

16/03/2021

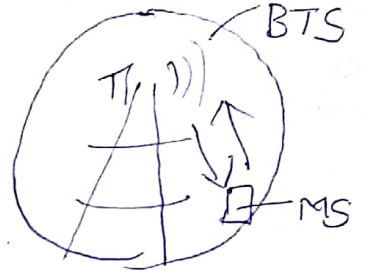
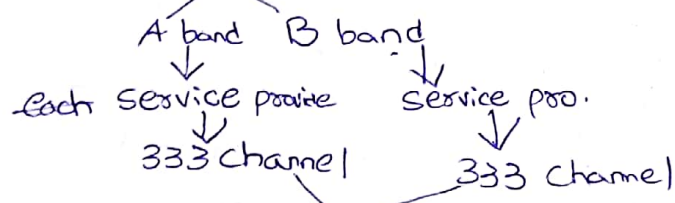
→ Different Gen. of w/l Cellular s/y :

**I. 1G (Advanced mobile Phones - AMPS)**

- analog freq. mod. schemes - ASK
- 2 separate freq. band. - Frequency division duplex (FDD)
  - Uplink (Reverse link) : MS to BTS - 869 to 894 MHz
  - downlink (forward link) : BTS to MS - 824 to 849 MHz

• FDM → ↑ s/y capacity

• 7800 MHz : FCC & ITU

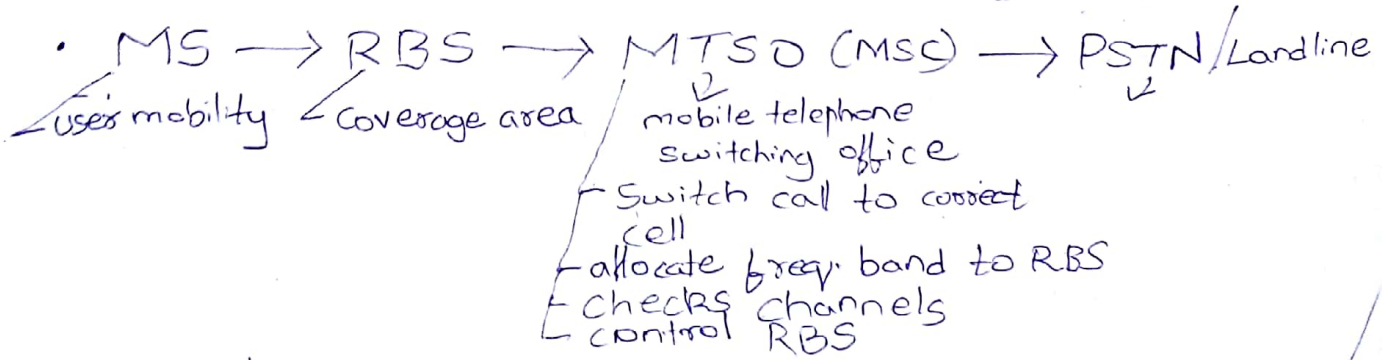


666 ⇒ 416 - traffic channel → Voice  
 250 - control → set up/clear call  
 ↳ for n/w op. call hand off  
 ↳ Idle BTS  
 ↳ o/p power adjustment mobile

**ID :**

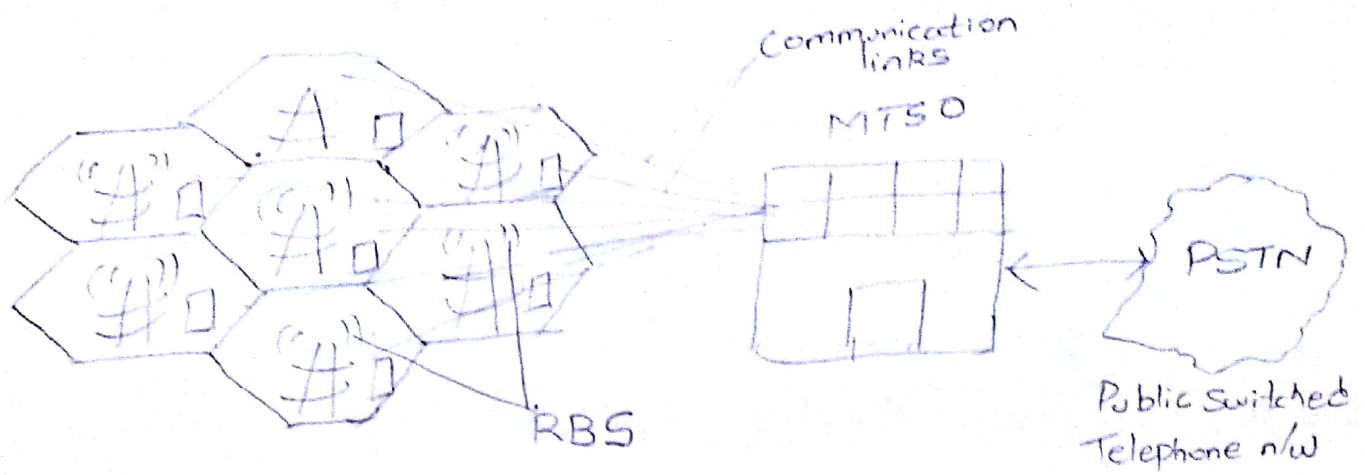
- MS ← ESN → electronic serial no. → from manufacturer
- MIN → mobile identification no. → 34 bit → 10 digit dialable no.

• BTS - 15 bit → SID - service Provider ID no.

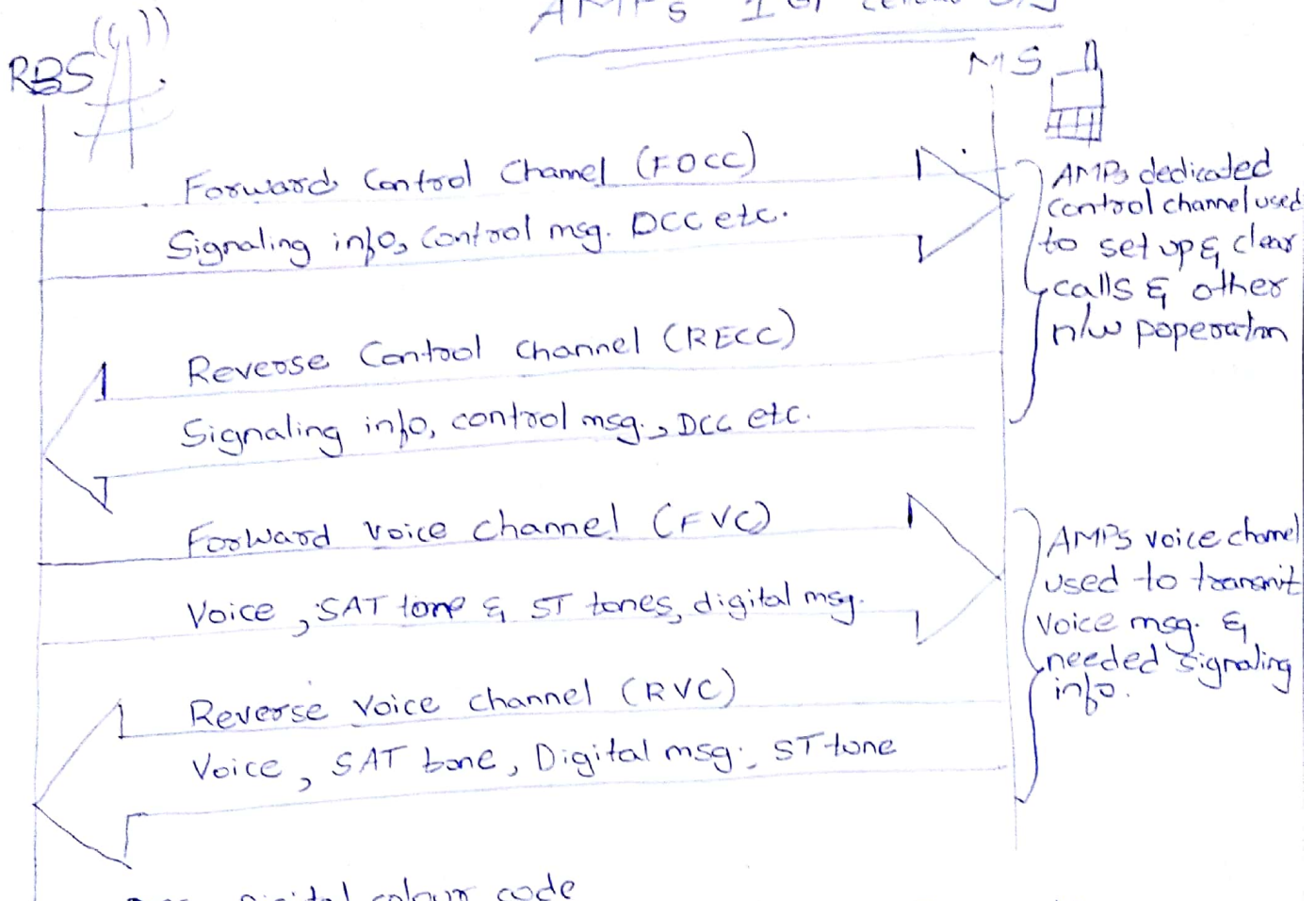


• channel spacing : 30 KHz

• each BTS Tx & Rx freq. : 45 MHz → to ↓ adj. channel interference.



### AMP's 1G cellular s/y



DCC - Digital colour code  
 SAT - Supervisory audio tone - 5970, 6000 & 6030 Hz  
 ST - signaling tone - 10 kHz - To send codes msg. to RBS.

### AMP's Forward & Reverse Control & Traffic Channels

1-312 → traffic } A      334 → 666 } B  
 21 → control

- 7 cells =  $N=7$  : 59 → traffic 3 → control.
- SAT : checks signal strength (Radio link status)

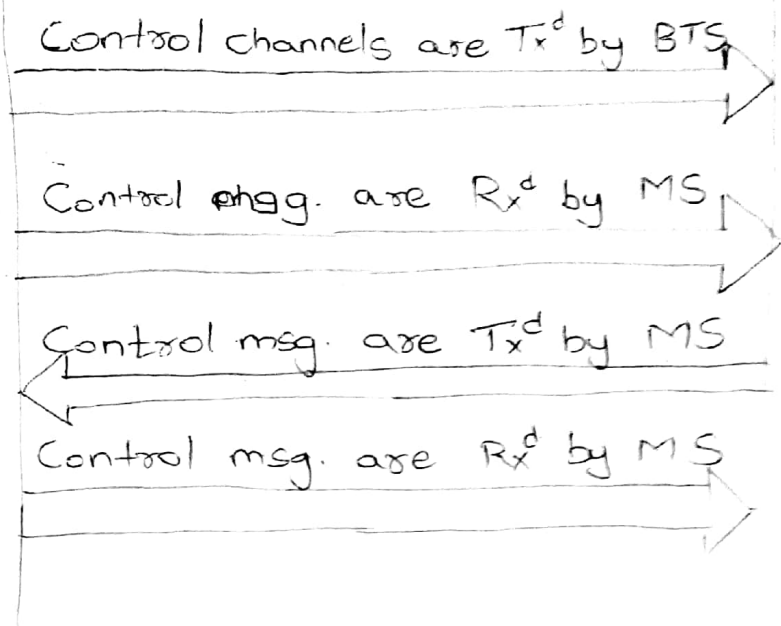
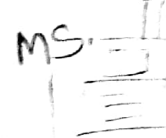


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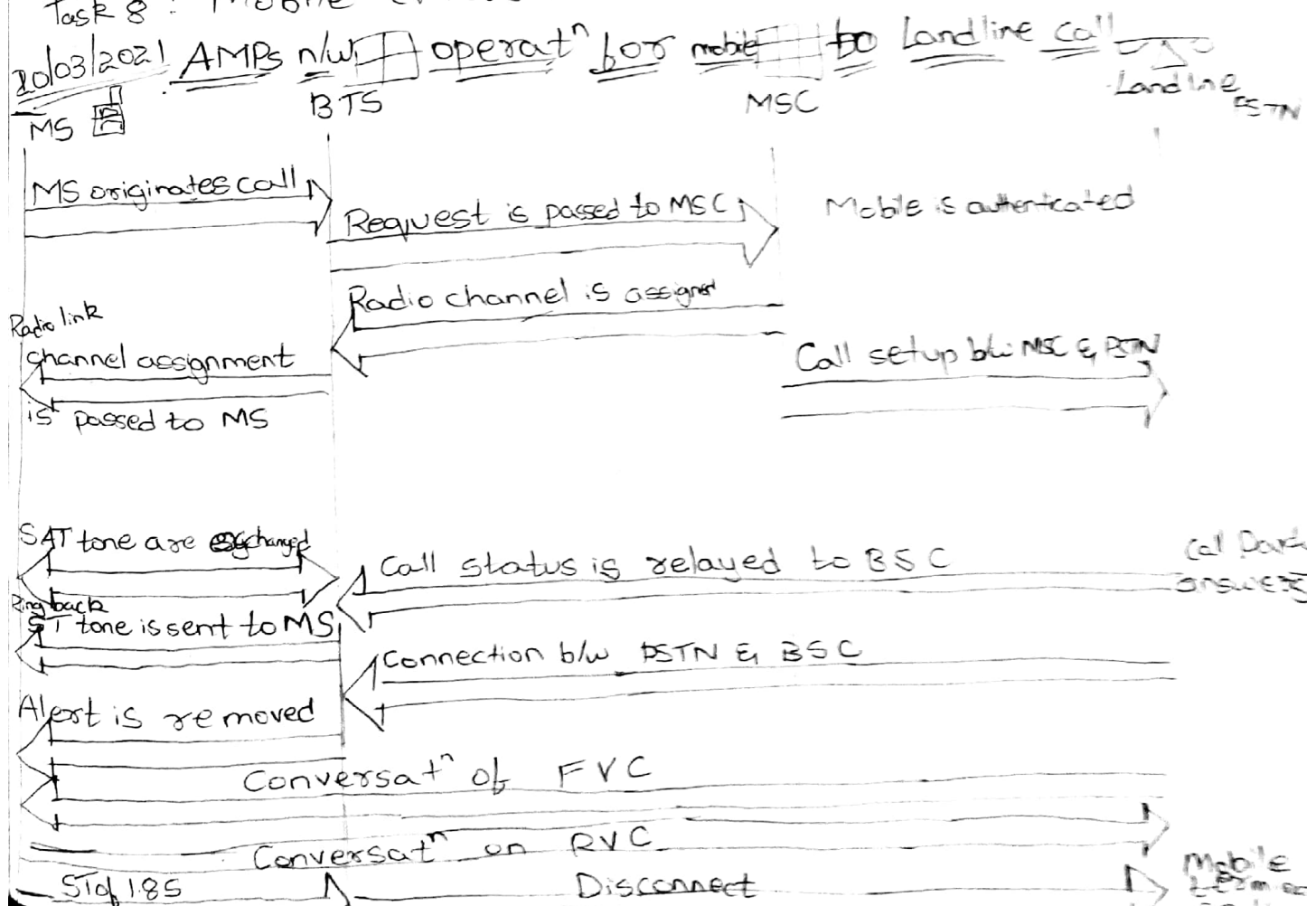
## Basic AMPs operation :

- i. Mobile phone initialisat<sup>n</sup> → outgoing
- ii. Mobile originated call (MS ↔ MS) (MS → PSTN)
- iii. Mobile terminated call (incoming call)
- iv. Call handoff (BSI ↔ BSI)
- Voice call : 30kHz
- analog mod. : 800MHz
- SAT: checks Radio link status
- ST: Sends order msg. BS ↔ MS
- i. alert order msg: alerts mobile of <sup>incoming</sup> call
- ii. audit - " - " : how many MS are working
- iii. change power - " - " : dis. cal<sup>n</sup> ⇒ changes power according
- iv. Intercept - " - " : any wrong while placing call
- v. Maintenance - " - " : Database
- vi. Release - " - " : disconnect<sup>n</sup> of call
- vii. Stop alert - " - " : stop ring tone if not received
- viii. Address - " - " : enter 10 digit no.
- Typically the BS in AMPs system controls the mobile phone by sending order msg. to mobile.
- 10kHz signaling tone can be Tx<sup>d</sup> over a voice channel to confirm orders & various signal request.
- i. Alerts mobile of incoming call.
- ii. Sent by BS to determine the mobile is still active in system
- iii. Used to change mobile RF o/p power
- iv. Used to inform the user that a procedural error has been made in placing a call
- v. Used to check the operat<sup>n</sup> of mobile.
- vi. Used to disconnect a call
- vii. Stop alerting/ringing
- viii. Base stat<sup>n</sup> requires a diled digit info

# Mobile Phone Initialisation



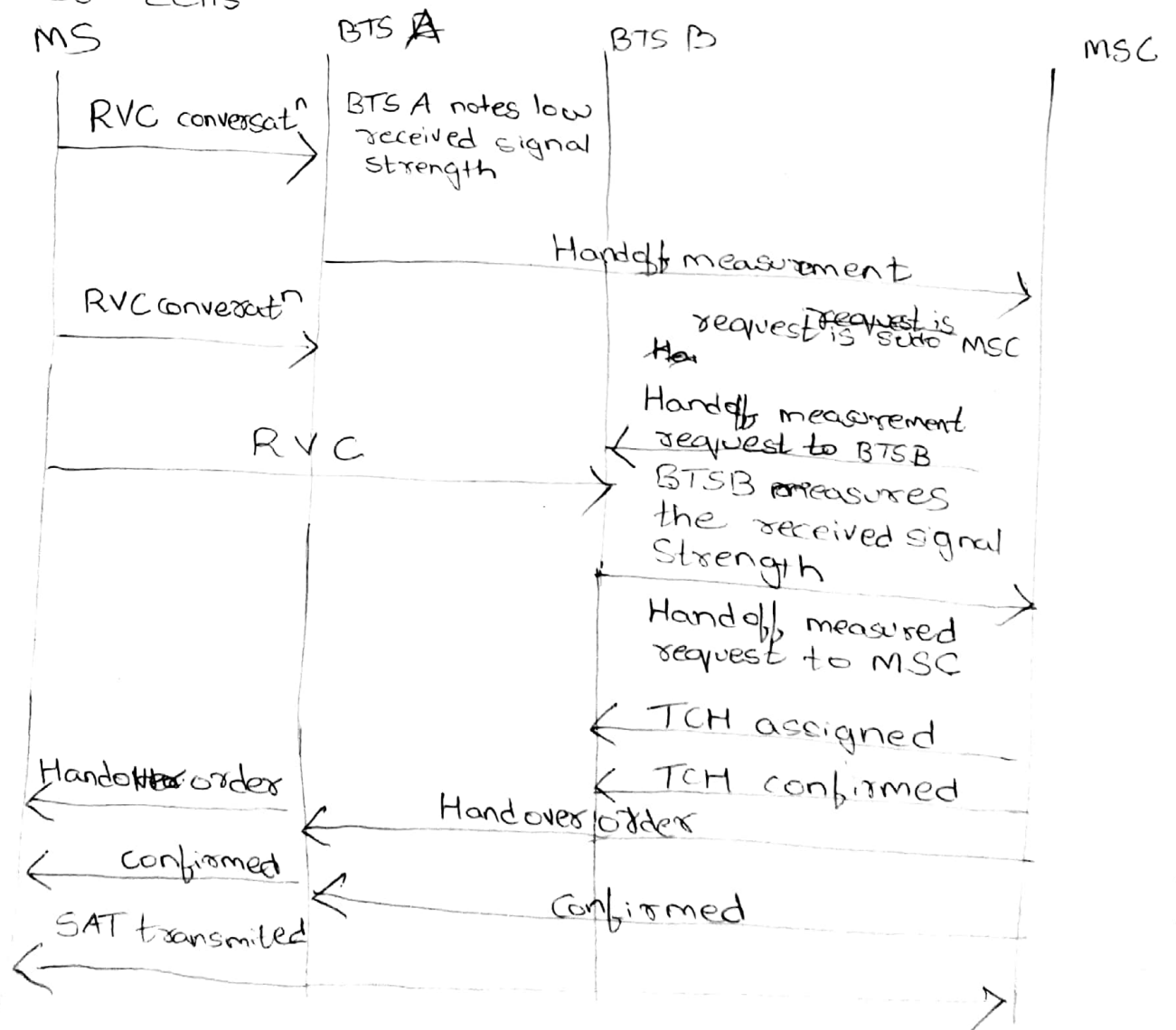
- Task 1: Mobile powers up
- Task 2: Mobile scans control channels of selected s/y (A or B)
- Task 3: Mobile updates cellular s/y info.
- Task 4: Mobile establishes paging channels
- Task 5: Mobile registers with cellular s/y (ESN, SID & MIN)
- Task 6: MS authentication
- Task 7: MS authentication verified
- Task 8: Mobile enters idle state



- The mobile subs. wants to make a call, several handshaking msg. must be exchanged b/w BS & MS & b/w MSC & PSTN.
- The inter sys. std. TIA/TIA TIA-EIA-634B is used b/w MSC & BS.
- After the radio link b/w MS & BS is confirmed, the telephone call is connected to called up party on PSTN.
- The called up party answers, alert ringback signal is removed. & a conversat<sup>n</sup> ensues on b/w & v voice channels.
- Either the called up party or MS may terminate the call.

## Handoff Operations

- An HOO occurs in a cellular sys when a MS moves to another cells

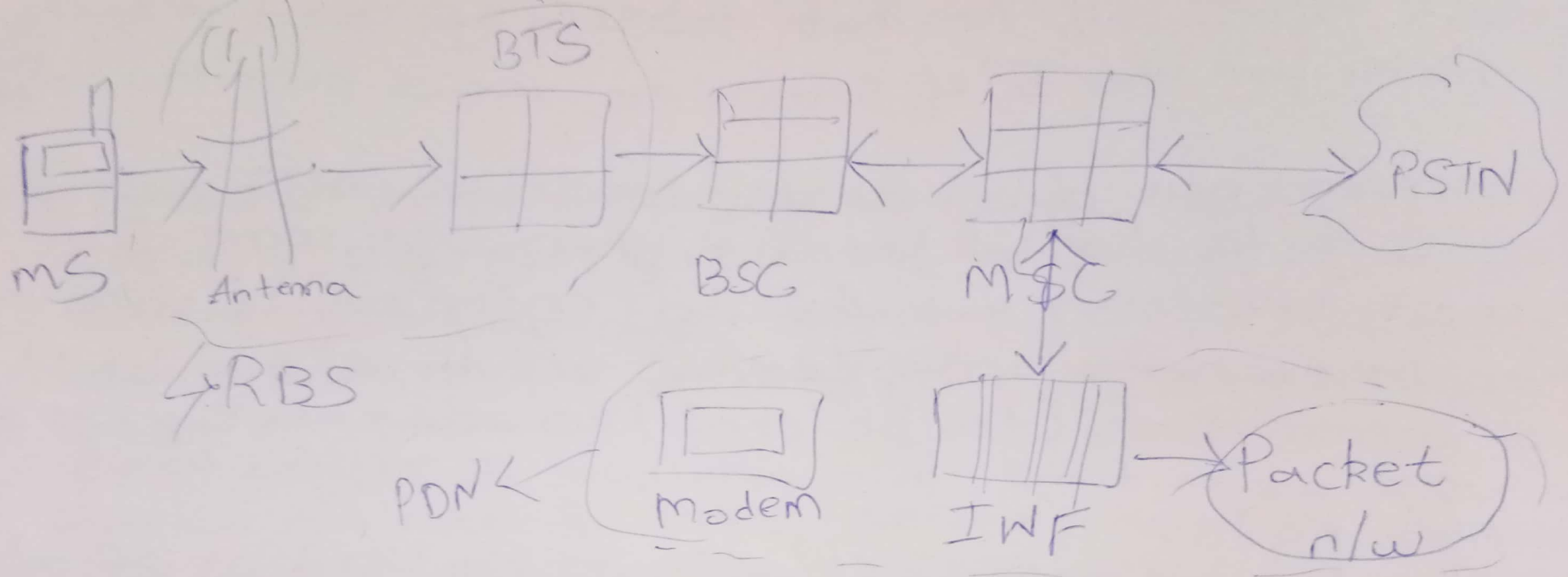


- The signal depicts the handshaking operation that takes place for handoff to occur.
- In this case a MSC connected to 2 or more BS within a geographic area.
- Consider that BS A is handing an active call from a MS within its area of coverage.
- However MS is in transit & is moving away from BS A & towards BS B's coverage area.
- BS A constantly monitors the received signal power from MS.
- When signal from MS goes below a pre-determined threshold level, BS A sends handoff measurement request to MSC.
- The MSC req. that all the BS that are able to Rx Tx from specified MS, monitor its power level.
- It is determined that BS B is Rx'g strongest signal from mobile.
- MSC assigns a traffic channel (TCH) to BS B.
- BS B responds & handover order is sent from MSC to BS A.
- BS A sends handoff control signal to MS with necessary new channel info. & then the mobile switches to new voice channel with this newly prescribed o/p power.
- As before mobile Rx's BS-B's SAT & returns it.
- If everything goes well handoff is confirmed.

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IT > 2 G

- The most basic diff. is that the 1G sys. used analog mod. tech. for the Tx<sup>r</sup> of subscribers voice over the traffic chnl.
- On subsequent gen. of cellular sys., convert a users voice ~~to~~ analog sig. to digital form & then use some form of dig. mod. to transmit the dig. encoding of voice msg.
- This conversion to a dig. format result in the ability of a comm. link (traffic chnl.) to accommodate more than one user at a time. This attribute is referred to as multiplexing.
- The 2 most popular form of multiplexing used by 2G cellular sys. are TDMA & CDMA.
- The control signals for 1G sys. used SAT & ST sig. that have no need for 2G sys.
- By using dig. encoding for user traffic, digital encryption may be employed to provide security & privacy for <sup>mobile</sup> users now. This was not possible in 1G cellular sys.
- Dig. encoding & mod. allows for use of error detect & correct<sup>n</sup> codes. The use of which to some extent combats the power type of fading & noise effect to radio chnl.
- The ability of a 2G cellular sys. to support more than one user per radio channel is through the use of adv. dig. muxing tech.
- TDMA sys. (GSM) use time slots to allocate a fixed periodic time, subs. has excl. use of particular chnl.
- The GSM sys. (TDMA) uses a Tx<sup>r</sup> format with 8 time slots & hence the sys. can support 8 users per channel simultaneously.
- CDMA cellular sys. uses a dig. mod. tech. known as spread spectrum.
- In this sys. at Tx<sup>r</sup>, each user's dig. encoded signal is further encoded by a special code that converts each bit of the original msg. into many bits.
- At the Rx<sup>r</sup> same special code is used to recover the original bit streams.
- The special code used to perform this encoding/decoding has unique prop. that each Rx<sup>r</sup> sig. looks like noise to a Rx that does not share the same code as the Tx<sup>r</sup> of sig.
- Hence in synch. sys., many radio sig. can be simul. Tx<sup>r</sup> in same radio chnl. w/o interfering with each other.

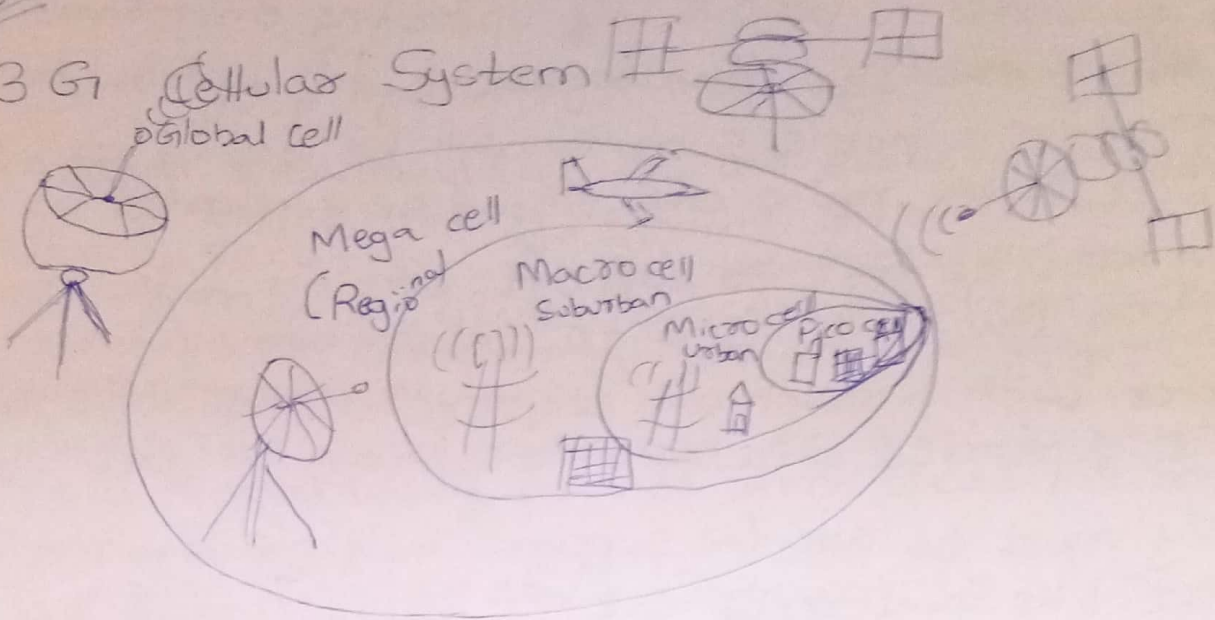


CDMA interworking functional nodes



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# I. 3G Cellular System



3G operating environment.

cell type →	Global cell	Mega cell	Macro cell	Micro cell	Pico cell
Max. cell radius	1000 km	100-500 km	35 km	1 km	50 m
operating environment	Global	Regional	Suburban (low user density)	Urban (high user density)	in-building
Installation Type	Satellite: GEO, MEO, LEO	Satellite: LEO, MEO	Tower or Building mounted	Tower (small)	Inside a building
Data Rate	100 s of kbps to Mbps	100 s of kbps to Mbps	144 kbps	384 kbps	200 kbps
Max. mobile speed	N/A	N/A	500 km/h	100 km/h	10 km/h

## 3G char. by cell size & Data

The term 3G mobile sly is used to represent a no. of cellular sly & their associated stds, that have the ability to support high data rate services, adv. multimedia services (voice, data & video) & global roaming.

These stds. are being facilitated by ITU & other regional bodies around the world.

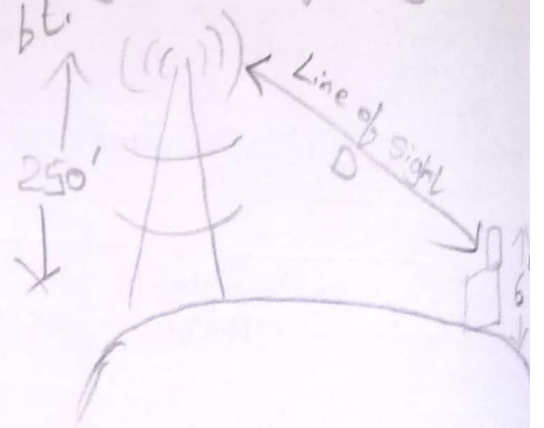
3G mobile n/w need to be able to provide high speed data transfer from packet n/w & to be able to permit global roaming.

- They also need to support adv. digital services & to be able to work in various diff. operating environments (low to high mobility, urban to suburban & to global locat<sup>n</sup> etc) i.e. anywhere a mobile subs. might be located except for the most severe radio env. should be supported by 3G.
- 3G s/y must be able to support varying data rates by providing BW on demand to subscriber.
- 3G char. with hierarchical cell str. in conn. size, mobility rate & supported data rate is shown in table.
- 3G s/y must be able to support multiple simultaneous connect<sup>n</sup> like conference call, IP addressing & be backward compatible with 2G n/w

1. Assume that  $T_x$  ant. for 1<sup>st</sup> mobile radio telephone s/y was located on a tower at a height of 250 ft. Det. the range of s/y, assuming line of sight  $T_x$  & a  $R_x$  ant. of height 6 ft.

$$D = \sqrt{2R_e}(\sqrt{h_t} + \sqrt{h_r}) ; R_e = 6350 \text{ km}$$

$$1 \text{ ft} = 0.3048 \text{ m}$$

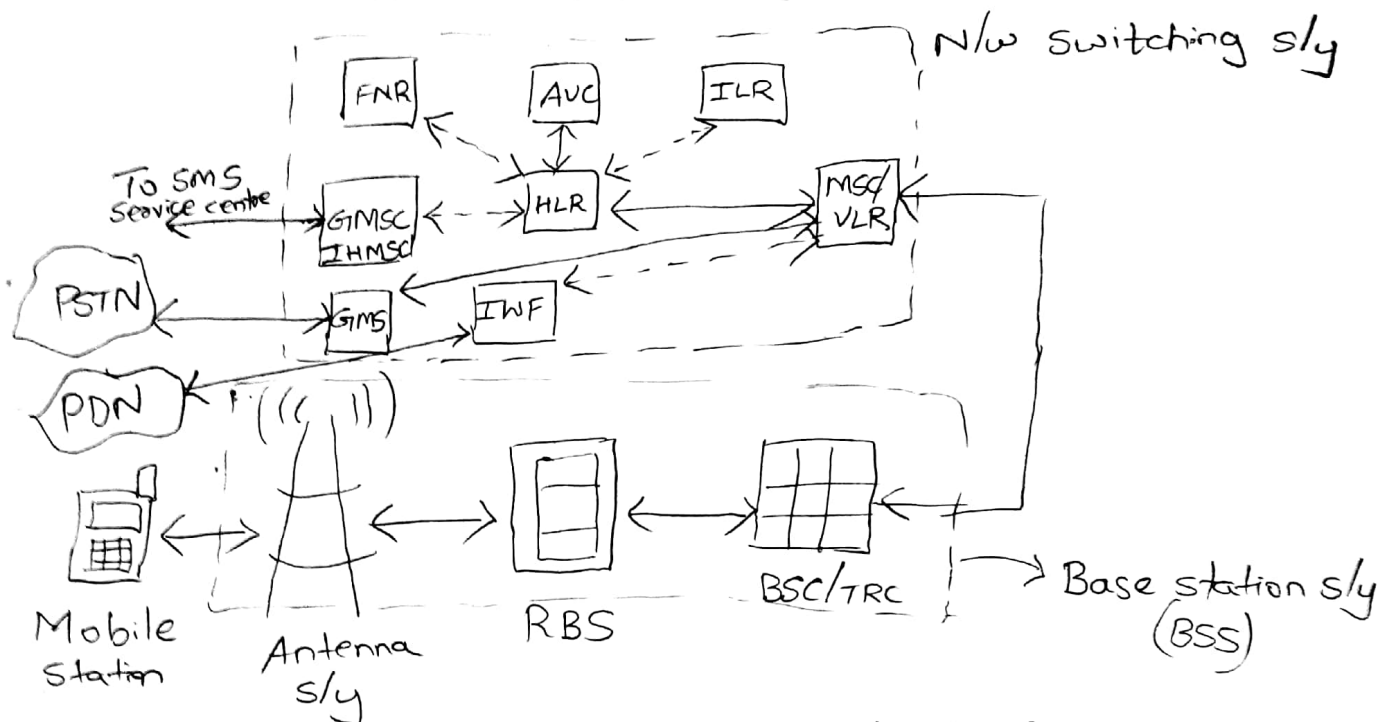


2. Which 2 components of AMPs provide air interface  
BTS, MS
3. Explain the purpose of AMPs supervisory audio tone
4. Describe the seq. of events when AMPs s/y is first turned on
5. What is the purpose of SID no.
6. What is the diff. b/w mobile originated & mobile terminated call
7. What event triggers AMPs hand off operat<sup>n</sup>.
8. What is the fundamental diff. b/w 1G & 2G s/y
9. How do 2G cellular s/y support more than 1 user per channel
10. Adv. of digi. encoding for higher gen. cellular s/y
11. Basic char. of 4G cellular s/y

## IV. 4G Cellular System

- Role of 4G is the convergence of w/e mobile with w/e access comm? tech.
- A converged broadband w/e s/y will evolve in response to the issues in BW efficiency, dynamic BW allocation, quality of service, security, digital transceiver tech, self organising n/w, future concerns related to all ip architecture & connectivity for anyone anywhere at any time mobile n/wing.
- 4G mobile n/w data rates are expected to reach over 20 Mbps & eventually provide ATM speed w/e connectivity

### → Common Cellular S/y Components



- FNR - Flexible Number Register (portability)
- AUC - Authentication centre (Authoisat<sup>n</sup>)
- ILR - Inter working location register (Roaming)
- EIR - Equipment Identity Register (Auditing of MS)
- HLR - Home Location Register (Data base)
- IWF - Inter working Functional Node ( PDN)
- MSC/VLR - Mobile Switching ctr /
- PDN - Public Data N/w
- BSC - Base Station Control
- TRC - Transcoder Controller (Vocoding/rate)
- GMSC - Gateway MSC