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W-CDMA on the Road to 4G

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Abstract- In the next few decades, hardly anyone can escape from being involved in some way with applications that have sprung into life from code- division multiple-access (CDMA) technology. There are 380 million CDMA users in China alone, making it the world leader in the mobile phone market. The world is demanding more from wireless communication technologies than ever before with subscription to wireless escalating in leaps and bounds.

Keywords- CDMA, wireless, 4G, GSM, hand-off,

I. INTRODUTION

The birth of CDMA

In May 1979, Andrew J. Viterbi made a prophetic introductory statement about the multiplicity of pread-spectrum techniques. A decade later, a technical team led by him developed the first successful CDMA cellular telephony system. In 1985, Viterbi, along with Irwin Jacobs, co-founded Qualcomm, which is today recognized as the pioneer of the CDMA digital ireless technology. Soon after this, the International

Telecommunication Union (ITU) adopted the technology to enhance its voice and data services. CDMA, the descendant of the military spread- pectrum system designed to avoid jamming, was first realized in the narrow band of about 1.25 MHz. The first practical form was introduced by Advanced Mobile Telephone Service in 1978 around the Chicago suburbs.

In 1981, the Federal Communications Commission (FCC) permitted cellular wireless radio services to begin. In the US, the FCC had allocated very limited amount of spectrum for single-cell, two-way radio telephone services, mostly reserved for police and dispatch services. In 1964 the very high-frequency (VHF) and in 1969 the ultra-high frequency (UHF) analogue radio systems, collectively known as ‘Improved Wireless Telephone Service’ were introduced for general mobile telephone service. In a geographical area, about 500 subscribers satisfactorily used 12 frequencies per band.

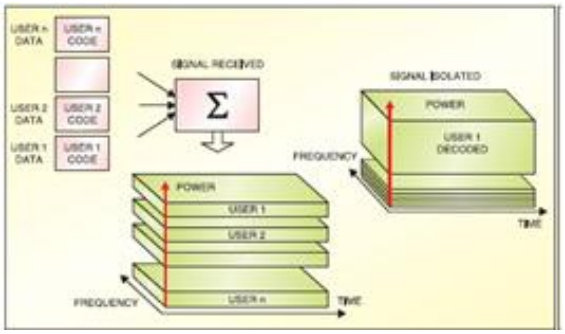

Fig. 1

At the receive input, a large number of unrelated signals are superimposed, constituting a noise-like input. But the desired signal can be separated by the receiver by knowing the correct sequence.

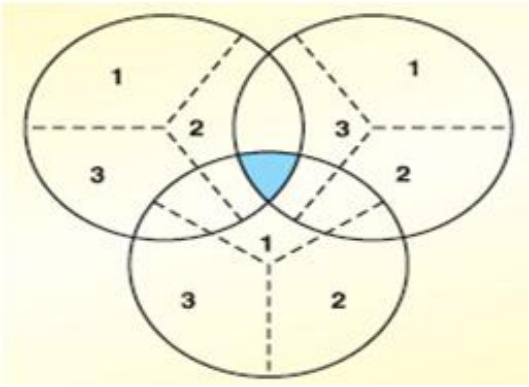

Fig. 2: The concept of three-way soft hand off

Table 1: Commonly Used Data Rates

Parameters	Speed	Unit	Medium
High Quality Video	128,60 12.2	Kbps	Over Air, User Data Rate
Normal Video	32,240 64	Kbps	Over Air User Data Rate
Packed Data Service	8,960 384	Kbps	Over Air User Data Rate

The technology behind it

CDMA is a spread-spectrum technology that allows many users to occupy the same time and frequency allocations in a given band/space. As the name implies, CDMA assigns unique codes to each user to differentiate it from others in the same spectrum. It is the platform on which 2G and 3G advanced services are built. This is claimed to be the fastest-growing wireless technology so far and there is every indication that it will continue to grow faster than any other contemporary technology. The foremost application of CDMA technology is Qualcomm's digital cellular phone technology operating in the 800MHz and 1.9GHz PCS bands. After the speech codec converts voice into digital, CDMA spreads the voice stream over the full 1.25MHz bandwidth of the CDMA channel, coding each stream separately so it can be decoded at the receiving end. The rate of the spreading signal is known as the 'chip rate,' as each bit in the spreading signal is known as 'chip.' All voice conversations use the full bandwidth at the same time. One bit from each conversation is multiplied into 128 coded bits by the spreading techniques; giving the receiving side an enormous amount of data it can average just to determine the value of one bit.

As mentioned above, CDMA uses unique spreading codes to spread the baseband data before transmission. The signal transmitted in a channel, like any spread-spectrum form, is below the noise level. The receiver uses a correlate to de-spread the wanted signal, which is passed through a nar narrow bandpass filter. Unwanted signals will not be de-spread and will not pass through the filter. Codes take the form of a carefully-designed 1/0 sequence produced at a much faster rate than of the baseband data.

The generic term 'CDMA' usually refers to the IS-95B standard. Technically speaking, it is only a means to transmit bits of information. For instance, IS-95B is a transmission protocol that employs CDMA. Another standard, cdmaOne, describes a complete wireless system based on the TIA/EIA

IS-95 CDMA standard, IS-95A and IS-95B revisions. It represents the end-to-end wireless system and all the necessary specifications that administer its operation. CDMA One provides a collection of related services including fixed wireless, wireless local loop and cellular within the Personal Communication Services (PCS) family.

There are many other versions in the CDMA group. For instance, CDMA2000 represents a family of ITU-approved, IMT-2000 (3G) standards and includes CDMA2000 1X and CDMA2000 1xEV technologies. CDMA2000 1X was the world's first commercially deployed 3G technology (October 2000). CDMA wireless subscribers around the world use smart card in the back of their CDMA handsets. These CDMA smart cards are called 'removable user identity modules.

Benefits

CDMA phones are known for their call quality and low power consumption. CDMA provides more than ten times the capacity of the analogue cell phone system AMPS and five times the calling capacity of GSM and TDMA. It requires fewer cell sites than the GSM and TDMA digital cell phone systems. CDMA virtually lets everyone transmit at the same time. It's the good-old digital modulation—spread spectrum—which makes it possible.

As in spread spectrum, in CDMA also the user's data is plattered across a very wide channel in a pseudo-random fashion. The pseudo part is very important here, since the receiver must be able to undo the randomization in order to collect the bits together in a coherent order. Supporters often allude to capacity as one of CDMA's biggest assets. Unlike other technologies like TDMA and FDMA, where the capacity is fixed and easily computed, CDMA can accommodate more users per MHz of bandwidth when the receiver witches from one cell site to another as it travels, a handoff occurs in every cellular system. In all mobile technologies other than CDMA, this handoff takes place when the network informs the handset that it has to switch to a new channel to maintain proper reception.

The phone then stops receiving and transmitting to the old channel and starts communicating with the new channel. But in CDMA, virtually every cell is on the same frequency. To switch on to a new base station, the receiver only needs to change the pseudo-random noise (PN) code sequence of the new base station. While a call is in progress, the network chooses two or more alternate sites that it feels are most probable handoff candidates. It simultaneously broadcasts a copy of message on each of these sites. The handset can then pick and choose between the different sources for a call and move between them at any point of time. This is known as 'soft handoff,' which is a CDMA specialty.

Table 2: Minimum Data Rates Needed for Different Applications

Applications	Representative Rate (Kbps)
V34 modem over telecom voice circuit	33
Inter-Office digital telephone voice circuit	64
Low Resolution conference quality video(compressed)	200
Compact Video Disk	1,400
VCR Quality TV(compressed)	1,500
Broadcast Quality (compressed)	5,000
HDTV(compressed)	20,000

Table 3: FOM (Carrier Rate/Interference Rate) of Well Known Systems

Systems	Carrier Rates/Interference Rate (dB)
APMS	17
TDMA	14-17
GSM	7-9
CDMA	-10 to -17

Theoretically, this should put an end to dropped calls and audio interruptions during the 'handoff' process. In fact, CDMA rarely drops a call due to a failed handoff. Moreover, if need arises, the handset can even combine the data received from two or more different sites to attain a good grade of service. Pitfalls CDMA is not entirely fault-free.

It always permits to add one more caller to a channel, however, after crossing a certain point, the channel begins to pollute and degrade and it becomes strenuous to retrieve an error-free data stream for any caller. Channel pollution also occurs when too many base stations are present at the subscriber's phone, but none is dominant. In this situation, the audio quality degrades rapidly, even if the signal seems to be strong.

Practically, the CDMA system restricts the number of users per sector to ensure that the processing gain remains at a usable range. Pollution occurs in CDMA system due to two reasons. First, densely populated urban areas where service providers must build many base stations in close proximity. Second, channel pollution can also result from enormous multi-path problems caused by too many high-rise buildings. This means that CDMA users will frequently see remarkably lower signal levels indoors than a GSM user will. But in the end, it all works out about the same. Basically, controlling channel pollution is a tuning and system design issue.

The onus is on the service provider to reduce
this phenomenon as much as possible. One of the things that every mobile user whimpers about is in-building coverage. On this issue, CDMA has a better performance index than other technologies. CDMA phone can produce a reasonable performance at signal level as low as –106 dBm, whereas a GSM phone might need –99 dBm to provide the same level of service. However, this 7dBm advantage of CDMA may become indistinguishable when the average performance of all other systems is tak n together. CDMA does have one distinction in the area of in-building penetration that does not affect TDMA.

When the number of users on a channel exceeds a certain limit, the general level of signal pollution increases accordingly. To be on the safe side, the CDMA system directs each user to transmit with slightly more power. If a user is already at its limit, no further raise in power is possible. The 'site breathing' or 'the shrinking coverage' phenomenon of CDMA is evident by the effect that during peak hours the response is poor or practically non-existent and during slow hours the response inside a building appears to be too good.

PCS technologies always struggle to minimize power consumption, especially during calls by keeping the transmission of unnecessary data to a minimum. In the case of phone calls, the receiver decides whether or not the speech activity is there or it hears just the background noise. If there is no intelligent data to transmit, it blanks the audio and reduces the number of transmitted bits.

TDMA also takes some defensive measure like reducing its duty cycle. When the audio is blanked, the listener may misunderstand it as a dropped call and may terminate the entire process of communication. To avoid this psycho-physical issue, many service providers insert a 'comfort noise' during the blanked periods. Comfort noise is nothing but a synthesized white Noise that mimics the volume and composition of the real background noise. It declares an active connection between the callers.

II. CONCLUSION

The WCDMA air interface is seen to develop far beyond its initial capabilities to satisfy future service and application needs. When looking at development of services, applications, or core networks, development especially in applications is much faster than traditional generation thinking assumes. This development will happen in an evolutionary way without clear generations. That is why here we consider quantum leaps in air interface development as different generations. The next such quantum leap will lead us to 4G.

This thinking is well in line with development from 1G to 2G and 3G. People clearly refer to air interface standards when referring to these generations. 4G needs to be something that 3G evolution cannot do. Looking at the complexity of application contents and development of such contents, going toward even higher data rates and availability of high data rates everywhere is a trend. Thus, one distinguishing factor between 3G and 4G will be the data rates. We assume that 4G should support at least 100 Mb/s peak rates in full-mobility wide area coverage and 1 Gb/s in low-mobility local area coverage.

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