Cellular communications assignment

? CELLULAR COMMUNICATIONS PAPER PRESENTED BY D. Jyothsnaco. in G. Anushaco. in ABSTRACT A cellular mobile communications system uses a large number of low-power wireless transmitters to create cells—the basic geographic service area of a wireless communications system. Variable power levels allow cells to be sized according to the subscriber density and demand within a particular region. As mobile users travel from cell to cell, their conversations are handed off between cells to maintain seamless service.

Channels (frequencies) used in one cell can be reused in another cell some distance away. Cells can be added to accommodate growth, creating new cells in unserved areas or overlaying cells in existing areas. Now we are going to discuss about – 1. Mobile communication principles 2. Mobile telephone system using the cellular concept 3. Cellular system architecture 4. North American analog cellular system 5. Cellular system components 6. Digital systems 1. Mobile Communications Principles Each mobile uses a separate, temporary radio channel to talk to the cell site.

The cell site talks to many mobiles at once, using one channel per mobile. Channels use a pair of frequencies for communication—one frequency (the forward link) for transmitting from the cell site and one Figure 1. Basic Mobile Telephone Service Network frequency (the reverse link) for the cell site to receive calls from the users. Radio energy dissipates over distance, so mobiles must stay near the base station to maintain communications. The basic structure of mobile networks includes telephone systems and radio services. Early Mobile Telephone System Architecture

Traditional mobile service was structured in a fashion similar to television broadcasting. One very powerful transmitter located at the highest spot in an area would broadcast in a radius of up to 50 kilometers. Instead of using one powerful transmitter many low-power transmitters were placed throughout a coverage area. For example, by dividing a metropolitan region into one hundred different areas with low-power transmitters using 12 conversations each, system capacity could be increased from 12 conversations or voice channels using one powerful transmitter to 1200 conversations using one hundred low-power transmitter

Figure 2. Early Mobile Telephone System Architectecture 2. Mobile Telephone System Using the Cellular Concept Interference problems caused by mobile units using the same channel in adjacent areas proved that all channels could not be reused in every cell. Areas had to be skipped before the same channel could be reused. Even though this affected the efficiency of the original concept, frequency reuse was still a viable solution to the problems of mobile telephony systems. Engineers discovered that the interference effects were not due to the istance between areas, but to the ratio of the distance between areas to the transmitter power (radius) of the areas. By reducing the radius of an area by 50 percent, service providers could increase the number of potential customers in an area fourfold. Systems based on areas with a one-kilometer radius would have one hundred times more channels than systems with areas 10 kilometers in radius. Speculation led to the conclusion that by reducing the radius of areas to a few hundred meters, millions of calls could be served.

The cellular concept employs variable low-power levels, which allow cells to be sized according to the subscriber density and demand of a given area. As the population grows, cells can be added to accommodate that growth. Frequencies used in one cell cluster can be reused in other cells. Conversations can be handed off from cell to cell to maintain constant phone service as the user moves between cells (see Figure 3). Figure 3. Mobile Telephone System Using a Cellular Architecture The cellular radio equipment (base station) can communicate with mobiles as long as they are within range.

Radio energy dissipates over distance, so the mobiles must be within the operating range of the base station. Like the early mobile radio system, the base station communicates with mobiles via a channel. 3. Cellular System Architecture Increases in demand and the poor quality of existing service led mobile service providers to research ways to improve the quality of service and to support more users in their systems. Because the amount of frequency spectrum available for mobile cellular use was limited, efficient use of the required frequencies was needed for mobile cellular coverage.

Provisioning for each region is planned according to an engineering plan that includes cells, clusters, frequency reuse, and handovers. Cells A cell is the basic geographic unit of a cellular system. Cells are base stations transmitting over small geographic areas that are represented as hexagons. Each cell size varies depending on the landscape the true shape of cells is not a perfect hexagon. Clusters A cluster is a group of cells. No channels are reused within a cluster. Figure 4 illustrates a seven-cell cluster. Figure 4 . A Seven-Cell Cluster

FrequencyReuse Because only a small number of radio channel frequencies were available for mobile systems, engineers had to find a way to reuse radio channels to carry more than one conversation at a time. The solution the industry adopted was called frequency planning or frequency reuse. Frequency reuse was implemented by restructuring the mobile telephone system architecture into the cellular concept. The concept of frequency reuse is based on assigning to each cell a group of radio channels used within a small geographic area.

Cells are assigned a group of channels that is completely different from neighboring cells. The coverage area of cells is called the footprint. This footprint is limited by a boundary so that the same group of channels can be used in different cells that are far enough away from each other so that their frequencies do not interfere (see Figure 5). Figure 5. Frequency Reuse Cells with the same number have the same set of frequencies. Here, because the number of available frequencies is 7, the frequency reuse factor is 1/7. That is, each cell is using 1/7 of available cellular channels.

Cell Splitting Unfortunately, economic considerations made the concept of creating full systems with many small areas impractical. To overcome this difficulty, system operators developed the idea of cell splitting. As a service area becomes full of users, this approach is used to split a single area into smaller ones. In this way, urban centers can be split into as many areas as necessary to provide acceptable service levels in heavy-traffic regions, while larger, less expensive cells can be used to cover remote rural regions (see Figure 6). Figure 6. Cell Splitting

Handoff The final obstacle in the development of the cellular network involved the problem created when a mobile subscriber traveled from one cell to another during a call. As adjacent areas do not use the same radio channels, a call must either be dropped or transferred from one radio channel to another when a user crosses the line between adjacent cells. Because dropping the call is unacceptable, the process of handoff was created. Handoff occurs when the mobile telephone network automatically transfers a call from radio channel to radio channel as a mobile crosses adjacent cells (see Figure 7).

Figure 7. Handoff between Adjacent Cells During a call, two parties are on one voice channel. When the mobile unit moves out of the coverage area of a given cell site, the reception becomes weak. At this point, the cell site in use requests a handoff. The system switches the call to a stronger-frequency channel in a new site without interrupting the call or alerting the user. The call continues as long as the user is talking, and the user does not notice the handoff at all. 4. North American Analog Cellular Systems

Originally devised in the late 1970s to early 1980s, analog systems have been revised and operate in the 800-MHz range. A group of government, telco, and equipment manufacturers worked together as a committee to develop a set of rules (protocols) that govern how cellular subscriber units (mobiles) communicate with the cellular system. Cellular development involves the following basic topics: frequency and channel assignments type of radio modulation and modulation parameters maximum power levels messaging protocols call-processing sequences

The Advanced Mobile Phone Service (AMPS) AMPS was released in 1983 using the 800-MHz to 900-MHz frequency band and the 30-kHz bandwidth for each channel as a fully automated mobile telephone service. It was the first standardized cellular service in the world and is currently the most widely used standard for cellular communications inU. S, China, Australia. AMPS uses frequency modulation for radio transmission. It maximized the cellular concept of frequency reuse by reducing radio power output.

The AMPS telephones have the familiar telephone-style user interface and are compatible with any AMPS base station. This makes mobility between service providers simpler for subscribers. Limitations associated with AMPS include the following: low calling capacity limited spectrum no room for spectrum growth poor data communications minimal privacy inadequate fraud protection Narrowband Analog Mobile Phone Service (NAMPS) Since analog cellular was developed, systems have been implemented extensively throughout the world as first-generation cellular technology.

In the second generation of analog cellular systems, NAMPS was designed to solve the problem of low calling capacity. The NAMPS concept uses frequency division to get 3 channels in the AMPS 30-kHz single channel bandwidth. NAMPS provides 3 users in an AMPS channel by dividing the 30-kHz AMPS bandwidth into 3 10-kHz channels. This increases the possibility of interference because channel bandwidth is reduced. 5. Cellular System Components The cellular system offers mobile and portable telephone stations the same service provided fixed stations over conventional wired loops.

It has the capacity to serve tens of thousands of subscribers in a major metropolitan area. The cellular communications system consists of the following four major components that work together to provide mobile service to subscribers. public switched telephone network (PSTN) mobile telephone switching office (MTSO) cell site with antenna system mobile subscriber unit (MSU) PSTN The PSTN is made up of local networks, the exchange area networks that interconnect telephones and other communication devices on a worldwide basis.

Mobile Telephone Switching Office (MTSO) The MTSO is the central office for mobile switching. It houses the mobile switching center (MSC), field monitoring, and relay stations for switching calls from cell sites to wireline central offices (PSTN). The MSC controls calls, tracks billing information, and locates cellular subscribers. The Cell Site The term cell site is used to refer to the physical location of radio equipment that provides coverage within a cell. A list of hardware located at a cell site includes power sources, interface equipment, radio frequency transmitters and receivers, and antenna systems.

Mobile Subscriber Units (MSUs) The mobile subscriber unit consists of a control unit and a transceiver that transmits and receives radio transmissions to and from a cell site. The following three types of MSUs are available: the mobile telephone (typical transmit power is 4. 0 watts) the portable (typical transmit power is 0. 6 watts) the transportable (typical transmit power is 1. 6 watts) The mobile telephone is installed in the trunk of a car, and the handset is installed in a convenient location to the driver.

Portable and transportable telephones are hand-held and can be used anywhere. The use of portable and transportable telephones is limited to the charge life of the internal battery. 6. Digital Systems As demand for mobile telephone service has increased, service providers found that basic engineering assumptions borrowed from wireline networks did not hold true in mobile systems. Engineers expected to assign 50 or more mobile phones to the same radio channel found that by doing so they increased the probability that a user would not get dial tone—this is known as call blocking probability.

As a consequence, the early systems quickly became saturated and the quality of service decreased rapidly. The general characteristics of time division multiple access, Global System for Mobile Communications, personal communications service 1900, and code division multiple access promise to significantly increase the efficiency of cellular telephone systems to allow a greater number of simultaneous conversations. Figure 8. Component Of Digital Cellular System The advantages of digital cellular technologies over analog cellular networks include increased capacity and security.

Technology options such as TDMA and CDMA offer more channels in the same analog cellular bandwidth and encrypted voice and data. Because of the enormous amount of money that service providers have invested in AMPS hardware and software, providers look for a migration from AMPS to digital analog mobile phone service (DAMPS) by overlaying their existing networks with TDMA architectures. Time Division Multiple Access (TDMA) North American digital cellular (NADC) is called DAMPS and TDMA. Because

AMPS preceded digital cellular systems, DAMPS uses the same setup protocols as analog AMPS.

TDMA has the following characteristics: 1. IS–54 standard specifies traffic on digital voice channels 2. initial implementation triples the calling capacity of AMPS systems 3. capacity improvements of 6 to 15 times that of AMPS are possible 4. many blocks of spectrum in 800 MHz and 1900 MHz are used 5. all transmissions are digital 6. TDMA/FDMA application 7. 3 callers per radio carrier (6 callers on half rate later), providing 3 times the AMPS capacity TDMA is one of several technologies used in wireless communications.

TDMA provides each call with time slots so that several calls can occupy one bandwidth. Each caller is assigned a specific time slot. In some cellular systems, digital packets of information are sent during each time slot and reassembled by the receiving equipment into the original voice components. Like NAMPS, TDMA provides three to six time channels in the same bandwidth as a single AMPS channel. TDMA is the digital standard and has 30-kHz bandwidth. Using digital voice encoders, TDMA is able to use up to six channels in the same bandwidth where AMPS uses one channel.

Fixed Wireless Access (FWA) FWA is a radio-based local exchange service in which telephone service is provided by common carriers (see Figure 9). It is primarily a rural application—that is, it reduces the cost of conventional wireline. FWA extends telephone service to rural areas by replacing a wireline local loop with radio communications. FWA systems employ TDMA or CDMA access technologies. Figure 9. Fixed Wireless Access Personal

Communications Service (PCS) The future of telecommunications includes PCS.

PCS at 1900 MHz (PCS 1900) is the North American implementation of digital cellular system (DCS) 1800 (GSM). Trial networks were operational in the United States by 1993, and in 1994 the Federal Communications Commission (FCC) began spectrum auctions. As of 1995, the FCC auctioned commercial licenses. In the PCS frequency spectrum, the operator’s authorized frequency block contains a definite number of channels. The frequency plan assigns specific channels to specific cells, following a reuse pattern that restarts with each nth cell. The uplink and downlink bands are paired mirror images.

As with AMPS, a channel number implies one uplink and one downlink frequency (e. g. , Channel 512 = 1850. 2-MHz uplink paired with 1930. 2-MHz downlink). Code Division Multiple Access (CDMA) CDMA is a digital air interface standard, claiming 8 to 15 times the capacity of analog. It employs a commercial adaptation of military, spread-spectrum, single-sideband technology. Based on spread spectrum theory, it is essentially the same as wireline service—the primary difference is that access to the local exchange carrier (LEC) is provided via wireless phone.

Because users are isolated by code, they can share the same carrier frequency, eliminating the frequency reuse problem encountered in AMPS and DAMPS. Every CDMA cell site can use the same 1. 25-MHz band, so with respect to clusters, n = 1. This greatly simplifies frequency planning in a fully CDMA environment. CDMA is an interference-limited system. Unlike AMPS/TDMA, CDMA has a soft capacity limit; however, each user is a noise source on the shared channel and the noise contributed by users accumulates.

This creates a practical limit to how many users a system will sustain. Mobiles that transmit excessive power increase interference to other mobiles. For CDMA, precise power control of mobiles is critical in maximizing the system's capacity and increasing battery life of the mobiles. The goal is to keep each mobile at the absolute minimum power level that is necessary to ensure acceptable service quality. Ideally, the power received at the base station from each mobile should be the same (minimum signal to interference). Conclusion:

By making use of advanced technologies like TDMA, CDMA, GSM, we can provide communication between people over a long distance without any interference . The frequency reuse is provided by assigning different frequencies to cells which are adjacent to each other, thus making use of same frequencies for a cell which is far away from the previously considered cell. The digital cellular technologies provide increased capacity and security over analog cellular networks. To keep each mobile at the absolute minimum power level, the power received at the base station from each mobile should be the same ideally.