3G TECHNOLOGY WHICH CAN PROVIDE AUGMENTED DATA TRANSFER RATES FOR GSM STANDARTS AND THE MODULATION TECHNIQUES

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ABSTRACT

In this study 3G (3rd Generation), which is the new technologies in the mobile communication, has been inspected. The family of standards that shall cover the 3G technology has been mentioned. By making the infrastructure analyses, which are necessary for current communication infrastructure and 3G, the advantages that will be brought by it into the communication in respect of capacity, scope, quality and data speed have been stated.

I. INTRODUCTION

Gaining acceleration of the demand for high speed data services and becoming wide spread of the mobile communication lately, has also increased the demand for high speed mobile services. Parallel to these tendencies, especially in the developed countries, studies for investing and developing new technologies in communication has been initiated. The 3G, is a specification which was determined by the ITU for third generation mobile communication and it is a new generation communication technology that shall carry the multimedia applications to the mobile area by taking the advantage of more band width. Thanks to the 3G, the communication speed varying between 384 Kbps and 2 Mbps shall be available.

II. 3G STANDARDS

For the 3G, there shall be a "standards family" which includes new Radio Transmission Technology (RTT). A CDMA based standard that has three optional modes as Multi-Carrier (MC), Direct Spread (DS) and Time Division Duplex (TDD) and a TDMA based standard (EDGE) take place in this standards family. The radio standards are combined with different main network standards (GSM MAP or ANSI-41) and can be operated in different frequency bands. The Multi-Carrier Mode (MC) is called as CDMA2000 MC, and the Direct Spread (DS) mode is called as WCDMA. The UMTS standards include WCDMA, TDD and GSM/MAP standards.

In general, the global telecommunications industry wants to reduce the number of third-generation mobile standards (from the current number of 2G standards), while at the same time respecting existing standards. With this approach, the industry has recently made two major achievements: the convergence of TDMA/136 and GSM, and the convergence of CDMA modes.

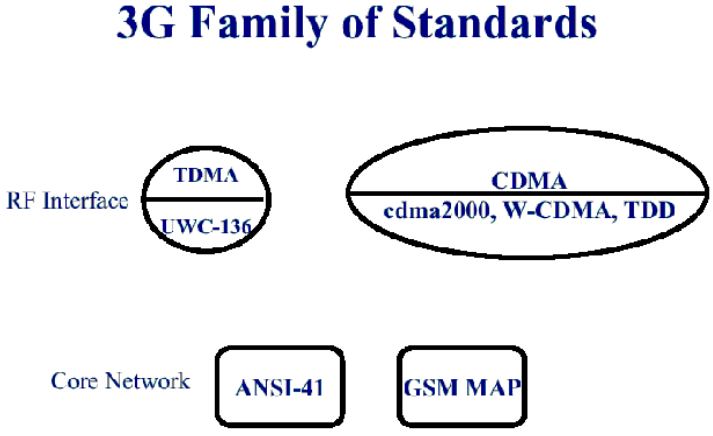
The convergence of TDMA/136 and GSM begins with the general packet radio services (GPRS) standard, which creates a common core network architecture and shares network components, and continues with EDGE, which unifies the radio network and terminals.

The convergence of the CDMA modes creates a single radio-access family of third-generation CDMA modes.

- WCDMA direct-sequence, frequency-division duplex (FDD) mode,
- WCDMA direct-sequence, time-division duplex (TDD) mode,
- Multicarrier CDMA, FDD mode,

The WCDMA direct-sequence, (WCDMA-DS) modes are the main modes being proposed for the universal mobile telecommunications system (UMTS). Basically the multicarrier CDMA mode is mainly for the evolution of CDMAOne/CDMA2000.

Figure-1



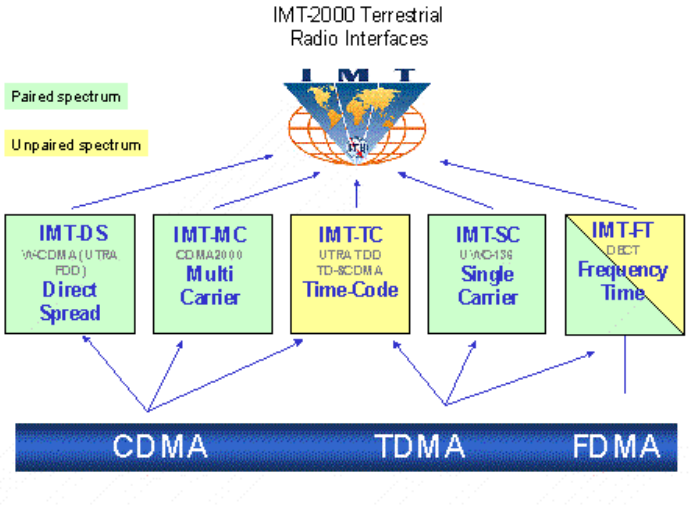


Figure-2 (Source: ITU)

III. FDMA (FREQUENCY DIVISION MULTIPLE ACCESS)

Frequency Division Multiple Access is the most common analog system. FDMA has been used for first generation analog systems.

Each channel in the FDMA us assigned to a certain frequency band. It means that each time each frequency shall carry a single call. One of the voice channels that is appropriate or available is assigned to each user who shall make a call. When a mobile user makes a call, a call arrangement is made which includes the transmission of the dialed numbers and sometimes other information from mobile unit to the base station. The base station conveys the commands to the mobile unit about jumping to a certain voice channel to establish a communicator link the communication.

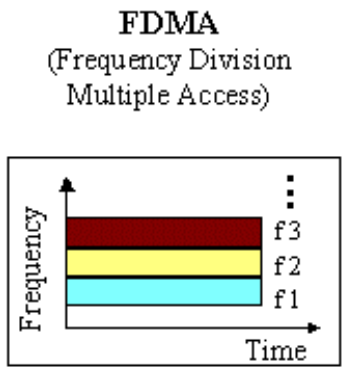


Figure-3

a) Single Circuit per Carrier: Each channel is arranged to carry a single telephone call at a time.

b) Continuous Transmission: Once the voice channel is assigned, the mobile unit and the base station transmit information continuously and synchronously.

c) Bandwith: The FDMA channels have a narrow bandwith of 25KHz since they carry one communication per carrier.

d) Symbol Duration: The symbol duration of FDMA is a long duration compared to the average delay spreading. This is an advantage of the FDMA in respect of other systems, because this means that the amount of the interference between symbols will be low.

IV.TDMA (TIME DIVISION MULTIPLE ACCESS)

TDMA is the dominant technology for the second generation mobile cellular networks.

In TDMA system, different users use same links in different time segments, for this reason the transmission is not continuous. The TDMA structure is rather complex comparing to the FDMA. 8 time sections are used for every frequency band and the channel conveying speed is faster as to be (8) in the number of time sections. The TDMA system forms a frequency-time matrix. It forms 8 time portions (it divides unit time into 8) for each frequency. Each cell in the matrix stands for a long distance call telephone voice circuit which can be accessed by the mobile users during the call.

When an incoming call is received, the base station sends a message to the mobile unit on the control portion for changing to a certain frequency and a certain time portion.

a) Multiple Circuits per Carrier: TDMA multiplies 8 circuit to each carrier.

b) Burst Transmission: The transmission from the mobile units is not continuous but within the certain time portions.

c) Bandwith: Uplink : 890.000- 915.000 MHz
Downlink : 935.000- 960.000 MHz

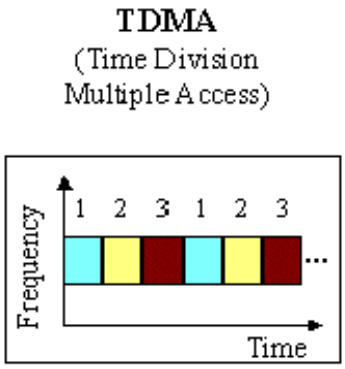


Figure-3

V. COMPARING TDMA AND FDMA

a) The channel gap ratio of the TDMA system is more than the FDMA system. This is an indication that there will be more important inter-symbol enterprise than the FDMA system.

b) The TDMA mobile unit has to do more work than FDMA mobile unit, at least in digital process point of view.

c) The basic advantage of the TDMA system compared to the FDMA system is that it can use effectively each radio channel as to provide opportunity to the user. For this reason cost of the equipment at the control section (base station) lower.

d) The validity and flexibility in long term of the TDMA is the most important advantage of the TDMA system. As the bit ratio required for the coding algorithms goes down, the TDMA channels can be reconfigured to take new technologies.

e) Although the FDMA design is less complex, and consequently cheaper than the TDMA, but since one carrier is assigned per channel, the base stations are required to have more equipment. For example: for providing enough service at one cell of 1000 users, 1000 telephone trunk circuits are necessary. In this case, one FDMA system, 100 channel elements at the cell section, in addition 100 transmitters, 100 receivers, 200 coders, 200 modems etc are needed. But, bit TDMA system multiplies 4 circuit for per carrier, it requires 25 channel for the same amount of users, it means 25 transmitters, 25 receivers, 50 coders and 50 modems. Due to the TDMA system is complex, the TDMA design is also expensive compared to the FDMA. But, the cost of the common system equipment for each user is cheaper than the FDMA.

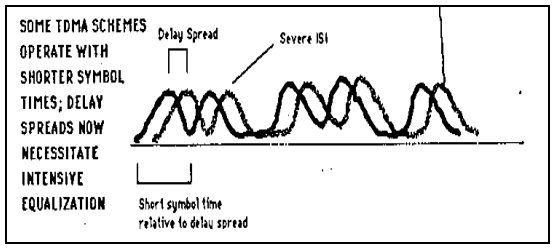


Figure-4

VI. CDMA (CODE DİVİSİON MULTİPLE ACCESS)

The CDMA is a form of the spread spectrum. It is an advanced digital communication technique. Instead of using frequency or time portions, mathematical codes are used for separating and transmitting the multi wireless communications. The dominant radio interface for third-generation mobile, or IMT-2000, will be a wideband version of CDMA with three modes (IMT-DS, IMT-MC and IMT-TC).

The CDMA spreads the information to a bandwidth, which is wider than the bandwidth of the original signal, where it is placed. The width of the used frequency channel is 1.244 MHz. All users share the same channel at the same time. The signal to be transmitted first spread into the all band gap. The signal is coded with certain codes. Since every signal in the channel has a different code, it can be distinguished from others and can be received smoothly. The transmitted codes are the most important character of the CDMA technology. The base of the codes is 64x64 Walsh matrix.

There are many key characteristics that make each code known in the Walsh matrix. Each row is vertical according to other row in the matrix. For this reason, due to the derived codes are used in the ID of the certain means, even two codes can not be similar. Furthermore, each code is different from each other in a precise and predetermined amount.

Theoretically, there is no limit for the capacity of the CDMA system. But in practice, due to the coding mechanisms are not exactly vertical to each other, it brings to the capacity a limit for making it operate without interference. Even if so, again the capacity is very high.

CDMA-based standard;

- Direct-Sequence CDMA (DS-CDMA) is more attractive for wireless access due to its numerous advantages over TDMA and FDMA.
- Soft handoff.
- Exploitation of multipath fading trough Rake combining.
- Capacity increase using cell sectorization.
- Most of the world is using CDMA technology already.

VII. CDMA ONE AND CDMA2000

CDMAOne is the only technology with a clear evolution to 3G because it builds on the design and framework of today's CDMAOne system. Looking at 3G from an operator's perspective, preservation of investments made in infrastructure and spectrum are significant issues in defining requirements for technology migration. Services designated as "3G" will be available with CDMAOne in existing as well as new spectrum bands. This point is important in considering the position of established operators who may not choose, or be able, to get new spectrum.

This point is also vitally important in developing regions considering the allocation of PCS spectrum for 2G. With CDMAOne, operators and subscribers in these regions can reap the benefits of today's advanced digital technology while assured their investments are protected. Evolution from technologies such as GSM to WCDMA, however, will require significant change out of equipment and costly upgrades.

As with GSM and TDMA/136, CDMAOne will also be enhanced to provide improved services, capacity, coverage, quality, and data rates. The current data rate is 14.4 kbit/s, but the introduction of CDMA2000/1XRTT will provide packet data rates of between 9.6 and 144 kbit/s. Later, the introduction of CDMA2000 wideband (multicarrier CDMA and WCDMA-DS) will increase data rates to as much as 2 Mbit/s.

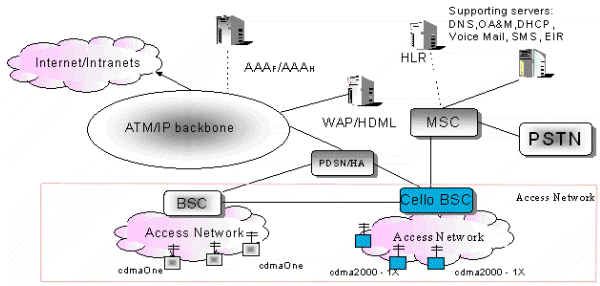


Figure-5

VIII. EDGE (ENHANCED DATA RATES FOR GLOBAL EVOLUTION)

EDGE is a new modulation scheme that is more bandwidth efficient than the Gaussian prefiltered Minimum Shift Keying (GMSK) modulation scheme used in the GSM standard. It provides a promising migration strategy for HSCSD and GPRS. The technology defines a new physical layer: 8-phase shift keying (8-PSK) modulation, instead of GMSK. 8-PSK enables each pulse to carry 3 bits of information versus GMSK's 1-bit-per-pulse rate. Thus, EDGE has the potential to increase the data rate of existing GSM systems by a factor of three.

EDGE retains other existing GSM parameters including a 4.615-ms frame length, eight timeslots per frame, and a 270.833-kHz symbol rate. GSM's 200-kHz channel spacing is also maintained in EDGE, allowing the use of existing spectrum bands. This fact is likely to encourage deployment of EDGE technology on a global scale.

Data rates: 384 kbps and above
Channel coding:
Outer block coding
Inner Convolutional coding
Interleaving scheme for error bursts
Modulation:
GMSK (Gaussian Minimum Shift Keying)
8-PSK (Phase Shift Keying)
Multiple Access: Combination of TDMA & FDMA
Duplex seperation 45 MHz
RF carrier spacing: 200 kHz
Number of TDMA slots on each carrier: 8
Channel allocation: 1 to 8 time slots per TDMA
One time slot: (Physical channel) 0.577 ms
Frame Interval: 4.615 ms
Asymmetric data traffic: different time slots for Uplink and downlink
Frequency Hopping: 217 hops/s (slow)
Equalizer: 16 µs time dispersion
Connectivity: Packet switched data networks such as IP and X.25
Asymmetric data traffic : different time slots for Uplink and downlink
Modulation: Gateway GPRS Support Node (GGSN) and Serving GPRS Support Node (SGSN)
Channel coding schemes : CS-1 through CS-4, MCS1-MCS9
Transmit Frequency bands:

Mobile station	Uplink	Reverse ch. 890 - 915 MHz
Base station	Downlink	Forward ch. 935 - 960 MHz

EDGE Protocol Stack

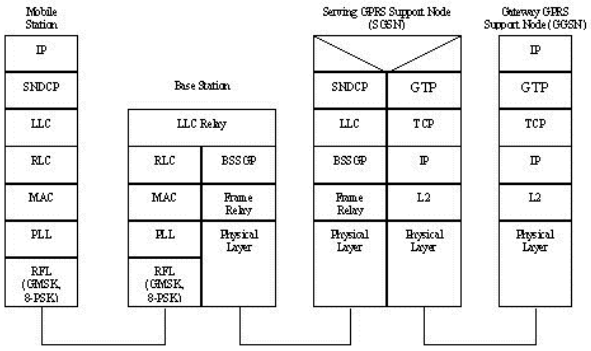


Figure-6

IX. CONCLUSION

The GSM/UMTS migration strategy, which includes dual-and multi-mode terminals, is a generic migration strategy between second and third-generation systems. Interworking units at the network level will enable different standards to interwork with one another.

The GSM and TDMA operators have two options to be able to use the 3G services: either they shall provide the evolution of the networks by using the EDGE modulation technology in the existing spectrums or they will use the WCDM which is present in the new IMT-2000 spectrum. The WCDMA-DS access will coexist with present-day as well as "evolved" GSM access (GPRS/EDGE), and the related dual-mode mobile terminals will support full roaming and handover from one system to another. In the introductory phases of WCDMA, the dual-mode terminals will ensure that subscribers can roam and interwork with the rest of the GSM community from the very outset. The evolved GSM core network will serve as the basis for a common GSM/UMTS core network that connects GSM/GPRS/EDGE and UMTS/WCDMA-DS access.

Currently we have less radio standard and network protocol in respect of previous ones. MAP/GSM, IS41/TDMA and edmaOne. For being able to operate the two third generation standards or modes and four second generation standards together, the inter-operability at the network level (at the units that inter-operate between the protocols) and at the terminal level (dual mode/multiple-mode terminals) must be ensured.

Standardisation effort is currently concentrating on compatibility questions and mostly precludes mechanisms on negotiations between terminal and network. With a greater variety on networks in the future, standardisation must be shifted to standardised protocol negotiations which provide the mechanisms to enable standardised and possibly new communication protocols being communicated and agreed between terminal and network.

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