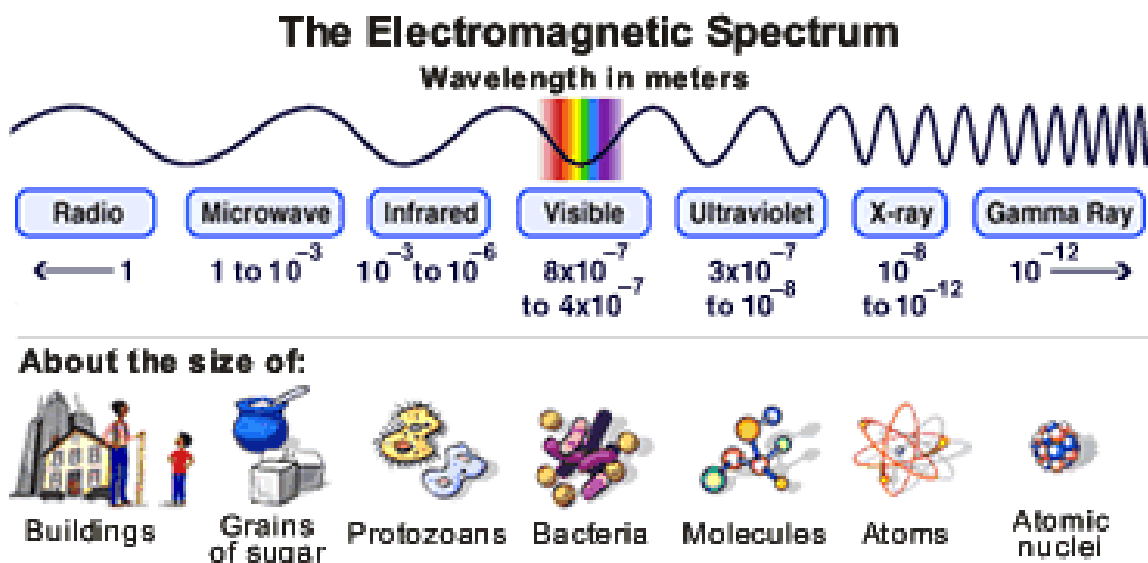


Wireless Networks – Overview

W.L.Honig

Spectrum – All Those Colors Filling the Room



The wavelength and frequency of light are closely related. The higher the frequency, the shorter the wavelength. Because all light waves move through a vacuum at the same speed, the number of wave crests passing by a given point in one second depends on the wavelength. That number, also known as the frequency, will be larger for a short-wavelength wave than for a long-wavelength wave.

The equation that relates wavelength and frequency for electromagnetic waves is: $\lambda \nu = c$ where λ is the wavelength, ν is the frequency and c is the speed of light.

The greater the energy, the larger the frequency and the shorter (smaller) the wavelength. Given the relationship between wavelength and frequency described above, it follows that short wavelengths are more energetic than long wavelengths.

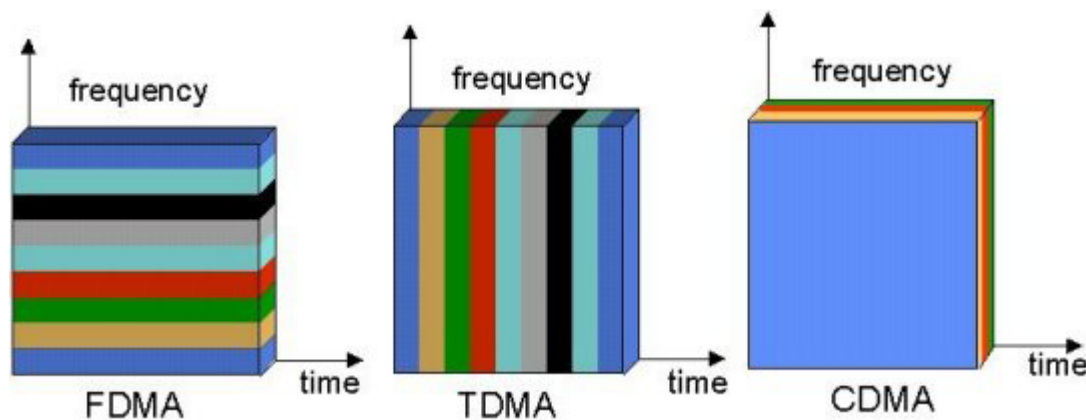
[See Radio Spectrum Charts](#)

Technologies – Different Radios

GSM (Time Division Multiple Access - underlying technology used in GSM) does it by chopping up the channel into sequential time slices. Each user of the channel takes turns to transmit and receive signals. In reality, only one person is actually using the channel at a specific moment.

CDMA (Code Division Multiple Access) on the other hand, uses special digital modulation **Spread Spectrum** which spreads the voice over very wide channel in *pseudo random fashion*. The receiver undoes the randomization to collect the bits together and produce the sound.

For radio systems there are two resources, frequency and time. Division by frequency, so that each pair of communicators is allocated part of the spectrum for all of the time, results in Frequency Division Multiple Access (FDMA). Division by time, so that each pair of communicators is allocated all (or at least a large part) of the spectrum for part of the time results in Time Division Multiple Access (TDMA). In Code Division Multiple Access (CDMA), every communicator will be allocated the entire spectrum all of the time. CDMA uses codes to identify connections.

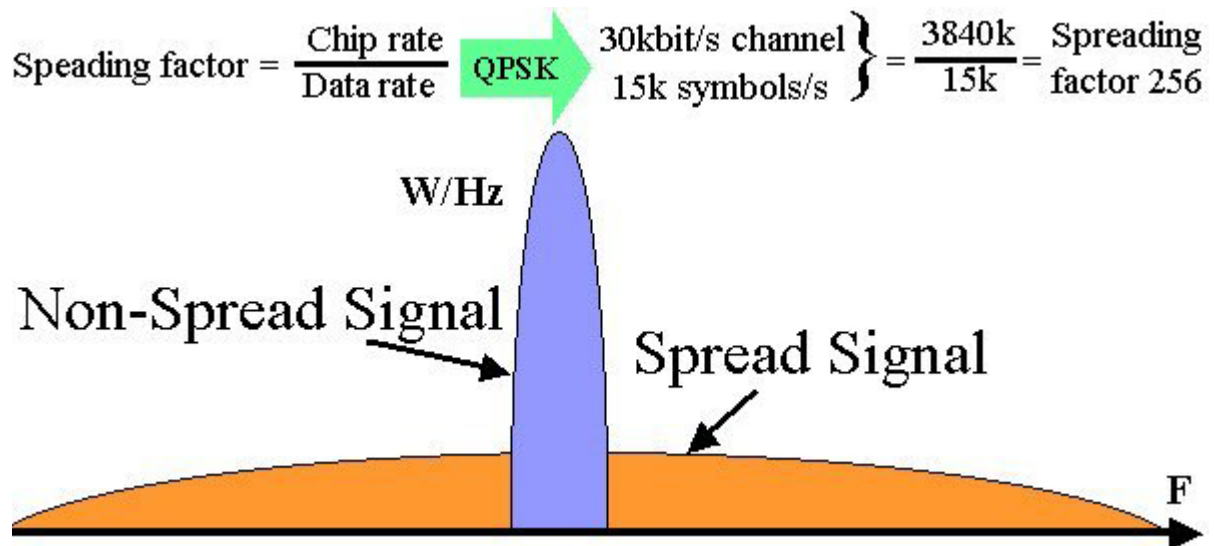


Multiple Access Schemes

THE SPREADING PROCESS

WCDMA uses Direct Sequence spreading, where spreading process is done by directly combining the baseband information to high chip rate binary code. The Spreading Factor is the ratio of the chips (UMTS = 3.84Mchips/s) to baseband information rate. Spreading factors vary from 4 to 512 in FDD UMTS. Spreading process gain can be expressed in

dBs (Spreading factor 128 = 21dB gain).
See [spreading page](#) for more details.



How it works:

<http://www.see.ed.ac.uk/~acmc/MCCDMA.html>

Phones, Equipment, Operators

Three main participants in making mobile systems work:

Infrastructure Providers:

Phone Providers:

System Operators:

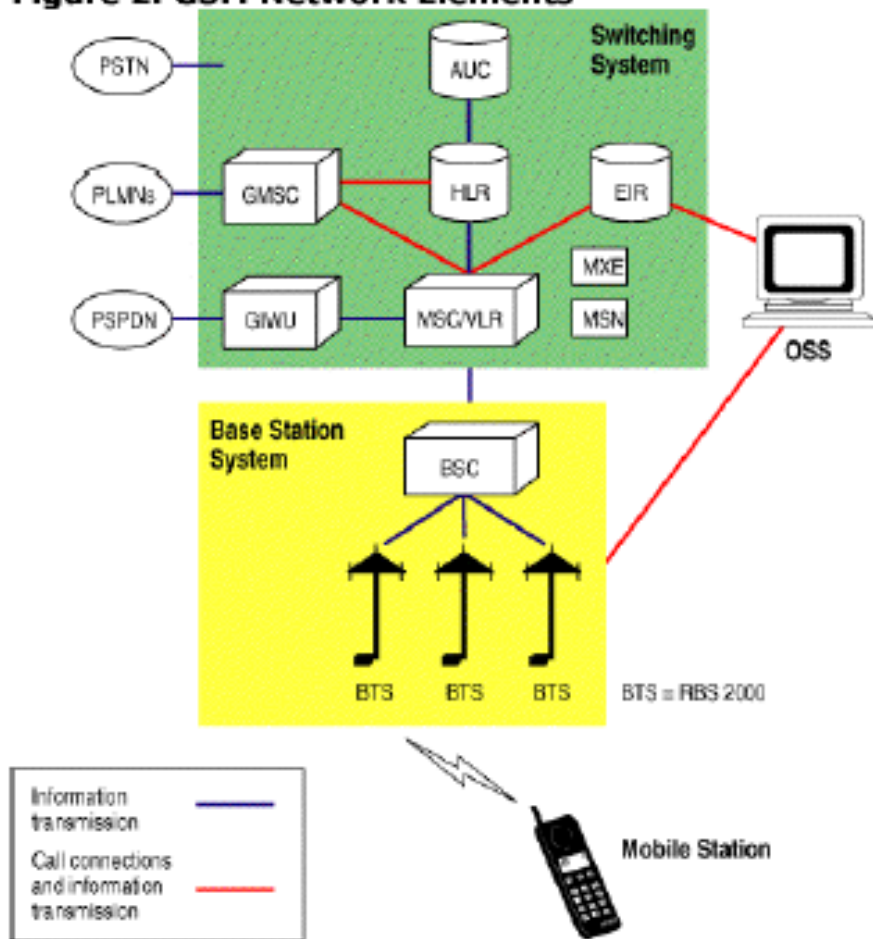
Network Architecture for Mobility

<http://www.morethanyouthink.com/communications/howphoneswork.html>



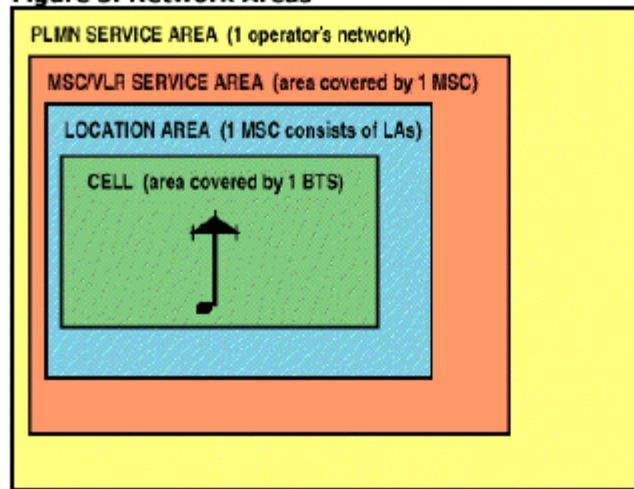


Figure 2. GSM Network Elements



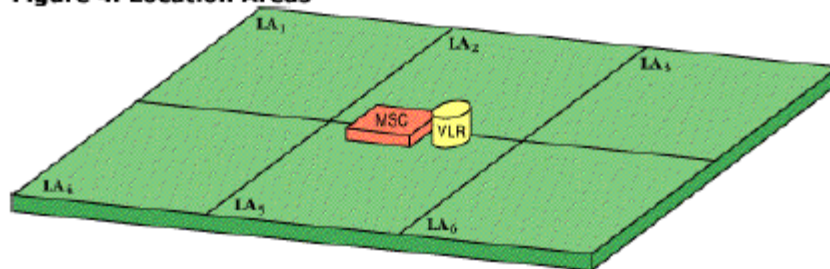
mobile network (PLMN) areas.

Figure 3. Network Areas



The cell is the area given radio coverage by one base transceiver station. The GSM network identifies each cell via the cell global identity (CGI) number assigned to each cell. The location area is a group of cells. It is the area in which the subscriber is paged. Each LA is served by one or more base station controllers, yet only by a single MSC (see *Figure 4*). Each LA is assigned a location area identity (LAI) number.

Figure 4. Location Areas



Roaming

The Switching System

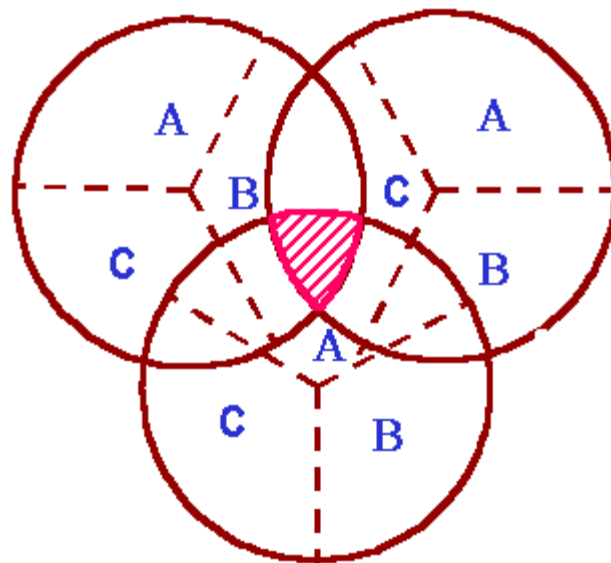
The switching system (SS) is responsible for performing call processing and subscriber-related functions. The switching system includes the following functional units:

- home location register (HLR)—The HLR is a database used for storage and management of subscriptions. The HLR is considered the most important database, as it stores permanent data about subscribers, including a subscriber's service profile, location information, and activity status. When an individual buys a subscription from one of the PCS operators, he or she is registered in the HLR of that operator.
- mobile services switching center (MSC)—The MSC performs the telephony switching functions of the system. It controls calls to and from other telephone and data systems. It also performs such functions as toll ticketing, network interfacing, common channel signaling, and others.
- visitor location register (VLR)—The VLR is a database that contains temporary information about subscribers that is needed by the MSC in order to service visiting subscribers. The VLR is always integrated with the MSC. When a mobile station roams into a new MSC area, the VLR connected to that MSC will request data about the mobile station from the HLR. Later, if the mobile station makes a call, the VLR will have the information needed for call setup without having to interrogate the HLR each time.

Handoffs and Dropped Calls

HANDOVER

Handover occurs when a call has to be passed from one cell to another as the user moves between cells. In a traditional "hard" handover, the connection to the current cell is broken, and then the connection to the new cell is made. This is known as a "break-before-make" handover. Since all cells in CDMA use the same frequency, it is possible to make the connection to the new cell before leaving the current cell. This is known as a "make-before-break" or "soft" handover. Soft handovers require less power, which reduces interference and increases capacity. Mobile can be connected to more than two BTS the handover. "Softer" handover is a special case of soft handover where the radio links that are added and removed belong to the same Node B.



3 Way Soft

CDMA soft handover

Wireless Data

Universal Mobile Telecommunications System (UMTS) Protocols and Protocol Testing

Definition and Overview

Definition

Universal Mobile Telecommunications System (UMTS) is envisioned as the successor to Global System for Mobile Communications (GSM). UMTS signals the move into the third generation (3G) of mobile networks. UMTS also addresses the growing demand of mobile and Internet applications for new capacity in the overcrowded mobile communications sky. The new network increases transmission speed to 2 Mbps per mobile user and establishes a global roaming standard.

Overview

UMTS, also referred to as wideband code division multiple access (W-CDMA), is one of the most significant advances in the evolution of telecommunications into 3G networks. UMTS allows many more applications to be introduced to a worldwide base of users and provides a vital link between today's multiple GSM systems and the ultimate single worldwide standard for all mobile telecommunications, International Mobile Telecommunications-2000 (IMT-2000).

Data Speeds:

GSM Circuit Switched: 115kbps
GSM GPRS: 171kbps
GSM EDGE: 553kbps
GSM UMTS (UTRA): 1920kbps aka WCDMA

CDMA IS95 (A,B,C) 14.4, 64, 115kbps
CDMA2000 1xEV-DO 2457kbps
CDMA2000 1x EV-DV 3072kbps

User Interface

Mobile Device Interfaces:

See Minority Report

<http://video.google.com/videoplay?docid=-9043883166300997447&q=minority+report&total=794&start=0&num=10&so=0&type=search&plindex=3>

<http://video.google.com/videoplay?docid=4375330965265421463&q=minority+report&total=794&start=0&num=10&so=0&type=search&plindex=0>

All applications becoming mobile