Assignment-2

ITA0302-Mobile Computing for 5G Technology

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1. List all the Multiple Access techniques used for Wireless communication. Do a neat comparison between TDMA, FDMA and CDMA.

Introduction: Multiple Access techniques are methods that allow multiple users to share the same communication channels effectively. In Wireless communication, the need for multiple access arises due to the limited Availability of frequency spectrum and the need to serve many users simultaneously.

Types of Multiple Access techniques:

1. FDMA (Frequency Division Multiple Access):

* Divides frequency band into multiple smaller channels.
* Each user is assigned a specific frequency band.
* Continuous transmission.
* Used in analog systems.
* Guard bands are required between channels to prevent interference between adjacent frequency bands.

2. TDMA (Time Division Multiple Access):

* Divides time into slots and assigns each user a time slot.
* users transmit in rapid succession.
* used in 2G systems.

3. CDMA (Code Division Multiple Access):

* All users use the same frequency and time simultaneously.
* Each user has a unique code to separate their signal.
* used in 3G systems.

4. OFDMA (Orthogonal Frequency Division Multiple Access):

* subset of frequencies assigned to different users.
* used in 4G LTE.

5. SDMA (Space Division Multiple Access):

* Based on geographical separation.
* uses smart antennas to serve multiple users in the same frequency band.

6. NOMA (non-orthogonal Multiple Access).

* superimposes multiple signals using power domain separation.

* proposed for 5G networks.

7. PDMA (pattern Division multiple Access).

* uses predefined transmission patterns to separate users.

* Designed to support massive connectivity with low complexity.

8. SCMA (sparse code multiple Access).

* An non-orthogonal technique based on codebooks with sparse structure.

* Allows direct mapping of bits to multi-dimensional codewords.

* Reduces decoding complexity through sparse representation

* used for 5G uplink to support massive machine-type communications (mMTC).

Detailed Comparison between FDMA, TDMA and CDMA.

Feature	FDMA	TDMA	CDMA.
Access type	Frequency division	Time division	code division
Synchronisation	Not Required	Strictly Required	Shared bandwidth.
Bandwidth Usage	Each user gets a separate band	Time-shared bandwidth	Required bandwidth but less stringent.
Guard Requirement.	Guard Bands	Guard Times	Not Required.
Interference.	Adjacent channel Interference.	Time slot overlapping.	near-far problem.
Capacity	Low	Moderate	High.
Handoff.	Frequency change	Time slot reassignment.	Soft handoff possible.
Data Rate support	Low	Moderate	High.
Used In	1G (analog)	2G (GSM)	3G (CDMA2000, WCDMA).

2. The use of the new modulation and the protocol enhancements result in dramatically increased throughput and capacity gains enabling 3G services in the existing GSM/GPRS networks. No changes are needed to the existing core network infrastructure to support EDGE. Examine on the fact that EDGE is only an add-on for BSS.

Introduction to EDGE:

EDGE is an digital mobile phone technology that acts as an enhancement to GSM networks. It is classified as a 2.75G technology and often seen as a bridge between 2G and 3G. It introduces new modulation techniques to increase data rates and network capacity.

Key features:

1. Higher Data Rates:

* offers up to 384 Kbps theoretically.

* Uses 8-PSK modulation instead of GMSK in GSM.

2. Backward Compatability:

* Compatible with GSM / GPRS infrastructure.

* no need for core network changes.

3. Protocol enhancements:

* Enhanced coding schemes (MCS-1 to MCS-9).

* new link adaptation mechanisms.

* Better error correction techniques.

Why EDGE is considered an "Add-on" to BSS:

1- No core network upgrade required:

* Edge only requires updates in Base Transceiver station (BTS) and Base station controllers (BSC).

* Mobile switching centers and GGSN/SGSN remain unchanged.

2. Software-Based Implementation:

* often implemented through software upgrades in existing BTS hardware.

3. Reuse of Existing spectrum:

* operates on the same frequency bands as GSM.

* No new frequency allocation needed.

4. Cost-Effective Evolution:

* Allows operators to offer higher data services without 3G licenses or infrastructure.

Impact on throughput and Capacity:		
Parameter	GSM / GPRS	EDGE.
Modulation	GMSK	GMSK + 8-PSK
Max Data Rate	~56 KBPS (GPRS)	~384 KBPS (EDGE)
Channel Coding	CS-1 to CS-4	MCS-1 to MCS-9.
User Experience.	Basic Internet access	Multimedia + web access.
Spectral Efficiency.	Moderate	High.

EDGE as a 3G Enabler:

* Though not totally 3G, EDGE allows operators to offer 3G-like services.

* helps in smooth migration to UMTS / WCDMA.

* Bridges the gap between voice-centric GSM and high-speed 3G.

Advantages:

For operators: * Minimal Investment.

* Faster deployment * Extended life of networks.

For users: * Better speed. * Improved quality of service.

* Access to richer applications.

Conclusion:

EDGE represents a significant improvement over GPRS, enhancing user experience without requiring core network changes. Its "add-on" nature allows operators to evolve their networks cost-effectively, serving as a stepping stone towards full 3G and beyond.