How Cell Phones Work Essay, Research Paper

Cellular Phones 101

Each day about 30,000 people in the United States sign up for and start using a cellular phone. Therefore it is likely that you or someone you know has a cell phone and uses it on a regular basis. They are such great gadgets – with a cell phone you can talk to almost anyone from just about anywhere, because about 80% of the U.S. has coverage (Dang). But have you ever wondered how a cell phone works?

One of the most interesting things about a cell phone is that it is really a radio- an extremely sophisticated radio, but a radio nonetheless. A good way to understand the sophistication of a cell phone is to compare it to a CB radio or a walkie-talkie. A CB radio is a simplex device. That is, two people communicating on a CB radio use the same frequency, so only one person can talk at a time. A cell phone is a duplex device, so it uses one frequency for talking, and a second separate frequency for listening (Dang). A CB radio has 40 channels. A cell phone can communicate on 1,664 channels. Cell phones also operate within cells and they can switch cells as they move around. Cells give cell phones incredible range. A walkie-talkie can transmit perhaps a mile. A CB radio, because it has much higher power, can transmit perhaps 5 miles. Someone using a cell phone, on the other hand, can drive clear across a city and maintain a conversation the entire time. Cells are what give a cell phone its incredible

range (Anonymous #2).

The genius of the cellular system is the realization that a city can be chopped up into small cells, and that the cells allow extensive frequency reuse across a city. Frequency reuse is what lets millions of people own cell phones without problems. It works because the carrier chops up an area to about 10 square miles (Dang).

In the dark ages before cell phones, people used radiotelephones in their cars. In the radiotelephone system there was one central antenna tower per city and perhaps 25 channels available on that tower. This central antenna meant that the phone in your car needed a powerful transmitter – big enough to transmit 40 or 50 miles. It also meant that not many people could use radiotelephones – there just were not enough channels (Anonymous #1).

Cell phones have low-power transmitters in them. Many cell phones have 2 signal strengths: 0.6 watts and 3 watts (for comparison, most CB radios transmit at 5 watts). The base station is also transmitting at low power. Low-power transmitters have two advantages. The first is that the power consumption of the cell phone, which is normally battery-operated, is relatively low. Low power means small batteries, and this is what has made hand-held cellular phones possible (Dang). The second is that the transmissions of a base station and the phones within its cell do not make it very far outside the cell. The same frequencies can be reused extensively across a city.

The cellular approach requires a large number of base stations in a city of any size. A typical large city can have hundreds of towers. But because so many people are using cell phones, costs remain fairly low per user. Each carrier in each city also runs one central office called the MTSO (Mobile Telephone Switching Office). This office handles all of the phone connections to the normal land-based phone system and controls all of the base stations in the region (Anonymous #2)

So let’s say you have a cell phone, it is turned on, and someone tries to call you. The MTSO gets the call, and it tries to find you. In early (pre-roaming) systems the MTSO found you by paging your phone (using one of the control channels, to which your phone is always listening) in each cell of the region until your phone responded. It then told both your phone and the base station in the cell your phone should be using. At that point you were connected to the base station and you could start talking and listening (Dang).

As you move toward the edge of your cell, your cell’s base station will note that your signal strength is diminishing. Meantime, the base station in the cell you are moving toward will be able to see your phone’s signal strength increasing. The two base stations coordinate themselves through the MTSO, and at some point your phone gets a signal on a control channel telling it to change frequencies. This handoff switches your phone to the new cell (Dang).

Roaming makes things a bit more interesting. In modern systems the phones listen for a System ID (SID) on the control channel when the power is turned on. If the SID on the control channel does not match the SID programmed into the phone, then the phone knows it is “roaming”. The phone also transmits a registration request and the network keeps track of your phone’s location in a database (this way the MTSO knows which cell you are in when it wants to ring your phone) (Anonymous #2). As you move between cells, the phone detects changes in the control channel’s strength and re-registers itself with the new cell when it changes channels. If the phone cannot find any control channels to listen to it knows it is out of range and displays a “no service” message (Anonymous #2).

The latest trend is digital cellular phones. They use the same radio technology (in different frequency bands – for example, PCS phones use frequencies between 1.85 and 1.99 gigahertz) but compress your voice into digital 1s and 0s. This compression allows between 3 and 10 cell phone calls to occupy the space of a single analog voice call. PCS digital phones also offer other features like paging and email (Anonymous #1).

The next time you pick up and use a cell phone – especially one of the new tiny ones that fit into your shirt pocket – keep in mind all of the technology packed into that amazing little device!