Cathay July 2015

www.cathayradio.org

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Mission: The Cathay Amateur Radio Club is basically an active social club of Ham Radio Operators and their spouses. We support local community requests for HAM emergency communications. Several of us are trained in CPR/ First Aid and are involved with community disaster preparedness.

Monday Night Net Time: 9 PM Local Time/PST, Frequencies: 146.67MHz -600KHz PL85.4 and 442.70 +5MHz PL 173.8. The repeaters are linked only during the CARC Monday night net.

Update: Link to repeater 442.70 is currently not active until further notice.

The CARC Monday night net is the best way to find out the latest club news.

All check-ins are welcome.

Message from the President: George Chong, *W6BUR*

Hello CARC Members and Friends;

I wish a happy July 4th to all our CARC members and service members. The original CARC club was founded by Asian American GIs returning from the Pacific Theater in 1946. As a former WWII US Army Air Corp crew member, my heart fills with pride every July 4th.

ARRL Field Day Saturday June 27, 2015

A more detailed write up will be in the August 2015 issue of the CARC newsletter.

I want to thank those CARC members that took the time to attend this special event that was very well attended.

Featured Tech Article Intro

CARC Member Alon Yu (WA6GTY) asks the simple question: Are Cellular phone single or duplex?

The answer is: Duplex. That information and more was pulled from Wikipedia. Please read on about cellular networks in the tech article of this newsletter.

CARC Final Wrap-up News

Chat sub s'em to all you CARC members! - George W6BUR.

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Public Service Announcements

HAM CRAM / HAM Licensing

For upcoming HAM Licensing locations please refer to:
http://www.arrl.org/find-an-amateur-radio-license-exam-session

Auxiliary Communications Service (ACS)

The Auxiliary Communications Service (ACS) was organized by the San Francisco Office of Emergency Services (OES) following the 1989 Loma Prieta Earthquake to support the communications needs of the City and County of San Francisco when responding to emergencies and special events.

The Auxiliary Communications Service holds General Meetings on the third Tuesday of each month at the San Francisco Emergency Operations Center, 1011 Turk Street (between Gough Street and Laguna Street), from 1900 hours to 2100 hours local time. All interested persons are welcome to attend.

The ACS Net begins at 1930 hours (7:30 p.m.) local time each Thursday evening, on the WA6GG repeater at 442.050 MHz, positive offset, tone 127.3 Hz. The purpose of this net is to practice Net Control skills, practice checking in with deployment status in a formal net, and to share information regarding upcoming ACS events. Guests are welcome to check in. ACS Members should perform Net Control duty on a regular basis. On the second Thursday of each month, the net will be conducted on the output frequency of the WA6GG repeater, 442.050 MHz no offset, tone 127.3 Hz, simplex.

For more information, please attend an ACS meeting or check in on a net, or call 415-558-2717.

Upcoming meetings: Tuesday 7pm, July 21, 2015
Tuesday 7pm, Aug 18, 2015
Tuesday 7pm, Sept 15, 2015

Gilbert Gin (KJ6HKD)

Free Disaster Preparedness Classes In Oakland:
http://www.oaklandnet.com/fire/core/index2.html

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CORE is a free training program for individuals, neighborhood groups and community-based organizations in Oakland. The underlying premise is that a major disaster will overwhelm first responders, leaving many citizens on their own for the first 72 hours or longer after the emergency.

If you have questions about the recertification process, you may contact the CORE Coordinator at 510-238-6351 or core@oaklandnet.com.

Free Disaster Preparedness Classes In San Francisco – NERT Taught by San Francisco Fire Department

Upcoming events

July

18th Intro to NERT Communications Team (NCT).
8:30am-3:30pm, SFFD DOT* details

Introductory class designed for both newly licensed operators and those planning to get licensed.

23rd: Triage Drill. Victims needed so bring a non-NERT friend!
6:00pm-9:30pm, SFFD DOT*

August

1st: Neighborhood Coordinator Leadership College.
8:30am-4:00pm, SFFD DOT*

2nd: Golden Gate Park Band Honors NERT/CERT
12:00 pm – 3:00 pm The band shell located in Golden Gate park between The Academy of Sciences and the de Young Museum.

The Golden Gate Concert Band will be honoring the volunteer efforts of NERT and CERT volunteers throughout the Bay Area through music and a short

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presentation by the group.
You are encouraged to come to the park and bring a picnic lunch. Gather at noon. Concert at 1pm. Wear your gear to represent your program. We will need a few people to help pass out information

South San Francisco Rotary Club is sponsoring the event and they have generously donated It's It ice cream for all to enjoy!

All are welcome. Bring friends and family.

RSVP to sffdnert@sfgov.org or call 415-970-2024 to register.
Visit www.sfgov.org/sffdnert to learn more about the training, other locations, and register on line. Upcoming Special NERT Events.

San Francisco Police Department: Auxiliary Law Enforcement Response Team (ALERT)

The Auxiliary Law Enforcement Response Team (ALERT) is a citizen disaster preparedness program designed. The ALERT program is for volunteers 16 years of age or older, who live, work, or attend high school in San Francisco.

Graduates of the San Francisco Police Activities League (P.A.L) Law Enforcement Cadet Academy are also eligible to join.

ALERT volunteers will first complete the Fire Department's Neighborhood Emergency Response Team (NERT) (www.sfgov.org/sfnert) training and then graduate into an 8 hour Police Department course specifically designed for ALERT team members.

ALERT members will work closely with full-time and/or Reserve Police Officers in the event they are deployed after a disaster. The Basic ALERT volunteer will have no law enforcement powers other than those available to all citizens.

SFPD ALERT Training

The next ALERT training classes have been scheduled for **Saturday, October 24th, 2015**. The classes will be held at the San Francisco Police Academy, in the parking lot bungalow, from 8am-5pm (one hour lunch break).

IMPORTANT- All participants must complete the background interview process in order to be eligible to attend the ALERT training class.

Eligible ALERT participants may register for a training class by contacting the ALERT

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Program Coordinator, Mark Hernandez, at sfpdalert@sfgov.org, or by telephone at 415-401-4615.

SFPD ALERT Practice/Training Drill

All active/trained ALERT members are asked to join us for our next training drill, scheduled for **Saturday, July 11th, 2015.** This will be a night drill and will be held in the Police Academy (350 Amber Drive) parking lot from 8pm -11pm. Details will be emailed to active ALERT members, prior to the date of the exercise. Participation is not required, but strongly encouraged.

For more information on the San Francisco Police Department ALERT Program, email us at sfpdalert@sfgov.org, or call Sergeant Mark Hernandez (SFPD, Ret.), SFPD ALERT Program Coordinator, at (415) 401-4615.

For additional information on the web please refer to:
http://sf-police.org/index.aspx?page=4019

Featured Tech Article:

Cellular network

https://en.wikipedia.org/wiki/Cellular_network

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A **cellular network** or **mobile network** is a wireless network distributed over land areas called cells, each served by at least one fixed-location transceiver, known as a cell site or base station. In a cellular network, each cell uses a different set of frequencies from neighboring cells, to avoid interference and provide guaranteed bandwidth within each cell.

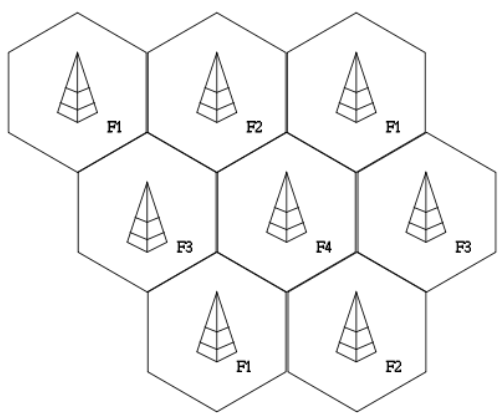
When joined together these cells provide radio coverage over a wide geographic area. This enables a large number of portable transceivers (e.g., mobile phones, pagers, etc.) to communicate with each other and with fixed transceivers and telephones anywhere in the network, via base stations, even if some of the transceivers are moving through more than one cell during transmission.

Cellular networks offer a number of desirable features:

- More capacity than a single large transmitter, since the same frequency can be used for multiple links as long as they are in different cells
- Mobile devices use less power than with a single transmitter or satellite since the cell towers are closer
- Larger coverage area than a single terrestrial transmitter, since additional cell towers can be added indefinitely and are not limited by the horizon

Major telecommunications providers have deployed voice and data cellular networks over most of the inhabited land area of the Earth. This allows mobile phones and mobile computing devices to be connected to the public switched telephone network and public Internet. Private cellular networks can be used for research[1] or for large organizations and fleets, such as dispatch for local public safety agencies or a taxicab company.[2]

Concept



Example of frequency reuse factor or pattern ¼

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In a cellular radio system, a land area to be supplied with radio service is divided into regular shaped cells, which can be hexagonal, square, circular or some other regular shapes, although hexagonal cells are conventional. Each of these cells is assigned with multiple frequencies (f_1 – f_6) which have corresponding radio base stations. The group of frequencies can be reused in other cells, provided that the same frequencies are not reused in adjacent neighboring cells as that would cause co-channel interference.

The increased capacity in a cellular network, compared with a network with a single transmitter, comes from the mobile communication switching system developed by Amos Joel of Bell Labs[3] that permitted multiple callers in the same area to use the same frequency by switching calls made using the same frequency to the nearest available cellular tower having that frequency available and from the fact that the same radio frequency can be reused in a different area for a completely different transmission.

If there is a single plain transmitter, only one transmission can be used on any given frequency. Unfortunately, there is inevitably some level of interference from the signal from the other cells which use the same frequency. This means that, in a standard FDMA system, there must be at least a one cell gap between cells which reuse the same frequency.

In the simple case of the taxi company, each radio had a manually operated channel selector knob to tune to different frequencies. As the drivers moved around, they would change from channel to channel.

The drivers knew which frequency covered approximately what area. When they did not receive a signal from the transmitter, they would try other channels until they found one that worked.

The taxi drivers would only speak one at a time, when invited by the base station operator (this is, in a sense, time division multiple access (TDMA)).

Cell signal encoding

To distinguish signals from several different transmitters, frequency division multiple access (FDMA) and code division multiple access (CDMA) were developed.

With FDMA, the transmitting and receiving frequencies used in each cell are different from the frequencies used in each neighbouring cell.

In a simple taxi system, the taxi driver manually tuned to a frequency of a chosen cell to obtain a strong signal and to avoid interference from signals from other cells.

The principle of CDMA is more complex, but achieves the same result; the distributed transceivers can select one cell and listen to it.

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Other available methods of multiplexing such as polarization division multiple access (PDMA) and time division multiple access (TDMA) cannot be used to separate signals from one cell to the next since the effects of both vary with position and this would make signal separation practically impossible. Time division multiple access, however, is used in combination with either FDMA or CDMA in a number of systems to give multiple channels within the coverage area of a single cell.

Frequency reuse

The key characteristic of a cellular network is the ability to re-use frequencies to increase both coverage and capacity. As described above, adjacent cells must use different frequencies, however there is no problem with two cells sufficiently far apart operating on the same frequency. The elements that determine frequency reuse are the reuse distance and the reuse factor.

The reuse distance, D is calculated as

$$D = R\sqrt{3N},$$

where R is the cell radius and N is the number of cells per cluster. Cells may vary in radius from 1 to 30 kilometres (0.62 to 18.64 mi). The boundaries of the cells can also overlap between adjacent cells and large cells can be divided into smaller cells.[4]

The frequency reuse factor is the rate at which the same frequency can be used in the network. It is $1/K$ (or K according to some books) where K is the number of cells which cannot use the same frequencies for transmission. Common values for the frequency reuse factor are 1/3, 1/4, 1/7, 1/9 and 1/12 (or 3, 4, 7, 9 and 12 depending on notation).[5]

In case of N sector antennas on the same base station site, each with different direction, the base station site can serve N different sectors. N is typically 3. A **reuse pattern** of N/K denotes a further division in frequency among N sector antennas per site. Some current and historical reuse patterns are 3/7 (North American AMPS), 6/4 (Motorola NAMPS), and 3/4 (GSM).

If the total available bandwidth is B, each cell can only use a number of frequency channels corresponding to a bandwidth of B/K, and each sector can use a bandwidth of B/NK.

Code division multiple access-based systems use a wider frequency band to achieve the same rate of transmission as FDMA, but this is compensated for by the ability to use a frequency reuse factor of 1, for example using a reuse pattern of 1/1. In other words, adjacent base station sites use the same frequencies, and the different base stations and users are separated by codes rather than frequencies. While N is shown as 1 in this example, that does not mean the CDMA cell has only one sector, but rather that the entire cell bandwidth is also available to each sector individually.

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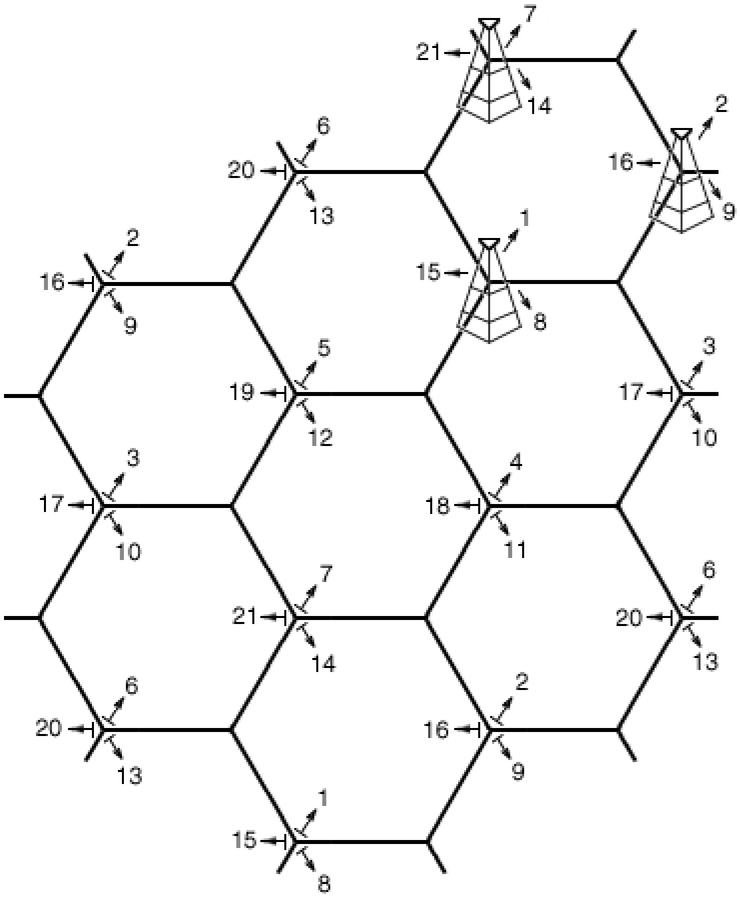
Depending on the size of the city, a taxi system may not have any frequency-reuse in its own city, but certainly in other nearby cities, the same frequency can be used. In a large city, on the other hand, frequency-reuse could certainly be in use.

Recently also [orthogonal frequency-division multiple access] based systems such as [LTE] are being deployed with a frequency reuse of 1. Since such systems do not spread the signal across the frequency band, inter-cell radio resource management is important to coordinate resource allocation between different cell sites and to limit the inter-cell interference. There are various means of [Inter-Cell Interference Coordination (ICIC)] already defined in the standard.[6] Coordinated scheduling, multi-site MIMO or multi-site beam forming are other examples for inter-cell radio resource management that might be standardized in the future.

Directional antennas



Cellular telephone frequency reuse pattern. See [U.S. Patent 4,144,411]

Cell towers frequently use a [directional signal] to improve reception in higher traffic areas. In the United States, the FCC limits omni-directional cell tower signals to 100 watts of power. If the tower has directional antennas, the FCC allows the cell operator to broadcast up to 500 watts of [effective radiated power] (ERP).[7]

Cell phone companies use this directional signal to improve reception along highways and inside buildings like stadiums and arenas.[7] As a result, a cell phone user may be standing in sight of a cell tower, but still have trouble getting a good signal because the directional antennas point in a different direction.[7]

Although the original cell towers created an even, omni-directional signal, were at the centers of the cells and were omni-directional, a cellular map can be redrawn with the cellular telephone towers located at the corners of the hexagons where three cells converge.[8]

Each tower has three sets of directional antennas aimed in three different directions with 120 degrees for each cell (totaling 360 degrees) and receiving/transmitting into three different cells at different frequencies. This provides a minimum of three channels, and three towers for each cell and greatly increases the chances of receiving a usable signal from at least one direction.

The numbers in the illustration are channel numbers, which repeat every 3 cells. Large cells can be subdivided into smaller cells for high volume areas.[9]

Broadcast messages and paging

Practically every cellular system has some kind of broadcast mechanism. This can be used directly for distributing information to multiple mobiles. Commonly, for example in mobile telephony systems, the most important use of broadcast information is to set up channels for one to one communication between the mobile transceiver and the base station. This is called **paging**. The three different paging procedures generally adopted are sequential, parallel and selective paging.

The details of the process of paging vary somewhat from network to network, but normally we know a limited number of cells where the phone is located (this group of cells is called a Location Area in the GSM or UMTS system, or Routing Area if a data packet session is involved; in LTE, cells are grouped into Tracking Areas).

Paging takes place by sending the broadcast message to all of those cells. Paging messages can be used for information transfer. This happens in pagers, in CDMA systems for sending SMS messages, and in the UMTS system where it allows for low downlink latency in packet-based connections.

Movement from cell to cell and handover

In a primitive taxi system, when the taxi moved away from a first tower and closer to a second tower, the taxi driver manually switched from one frequency to another as needed. If a communication was interrupted due to a loss of a signal, the taxi driver asked the base station operator to repeat the message on a different frequency.

In a cellular system, as the distributed mobile transceivers move from cell to cell during an ongoing continuous communication, switching from one cell frequency to a different cell

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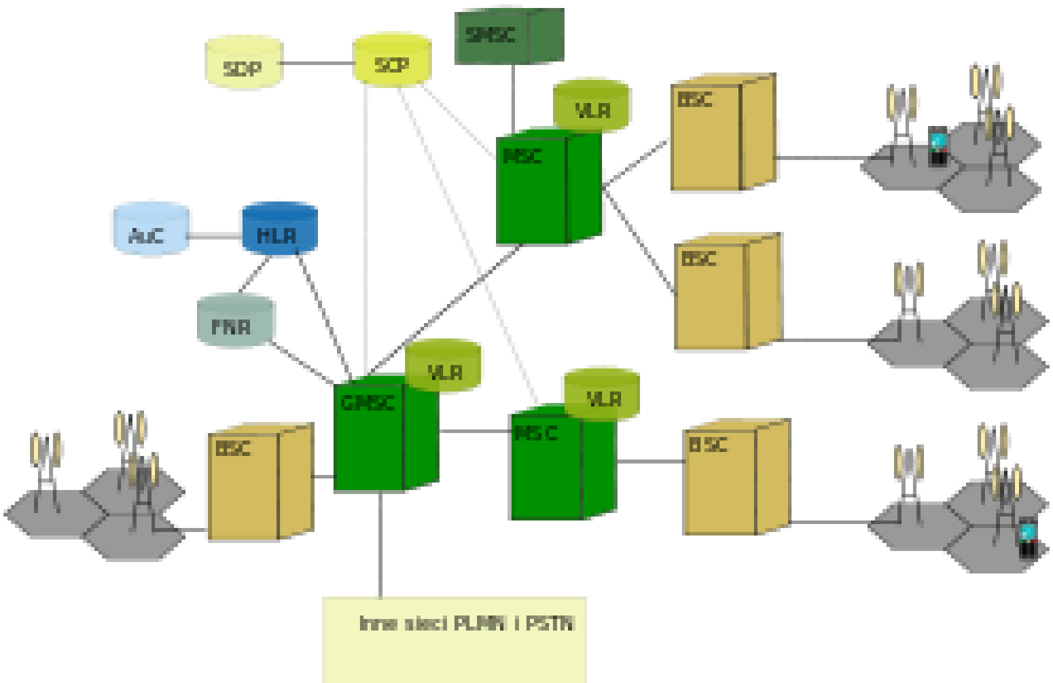
frequency is done electronically without interruption and without a base station operator or manual switching. This is called the handover or handoff. Typically, a new channel is automatically selected for the mobile unit on the new base station which will serve it. The mobile unit then automatically switches from the current channel to the new channel and communication continues.

The exact details of the mobile system's move from one base station to the other varies considerably from system to system (see the example below for how a mobile phone network manages handover).

Mobile phone network



GSM network architecture

The most common example of a cellular network is a mobile phone (cell phone) network. A mobile phone is a portable telephone which receives or makes calls through a cell site (base station), or transmitting tower. Radio waves are used to transfer signals to and from the cell phone.

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Modern mobile phone networks use cells because radio frequencies are a limited, shared resource. Cell-sites and handsets change frequency under computer control and use low power transmitters so that the usually limited number of radio frequencies can be simultaneously used by many callers with less interference.

A cellular network is used by the mobile phone operator to achieve both coverage and capacity for their subscribers. Large geographic areas are split into smaller cells to avoid line-of-sight signal loss and to support a large number of active phones in that area. All of the cell sites are connected to telephone exchanges (or switches), which in turn connect to the public telephone network.

In cities, each cell site may have a range of up to approximately ½ mile (0.80 km), while in rural areas, the range could be as much as 5 miles (8.0 km). It is possible that in clear open areas, a user may receive signals from a cell site 25 miles (40 km) away.

Since almost all mobile phones use cellular technology, including GSM, CDMA, and AMPS (analog), the term "cell phone" is in some regions, notably the US, used interchangeably with "mobile phone". However, satellite phones are mobile phones that do not communicate directly with a ground-based cellular tower, but may do so indirectly by way of a satellite.

There are a number of different digital cellular technologies, including: Global System for Mobile Communications (GSM), General Packet Radio Service (GPRS), cdmaOne, CDMA2000, Evolution-Data Optimized (EV-DO), Enhanced Data Rates for GSM Evolution (EDGE), Universal Mobile Telecommunications System (UMTS), Digital Enhanced Cordless Telecommunications (DECT), Digital AMPS (IS-136/TDMA), and Integrated Digital Enhanced Network (iDEN).

Structure of the mobile phone cellular network[edit]

A simple view of the cellular mobile-radio network consists of the following:

- A network of radio base stations forming the base station subsystem.
- The core circuit switched network for handling voice calls and text
- A packet switched network for handling mobile data
- The public switched telephone network to connect subscribers to the wider telephony network

This network is the foundation of the GSM system network. There are many functions that are performed by this network in order to make sure customers get the desired service including mobility management, registration, call set up, and handover.

Any phone connects to the network via an RBS (Radio Base Station) at a corner of the corresponding cell which in turn connects to the Mobile switching center (MSC). The MSC

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provides a connection to the public switched telephone network (PSTN). The link from a phone to the RBS is called an uplink while the other way is termed downlink.

Radio channels effectively use the transmission medium through the use of the following multiplexing and access schemes: frequency division multiple access (FDMA), time division multiple access (TDMA), code division multiple access (CDMA), and space division multiple access (SDMA).

Small cells[edit]

Main article: Small cell

Small cells, which have a smaller coverage area than base stations, are categorised as follows:

- Microcell, less than 2 kilometres
- Picocell, less than 200 metres
- Femtocell, around 10 metres

Cellular handover in mobile phone networks[edit]

Main article: Handover

As the phone user moves from one cell area to another cell while a call is in progress, the mobile station will search for a new channel to attach to in order not to drop the call. Once a new channel is found, the network will command the mobile unit to switch to the new channel and at the same time switch the call onto the new channel.

With CDMA, multiple CDMA handsets share a specific radio channel. The signals are separated by using a pseudonoise code (PN code) specific to each phone. As the user moves from one cell to another, the handset sets up radio links with multiple cell sites (or sectors of the same site) simultaneously. This is known as "soft handoff" because, unlike with traditional cellular technology, there is no one defined point where the phone switches to the new cell.

In IS-95 inter-frequency handovers and older analog systems such as NMT it will typically be impossible to test the target channel directly while communicating. In this case other techniques have to be used such as pilot beacons in IS-95. This means that there is almost always a brief break in the communication while searching for the new channel followed by the risk of an unexpected return to the old channel.

If there is no ongoing communication or the communication can be interrupted, it is possible for the mobile unit to spontaneously move from one cell to another and then notify the base station with the strongest signal.

Cellular frequency choice in mobile phone networks[edit]

Main article: Cellular frequencies

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The effect of frequency on cell coverage means that different frequencies serve better for different uses. Low frequencies, such as 450 MHz NMT, serve very well for countryside coverage. GSM 900 (900 MHz) is a suitable solution for light urban coverage. GSM 1800 (1.8 GHz) starts to be limited by structural walls. UMTS, at 2.1 GHz is quite similar in coverage to GSM 1800.

Higher frequencies are a disadvantage when it comes to coverage, but it is a decided advantage when it comes to capacity. Pico cells, covering e.g. one floor of a building, become possible, and the same frequency can be used for cells which are practically neighbours.

Cell service area may also vary due to interference from transmitting systems, both within and around that cell. This is true especially in CDMA based systems.

The receiver requires a certain signal-to-noise ratio, and the transmitter should not send with too high transmission power in view to not cause interference with other transmitters. As the receiver moves away from the transmitter, the power received decreases, so the power control algorithm of the transmitter increases the power it transmits to restore the level of received power.

As the interference (noise) rises above the received power from the transmitter, and the power of the transmitter cannot be increased any more, the signal becomes corrupted and eventually unusable. In CDMA-based systems, the effect of interference from other mobile transmitters in the same cell on coverage area is very marked and has a special name, *cell breathing*.

One can see examples of cell coverage by studying some of the coverage maps provided by real operators on their web sites or by looking at independently crowdsourced maps such as OpenSignal. In certain cases they may mark the site of the transmitter, in others it can be calculated by working out the point of strongest coverage.

Coverage comparison of different frequencies

The following table shows the dependency of the coverage area of one cell on the frequency of a CDMA2000 network:[10]

Frequency (MHz)	Cell radius (km)	Cell area (km2)	Relative Cell Count
450	48.9	7521	1
950	26.9	2269	3.3
1800	14.0	618	12.2
2100	12.0	449	16.2

References

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c. Pauli, Volker; Naranjo, Juan Diego; Seidel, Eiko (December 2010). "Heterogeneous LTE Networks and Inter-Cell Interference Coordination" (PDF). Nomor Research. Retrieved 2 April 2012.

d. [a] [b] [c] Drucker, Elliott, *The Myth of Cellular Tower Health Hazards*, retrieved 2013-11-19

e. "Cellular Telephone Basics". Privateline.com. 1 January 2006. p. 2. Retrieved 2 April 2012.

f. U.S. Patent 4,144,411 – *Cellular Radiotelephone System for Different Cell Sizes* – Richard H. Frenkiel (Bell Labs), filed Sep 22, 1976, issued March 13, 1979

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