *spike* is a short duration burst of high voltage of electricity, ranging from 200 to 6000 volts. Spikes may occur during the switching of large electrical loads to on or off, during utility switching, static discharges or lightning. A spike can cause damage to the hardware of the computer and destroy or damage network interface cards. It can also damage delicate equipment microchips, can corrupt data, or can create printer, terminal and data processing errors. The damage to these systems may be immediate or latent.

Surge

A *surge* is a momentary over-voltage that lasts longer than one cycle (1/60th of a second.) Surges can occur when an on-line device draws a large amount of power and then suddenly stops. They are dangerous not because of their magnitude, but because of their duration. Surges can cause damage to the hardware of the computer.

Sag

A *sag* is the opposite of a surge and involves under-voltage conditions. They can be caused by undersized power systems or the sudden start up of large electrical loads. Sags may slow the speed of disk drives, resulting in read errors or disk crashes. They may also cause the computer to freeze up.

Brownout

A *brownout* is a longer-term under-voltage which may last for minutes or hours. A brownout will deprive a system of the voltage needed to operate it properly. Brownouts often occur when peak demands of equipment exceed the capacity of generating power. Computer malfunctions may occur. Hardware damage may also occur and will be similar to damage caused by sags.

Blackout

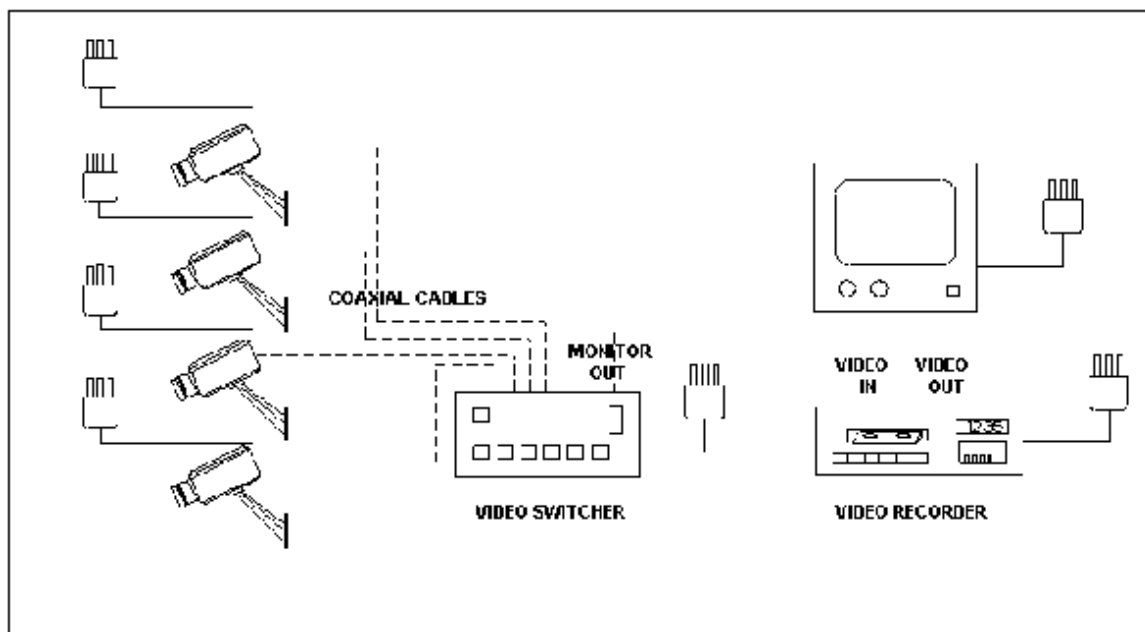
A *blackout* is a zero voltage condition that may last from a few minutes to days. Blackouts may be the result of acts of nature or by an overtaxed distribution grid. Blackouts can cause a complete system crash. They may also cause system component damage at the time power is lost.

Chapter 5: Closed Circuit Television Systems (CCTV)

Introduction to Closed Circuit Television

Closed circuit television as the name implies, is an interconnected circuit of video imaging where all of the elements are directly connected. These systems can be connected by microwave, infrared beams, telephone lines, digital cable etc. This differs from broadcast television where a tuned receiver can pick up signals from the airwaves.

Multi-Camera System with Video Recorder



CCTV is most commonly used in security systems, retail stores, banks, gas stations and government offices. The Ministry of Transportation & Highways maintains a video record of all vehicle license plates that pass through the Coquihalla Highway in British Columbia. Canada Customs has a similar system that captures images of license plates entering from the US. Those plates are then entered into a searchable database.

In the Lower Mainland there are CCTV systems installed at the Massey Tunnel, 48 cameras; the Cassiar Tunnel, 24 cameras; the Lion's Gate Bridge, 12 cameras; and the Skytrain system, over 400 cameras. Each of

these systems monitor traffic movement and provide video surveillance to security personnel. Transit is looking to expand their CCTV to over 800 cameras in the future. The private security industry has experienced a tremendous growth over the past five years and the use of CCTV systems continues to grow. It is estimated that the average Canadian is captured on video approximately 12 times a day!

Statistics from the United States and Europe indicate that cities that have adopted CCTV systems as part of their crime prevention goals have realized a reduction in crime.

Timothy McVeigh, the man convicted of the Oklahoma bombing was caught on a McDonalds restaurant video the day of the bombing dismissing his alibi that he was not in the area. The Ryder truck that he used was later tracked throughout the city by reviewing CCTV images from different city and private systems. Oklahoma does not have a police monitored surveillance system.

There are currently 41 Canadian municipalities investigating CCTV options for crime prevention strategies. Montreal, Sherbrooke, Hull, Winnipeg and Sudbury have already started this in a limited capacity. With these systems being monitored by police agencies, they can detect criminal activity, respond to a variety of calls quicker and have the ability to use the videotaped evidence for court purposes.

CCTV has been in use in the UK for approximately a number of years and there are still mixed reviews of its effectiveness.

The Vancouver Police used a large amount of video-taped evidence from the Stanley Cup riots in 1994. Much of the video came from private security cameras mounted on buildings in the area. There was a very high conviction rate for those charged in the riots based on the evidence provided by the video cameras.

Civil Libertarians believe the use of CCTV is like “Big Brother” images, saying that it invades people’s privacy. There is still a lot of controversy around a more widespread use of this technology in the Vancouver area.

The Supreme Court of Canada recognizes the value of video as an evidentiary tool. In the case of *Regina v Nikolovski*, the Supreme Court

stated its preference for video evidence over eye witness testimony when identification is at issue. In this case, the Court articulated the “Strengths of Video Taped Evidence”¹:

- ☐ It is never subject to stress.
- ☐ Through tumultuous events it continues to record accurately and dispassionately all that comes before it.
- ☐ Although silent, it remains a constant and unbiased witness, with instant and total recall of all it observes.
- ☐ The trier of fact may review the evidence of this silent witness as often as desired.
- ☐ The tape may be stopped and studied at any critical juncture.

¹ http://www.droit.umontreal.ca/doc/csc-scc/en/pub/1996/vol3/html/1996scr3_1197.html

(*R. v. Nikolovski*, SCC (1996), 111 CCC (3d) 403)

Chapter 6: Call Processing Systems

The majority of public safety communications centres are small operations that do very high quality work. Some of these smaller operations do not have highly technical consoles and equipment. They routinely use pencil and paper to record emergency calls and maintain the status of their units. They may only use a single radio channel in their operations. In simple operations, there are fewer chances that things can go wrong. For example, a pencil and paper system is not affected by power failures. There are no sophisticated software driven systems that might fail. It is inevitable that even the most complicated, sophisticated centre must revert to manual operation –pencil and paper – when other systems fail. Public safety communicators need to know how to perform their duties professionally using any system, from pencil and paper to the most sophisticated computerized equipment.

Inputting information

Depending on the system in use, communicators may hand write data onto forms, type or keyboard information, or input it electronically. When an automated systems fails, calls will be processed manually into a log or onto a ticket, and will be entered into the computer system when it is back on line.

When a communicator has gathered enough facts from the caller to assign a priority to the call, the call must be processed. This means forwarding the information to the dispatcher or to the field unit so they can take action on the call.

In smaller agencies, this may entail simply giving the dispatcher a hand written or typed form. For record keeping purposes, a log book will likely also be completed, as well as an occurrence report which is either filed or attached to the investigator's report.

Using an automated system requires less repetition as everything is recorded automatically within that system. Communicators enter data into a form on the dispatch screen, moving from field to field as needed while questioning the caller. When the call is complete, it will appear on the dispatcher or field unit's screen instantly with the push of a few buttons.

Manual Call Processing Systems

In a manual call processing system, forms become an integral part of the operation. The forms used to record calls are usually simple and straightforward. Public safety agency call takers need to obtain enough information to allow a safe and appropriate emergency response to occur. This information will go into the appropriate place on the form and includes – but is not restricted to – the following:

- incident location information;
- basic caller information such as name, address, phone number;
- details describing the incident situation and including all relevant information concerning safety, the condition of the caller, victims, alcohol, drugs, weapons;
- the priority assigned to the incident;
- responding units (unit call signs);
- time information such as time in, time dispatched, time units arrive, and time units clear the scene.

The amount of detail beyond the above information depends on each operation. For example, if the centre does only call answering, interrogation and call transfer, the use of forms may not be required at all. However, if the operation is a combination public safety communication centre and dispatch operation, the forms require places for details related to dispatch. The safety of both the public and the responders (field operations personnel) is always the main concern. An incident recording form should be simple and brief. Information beyond the initial recording and response is not the operator's responsibility and should occur outside the operational framework of the communications centre.

Components of a call always contain the essential information needed for assessing and dispatching each incident. The order in which this information appears on different screens, masks, log sheets or dispatch tickets may change from agency to agency.

Each call will require a *location*, which refers to WHERE the incident occurred or is occurring. It does not refer to the location of the caller or where the field units are required. Many times they may be the same place, but never assume they are. Be clear on what location means and identify specifically where the caller is, and where the field units are to attend in the appropriate areas of your report.

You will need to have the *details* of the call in order to process it. This includes: WHAT happened, WHEN did it happen, WHO is involved, WHY did the incident occur. Automated systems will automatically assign a code type to your call for record maintenance purposes, based on information you generate within the system. (e.g., B&E). However, in most cases you are responsible for assigning a priority to the call.

You will need to know WHO the principals are, HOW they are involved or related to the caller, WHY they are suspect in the occurrence. Suspect information will also include HOW they committed the crime, WHAT tools or weapons are involved, WHAT the suspect looks like, WHERE the suspect is located. If the suspect has left the scene, you will need to know WHERE the suspect went, HOW they left the scene, their direction of travel and the time delay involved.

Although there are a number of generic reports, each agency may have a form unique to it or an applicable department. The basics of information taking always apply to any form or screen communicators are responsible for completing.

Some calls will become part of a *bulk* file. A bulk file is a file with a unique file number under which a group of similar occurrences are recorded. An example of a bulk file could be a firecracker file created for the weeks surrounding Halloween. Instead of creating a different occurrence number for each firecracker complaint, complete details are still obtained and recorded, though all such calls are processed under one bulk file number. Snowball complaints, no case seizure of liquor (liquor is seized without charges being laid) on New Years Eve Night may also fall under this system. These files are archived for a specific amount of time as designated by law or agency policy.

All files are either SUI (still under investigation) or CH (concluded here). When a field unit requests you *write off* a file, and when no further action is required by the field unit or support staff, you *conclude the file* (CH). Many times call takers will write off a file directly, indicating that no other action is required by the agency. To CH a file in the communications centre, a call is typically generated for information or insurance purposes and is a call where no physical action is to be taken.

Any further action, whether in attendance or by phone, by a field unit or support staff in your agency after the initial call will render your file or call SUI. Communicators need to know their agencies' policies and their own responsibilities for writing off files.

Semi-Automated Call Processing Systems

Semi-automated call processing systems are simple Computer Aided Dispatch (CAD) programs on personal computer and other interactive systems, one notch above pencil and paper systems. Many medium-sized public safety communications centres use semi-automated systems. In a semi-automated call taking system, forms are replaced by a simple CAD program that provides an occurrence or incident screen. These basic CAD programs run on individual computer work stations, or can be networked among several computer stations. The call-taking screen is an electronic representation of the call taking form previously described. As in manual call-taking systems, call takers need to obtain enough information to allow for a safe and appropriate emergency response to occur.

Some systems have *menu windows* that open up as each area of the form is selected. For example, when the cursor moves to the type of event area of the screen, a small window opens that presents the most common types of calls, usually displayed in an abbreviated format. Date, time and event numbers are automatically loaded into the form. There is also an area that is reserved for comments or additional details. Depending on the sophistication of the CAD program, responding units may also become part of the occurrence screen.

Zoned Distribution Systems

A *zoned distribution system* automatically decides where a call should be sent for processing. Typically, when a call is received on an enhanced 9-1-1 system, information is presented that tells the call taker to which emergency services the call should be switched. For example, if a call originates in a particular jurisdiction that has its own police and fire services, the call taker is presented with call down-streaming options that default to the appropriate service in the appropriate jurisdiction. This information is determined by the ALI/ANI information delivered with the call. In some situations, the ALI/ANI information will be irrelevant or of no value to the automated system. In such cases the call taker must determine location, jurisdiction and appropriate response agencies. An example is a cellular call reporting an accident on a freeway passing through a jurisdiction that responds for fire but not for police.

When a call has been received by the appropriate agency, the call is assigned a zone code. Some systems do this automatically through the addressing software, or it may be assigned by the call taker. Assuming that the call has been assigned the appropriate zone code, the automated system will route the call to the appropriate dispatch position responsible for that zone. (A common term used to describe this action is *posting the call*.) The call is posted to the appropriate dispatch console. In the event that the call is borderline to another zone or has an impact on another zone, it can be *sent* to another dispatch position.

Logging Recorders

All public safety agencies use some type of device to record telephone conversations and/or radio transmissions for that specific department. These devices may be as simple as a reel to reel tape machine with 24 hour capabilities for a few channels, or as complex as a several-hundred-channel digital recorder with the capacity to store several days worth of conversation on a computer hard drive or DVD. As technology develops and budgets allow, there is a move to digital recording equipment. They are easier to play back as many are connected to a Windows format on a PC. They greatly reduce storage due to the amount of information held on a single tape. They also offer

many features that were not previously available in reel to reel models, such as variable speed playback, instant call retrieval from the computer hard drive, automatic erase and tape protection, and password control. The variety of recording equipment is vast, and varies greatly among communication centres.

The purpose of logging recorders is to create a record of all information received and transmitted by the particular agency. For the most part, much stored information is kept for a specified period of time as an archive, and then erased if not needed. The Radio Act of Canada dictates the retention time for some types of agencies logging tapes. Retention times for logging tapes can vary depending on the agency mandate, ranging from a month to over a year, and depending upon the inventory of tapes. In the case of a major incident or pending court case, the tapes are removed from the archive and kept as part of the evidence of the case throughout the duration of the proceedings.

Communicators may at first feel uncomfortable knowing that all conversations are recorded, though they may quickly become accustomed to the idea and may even find it comforting. Recordings can be replayed to verify that communicators said the right things to members of the public and to field units.

Logging recorders can also be a valuable learning tool that allows the listener to review an incident and to critique the response. By reviewing tapes, communicators can determine how they as call takers or dispatchers are perceived by the public or field units. Do the communicators sound authoritative or demanding? Do they present themselves and their department in a positive manner? Communicators' conduct both on the radio or over the telephone reflects directly back on the agency for which they work.

Chapter 7: Radio Communication Equipment

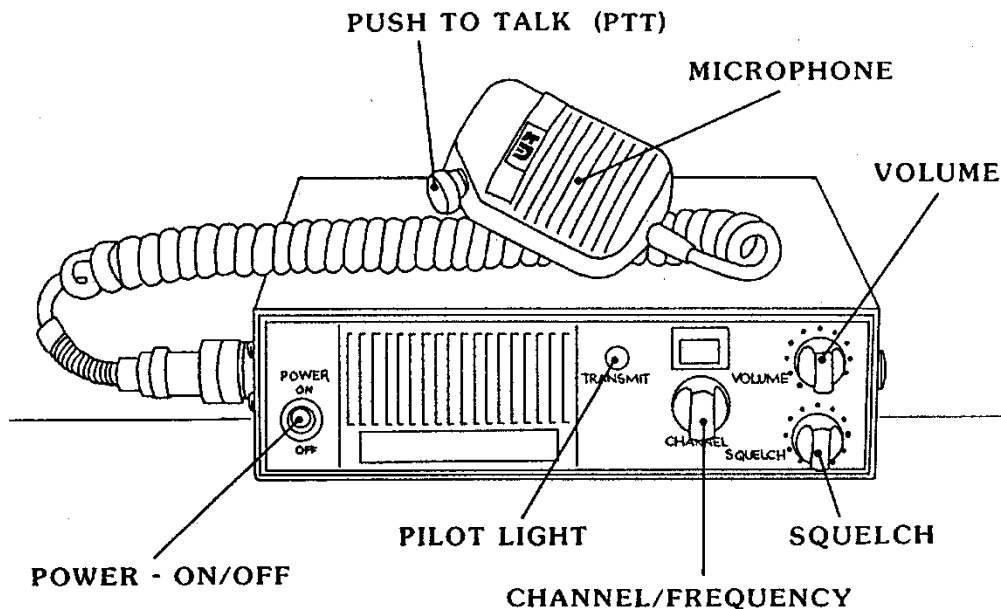
Once a call is taken and prioritized, it usually needs to be dispatched. Most agencies communicate by transmitting and receiving voice messages over a radio system. The most common radio system used by public safety agencies consist of a base station operating on one or two radio channels and portable or mobile radios tuned to the frequency of the base station.

Base Station

Base stations can be powered by public utility power sources because they are stationary. They are therefore able to transmit with greater power than mobile radios. Similarly, antennas for base stations can be of significant size and can be positioned for most efficient transmission of their signals. The strength of the base station determines the range of its coverage. Base stations are designed for ease of operation.

Mobile Radios

Mobile radios can be installed in cars, trucks, vans, buses, aircraft, or marine vessel. Citizen's band radios are one example of mobile radios. Public safety agencies use mobile radios in their vehicles. Radio controls typically consist of an on/off switch, a volume control, a channel selector and a squelch control. The latest mobile radios may not have a channel or squelch control, but the other controls are standard. Mobile radios, though less powerful than base stations, generally have a higher powered transmitted signal and performs better than portable radios.



A mobile radio system

Portable Radios

The portable radio, also known as a walkie-talkie, porta phone, personal radio device and so on, is a scaled down version of the mobile radio, and has most of the same controls and buttons. Portable radios are smaller than mobile radios, the power output of their transmitters is weaker, and they have a poorer antenna system. Users wear them on their belts and use a speaker microphone attachment to communicate. Since the human body is good at absorbing and deflecting radio waves, wearing the portable against the body reduces the amount of transmitted signal.

Repeater Systems

Virtually all large coverage radio systems use devices known as repeaters, which perform one single function: *repeating* or re-broadcasting radio signals. Repeaters are usually located at the high point in a coverage area. In a city, a repeater will be located atop a tall building or structure situated to provide the widest coverage possible. If coverage is required inside a building (like a shopping centre complex), the repeater can be inside the building connected to an internal antenna system. Outside the city, the repeater might be located on a mountain top, or on a tall communications tower.

Repeaters are used to boost the coverage of a radio system. Without a repeater, the typical range of VHF/UHF equipment is limited to several miles. With a repeater, coverage is extended significantly. Coverage is dependent on several factors, the most important being the location of the antenna, the power or strength of the transmitted signal, and the complexity of the geography of the coverage area.

In order to access the repeater system, the radio equipment must be capable of transmitting on one frequency and receiving on another frequency. This is known as a *duplex operation*. As a signal arrives at the repeater, it is simultaneously rebroadcast away from the repeater. The repeater receives and sends on the opposite frequencies of the radios to which it is tuned. The output frequency (transmit) of the mobile radio becomes the input frequency of the repeater (receive). The output frequency of the repeater (transmit) becomes the input (receive) frequency of the mobile radio. The same configuration applies to the portable radio.

Repeaters can be controlled in two ways. A *wild repeater* operates whenever it receives its assigned radio frequency signal. A *controlled repeater* operates remotely, that is, it can be controlled from a remote communications facility. It can be remotely turned on or off, or it may even be interconnected to other repeaters to form a network of linked repeaters. Linked repeaters can offer radio coverage to users over great geographic distances.

A simple system may use only several radio channels connected from a basic operating console to remote base stations, and repeater equipment that could be located on the building housing the communications centre, on a tower beside the communications centre building, or on some other strategically located site that could be a significant distance away. It is activated whenever the base station – or a mobile or portable radio – transmits a signal.

Semi-automatic repeater systems can be controlled to a degree by the dispatcher. This may involve the remote activation or de-activation of the repeater, or the interconnection of one repeater to another. This enables units on the road to contact other units that are out of the range

of one repeater, but in the range of another. In some systems, units that are hundreds of kilometers apart communicate with each other. Most semi-automatic repeater systems have an RTT system, which allows mobile units to get the attention of the dispatcher.

Radio Frequencies

Voice and data communications are sent and received over several types of radio systems. The radio communications spectrum consists of several frequency bands, each exhibiting unique characteristics according to the physics of the spectrum. Public safety communications have historically worked in the very high frequency (VHF) band, but in large urban areas, agencies have moved to the next higher group of frequencies called the ultra high frequency (UHF) band. Problems with skip are substantially – but not entirely – reduced in the VHF band. Under certain conditions, VHF signals tend to skip which disrupts the signal or causes noisy reception.

In large metropolitan areas, competition for VHF channels is great, and the entire VHF spectrum may be completely used up by taxi companies and other groups needing radio dispatch channels. UHF radio equipment requires a higher level of technology, but performs better than VHF equipment in some ways. Skip is virtually eliminated, and signal penetration through buildings and obstacles is better. VHF signals have a greater range than UHF signals, but for concentrated areas, UHF is the preferable. Most CAD systems operate in the UHF band. Some agencies leave their voice communications on VHF, switched to UHF for their CAD equipment, and continue to operate under a combination of the two systems.

Semi-Automated Radio Systems

Semi-automated radio systems have the capacity for remote control and inter-connection of repeaters, which allows better communications and leaves fewer *dead* areas. They also have the capacity to interface the repeater or radio system with a telephone line.

In some systems, there is a provision within the CAD program to perform limited control of the radio system, although the most common method to control radio systems is through a console. Radio consoles

consist of a series of control buttons that cause actions such as transmit, mute, volume, select, un-select and so on. Most consoles also have items such as a boom microphone, a vu-meter, which displays the operator's voice level, a hand and foot activated *push to talk* (PTT) switch, a speaker, a headset interface and one or more headsets.

In addition to the basic controls and functions, semi-automated radio equipment may have *request to talk* (RTT) and *emergency* buttons. Both buttons, when activated by the user, cause the radio to transmit a code that alerts the dispatcher to either a request by the user to speak to the dispatcher or to an emergency situation existing at the user end.

Voting Receivers

Voting receivers provide a useful interface for maximum radio coverage under certain conditions. Most modern dispatch operations use repeaters; however, where large concrete or other structures interfere with transmission, a voting receiver connected to a controller can be installed. The controller *votes* on which receiver is getting a better signal from a portable or mobile and passes the better signal to the repeater for re-broadcasting. This enhancement is common in large metropolitan radio systems.

Trunked Radio Systems

Radio trunking is a computer-controlled system that enables groups of users with a common interest to share a radio system. Trunking disassociates the user from a dedicated radio channel, but dedicated certain *talk channels*. A trunk radio system is much like the land based telephone system or its cellular radio extension, which consists of a dedicated person-to-person conversation sharing facilities with others. In trunking, groups of users talk together, much like in the party line telephone system. All the repeaters are linked to an exchange, which has automatic channel selection and direct dialing. Two units can have a private conversation, or several units can have an open channel conversation.

Trunked radio systems work by sending computer data between a mobile radio and a central controller. When a mobile radio user presses the push-to-talk button, the radio sends a digital message to the system

controller requesting a channel assignment. If a channel is available, the system controller sends a message back to the mobile radio with the channel assignment information, and also broadcasts a similar message to other radios in the fleet so that they can tune to the designated channel if necessary. A voice conversation can occur after the channel assignment process is completed.

Trunked radio systems can be designed to use analog or digital modulation for voice, even though the control channel is used for data.

A simple analogy is to think of a trunked radio system much like the waiting line in a bank. Customers typically wait in one line for the next available teller. Conventional (non-trunked) radio systems work more like a supermarket, where customers queue up behind a checker that they choose. Rules of queuing theory prove that more customers per hour can usually be handled with a single line such as in a bank, but practicality often dictates that the supermarket model sometimes works better. Trunking systems have many specialized options that adds flexibility to the system, such as paging and telephone interconnect. The users share the air traffic in groups, which improves radio spectrum utilization.

In trunked systems, base and mobile units are assigned from 5 to 20 frequencies each. Systems are computer controlled, with the frequencies chosen by the computer. A trunked system usually has several channels at one repeater site. The main difference from a cellular network is that there are no hand overs; conversations end at the boundaries of the coverage area of one repeater. (The radio changes frequency on its own rather than under the control of the network.)

The radios are *frequency agile*; you do not know between successive microphone presses which frequency you are going to transmit on. When idle, all the radios listen on one common control channel; the base station or repeater transmits a constant signal on this frequency. This signal contains information about the base station, such as what frequencies are available from it. The receiver can also use this signal to measure the strength of signal from the base/repeater to decide

whether the signal is good enough to provide an acceptable service quality.

When the transmit switch is pressed, the repeater and mobile both agree on a frequency to use, tune to it, and set up the link. When the transmitter is de-keyed, the frequency that was being used is released for use by another person. The computer may be programmed to have a delay specified (hang time), usually two seconds. If there are no more than two seconds between the transmissions of the two units assigned that frequency, the computer will not go to another frequency.

Each radio is given an individual unit identification as well as a fleet identification for all of the units in the agency. Each fleet is unique. From the mobile unit, there is no way to monitor other conversations on the channel. The control channel regulates traffic flow. Telephone interconnects are also handled through the control channel. A repeater is linked through the phone line and attached to the mobile. Depending on the radio, a full duplex conversation can then be started.

A trunked radio system can be partitioned because it is computer controlled. For example, two or more groups can be combined into one comprised of groups from different agencies. Groups could consist of only public safety agencies, could be a city-wide system, a public utility system, or a government entity.

Chapter 8: Status Keeping Systems

Radio Logs

Status keeping of operational field units is a vital function of the public safety communications operator. Every public safety communications operation must have a status keeping system that is simple to use, accurate and reliable. Basic status keeping is done using handwritten radio log sheets.

A radio log is a status keeping record to assist operators in keeping track of their operational units. All official radio communications should be recorded on this form, along with date, time and any other relevant operational information. This system, along with a voice logging recorder, is adequate for a small operations. If information on the sheets must be verified or double checked, the voice playback from the logging or call check recorder is available.

Semi-Automated Status Keeping Systems

Simple computer aided dispatch (CAD) programs allow for manual entry of status for units registered on the CAD system. The status keeping function has a degree of automation and can alert the dispatcher of unit status at specified times. Common status codes can be loaded into a small window that opens when the cursor hits the status line. All status changes are electronically archived, complete with automated date and time stamp. The inputting of information from units is still done manually, while the system acts as an “alarm clock” and ongoing record of interactions.

Mobile Data Terminals (MDT)

Some vehicles are equipped with data terminals that look like portable computers. Semi-automated mobile data terminals perform rudimentary functions such as basic querying and unit to unit mobile messaging. Depending on the degree of automation, there may be status buttons, RTT buttons or an emergency button. Pushing a button on the MDT sends a signal to the radio receiver and console at the agency, where the communicator on duty can take this electronic signal and update the status keeping records.

If the Zoned Distribution system of call processing is interfaced with mobile data terminals, the system will distribute calls in a similar fashion to available field units. Interactive mobile data terminals are powerful lap-top computers capable of multiple functions: CAD terminal; messaging terminal; form screens for the various forms that must be completed (e.g., in police applications, with full CPIC and PIRS query capability). Some terminals can be removed from the car and taken to the scene of an incident. Built in cellular-type radio technology keeps the computer connected to the main system and enables officers to take all the capabilities of their systems wherever they go. Their status is also constantly being monitored and updated. It is expected that, as technology improves, mobile work stations will become standard equipment emergency personnel.

Chapter 9: Other Specialized Communication Equipment

Other Systems

Paging

Using a paging system is another method of dispatch used by public safety agencies. Paging systems are used by a variety of fire departments, ambulance companies and rescue organizations for paging and calling out full-time, part-time, or volunteer personnel. A caller with an emergency calls an answering service and leaves information about the emergency. The answering service immediately pages the personnel required to respond. The pagers are activated and the responders either listen to the message that details the event, or call a number to retrieve the information. Some pagers are capable of displaying the event information electronically to the responder.

Voice mail

Some agencies use a system of voice mail to respond to calls for assistance. Although these types of systems are rare and are not considered an ideal way to deal with emergencies, they do exist. The system works like this - a caller dials a number and gets an a voice mail answering system. The caller is prompted to leave the details of the emergency on the voice mail answering system. Upon disconnection, a call back system designed to reach a member of the emergency service is activated. The member of the service listens to the voice mail message and takes subsequent action to call out the responders. This can be done either by phone fan-out, or by pager.

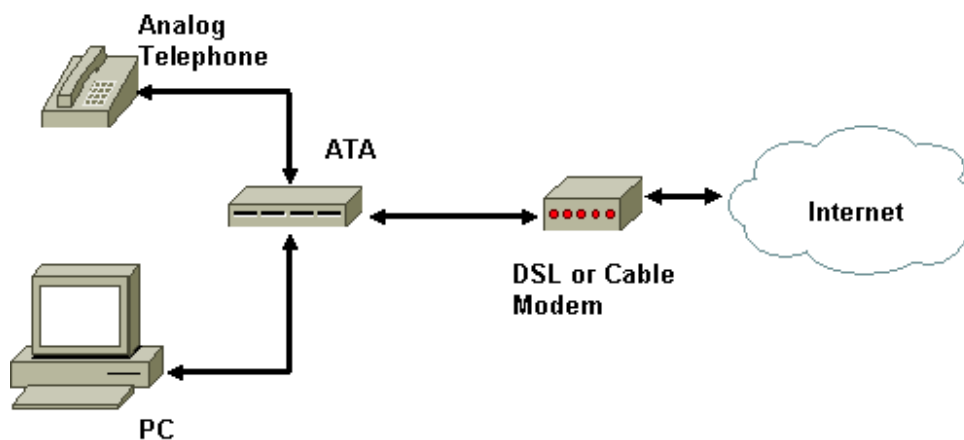
Voice over Internet Protocol (VoIP)

VoIP converts voice telephone calls to packets of data that can be transmitted across the internet or other data networks. The simplest type of VoIP services, such as instant messaging, allows two people to talk free of charge using their computers and the internet. Nothing else is need except a microphone and speakers.

VoIP is a technology to make phone calls using a Broadband Internet connection instead of regular phone service. It is also referred to as

Voice over IP, Broadband phone, Internet phone service and Digital Voice. The only requirement for this technology is a high speed internet connection, such as DSL or cable, as the service is based on broadband Internet communication. VoIP requires a speed of up to 90Kbps depending on the voice compression algorithm chosen by the service provider. This is a higher speed than dial-up Internet so a Broadband Internet connection is a basic requirement.

A person's voice, which is an analog signal, is converted into small packets of digital data and sent over a Broadband Internet connection to the VoIP service provider.



Voice Privacy

Some manufactures of mobile radio systems offer a feature called *voice privacy*. The radio signals are scrambled, which makes them more difficult to monitor. The signals are still there and can be picked up by scanners, but person using a scanner hears only white noise. Many special police services use a form of voice privacy to ensure confidentiality of their radio communications. Problems associated with voice privacy include reduced range and degraded audio quality.

Some equipment uses key codes that change the method of scrambling from day to day, week to week, or as often as the agency decides it is going to change the codes. Someone from the agency must look after changing the codes on a regular basis, safeguarding the code booklets and ensuring the programmer used for loading the keys into the radio

equipment does not get lost. Some modern digital radio systems have encryption that scrambles the signals automatically built right into the circuitry with no requirement for human intervention.

Cellular Digital Packet Data (CDPD)

Cellular digital packet data (CDPD) systems are the most recent cellular data communications technology behind *personal communication systems* (PCS). CDPD systems are digital, packet-data systems. Packets of data are sent and received between terminals through a cellular network. The system operates similarly to conventional cellular telephone, with a few variations. The CDPD user does not have to dial the desired destinations. The system, by use of routing information imbedded in the signal, does all communications automatically. The CDPD system is constantly hand-shaking with all on-line units. Data communications happen in the background at moderate data rates.

CDPD technology was developed for mobile office applications. It is designed for a company to move a portable office facility into a remote location and to be instantly on-line for facsimile, data and voice communications. CDPD availability is dependent on the cellular vendor. This technology is offered only where existing cellular service is offered and only if the appropriate digital system upgrades have been installed.

For public safety agencies, CDPD technology provides a world of expansion and enhancements to CAD and MDT systems. CDPD does not require permanent radio channels or equipment. Coverage for CDPD users is an improvement over existing dedicated radio systems because a user can theoretically travel anywhere there is CDPD coverage and never be out of contact. Cellular vendors have alliances with each other. Users could travel across the continent and, as long as they are within range of a compatible cellular system, will have full terminal capabilities. CAD systems with major system enhancements will soon be operating successfully on the CDPD platform. Full dispatch and query capabilities, along with form macros, will be available.

Satellite Technology

Satellite communications have not yet been completely implemented by public safety agencies because of the high cost of dedicated channels. For most agencies that require long haul communications, linked repeaters or leased land-lines are more cost effective. However, the use of satellites for geographic positioning is receiving a great deal of attention.

Global Positioning System (GPS)

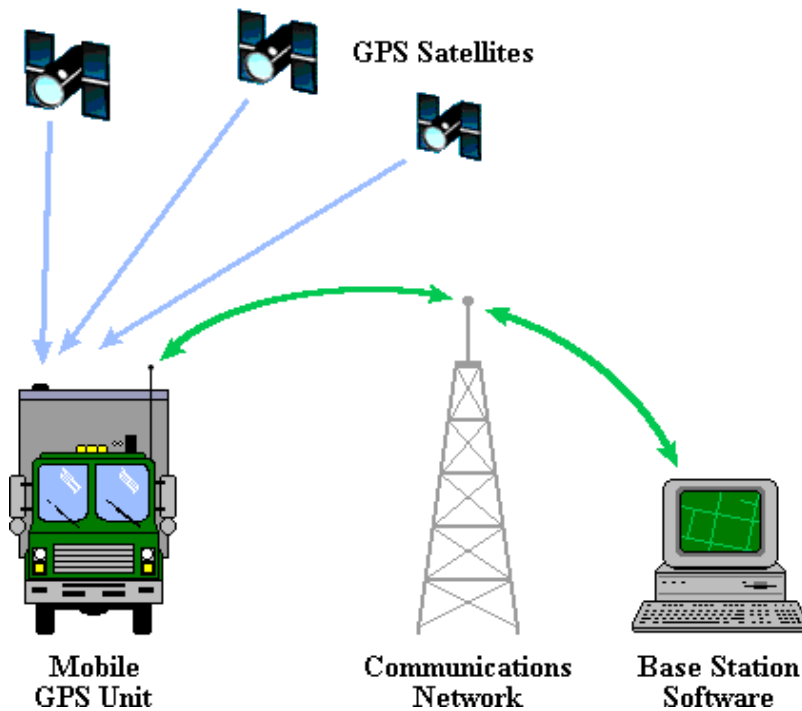
The US Department of Defense started the *global positioning system* (GPS) operated by 24 satellites now orbiting the earth at a height of 10,900 nautical miles. This system allows persons with a GPS receiving device (transponder) to pinpoint their position within several meters, almost anywhere on the surface of the earth, by receiving signals from three different satellites. Transponders can be hand held, or permanently affixed to a vehicle, bicycle or any other moving object. This technology may provide the much-needed geographic location information for cellular telephone systems. It is already used extensively in the aviation and marine industry for position and course plotting.

Public safety agencies are indirectly using satellite technology to communicate. Long distance telephone calls and some leased lines services may be routed through satellite channels, but this is completely transparent to the user.

Automatic Vehicle Locator Systems (AVL)

Automatic Vehicle Locator (AVL) systems allow the location of tagged operational units to be displayed on a map. AVL systems require the installation of a transponder in each mobile unit. Signals from the transponder must be interpreted and displayed on a computer-generated map. The map must be quite detailed and clearly visible to each operator involved in the dispatch operation. In a large metropolitan area with many units in service, the system is a huge asset.

Such systems have advantages when it comes to tactical operations involving setting up perimeters, pursuits, or other operational



situations. Dispatchers and supervisors can see at a glance the deployment and availability of operational resources. They also have a birds-eye view of their area of responsibility, including specific details of the city streets and so on. AVL systems require complex radio systems, powerful computer equipment with high data storage capacity and high quality image projection.

Geographical Information Systems (GIS)

Geographical information system (GIS) is a computer assisted system for acquisition, storage, retrieval, mapping, analysis and display of geographic data. Spatial features are stored in a coordinate system (latitude / longitude), which references a particular place on the earth. Descriptive attributes in tabular form are associated with spatial features. Spatial data and associated attributes in the same coordinate system can then be layered together for mapping and analysis. GIS can be used for scientific investigations, resource management, and development planning. It is a way to have maps benefiting from common database operations.

GIS differs from CAD and other graphical computer applications in that all spatial data is geographically referenced to a map projection in an earth coordinate system.

Geographic information displayed on a terminal are used to aid dispatchers and responders in coordinating perimeters, deciding which route is most appropriate, and locating information specific to a given location. Most systems have the capability of displaying overhead or mapped views of a particular location and can zoom in or out, depending on the sophistication of the system and the detail of the database.