

CDMA versus TDMA

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Introduction:

In today's world cell phone have become the single greatest tool in day today life. It has become a necessity that business associates should be able to communicate on the go. That's why it has become so important to make choices in choosing which handheld device one should go for. A handheld device is selected according to its features and benefits, like does it provide access to internet and email or does it look slick and more.

An important question when designing and standardizing cellular systems is the selection of the multiple access schemes. There are three basic principles in multiple access, FDMA (Frequency Division Multiple Access), TDMA (Time Division Multiple Access), and CDMA (Code Division Multiple Access). All three principles allow multiple users to share the same physical channel. But the two competing technologies differ in the way user sharing the common resource. TDMA allows the users to share the same frequency channel by dividing the signal into different time slots. Each user takes turn in a round robin fashion for transmitting and receiving over the channel. CDMA uses a spread spectrum technology that is it spreads the information contained in a particular signal of interest over a much greater bandwidth than the original signal. In TDMA users can only transmit in their respective time slot. Unlike TDMA, in CDMA several users can transmit over the channel at the same time.

Voice encoding:

Transmission of digital audio has two different issues. First is the way in which the stream of bits is transferred from one end to the other this is where the two technologies (CDMA and TDMA) differ from each other. Second is the compression algorithms used to encode the original audio into as small stream of bits as possible. These encoders (vocoders) take advantage of the predictable elements in human speech.

Although each technology has chosen their own unique vocoders, it is not necessary that one transmission method should use only particular vocoders.

Voice encoding schemes differ from each other slightly in the way it approaches problem. Because of that, certain types of human voice sound better with some vocoders than they do with others. Due to this reason it has lead some people to choose certain technology over the other. All of the vocoders try to minimize the battery consumption by keeping the transmission of unnecessary data to a minimum. The cell phone decides whether you are presently speaking or not, or the sound it hears is just a background noise. If the phone decides whether it is an unnecessary data, it blanks the audio and it reduces the transmitter duty cycles (TDMA) or the number of transmitted bits (CDMA). These blank in the audio will result in receiver to think that the call is dropped. To avoid this problem many service providers insert a comfort noise during the blank periods. Comfort noise is nothing but a synthesized white noise which tries to mimic the structure and volume of the real background noise. This fake noise assures the receiver that the connection is not dropped. CDMA uses newer vocoder called EVRC, which suppress the background noise even when the user is talking. [2]

TDMA:

In late1980's, as a search to convert the existing analog network to digital as a means to improve capacity, the cellular telecommunications industry association chose TDMA over FDMA. Time Division Multiplex Access is a type of multiplexing where two or more channels of information are transmitted over the same link by allocating a different time interval for the transmission of each channel.

The most complex implementation using TDMA principle is of GSM's (Global System for Mobile communication). To reduce the effect of co-channel interference, fading and multipath the GSM technology can use frequency hopping, where a call jumps from one channel to another channel in a short interval. The first GSM network started their operation from 1991, since then it has been steadily progressing. GSM speech service has seen some improvements half rate codec to double the network capacity and enhanced full rate (EFR) codec to provide speech quality. GSM phase 2 standards has

introduced a new set of supplementary services such as line identification service, call hold, multi-party call, closed user group and advice of charge in addition to Phase 1 features call forwarding and call barring. Another technology which uses TDMA principle is IS-136. This technology is being abandoned in favor of GSM technology. [9]
[5]

TDMA systems still rely on switch to determine when to perform a handoff. Handoff occurs when a call is switched from one cell site to another while traveling. The TDMA handset constantly monitors the signals coming from other sites and reports it to the switch without caller's awareness. The switch then uses this information for making better choices for handoff at appropriate times. TDMA handset performs hard handoff, which means that whenever the user moves from one site to another it breaks the connection and then provide a new connection with the new site.

Advantages of TDMA:

There are lots of advantages of TDMA in cellular technologies. It can easily adapt to transmission of data as well as voice communication. It has an ability to carry 64 kbps to 120 Mbps of data rates. This allows the operator to do services like fax, voice band data, and SMS as well as bandwidth-intensive application such as multimedia and videoconferencing. Since TDMA technology separates users according to time, it ensures that there will be no interference from simultaneous transmissions. It provides users with an extended battery life, since it transmits only portion of the time during conversations. Since the cell size grows smaller, it proves to save base station equipment, space and maintenance. TDMA is the most cost effective technology to convert an analog system to digital. [9]

Disadvantages of TDMA:

One major disadvantage using TDMA technology is that the users has a predefined time slot. When moving from one cell site to other, if all the time slots in this cell are full the user might be disconnected. Likewise, if all the time slots in the cell in which the user is currently in are already occupied, the user will not receive a dial tone.

Another problem in TDMA is that it is subjected to multipath distortion. To overcome this distortion, a time limit can be used on the system. Once the time limit is expired the signal is ignored. [9]

CDMA:

CDMA scheme has two concepts, spread spectrum techniques with single user detection and multi user concepts with joint detection of user signals. In single user detection, all user signals from the own cell except for the desired one and all user signals from other cells are treated as noise. Therefore, in this type of CDMA the desired user signal is not only disturbed by intercellular interference but also by intracellular interference. In joint detection method all user signals of a cell are simultaneously detected by exploiting a prior knowledge of the used CDMA codes and the channel impulse response. Thus, in this type of CDMA intracellular interference is avoided.

CDMA gives the user entire spectrum all of the time. CDMA spread spectrum technology in which it uses unique spreading codes to spread the baseband data before transmission. The receiver then dispreads the wanted signal, which is passed through a narrow band pass filter. The unwanted signals are not dispread and will not be passed through the filter. The codes are a sequence of zeros and ones produced at a much higher rate of that of the baseband data. The rate of spreading code is referred to as chip rate. [1]

In a traditional hard handoff, the connection to the current cell is broken and then the connection to the new cell is made. Since CDMA uses the same frequency, the connection to the new cell site can be made without breaking the connection of the current cell which is known as soft handoff. Soft handoff requires less power, which reduces interference and increases capacity. The network chooses one or more alternative sites that it feels are handoff candidates while a call is in progress. It simultaneously broadcasts a copy of the call in each of these sites. It can then choose one of the sites and can move between them whenever it feels like it. This puts the phone in complete control of the handoff process. [2]

Advantages of CDMA:

One of the main advantages of CDMA is that dropouts occur only when the phone is at least twice as far from the base station. Thus it is used in the rural areas where GSM cannot cover. Another advantage is its capacity; it has a very high spectral capacity that it can accommodate more users per MHz of bandwidth. It uses a vocoder EVRC for noise reduction where the background noise is reduced. This is exclusively available in CDMA technology only.

Disadvantages of CDMA:

One major problem in CDMA technology is channel pollution, where signals from too many cell sites are present in the subscriber's phone but none of them is dominant. When this situation arises the quality of the audio degrades. Another disadvantage in this technology when compared to GSM is the lack of international roaming capabilities. The ability to upgrade or change to another handset is not easy with this technology because the network service information for the phone is put in the actual phone unlike GSM which uses SIM card for this. One another disadvantage is the limited variety of the handset, because at present the major mobile companies use GSM technology.

Spectrum efficiency of CDMA compared with TDMA:

Spectrum efficiency is defined as the maximum number of traffic channels per MHz per cell. The spectrum efficiency depends upon the average bit error rate that is adequate for a service quality. In TDMA system, the channel capacity is fixed to a finite number of time slots and new users cannot be accommodated when each of these slots is filled. Due to GSM's better error management and frequency hopping the interference of the co-channel is reduced. This allows the frequency to be reused without any degradation in quality of the service. With three different sets of frequency allotted to spread TDMA can have an efficiency of 6.6. To compute this in a CDMA technology certain assumptions are made. Using very optimistic assumption it gives an efficiency of

45 users per call per MHz and the pessimistic assumption the value is 12 which still gives CDMA a 2:1 advantage over TDMA.[2][5]

CDMA Vs TDMA in travel:

Both GSM and CDMA can be found across United States, which doesn't mean that it doesn't matter which technology we choose. When we travel domestically it is possible that we reach areas where digital service is not available. While traveling between places it is possible that we reach certain rural areas where only analog access is offered. CDMA handsets offer analog capabilities which the GSM don't offer. Another difference between GSM and CDMA is in the data transfer methods. GSM's high-speed wireless data technology, GPRS (General Packet Radio Service), usually offers a slower data bandwidth for wireless data connection than CDMA's high-speed technology, which has the capability of providing ISDN (Integrated Services Digital Network) with speeds as much as 144Kbps.

GSM's benefits over the CDMA in domestic purpose are that GSM uses SIM card that identifies a user and stores the information in the handset. The SIM card can be swapped between handsets, which enable to move all the contacts to the new handset with ease. CDMA can have this flexibility with their own service that stores data on the operator's database. This service allows the user to swap data's between two handsets with a little trouble, but the advantage is it can be done when the handset is even lost but in GSM technology, when a handset is lost, SIM card is also lost with it.

When it comes for international roaming handsets with GSM is far better than CDMA handsets because GSM is used in most the markets across the globe. Users using tri-band or quad-band can travel to Europe, India and most of Asia and still can use their cell phone. CDMA does not have this multiband capability, thus cannot be used multiple countries with ease. [10]

Differences between CDMA and TDMA:

CDMA technology claims that its bandwidth is thirteen times efficient than TDMA and forty times efficient than analog systems. CDMA also have better security and higher data and voice transmission quality because of the spread spectrum technology it uses, which has increased resistance to multipath distortion. The battery life is higher in TDMA compared to CDMA because CDMA handsets transmit data all the time and TDMA does not require constant transmission. CDMA has greater coverage area when compared to TDMA. Though, when it comes to international roaming TDMA is better than CDMA. CDMA is patented by Qualcomm, so an extra fee is paid to Qualcomm. When it comes to United States and Canada market size for CDMA is larger than GSM's market size but worldwide the market size for GSM is far bigger both in the number of subscribers and coverage ,than CDMA.

Conclusion:

From the comparisons made above we cannot say that TDMA is better than CDMA or vice versa. The main advantage of the CDMA is that, in the single detection method it is more flexible than TDMA or joint detection. CDMA is said to have higher capacity than TDMA. But in the future GSM can be extended by an optional CDMA component in order to further increase the capacity. Finally, it does not matter whether which one is better CDMA or TDMA right now. It can be only found out with the evolution of these technologies. When going for a cell phone the user should choose the technology according to where they use it. For users who travel abroad it is better to go with GSM handsets. For the users in United States CDMA is better than TDMA because of the coverage we can get at rural areas where digital signals cannot be transmitted.

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