

# **GSM Job Interview Questions And Answers**



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## GSM Interview Questions And Answers Guide.

### Question - 1:

Does Extended Cell have any impact on the system? If yes, what?

#### Ans:

- \* The cell radius could be double or even more, based on the antenna, type of terrain and timing advance.
- \* Indoor coverage is supported by GSM and could be achieved with the usage of picocell base station or an indoor repeater along with distributed indoor antennas.

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### Question - 2:

What do you mean by extended cell?

#### Ans:

- \* Extended cell feature enables the operators for extending the coverage without installing new cell sites.
- \* Extended cell feature is designed specifically for providing covering in rural areas, where density of population is low and installation of additional cell sites.
- \* New features can be deployed in coastal areas for providing GSM coverage in offshore waters.

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### Question - 3:

Explain TDD in GSM Technology?

#### Ans:

- \* Time Division Duplexing, a 3GPP standardized version of Universal Mobile Telecommunications System networks.
- \* The designated mobile sends the data in a stipulated time and receives data from the BTS in another time.
- \* The time is divided into various time slots and user sends data in few time slots and receives the data in the rest of the time slots.
- \* Alternative downlink and uplink directions are used.

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### Question - 4:

Explain FDD in GSM Technology?

#### Ans:

- \* Frequency Division Duplex is one of the techniques, in which one frequency band is utilized for transmitting and another used for receiving.
- \* To up-link the carrying data from mobile phones to the base station, one electromagnetic block spectrum is allocated.
- \* Various blocks of spectrum is allocated to down-link carrying data from the base station to the mobile telephone hand sets.

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### Question - 5:

What is the mean of power control in GSM Technology?

#### Ans:

- \* Power control is the intelligent selection of transmit power in a communication system for achieving best performance within the system.
- \* The performance is depend on context and there are chances to include optimizing metrics like link data rate, network capacity, geographic coverage and range.
- \* A higher transmit power translates into a higher signal power at the receiver.
- \* The bit error rate will be reduces at the receiver of a digital communication link, by having higher signal-to-noise ratio.
- \* Higher transmit power provides more protection against a signal fade in a wireless fading channel.

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### Question - 6:

What do you mean by ARFCN in GSM Technology?

#### Ans:

- \* Absolute Radio Frequency Channel Number, a code to specify a pair of physical radio carriers and channels within the spectrum that is allocated for cellular mobile communications.



- \* ARFCN is used for transmitting and receiving on the UM Interface, one to uplink signal and one to downlink signal.
- \* ARFCN's bandwidth is 270.833 kHz; channel spacing is 200 kHz in a given GSM band.
- \* The uplink-downlink spacing is generally 45 / 50 MHz.
- \* If Frequency Division Duplex is operated in the system, then the channel number is associated with both uplink and downlink radio channels.
- \* ARFCN is 1-124 within GSM900 spectrum, 512-885 within GSM1800, 512-810 within GSM1900, are used.

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### Question - 7:

Explain MS-IDN in GSM Technology?

#### Ans:

- \* Mobile Subscriber Integrated services Digital Network Number, a unique number identifying a subscription in a GSM / UMTS mobile network.
- \* It is the telephone number of the SIM card in a mobile phone.
- \* MSIDN and IMSI are important numbers used to identify a mobile subscriber
- \* MSIDN is used for routing the calls to the subscriber, where as IMSI identifies the SIM.
- \* In the HLR, the IMSI is the key, and MSIDN is the number that is dialed for connecting a call to the mobile phone.

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### Question - 8:

What is IMEI in GSM Technology?

#### Ans:

- \* International Mobile Equipment Identity is a number usually unique for identifying GSM, WCDMA and iDEN mobile phones.
- \* It is generally printed inside the battery compartment of the phone.
- \* The number can be displayed on the screen by entering \*#06# into the keypad on most of the phones.
- \* A stolen phone can be stopped from accessing the network within the country, by using IMEI number for valid devices.
- \* Unlike CDMA/MEID's electronic serial number, the IMEI is only used for identifying the device and has no permanent relation to the subscriber
- \* The subscriber is identified by IMSI number, stored on the SIM card, which then can be transferred to any other handset.

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### Question - 9:

What is TMSI in GSM Technology?

#### Ans:

- \* Temporary Mobile Subscriber Identity for most commonly sent between the mobile and the network.
- \* TMSI is assigned randomly by VLR to each mobile in the area.
- \* The TMSI number is local for a specific local area, and need to be updated every time when the mobile moves to a new geographical area.
- \* Paging a mobile is the key use of the TMSI.
- \* The communication between the mobile and the base station is known as paging.
- \* The emphasis of broadcast information is top set up channels for paging.
- \* Broadcast mechanism is available in every cellular system for distributing broadcast information to a plurality of mobiles.

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### Question - 10:

Explain IMSI in GSM Technology?

#### Ans:

- \* International Mobile Subscriber Identity - a unique identification that is associated with all GSM and UMTS network mobile phones.
- \* The SIM inside the phone contains it as a 64 bit field.
- \* Used for acquiring certain details in Home Location Register or Visitor Location Register.
- \* IMSI is rarely sent for preventing eavesdroppers to identify and track the subscriber on the radio interface.
- \* It is presented as 15 digit long number, where first 3 digits represent the Mobile Country Code and followed by the Mobile Network Code.
- \* Remaining digits are mobile station identification number within the customer base network.

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### Question - 11:

What is GoS in GSM Technology?

#### Ans:

- \* Grade of Service is a probability of a cell in a circuit group which is blocked / delayed for more than a specified interval.
- \* GoS is expressed as a vulgar fraction / decimal fraction.
- \* It is with reference to the busy hour at the time of greatest intensity of the traffic.
- \* GoS may be viewed independently from the perspective of incoming vs outgoing calls.
- \* The GoS is not essentially equal between source to destination pairs.

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### Question - 12:

What is Erlangs in GSM Technology?

#### Ans:

- \* Total traffic volume per hour / 3600 seconds is described by erlang
- \* For example, 60 calls in one hour and each lasting 5 minutes results the following:  
Minutes of traffic in an hour = Number of calls x Duration  
Minutes of traffic in an hour = 60 x 5 = 300 minutes  
Hours of traffic in the hour = 300 / 60 = 5 hrs



The traffic figure = 5 erlangs

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### Question - 13:

What is TRX in GSM Technology?

#### Ans:

- \* The transceivers allows to serve several frequencies and different sectors of the cell.
- \* Sends and receives signals from / to higher network entities.

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### Question - 14:

What is DRX in GSM Technology?

#### Ans:

- \* DRX is referred as driver receiver.
- \* DRX performs the transmission and reception of signals.
- \* Sends and receives the signals to or from higher network entities, as in base station controller in mobile telephony.

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### Question - 15:

What is DTX in GSM Technology?

#### Ans:

- \* Discontinuous Transmission is one of the methods which is based on the advantage of the fact that a person speak less
- \* Nearly 40% of time in general conversation, the transmitter is turned off during silence periods
- \* Mobile phone power conservation is an added benefit of DTX
- \* Voice Activity Detection is the most important component of DTX
- \* DT X distinguishes between voice and noise inputs.
- \* The transmitter is turned off when a voice signal is misinterpreted as noise. This causes annoying effect known as clipping is heard at the receiver's end
- \* Comfort noise is created at the receiving end, in order to ensure the non-connection.

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### Question - 16:

What is HSN in GSM Technology?

#### Ans:

- \* Hopping sequence number is utilized, to spread the interference between all cells that uses the same hopping TCHs.
- \* The correlation between closely located cells can be avoided by using HSN.
- \* HSN of zero corresponds to the cyclic hopping sequence, and 1 through 63 corresponds to various pseudo random patterns.

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### Question - 17:

What is cycling frequency hopping in GSM Technology?

#### Ans:

- \* In Cycling Frequency Hopping, the frequencies are changed, in every TDMA frame.
- \* For ex:  $f_1, f_2, f_3$ . Where  $f_1, f_2, f_3$  are frequency hopping sequence numbers
- \* The specified setting parameter is HSN.
- \* Hopping Sequence Number is set to 0 in a cyclic sequence hopping.
- \* The sequence of frequencies starts from the lowest absolute frequency number in a set of frequencies specified for a specific channel group, to highest absolute frequency number.

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### Question - 18:

What is base band frequency hopping in GSM Technology?

#### Ans:

- \* Base Band Frequency Hopping is one of the frequency hopping techniques.
- \* Time division multiplexing mapping is used in BBFH
- \* BBFH is supported by a base station having a broadband transceiver
- \* Physical channels are permitted by BBFH based upon mobile subscribers' communication with the base station.
- \* In this, static transceiver frequencies are used while operating with broadband transceiver. This method is an exclusive of switching communication signals between transceivers.

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### Question - 19:

What is synthesised frequency hopping in GSM Technology?

#### Ans:

- \* The GSM's number of frequencies is 124
- \* When the operators do not have enough frequencies, the range to be used is CDS 1800
- \* Frequency hopping is used when the frequencies used are more with high interference.



- \* Frequency hopping is utilized to equalize interference for the frequencies that are used in their range.
- \* One of the frequency hoppings is Synthesised Frequency Hopping
- \* Synthesized hopping allows the transmitter to change its frequency based on time slots. Because of this process SFH is known as fast hopping.

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### Question - 20:

What is MAIO in GSM Technology?

#### Ans:

- \* Mobile Allocation Index Offset is applied to same timeslot of different TRX.
- \* Every time slot will have a separate / different MAIO, as they are using the same HSN
- \* In case all time slot have the same HSN, a their sequence need to be started at different frequencies
- \* The MAIO will set the index of the sequence for each timeslot.
- \* The HSNs do not run the same pseudo random sequence at the same moment.

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### Question - 21:

What is MA in GSM Technology?

#### Ans:

- \* The Absolute Radio Frequency Carrier Number is used in hopping sequence pattern are determined by certain contents of the test set's Mobile Allocation Table.
- \* The hopping sequence beginning point is known as Mobile Allocation Index Offset.
- \* The first entry of Mobile Allocation is corresponds to zero.
- \* An MA table is a list of ARFCNs. They present in Cell Allocation Table which shares the same frequency band.
- \* A separate MA table is allocated for each frequency band.

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### Question - 22:

What is WPS in GSM Technology?

#### Ans:

- \* The wireless equivalent of the Government Emergency Telecommunications Services is referred to WPS.
- \* WPS provides access based on the priority to wireless telephone service during emergencies
- \* Certain governing bodies such as authorized federal, officials of state and local, and certain key private sector officials can be put first in line for an open cellular channel by dialing 272 just before entering the number being called
- \* It is T-Mobile, which began offering an initial operating capability in New York and Washington and had it deployed later.

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### Question - 23:

What is cell splitting in GSM Technology?

#### Ans:

- \* The process of dividing the radio coverage of a cell site within a wireless telephone system into new cell sites is known as Cell Splitting
- \* Additional capacity within the region can be achieved by using Cell Splitting

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### Question - 24:

Do you know what is frequency re-use?

#### Ans:

- \* Frequency Reuse is one of the techniques for improving capacity and spectral efficiency
- \* Commercial wireless systems are based on Frequency Reuse, that involves the partitioning of an RF radiation area into cell segments.
- \* A frequency that is far enough away from the frequency in the bordering segment is used by one segment of the cell.
- \* Similar frequency is used at least two cells apart from each other.
- \* This practice enables various cellular providers to have several customers for a given site license.

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### Question - 25:

What is channel coding in GSM Technology?

#### Ans:

- \* The data rate for the radio channel is 270 kbps
- \* The data rate is split into 8 full rate or 16 half rate traffic channels, along with signaling channels
- \* In order to have the maximum chance for detecting and correcting errors, the code is complex in a typical propagation path
- \* Forward Error Correction is applied in order to get the speech coder encryption, coding and interleaving in a sophisticated way
- \* The data is sent as bursts in 577 mus time slots. Each contains 116 encrypted bits
- \* Every TDMA frame consists of 8 or 16 time slots
- \* Transmit time slots are staggered, so that at some instant the mobile station will not receive the same instants while transmitting, which enables the simplifying the filtering requirements
- \* At least one spare slot between transmit and receive is available with this scheme.

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### Question - 26:



What is speech coding in GSM Technology?

**Ans:**

- \* Speech coding is all about turning voice into digital form
- \* Speech is inherently analog, as GSM is a digital system.
- \* The digitization is employed by ISDN, and the current telephone systems that are used for multiplexing voice lines, with high speed trunks, optical fiber lines is done by Pulse Code Modulation(PCM)
- \* The PCM output is 64 kbps, which is too high over a radio link in feasibility
- \* The 64 kbps signal is redundant
- \* The algorithm used in conventional cellular is Vector Sum Excited Linear Predictive speech compression.

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**Question - 27:**

What is interleaving in GSM Technology

**Ans:**

- \* Time diversity in a signal communication system is obtained by using Interleaving.
- \* The possibility of losing whole bursts will be decreased by interleaving
- \* Total 456 bits from convolution encoder, including 20ms of speech, is subdivided into eight blocks. Each block consists of 57 bits.
- \* All these blocks are transmitted in consecutive time slots.
- \* Enough information is available in 7 blocks, in case one of the blocks is lost due to burst errors. This enables whole segment recovery by using error correction.

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**Question - 28:**

What is equalisation in GSM Technology

**Ans:**

An adaptive equalizer is employed by a GSM receiver for overcoming the impact of non-ideal channel characteristics which are caused by multipath propagation. Adaptive equalizer is required because the channel characteristics are often changing fast. Tuning for each time slot is done by the equalizer.

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**Question - 29:**

Name the algorithms used in following?

- Ciphering
- Authentication

**Ans:**

- \* Ciphering  
The algorithm 129-EEA3 and 128-EIA3, 3GPP Confidentiality and Integrity Algorithm is used for ciphering in GSM
- \* Authentication  
The algorithm by name A3 is used for authentication in the GSM systems  
This algorithm is used in implementing Subscriber Identity Module.

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**Question - 30:**

Which up-link/ down-link spectrum is allocated to following?

- GSM - 900
- DCS - 1800

**Ans:**

- \* GSM - 900: Up-link spectrum is 890.2-914.8 and down-link spectrum is 935.2-959.8
- \* DCS - 1800: Up-link spectrum is 1710.2-1784.8, and down-link spectrum is 1805.2-1879.8

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**Question - 31:**

What is discontinuous transmission in GSM Technology?

**Ans:**

- \* Discontinuous Transmission, also known as DTX in short is a method of momentarily powering down a mobile set when there is no voice input to the set.
- \* The overall efficiency of a wireless voice communication system is optimized by DTX.
- \* Each speaker in a two way conversation speaks slightly less than half of the time.
- \* The workload of the components in the transmitter amplifiers are made easy and reduces interference.

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**Question - 32:**

What is transmitted power control in GSM Technology?

**Ans:**

- \* Transmitted power control is one of the technical mechanism used within some networking devices
- \* TPC is used for preventing too much unwanted interference among wireless networks
- \* The central idea is to automatically reduce the transmission output power used, when other networks are within the same range.
- \* TPC reduces interference problems and increases the battery capacity  
The power levels of a single mobile device can be reduced by 6dB



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### Question - 33:

What is frequency Re-use in GSM Technology?

#### Ans:

- \* Frequency re-use is the key factor of cellular network ability for increasing both coverage and capacity.
- \* Different frequencies are utilized by adjacent cells; however problem does not arise to determine the cell sufficiently far apart using the same frequency.
- \* Reuse distance and the reuse factor are the two elements that influence frequency re usability
- \* The frequency is  $1/K$ , where K is the number of cells that cannot use the same frequencies for transmission.

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### Question - 34:

What is sectorization of a cell in GSM Technology?

#### Ans:

- \* Sectorization is a process to cut down equipment costs in a cellular network. It influences in traffic load and cell size
- \* Sectorization reduces co-channel interference, when applied to clusters of cells
- \* The maximum traffic capacity of sector-ed antennas is more than omni directional antennas.

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### Question - 35:

Explain the maximum data rate supported by a GSM system?

#### Ans:

The maximum data rate supported by a GSM system is 9.6 kbps. However there are extensions to GSM standard to improve throughput. GPRS is one of the extended GSM service. The extended standards of GSM allows theoretical data rates on the order of 114 Kbit/s, but with throughput closer to 40Kbit/s in practice.

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### Question - 36:

What are the services offered by GSM Technology?

#### Ans:

- \* The services offered by GSM are ISDN compatible
- \* GSM allows synchronous data and asynchronous data to be transported as bearer service, one of the telecommunication services offered by GSM, and forms ISDN terminal
- \* The data could be either transparent service or nontransparent service
- \* Telephony is one of the services offered by GSM, which an emergency and the service provider is notified by dialing 3 digits
- \* By using appropriate fax adapter, G3 fax service is supported
- \* One of the features of GSM is Short Messaging Service
- \* Certain services, namely supplementary services are provided on top of teleservices or bearer services by GSM, such as, caller identification, call forwarding, multiparty conversations, barring outgoing calls and call waiting.

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### Question - 37:

Do you know what is GSM technology?

#### Ans:

- \* Short form of Global System for Mobile Communications, is a wireless network system
- \* A standard for digital cellular mobile communications
- \* International roaming arrangements are enabled among mobile network operators, by providing the subscribers to use their personal mobile phones anywhere in the world.
- \* GSM is considered as second generation mobile, as signaling and speech channels are digital
- \* The carriers can be replaced without replacing mobile phones.
- \* The ubiquity of GSM implementations is also enabling the switching between network operators, who can choose equipment from many GSM equipment vendors.
- \* GSM pioneered low cost SMS implementation
- \* The GSM standard includes a worldwide emergency telephone number feature.

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### Question - 38:

What is the SSI?

#### Ans:

Small-scale integration; the process of concentrating semiconductor devices in a single integrated circuit.

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### Question - 39:

What is the value for TEI 1st T1?

#### Ans:

SS7 is the protocol used for transmission of non voice data transfer[signalling ],that r used for call setup etc





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**Question - 40:**

How do you link a T1 from the 1st BTS to 2nd BTS?

**Ans:**

There r so many ways o transferring E1/t1 FROM ONE BTS TO ANOTHER..used twisted pair cable w E1T1 card or RRI w in use but power off ..so many ways..

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**Question - 41:**

What is the different between CDU C and CDU A?

**Ans:**

CDU A uses filter combiner and c uses hybrid

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**Question - 42:**

Explain What is the difference between Diplexer and Duplexer and what position?

**Ans:**

diplexer is used if we want to use same antenna line[feeder] for two different type of waves.like using same feeder for gsm n cdma transmission to gsm..even if to physically separated antennas are there only a set of feeder will be required DUPLEXER is used if we want same antenna to transmit n receive..instead of using two separate ones..

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**Question - 43:**

Do you know what is Telecom regulatory body of India?

**Ans:**

TRAI-Telecom Regulatory authority of India  
it gives spectrum,it allocate new operator,and for which circle u hve to provide your Network.  
If operator cross thatCircle then TRAI can also ban that operator or take Fine also.

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**Question - 44:**

What are the various blocks in GSM architecture?

**Ans:**

these are the various block in gsm architecture -

- 1>BSS-Base Station Subsystem
  - a.MS
  - b.BTS
  - c.BSC
- 2>NSS-Network Swithing Subsystem
  - a.HLR
  - b.VLR
  - c.AUC
  - d.MSC
  - e.OMC
- 3>Public Network
  - a.PSTN
  - b.ISDN
  - c.Data Networks

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**Question - 45:**

Which is the digital modulation used today in telecom?

**Ans:**

Currently the digital modulation used in telecom is GSMK  
GMSK is a form of modulation used in variety of digital radio communication systems.It has an advantage4s of being able to carry digital modulation while still using the spectrum efficiently.

One of the problems with other forms of phase shift keying is that the sidebands extend outwards from the main carrierand this can cause interference to the other radio communication systems using nearby channels.

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**Question - 46:**



What is the main difference between GSM and CDMA?

**Ans:**

The main difference between GSM and CDMA is: In GSM, the entire frequency band is not available to the end-user, while in CDMA the entire frequency band is available to the end-user. So, the Frequency Re-use factor is 1 in CDMA. GSM Works as follows:

-----  
The entire frequency band is divided into chunks and each such chunk is divided into timeslots and each such portion is made available to a user.

CDMA Works as follows:

-----  
The entire frequency band is available to the user. So, in order to differentiate, the transmission from each user is "spread" or coded using a unique code given to individual user. At the receiving end, the spread information is decoded.

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**Question - 47:**

Explain about LTE and GSM internetworking.  
Is it like GSM is used for backbone comm in LTE?

**Ans:**

Long Term Evolution (LTE) is the next step from 3G/WCDMA & HSPA for many already on the GSM technology curve but also for others too, such as CDMA operators. This new radio access technology will be optimized to deliver very fast data speeds of up to 100Mb/s downlink and 50Mb/s uplink (peak rates).

Designed to be backwards-compatible with GSM and HSPA, LTE incorporates Multiple In Multiple Out (MIMO) in combination with Orthogonal Frequency Division Multiple Access (OFDMA) in the downlink and Single Carrier FDMA in the uplink to provide high levels of spectral efficiency and end user data rates exceeding 100 Mbps, coupled with major improvements in capacity and reductions in latency. LTE will support channel bandwidths from 1.25 MHz to 20 MHz and both FDD and TDD operation.

Although both LTE and WiMAX use the OFDMA air interface, LTE has the advantage of being backwards compatible with existing GSM and HSPA networks, enabling mobile operators deploying LTE to continue to provide a seamless service across LTE and existing deployed networks.

Several major mobile operators, including some running CDMA networks today, have indicated they will adopt LTE in the next few years. Japanese mobile operator NTT DOCOMO has said that it is aiming to launch a commercial LTE network by the end of 2009, while in the U.S., the largest CDMA operator, Verizon Wireless, is currently trialing LTE with a view to launching a commercial LTE service in 2010.

LTE- Advanced

LTE-Advanced extends the technological principles behind LTE into a further step change in data rates. Incorporating higher order MIMO (4x4 and beyond) and allowing multiple carriers to be bonded together into a single stream, target peak data rates of 1Gbps have been set.

LTE-Advanced also intends to use a number of further innovations including the ability to use non-contiguous frequency ranges, with the intent that this will alleviate frequency range issues in an increasingly crowded spectrum, self back-hauling base station and full incorporation of Femto cells using Self-Organising Network techniques. LTE-Advanced will be 3GPP's technology as a candidate for the ITU-R IMT-Advanced process, which is intended to identify '4G' technologies.

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**Question - 48:**

Explain what is the relation between RXLEV [0 to 63] and rxlev [-110 to -47]?

**Ans:**

Rx level 0 to 63 is GSM unit. While -110 to -47 is dbm Rxlevel unit of GSM. When we will add 110 to Rxlevel [dbm], it will get convert into GSM unit 0 to 63.

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### Question - 49:

Tell me What is the difference between FER and BER?

#### Ans:

Error ratios used in conjunction with GSM speech channels:

• Frame Erasure Rate, FER, is defined as the amount of swept speech frames (260 bits each) divided by the amount of transmitted speech frames. The speech frame is swept if even one of its most important 50 bits is observed not to be correct. The three parity bits following the 50 class Ia bits are used for error detection.

• Bit Error Rate, BER, is the ratio of erroneously received bits to all received bits. It is important to notice that BER is evaluated before channel decoding, i.e. after equaliser. BER is used for defining the RXQUAL value

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### Question - 50:

Explain What is the deference between Rx Lev Sub and Rx Lev Full?  
What you mean by Link Budget?

#### Ans:

Rx\_Level\_Full is measured when DTX is off & Sub is when DTX is on.

RX Lev Full: Its is nothing but the Mobile transmit the measurment report(SACCH multiframe) for every 480ms. this multiframe contains 104 TDMA frames, in 104 TDMA frames 4 TDMA frames for Decode the BSIC and remaining 100 TDMA frames for Average measurment of serving cell and neighbouring cell.This average measurment of 100 TDMA frames are RX Lev Full

RX Lev Sub: DTX is a discontinouse trasmission, When the mobile conversation 40% of the time either Trasmmitter or Receive is idle. When DTX is ON, DTX will switch off the Trasmmitter or Receiver when they is no speech Pulses. only few TDMA frames will trasmit, the average of this TDMA frames is called RX Lev Sub, give you proper measurment of RX level

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### Question - 51:

I know that the main function of bts is to air interface signaling. But why?

#### Ans:

mobile station is normally mobile in nature which is an advantage over pstn network . and in order to provide connection to mobile station we use radio resource (air)... in order to provide interface between mobile and bss . bts is used.. a bts is responsible to cover a small geographical area called cell...

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### Question - 52:

What is the GSM?

#### Ans:

GSM, which stands for Global System for Mobile communications,

reigns as the world's most widely used cell phone technology.

Cell phones use a cell phone service carrier's GSM network by searching for cell phone towers in the nearby area.

The origins of GSM can be traced back to 1982 when the Groupe Spéciale Mobile (GSM) was created by the European Conference of Postal and Telecommunications Administrations (CEPT) for the purpose of designing a pan-European mobile technology.

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