International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 3 Issue 2, February-2014, pp: (39-44), Impact Factor: 1.252, Available online at: www.erpublications.com

Emergence of Enhanced Data for Global Evolution (EDGE) System in Cellular Communications- A Review Article

G S Ajay Kumar Reddy[1], G Keerthy[2], G Lokesh Reddy[3]
[1]Assistant System Manager, Tata Consultancy Services, Bengaluru Section, India
[123]Graduating in Department of Electronics and Communication Engineering,
Lakireddy Bali Reddy Autonomous Engineering College, Mylavaram, A.P., India

Abstract: Today's fast growing world needs fast communication, either it may be voice or data .This calls for a new technology which is faster than all existing technologies in mobile communication and hence can replace technologies like GPRS .Enhanced Data for Global Evolution (EDGE) is such a technology .EDGE is a member of global system for mobile communications(GSM). In short EDGE is a technology which enhances data rates for mobile communications. EDGE not only enhances data rates but also intended for efficient spectrum utilization which it has passed successfully .This paper is intended for explaining how theoretical data rates of 384 kbps is possible with EDGE technique. And how enhanced data for global evolution (EDGE) can play an important role in the evolution toward wideband code division multiple access (WCDMA). And this paper also includes brief details on EDGE and modulation scheme used for EDGE. It can be introduced in two ways: (1) as a packet-switched enhancement for general packet radio service (GPRS), known as enhanced GPRS or EGPRS, and (2) as a circuit-switched data enhancement called enhanced circuit-switched data (ECSD). My paper, however, will only discuss the packet-switched enhancement, EGPRS.

The purpose of this paper is to describe EDGE technology and how it leverages existing GSM systems and complements WCDMA for further growth.

Keywords: GSM, EDGE Technology, GPRS, Packet Data, EGPRS.

1. INTRODUCTION

EDGE is the next step in the evolution of GSM and IS-136. The objective of the new technology is to increase data transmission rates and spectrum efficiency and to facilitate new applications and increased capacity for mobile use .With the introduction of EDGE in GSM phase 2+, existing services such as GPRS and high-speed circuit switched data (HSCSD) are enhanced by offering a new physical layer. The services themselves are not modified. EDGE is introduced within existing specifications and descriptions rather than by creating new ones.

This paper focuses on the packet-switched enhancement for GPRS, called EGPRS.GPRS allows data rates of 115 kbps and, theoretically, of up to 160 kbps on the physical layer. EGPRS is capable of offering data rates of 384 kbps and, theoretically, of up to 473.6 kbps. A new modulation technique and error-tolerant transmission methods, combined with improved link adaptation mechanisms, make these EGPRS rates possible. This is the key to increased spectrum efficiency and enhanced applications, such as wireless Internet access, e-mail and file transfers.

GPRS/EGPRS will be one of the pacesetters in the overall wireless technology evolution in conjunction with WCDMA. Higher transmission rates for specific radio resources enhance capacity by enabling more traffic for both circuit- and packet-switched services. The goal of EDGE is to boost system capacity, both for real-time and best effort services, and to compete effectively with other third-generation radio access networks such as WCDMA and CDMA 2000.

2. Technical differences between GPRS and EGPRS

Regarded as a subsystem within the GSM standard, GPRS has introduced packet-switched data into GSM networks. Many new protocols and new nodes have been introduced to make this possible .EDGE is a method to increase the data rates on the radio link for GSM. Basically, EDGE only introduces a new modulation technique and new channel coding that can be used to transmit both packet-switched and circuit-switched voice and data services. EDGE is therefore an add-on to GPRS and cannot work alone .GPRS has a greater impact on the GSM system than EDGE has. By adding the new modulation and coding to GPRS and by making adjustments to the radio link protocols, EGPRS offers significantly higher throughput and capacity.

GPRS and EGPRS have different protocols and different behavior on the base station system side .However, on the core network side, GPRS and EGPRS share the same packet-handling protocols and, therefore, behave in the same way. Reuse of the existing GPRS core infrastructure (serving GRPS support node/gateway GPRS support node) emphasizes the fact that EGPRS is only an "add-on" to the base station system.

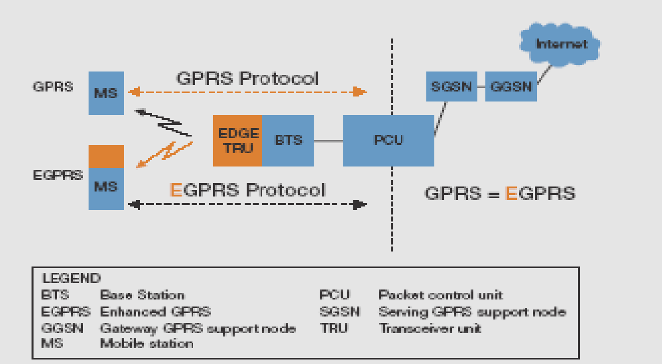

Figure 1. EGPRS introduces changes to GPRS only on the base station system part of the network.

In addition to enhancing the throughput for each data user, EDGE also increases capacity. With EDGE, the same time slot can support more users. This decreases the number of radio resources required to support the same traffic, thus freeing up capacity for more data or voice services. EDGE makes it easier for circuit-switched and packet-switched traffic to coexist while making more efficient use of the same radio resources. Thus in tightly planned networks with limited spectrum, EDGE may also be seen as a capacity booster for the data traffic.

3. EDGE Technology

EDGE leverages the knowledge gained through use of the existing GPRS standard to deliver significant technical improvements.

	GPRS	EDGE
Modulation	GMSK	8-PSK/GMSK
Symbol rate	270 ksym/s	270 ksym/s
Modulation bit rate	270 kb/s	810 kb/s
Radio data rate per time slot	22,8 kb/s	69,2 kb/s
User data rate per time slot	20 kb/s (CS4)	59,2 kb/s (MCS9)
User data rate (8 time slots)	160 kb/s	473,6 kb/s
	(182,4 kb/s)	(553,6 kb/s)

Figure 2. GPRS and EDGE: A comparison of technical data. (Legend: 8PSK, 8-phase shift keying; GMSK, Gaussian minimum shift keying; MCS, Modulation coding scheme)

In fig 2 compares the basic technical data of GPRS and EDGE. Although GPRS and EDGE share the same symbol rate, the modulation bit rate differs. EDGE can transmit three times as many bits as GPRS during the same period of time. This is the main reason for the higher EDGE bit rates. The differences between the radio and user data rates are the result of whether or not the packet headers are taken into consideration. These different ways of calculating throughput often cause misunderstanding within the industry about actual throughput figures for GPRS and EGPRS .The data rate of 384 kbps is often used in relation to EDGE. The International Telecommunications Union (ITU) has defined 384 kbps as the data rate limit required for a service to fulfill the International Mobile Telecommunications-2000(IMT-2000) standard in a pedestrian environment. This 384 kbps data rate corresponds to 48 kbps per time slot, assuming an eight-time slot terminal.

3.1 EDGE Modulation Technique

The modulation type that is used in GSM is the Gaussian minimum shift keying (GMSK), which is a kind of phase modulation. This can be visualized in an I/Q diagram that shows the real (I) and imaginary (Q) components of the transmitted signal (Figure 3).Transmitting a zero bit or one bit is then represented by changing the phase by increments of + or - p. Every symbol that is transmitted represents one bit;

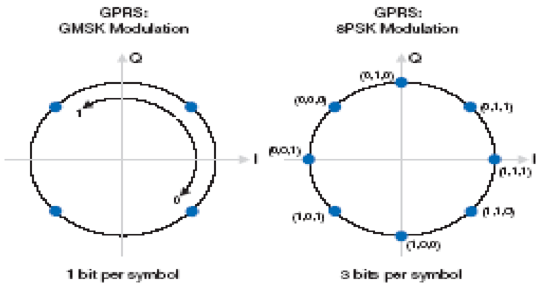

Figure 3. I/Q diagram showing EDGE modulation benefits.

that is, each shift in the phase represents one bit.To achieve higher bit rates per time slot than those available in GSM/GPRS, the modulation method requires change. EDGE is specified to reuse the channel structure, channel width, channel coding and the existing mechanisms and functionality of GPRS and HSCSD. The modulation standard selected for EDGE, 8-phase shift keying (8PSK), fulfills all of those requirements. 8PSK modulation has the same qualities in terms of generating interference on adjacent channels as GMSK. This makes it possible to integrate EDGE channels into an existing frequency plan and assign new EDGE channels in the same way as standard GSM channels. The 8PSK modulation method is a linear method where three consecutive bits are mapped onto one symbol in the I/Q plane . The symbol rate, or the number of symbols sent within a certain period of time, remains the same as for GMSK, but each symbol now represents three bits instead of one. The total data rate is therefore increased by a factor of three .The distance between the different symbols is shorter using 8PSK modulation than when using GMSK. Shorter distances increase the risk from interpretation of the symbols because it is more difficult for the radio receiver to detect which symbol it not matter. Under poor radio conditions, however, it does. The “extra” bits will be used to add more error correcting coding, and the correct information can be recovered. Only under very poor radio environments is GMSK more efficient. Therefore the EDGE coding schemes are a mixture of both GMSK and 8PSK.

3.2 CODING SCHEMES

For GPRS, four different coding schemes, designated CS1 through CS4, are defined. Each has different amounts of error-correcting coding that is optimized for different radio environments. For EGPRS, nine modulation coding schemes, designated MCS1through MCS9, are introduced. These fulfill the same task as the GPRS coding schemes. The lower four EGPRS coding schemes (MSC1 to MSC4) use GMSK , whereas the upper five (MSC5 to MSC9) use 8PSKmodulation. Figure 4 shows both GPRS and EGPRS coding schemes, along with their maximum throughputs .GPRS user throughput reaches saturation at a maximum of 20 kbps with CS4, whereas the EGPRS bit rate continues to increase as the radio quality increases ,until throughput reaches saturation at 59.2 kbps .Both GPRS CS1 to CS4 and EGPRS MCS1 to MCS4use GMSK modulation with slightly different throughput performances. This is due to differences in the header size (and payload size) of the EGPRS packets. This makes it possible to resegment EGPRS packets.

A packet sent with a higher coding scheme(less error correction) that is not properly received, can be retransmitted with a lower coding scheme (more error correction) if the new radio environment requires it. This resegmenting (retransmitting with another coding scheme) requires changes in the payload sizes of the radio blocks, which is why EGPRS and GPRS do not have the same performance for the GMSK modulated coding schemes. Re-segmentation is not possible with GPRS.

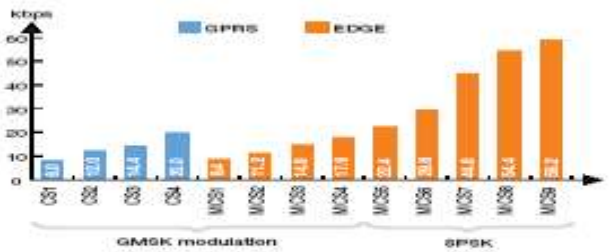

Figure 4. Coding schemes for GPRS and EGPRS (user data rate). (Key: 8PSK, 8-phase shift keying; CS, Coding scheme; EGPRS, Enhanced GPRS; GMSK, Gaussian minimum shift keying; MCS, Modulation coding scheme)

4. PACKET HANDLING

Another improvement that has been made to the EGPRS standard is the ability to retransmit a packet that has not been decoded properly with a more robust coding scheme. For GPRS, resegmentation is not possible. Once packets have been sent, they must be retransmitted using the original coding scheme even if the radio environment has changed. This has a significant impact on the throughput, as the algorithm decides the level of confidence with which the link adaptation (LA) must work.

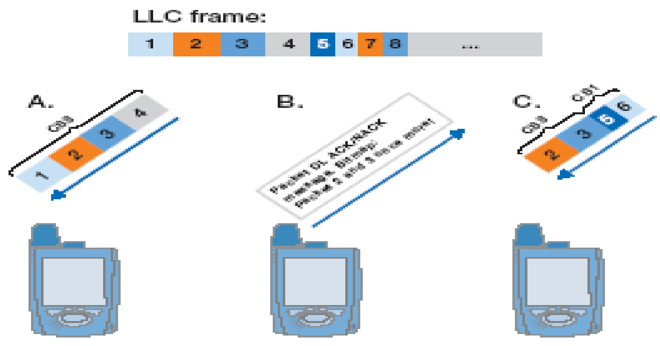

Figure 5. Packet transfer and retransmission for GPRS. (Legend: ACK/NACK, acknowledged/unacknowledged; CS, Coding Scheme)

5. ADDRESSING WINDOW

Before a sequence of coded radio link control packets or radio blocks can be transmitted over the Um (radio) interface, the transmitter must address the packets with an identification number. This information is then included in the header of every packet. The packets in GPRS are numbered from 1 to 128.After transmission of a sequence of packets (e.g., 10packets), the transmitter asks the receiver to verify the correctness of the packets received in the form of an acknowledged/unacknowledged report. This report informs the transmitter which packet or packets were not successfully decoded and must be retransmitted .Since the number of packets is limited to 128 and the addressing window is 64, the packet sending process can run out of addresses after 64 packets. If an erroneously decoded packet must be retransmitted,it may have the same number as a new packet in the queue. If so, the protocol between the terminal and the network stalls, and all the packets belonging to the same low-layer capability frame must be retransmitted. In EGPRS, the addressing numbers have been increased to 2048 and the window has been increased to 1024 in order to minimize the risk for stalling. This,in turn, minimizes the risk for retransmitting low-layer capability frames.

6. INTERLEAVING

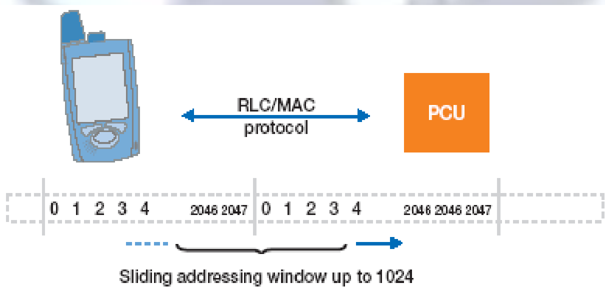

Figure 6. Protocol stalling. (Legend: MAC, Mobile allocation channel; PCU, Packet control unit; RLC, Radio link control)

To increase the performance of the higher coding schemes in EGPRS (MCS7 to MCS9) even at low C/I ,the interleaving procedure has been changed with in the EGPRS standard. When frequency hopping is used, the radio environment is changing on a per-burst level. Because a radio block is interleaved and transmitted over four bursts for GPRS, each burst may experience a completely different interference environment. If just one of the four bursts is not properly received, the entire radio block will not be properly decoded and will have to be retransmitted. In the case of CS4 for GPRS ,hardly any error protection is used at all .With EGPRS, the standard handles the higher coding scheme differently than GPRS to combat this problem. MCS7, MCS8 and MCS9 actually transmit two radio blocks over the four bursts, and the interleaving occurs over two bursts instead of four .This reduces the number of bursts that must be retransmitted should errors occur. The likelihood of receiving two consecutive error free bursts is higher than receiving four consecutive error free bursts. This means that the higher coding schemes for EDGE have a better robustness with regard to frequency hopping.

7. Impact of EGPRS on existing GSM/GPRS networks

Due to the minor differences between GPRS and EGPRS, the impact of EGPRS on the existing GSM/GPRS network is limited to the base station system. The base station is affected by the new transceiver unit capable of handling EDGE modulation as well as new software that enables the new protocol for packets over the radio interface in both the base station and base station controller. The core network does not require any adaptations. Due to this simple upgrade, a network capable of EDGE can be deployed with limited investments and within a short time frame.

8. EGPRS benefits Short-term benefits: Capacity and performance

EGPRS introduces a new modulation technique, along with improvements to the radio protocol, that allows operators to use existing frequency spectrums (800, 900, 1800 and 1900 MHz) more effectively. The simple improvements of the existing GSM/GPRS protocols make EDGE a cost-effective, easy-to implement add-on. Software upgrades in the base station system enable use of the new protocol; new transceiver units in the base station enable use of the new modulation technique.

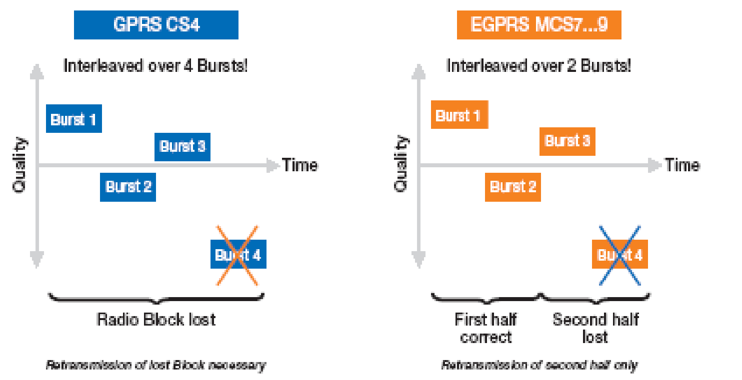

Figure 7. Interleaving. (Legend: CS, coding scheme; EGPRS, enhanced GPRS; MCS, modulation coding scheme)

EDGE triples the capacity of GPRS. This capacity boost improves the performance of existing applications and enables new services such as multimedia services. It also enables each transceiver to carry more voice and/or data traffic. EDGE enables new applications at higher data rates. This will attract new subscribers and increase an operator's customer base. Providing the best and most attractive services will also increase customer loyalty

.

8.1 Mid-term benefits: Complementary technology

EDGE and WCDMA are complementary technologies that together will sustain an operator's need for third generation network coverage and capacity nationwide. Enhancing a GPRS network is accomplished through evolution with EDGE within the existing spectrum and by deploying WCDMA in the new frequency band. Rolling out the two technologies in parallel enables faster time to market for new high-speed data services as well as lower capital expenditures. EDGE is designed to integrate into the existing network. The installed base evolves; it is not replaced or built from scratch, making implementation seamless. Fast, easy rollout means shorter time to market, which in turn can lead to increased market share. With EDGE, operators can offer more wireless data applications, including wireless multimedia, e-mail, web infotainment and positioning services, for both consumer and business users.

Subscribers will be able to browse the Internet on their mobile phones ,personal digital assistants or laptops at the same speed as on stationary personal computers.

8.2 Long-term benefit: Harmonization with WCDMA

EDGE can be seen as a foundation toward one seamless GSM and WCDMA network with a combined core network and different access methods that are transparent to the end user.

9. Future evolution of GSM/EDGE towards WCDMA alignment

The next evolutionary step for the GSM/EDGE cellular system includes enhancements of service provisioning for the packet-switched domain and increased alignment with the service provisioning in UMTS/UTRAN (UMTS terrestrial radio access network).

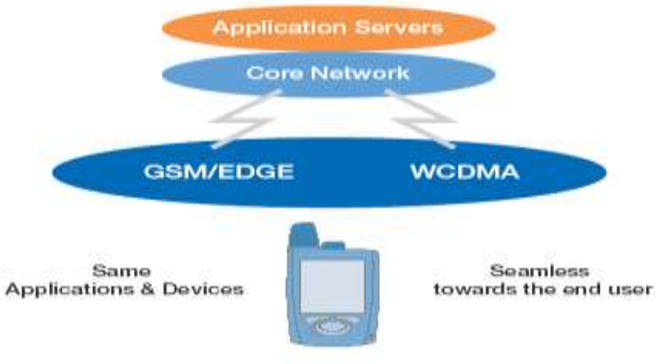

Figure 12. One seamless GSM and WCDMA network.

This part of the GSM/EDGE evolution focuses on support for the conversational and streaming service classes, because adequate support for interactive and background services already exists. Additionally , multimedia applications will be supported by parallel simultaneous bearers with different QoS characteristics towards the same MS, such as multiple media streams handled through IMS domain .A driver for such evolution on the packet-switched side is the paradigm shift within the telecommunications world from circuit to packet-switched communications .Both the core network defined for GPRS and the current GSM/EDGE radio access network require modifications to support enhanced packet services.

CONCLUSION

The above emphasized technology is now going to emerge as a full pledged technology due to its inherent advantages. The implementation of EDGE can over shadow the existing mobile technologies in near future. we can aspire major strides in mobile technologies with EDGE.