# A Comparative Review Between Global System for Mobile Communications (GSM) and Code Division Multiple Access (CDMA) Technology

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## ABSTRACT

This project is based on a comparative review of two competing digital wireless technologies used today in the telecommunication industry and assess their utility in a developing nation like Nigeria. They were developed as a method of solving previous analog wireless telecommunication problems.

The Global System for Mobile Communication (GSM), which uses time-sharing protocol techniques, is closely compared with Code Division Multiple Access (CDMA) which, unlike GSM, uses spread spectrum techniques.

A comparative review is done based on information obtained primarily from reports, journals, and research works, using such criteria as coverage, clarity, compatibility, and security in addition to traffic capacity within a given radio frequency spectrum. The results obtained from this comparative review tend to indicate that the CDMA technology appears to be more suitable than the GSM for the Nigerian environment, needs, and applications.

(Key words: wireless, telecommunications, coverage, clarity, compatibility, security).

## INTRODUCTION

One of the most contentious battles being waged in the wireless infrastructure industry is the debate over the efficient use and allocation of frequency spectrum. The GSM system's Subscriber Identity Module (SIM) card is a novel approach that implements personal mobility in addition to terminal mobility. Added to this is the international roaming feature and support for many other services such as data transfer, fax, Short Message Service, and supplementary services [1].

The CDMA on the other hand provides around 10 to 20 times [2] more capacity than analog networks; far more than the GSM.

CDMA brings many other benefits to carriers and consumers, including better voice quality, more traffic support, soft handoff, broader coverage, and stronger security [3, 4]. The Telecommunication Answer Associates (TAA), NCC (Nigerian Communication Commission) reported on a record of studies conducted in the cellular mobile telecommunication system in Nigeria as of December 30, 1994 and recommended CDMA for adoption for the digital services, alongside the analog technology that was already in existence in the country [5]. The report did not come out clearly on the technical advantages of CDMA over that of GSM. This research project, therefore, has attempted to provide further comparison, mostly from the technological point of view, between these two systems in order to ascertain which is better for the Nigerian environment, needs, and application.

## METHODOLOGY

A comparative review is done based on information obtained primarily from reports, journals, and various research works using such criteria as coverage, clarity, compatibility and security in addition to traffic capacity within a given radio frequency spectrum.

The models used for this work were a simplified version of IS-95 CDMA and a simple GSM Nokia system. Their concept of network architecture, radio interface, and control of radio resources were examined respectively, together with their basic digital components which included:

**a)** Mobile Phones: Personal Station (PS), Mobile Station (MS), or User Terminal (UT).

**b)** Base Station Transceiver Subsystem (BTS): Base Station (BS) or cell site.

**c)** Base Station Controller (BSC): Mobile Switching Center (MSC) or switch.

## THE COMPARISON

The following comparative facts between the two technologies emerge.

### 1. Climate and Landscape Conditions:

CDMA really comes into its element when in the countryside with few sites covering large expanses of land. Under these conditions CDMA provides extremely stable audio with few frame errors because Channel Pollution is almost non-existent. In this situation, the phone is exposed to multi-signals from countless sites in the densely populated areas, but lacks dominant signals from a close-by site.

GSM systems on the other hand, have great difficulties in open regions just outside densely populated areas. When a call in GSM is handed off to another site, a short break in the audio occurs. This break can chop up a word or two, and force users to ask callers to repeat massages. Driving in a very open area with no sites in the immediate vicinity, audio dropouts may be experienced. This happens because of co-channel interference. The CDMA usually does not suffer from such interference, since everyone is on the same channel. However, CDMA tends to degrade when there are too many signals present or too many added stations. Even in this situation, the degradation is gradual, hence called graceful degradation [6].

### 2. Power Control:

In GSM, there are five classes of mobile stations defined, according to their peak transmitter power, rated at 20, 8, 5, 2, and 0.8 watts. Power levels can be stepped up or down in steps of 2 dB from the peak power for the class down to a minimum of 13 dBm (20 milliwatts). Power control in GSM is handled with care, since there is the possibility of instability. In CDMA, the power control is less, but it gradually increases with respect to distance from Base Station.

### 3. Increased Battery Life:

CDMA significantly enhances battery performance more than the GSM [7]. It saves a great amount of energy since its typical mobile transmitter power is less than 200 milliwatts, while that of GSM is greater than 250 milliwatts.

### 4. Multipath:

Smooth surfaces, such as a body of water, a flat stretch of earth, or a metal roof reflect radio signals, which can bounce off objects and then travel to the receiver.

Multi-path is a problem facing GSM systems. It may cause a loss of the signal through cancellation. CDMA rake-receiver combats multipaths and leads to increases in the quality of the signal. This feature turns what is a problem in GSM into an advantage for the CDMA [8].

### 5. Hand Over Process:

The process of hand-off can be accomplished in several ways. The break-and-make approach, also known as hard hand-off, occurs in the GSM but its duration is very short. It is hardly noticeable in voice communication, unlike data communication, where it is visible and noticeable. Hard hand-off does not put the phone in major control of the switching processes, thus, its interval of switching often results in dropped calls due to failed connections.

On the other hand, make-and-break connections, also called soft hand-off processes, put the CDMA in almost complete control of the hand-off. It should always ensure that a new site is primed and ready to take over the call in a most graceful and smooth way of transition. This gentle approach offers considerable advantages in the transmission of data, particularly when supporting high-speed vehicular traffic, which may move between many cells in a relatively short period of time [9].

### 6. Spectral Efficiency:

CDMA has a very high "spectral efficiency"; it can accommodate more users' "Soft Capacity" per MHz of bandwidth than the GSM. It delivers the highest voice capacity and packet data throughput using the least amount of spectrum for the lowest cost while the GSM capacity has fixed "hard capacity" that is easily computed since the principle of slot sharing is used.

### 7. Relevance of Technology:

CDMA has a clear advantage by using the entire frequency spectrum; hence the broadcast can happen at very high signal strength spread over a bigger radius than GSM. For a country like

Nigeria, the GSM grids requires something on the order of 1,400 base stations to cover the country while CDMA requires roughly 880 base stations [10].

**8. Security:**
Additional security is derived using CDMA. The receiver is synchronized to switch frequencies in the same pattern; this is effective in preventing detection (interception) and jamming. It is presently (nearly) impossible to recover the transmitted data having roughly 4.4 trillion ways of cracking each code. Each conversation is modulated, in the digital domain, with a unique code that distinguished it from other calls in the frequency spectrum.

**9. Co-Channel Inference:**
In the GSM, calls are interfered with by another site operating on the same physical channel and time slot. It is often observed that a signal from that other conversation can interfere with the signal that is actually received. This will result in audio dropouts and generally poor audio quality.

The CDMA usually does not suffer from such interference since everyone is on the same channel. Signals only tend to degrade gradually, when there are too many signals present or too many added stations.

**10. Roaming:**
A major network standard in the world is the GSM MAP that supports the GSM radio interface. In CDMA systems a standard known, as ANSI-41 (also called TIA/EIA-41 or IS-41) provides roaming services for CDMA systems. The major drawbacks in GSM roaming include:

**a.** Forwarding of GSM systems calls from the serving system, which often results in calls looping from a home system to serving system and back to the home system.

**b.** The Authentication Center (AuC) in GSM which requires a transfer of authentication data for every call and which must perform authentication calculations. In practice, GSM carriers often avoid this, since it reduces the level of security that their systems provide. It is only a matter of time before a good hacker cracks the GSM mathematical algorithms. Just like Internet is “hackable”, GSM is clonable.

The implication is that somebody can recreate the SIM card codes and can make and receive calls on the subscriber’s behalf. This could retard future transitional development from E-commerce (Electronic commerce) to M-commerce (Mobile commerce) in a big way via the GSM technological approach, unlike that of the CDMA technology that easily supports such development with backward compatibility, and thus does not require new standards.

**11. Intrinsic Safety:**
A negative side effect of GSM recently clamed its first officially reported death in Nigeria. A top Lagos lawyer who lived in Aguda, Surulere area in Lagos State was said to have become a victim when his mobile phone exploded as he took a call during the course of attempting to refill his power generating set with fuel from a jerry can. The explosion from the GSM handset is said to have ignited the fuel, which over took him and lead to first-degree burns. He later died in a London hospital after several attempt to save his life [11].

In Vietnam, a similar incident (mobile phone explosion) occurred when a young Vietnamese woman was injured after her mobile phone apparently exploded. These two cases clearly show the negative side effect of GSM systems’ power requirements.

In addition, the radiated power level in GSM, can create near field RF level greatly in excess of the current European class A limit of 10V/m which forms the basis of immunity required for industrial and safety critical equipment [12, 13].

**12. New Product:**
New products are being developed and deployed which will further boost the capacity of CDMA networks. These include Selectable Mode Vocoder (SMV); receive diversity, and Smart Antenna technologies. SMV and receive diversity are specific to CDMA technologies.

Both are backward compatible and they do not require new standards. They are completely transparent to the end user and can be rolled out as needed over time.

## RESULTS

Stated below are the summarized key results arising from the comparative research are shown in Table 1.

**Table 1:** Key comparative results between CDMA and GSM

| *Comparative Tool* | *CDMA* | *GSM* |
|---|---|---|
| ***Technology*** | American Digital | Pan European Digital |
| ***Roaming Capability*** | On Trail | Implemented |
| ***System Modulation*** | Binary Phase Shift Keying (BPSK) | Gaussian Minimum Shift Keying (GMSK) |
| ***Typical Mobile Transmit Power*** | < 200 mW | > 250 mW |
| ***Smart Card Used*** | Removable User Identity Module (R-UIM) | Subscriber Identity Module (SIM) |
| ***Systems Signal Jamming*** | Not Affected | Affected |
| ***Speech Encoding*** | Code Exited Liner Predictive Codec (CELP) | Regular Pulse Excited Linear Predictive Codec (RPE-LTP) |
| ***Basic CODEC used*** | Extended Variable Rate Coding (EVRC) | Enhance Full Rate (EFR) |
| ***Hand off*** | Soft hand off | Hard Hand off |
| ***Drop Calls*** | Rarely occurs | Occurs frequently |
| ***Large open land coverage*** | Works very well | Unstable audio |
| ***High Ground*** | Functions well | Chops audio receptions |
| ***Co-channel's effect*** | Avoided via site selections | Competes with the needed signals |
| ***Multipath*** | Usually Constructive | Usually Destructive |
| ***Health Risk*** | Reduced | Higher (uses lots of power) |
| ***Coverage Comparison*** | 1.7 – 3X GSM | ----- |
| ***Frequency Re-use Gains*** | 20X TDMA | 3X TDMA |
| ***Service Offered*** | Voice, data, paging, M-commerce | Voice, data, paging. |
| ***Eavesdropping (Security)*** | Highly secure (PN codes = 4.4 trillion Combinations) | Hackable (far less combinations) |

## ANALYSIS AND CONCLUSION

From the result in Table 1, it is evident that there are many reasons why CDMA tends to be a better choice for the next generation of digital wireless communications, products, and services. These include; outstanding voice and call quality, greatest coverage per unit cost, longer battery life, fewer dropped calls, improved security and privacy, greater capacity, reduced background noise and interference, rapid deployment, continuing technology advances, and the cost of CDMA implementation and compatibility with future advanced generations of cellular network technology [14].

Some of the advantages of the GSM over CDMA includes: easy activation of connections, low initial start-up costs, and a larger world coverage subscribers-base than CDMA technology due to early commercialization and early international roaming. The CDMA trail-roaming versions are now being tested.

Based on the comparison of the two systems, it is clearly observed that there is a potential interference problem with all types of mobile system operating on the GSM system.

Accordingly, the critical issues that operators face center on which "next-generation technology" path to follow. The future trend of cellular system development tends to point towards CDMA, making it the technology of choice for new third-generation systems. Nigeria therefore would be highly favored if she too follows this trend in communications development.

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