Work-Ready Electronics

Synchronizing Curriculum to the Rapidly Changing Workplace

Module: Contemporary Wireless Technology: Cell Phones, Wireless Local Area Networks, and Short-Range Radio

WORKREADY ELECTRONICS

Contemporary Wireless

Wireless means radio in its broadest sense. However, in the early 21st century, wireless refers primarily to the two dominant forms of wireless: cell phones and wireless local area networks (WLANs).

This module describes the idea behind the cellular telephone system, how it works, and the primary technologies used in the US and throughout the world.

This module also introduces the wireless local area network or WLAN. WLANs are radio-linked computers that are part of a larger network. The wireless links make portability and mobility of computers possible.

This module also briefly introduces four common forms of short-range wireless: Bluetooth, ZigBee, ultra wideband (UWB) and RFID.

Prerequisites

Completion of the WRE *Introduction to Wireless* module, or knowledge of:

Basic components of any wireless system

How radio works

The electromagnetic spectrum

Radio waves and propagation

Modulation and multiplexing methods

Basic radio circuits

What Technicians Need To Know

The cellular spectrum

Background of the cellular system

Radio technologies used in cellular

Types of local area networks

Wireless LAN standards and technology

WLAN applications

Personal area networks (PANs)

Technology, benefits, and applications of Bluetooth, ZigBee, ultra wideband, and RFID

The Cellular Telephone System

Historical Information

The cell phone system was originally developed by Motorola in the late 1970's and early 1980's. The first service was implemented in Chicago in the 1983-84 time frame.

The first systems were mounted in cars and trucks. These car phones quickly became popular and service was rolled out in most of the major cities over the next few years.

As integrated circuits technology developed, it became possible to package the cell phone in a walkie-talkie size handset. These initial handsets were large and heavy but popular. Further technological developments ultimately has produced the tiny handset that we know as a cell phone today.

Cell Phone Generations

The first cell phones are referred to as the first generation (1G). These phones used standard FM analog radio technology.

As the demand for cell phone service grew and more subscribers were added, it became apparent there was not enough radio spectrum space to handle the demand. Therefore new digital radios were developed. These radios permitted more subscribers to share the available spectrum. Digital transmission also made cell phone calls more reliable. These first digital cell phones are referred to as the second generation or 2G.

More advanced digital cell phones were defined and these are referred to as third generation (3G) cell phones. 3G phones have the additional benefit of being able to handle computer data making them capable of Internet access, email, and other packet data applications. The 3G phones require more spectrum space than available so they have not yet been widely adopted.

Inter-Generational Cell Phones

Several new variations were developed to provide the data handling capability of the 3G phones but still use modified 2G technology. These are generally referred to as 2.5G phones.

Today, most cell phones are of the digital 2.5G variety. There are multiple radio technologies and different protocols used but all of them transmit packet digital data and give Internet access, email, and other digital data applications.

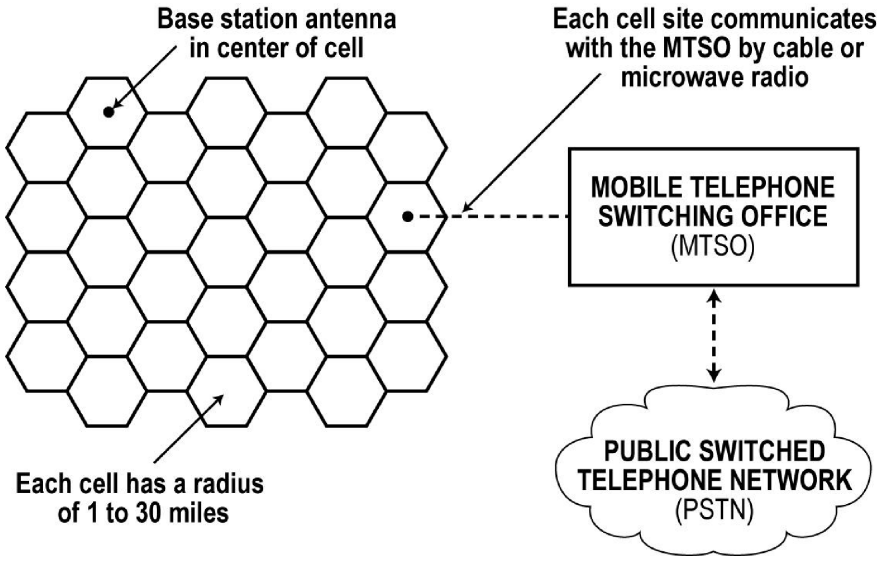
Photo courtesy Motorola

3G and 4G Cell Phones

As the limits of the 2.5G phones have been reached, attention has turned to the 3G phones. Some systems are now being implemented especially in parts of Europe and Asia. 3G is expected to be ultimately available in the US beyond 2006.

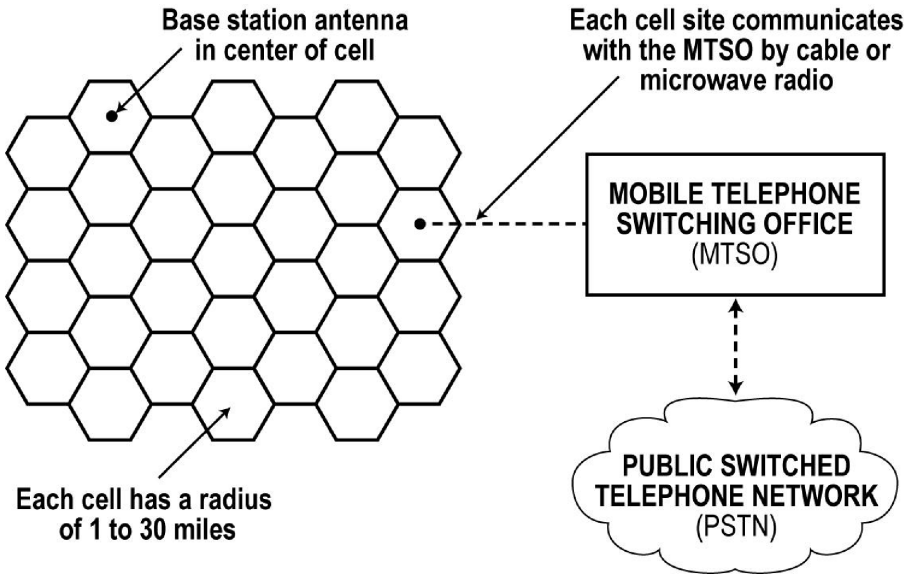
Fourth generation (4G) phones have been defined but have not yet been implemented.

The Basic Idea of Cellular



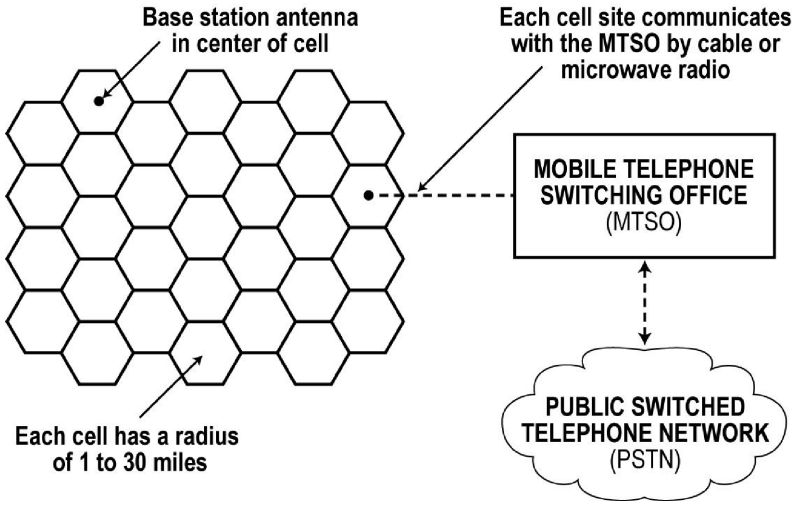
The modern cellular telephone system is based on the concept of using many two-way radio base stations, also called cell sites, with overlapping coverage of a desired geographic area. For example, to provide coverage over an entire city, many base stations with tall antennas are needed to provide access to those who have cell phones.

The Basic Idea of Cellular: Cell Coverage



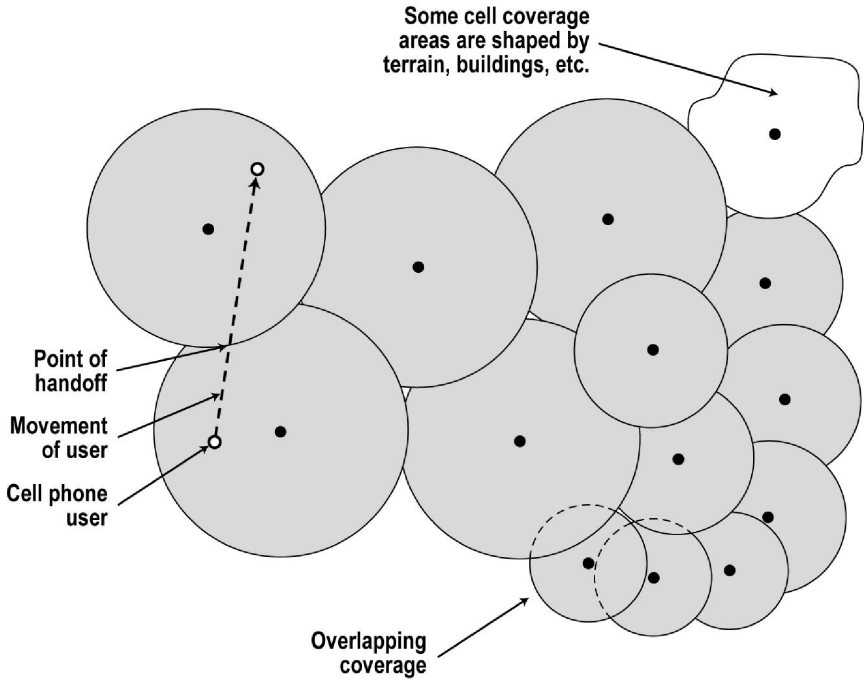
The original idea was to use many equal size cells each covering the same amount of area to form a honeycomb-like coverage of the city. Each base station can communicate only with phones within its coverage area.

The Basic Idea of Cellular: Connection



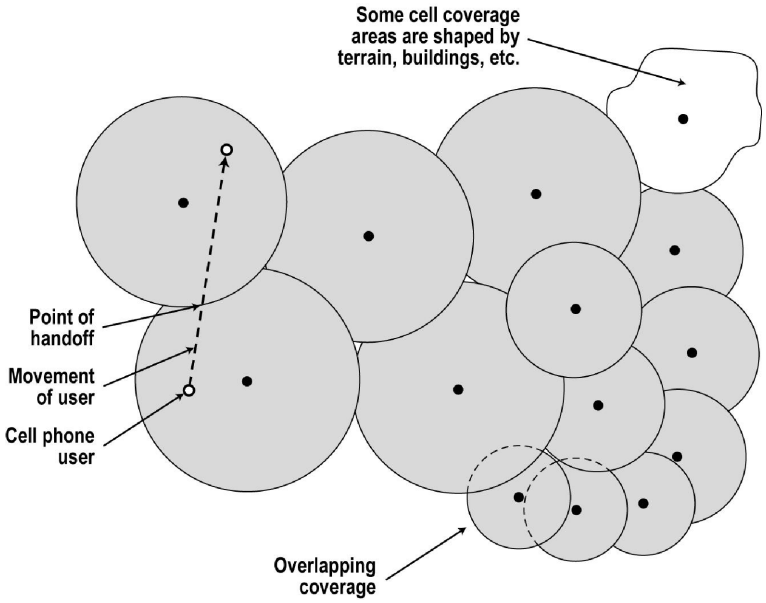
A cell phone communicates with the closest base station because its signal strength will be greatest at this station. The base station then communicates by either wire or wireless link to the mobile telephone switching office (MTSO) which then connects to the main telephone system known as the public switched telephone network (PSTN).

Cellular Concepts



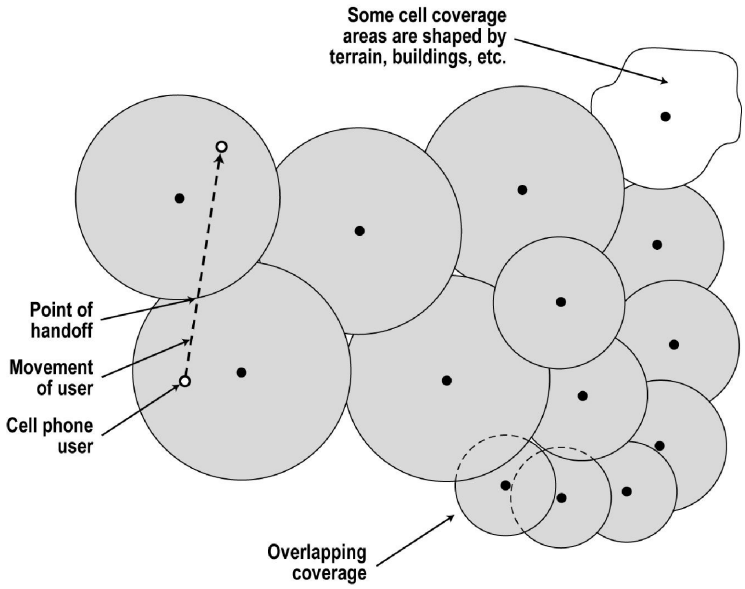
In most cellular systems, the size of the coverage of a cell site is not constant. Some base stations will cover only a small area while others can cover a much larger area. Furthermore, the coverage area is not hexagonal as shown in the previous slides. Instead, most antennas have an approximately circular radiation pattern.

Area of Coverage



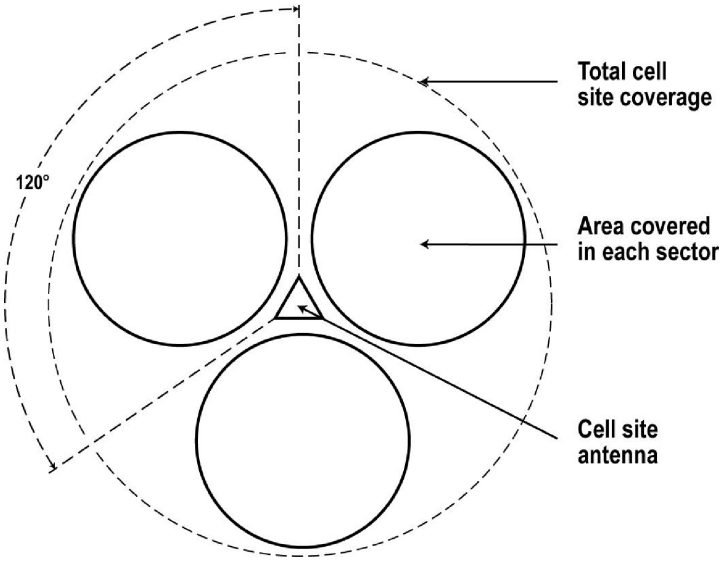
The circular coverage is further modified by the surrounding objects like trees, buildings, water towers, etc. The resulting pattern is only roughly circular. The area of coverage is determined by the height of the base station antenna and the transmitter power. The higher the antenna, the broader the coverage. Obstacles like tall buildings and trees will affect the area of coverage.

Subscriber Movement



As a cell phone subscriber moves from one place to another by car or other means, the cell phone will eventually leave the coverage area of the base station. When this happens, the subscriber moves into the coverage area of an adjacent cell site. The system is designed to detect this movement so that the call is handed off from one base station to the other without the subscriber noticing.

Sectorized Cell Sites



Most cell sites have an antenna array that divides the coverage into three areas or sectors as shown here.

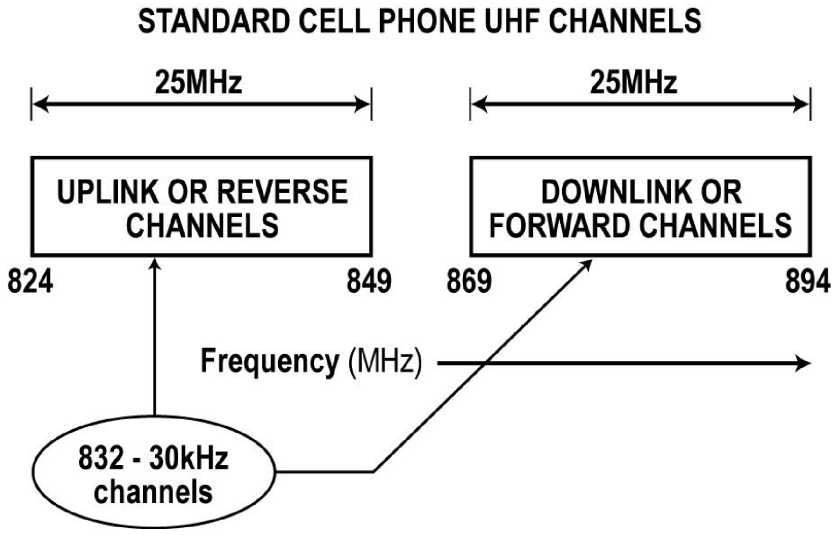
Each sector of the antenna can serve a separate cell site within the larger site.

This has the benefit of multiplying the number of potential subscribers.

Cell Phone Antennas

Because the antennas are directional they send and receive over only one 120° sector. One sector does not interfere with any of the others.

Spectrum Allocations

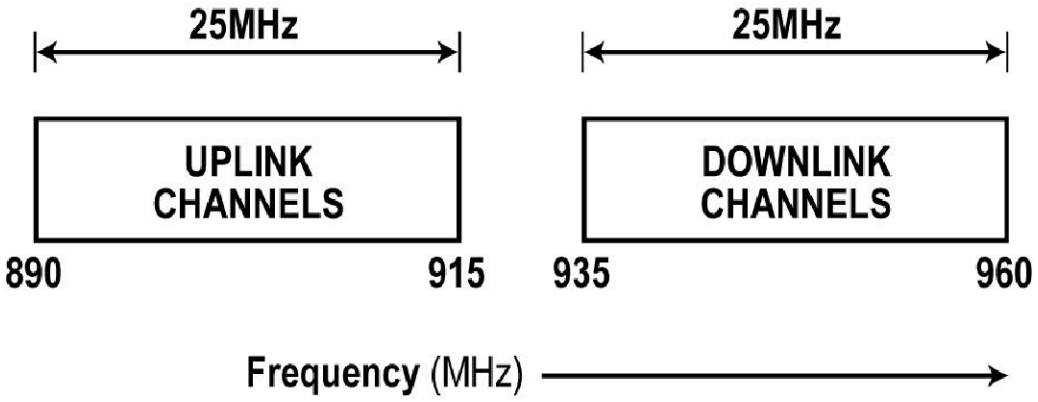


The Federal Communications Commission (FCC) allocates spectrum space for cell phone operation. In the current arrangement shown here, there are two 25 MHz bands.

The lower spectrum from 824 to 849 MHz contains 832 30 kHz wide channels for the uplink from the cell phone to the base station.

The upper spectrum from 869 to 894 MHz contains 832 30 kHz channels for the downlink from the base station to the cell phone.

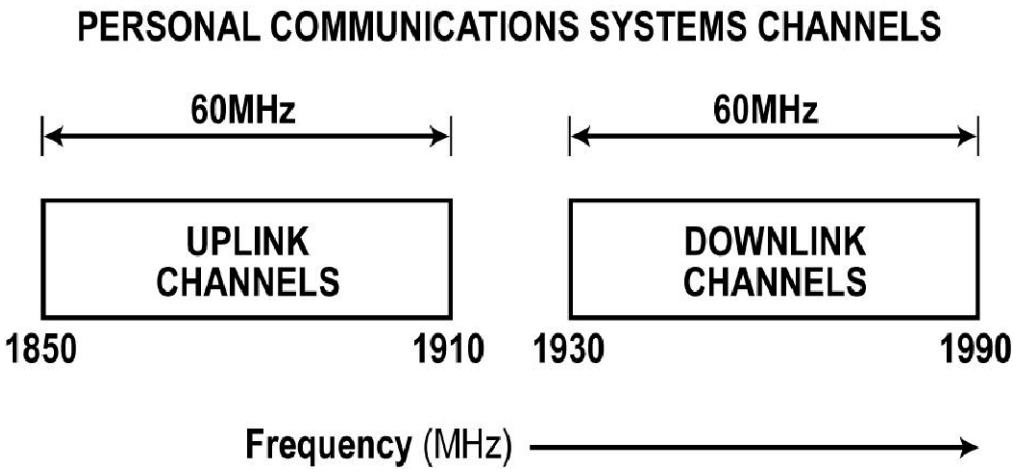
Additional Spectrum Allocations



Two 25 MHz bands between 890 and 960 MHz are also used.

The lower spectrum from 890 to 915 MHz is used for the uplink from the cell phone to the base station while the upper spectrum from 935 to 960 MHz is used for the downlink from the base station to the cell phone.

Personal Communications Systems Channels



Later as more spectrum was needed, the FCC allocated space in the 1900 MHz range generally known as the Personal Communications Service (PCS) bands. Only digital phones use these bands.

The overall frequency range of the PCS band is 1850 to 1990 MHz. This range is divided to provide both uplink and downlink bands as shown above.

Designated Channel Blocks

These bands are further divided up into six blocks each designated blocks A through F. These blocks are either 5 or 15 MHz wide.

Though the basic channel size within each block is 50 kHz, they are usually combined to make larger bandwidth channels, 200 kHz and 1.25 MHz, for the various types of radio technologies used.

Most other countries use similar frequency ranges. In Europe the bands are in the 900 and 1800 MHz ranges.

Forthcoming 3G phones will use frequencies in the 1900 to 2300 MHz range.

Test your knowledge

Contemporary Wireless Technology
Knowledge Probe 1
The Cellular Telephone System

Click on Course Materials at the top of the page.
Then choose **Knowledge Probe 1**.