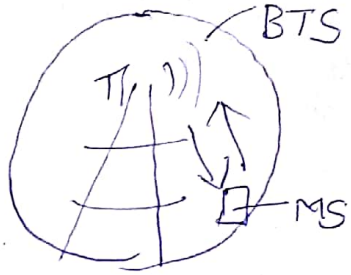
16/03/2021

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

I. 1G (Advanced mobile Phones - AMPs)

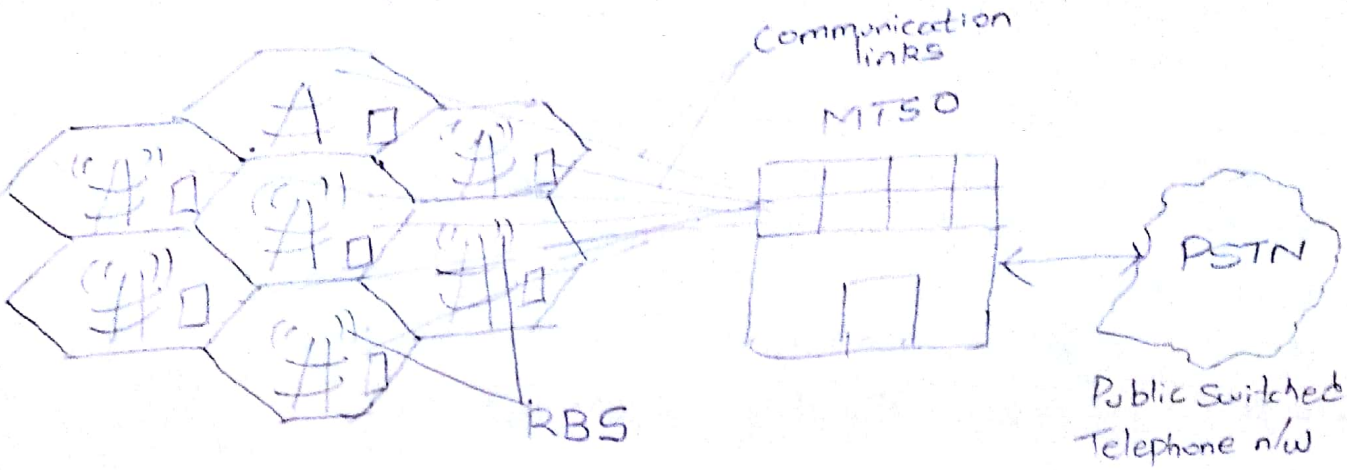
- analog freq. mod. schemes - ASK
- 2 separate freq. band. - Frequency division duplex (FDD)
  - Uplink (Reverse link) : MS to BTS - 869 to 894 MHz
  - downlink (forward link) : BPS to MS - 824 to 849 MHz
- FDM → ↑ s/y capacity
- 800 MHz : FCC & ITU



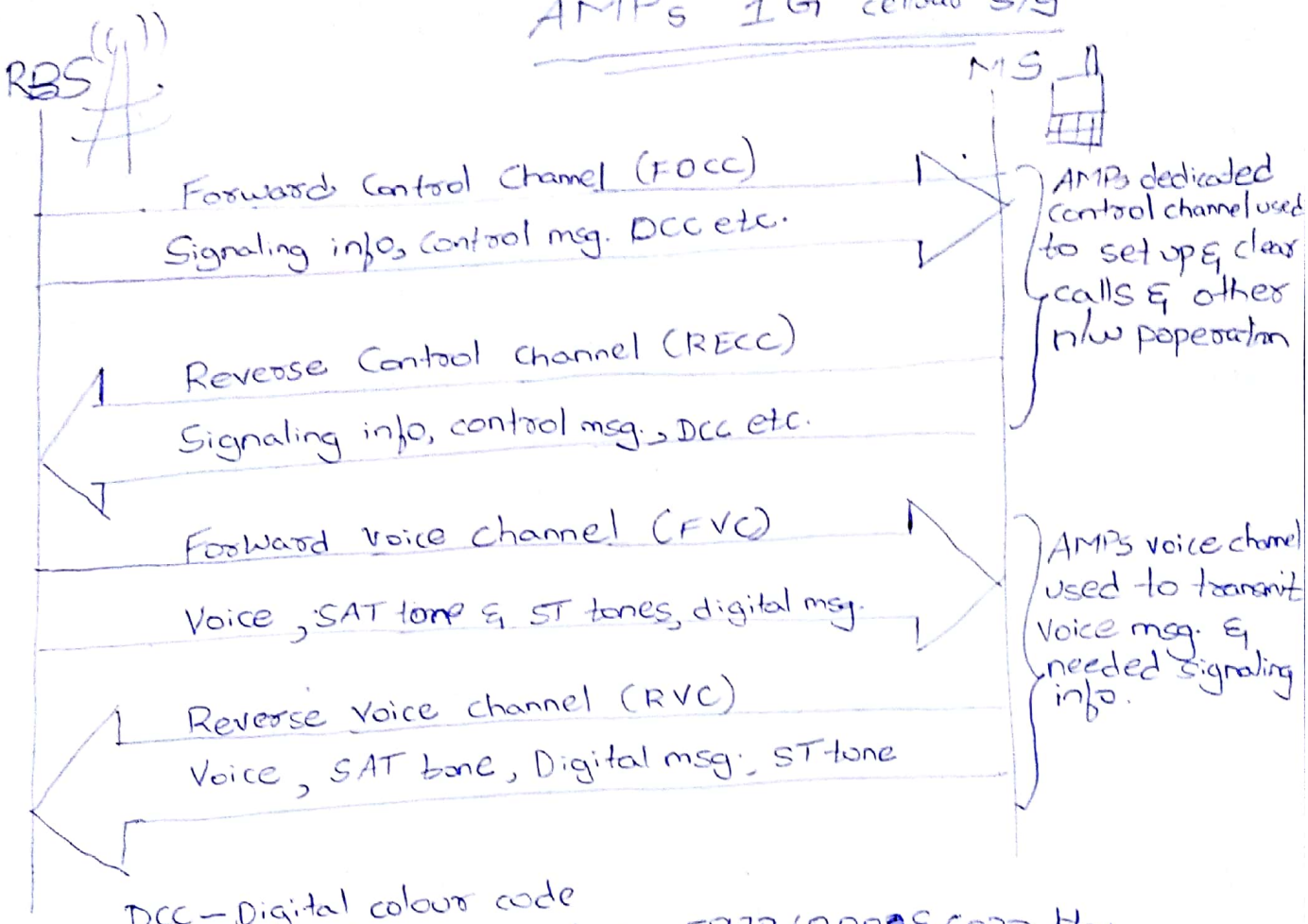
A band B band
↓ ↓
each service provide service pro.
↓ ↓
333 channel 333 channel

666 ⇒ 416 - traffic channel → voice
250 - control → set up/clear a call
↳ or n/w op^n - call hand off
→ Idle BTS
↳ o/p power adjustment

- ID :
  - MS < ESN → electronic serial no. → from mobile manufacturers
    MIN → mobile identificat^n no. → 34 bit → 10 digit dialable no.
  - BTS - 15 bit → SID - service Provider ID no.
- MS → RBS → MTSO (MSC) → PSTN/Landline
  - user mobility
  - coverage area
  - MTSO: mobile telephone switching office
    - Switch call to correct cell
    - allocate freq. band to RBS
    - checks channels
    - control RBS
- channel spacing : 30 KHz
- each BTS Tx^t & Rx^e freq. : 45 MHz → to ↓ adj. channel interference.



AMPS 1G cellular S/y



DCC – Digital colour code
SAT - Superwisory audio tone - 5970, 6000 & 6030 Hz
ST - signaling tone - 10 kHz · to send orders msg. to MS.

AMPS Forward & Reverse Control & Traffic Channels

- 1-312 → traffic } A
  21 → control
  334 → 666 } B
- 7 cells ⇒ N = 7 : 59 + traffic 3 - control.
- SAT : checks signal strength (Radio link status)

19/03/2021

Basic AMPS Operation

i. Mobile phone initialisat^n
ii. Mobile originated call (MS↔MS) → outgoing (MS↔ PSTN)
iii. Mobile terminated call (incoming call)
iv. Call handoff (BSI↔BSII)

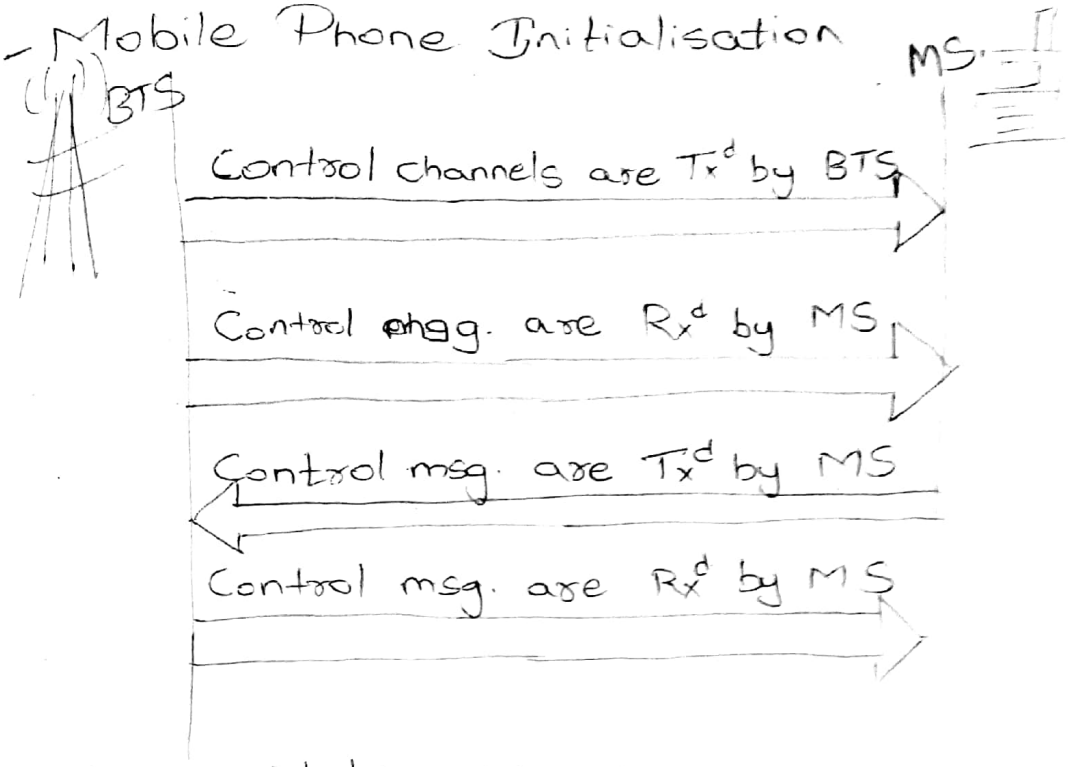
- Voice call · 30kHz
- analog mod. · 800 MHz
- SAT: checks Radio link Status
- ST: Sends order msg. BTS ↔ MS

→ i. alert order msg : alerts mobile of incoming call
ii. audit -"- -"- : how many MS are working
iii. change power -"- -"- : dis. cal^n ⇒ changes Power according
iv. Intercept -"- -"- : any wrong while placing call
v. Maintainance -"- -"- : Database
vi. Release -"- -"- : disconnect^n of call
vii. Stop alert -"- -"- : stop ring tone if not received
viii. Address -"- -"- : enter to digit no.

- Typically the BS in AMPS system, controls the mobile phone by sending order msg. to mobile.
- 10kHz signaling tone can be Tx^d over a voice channel to confirm orders & various signal request.

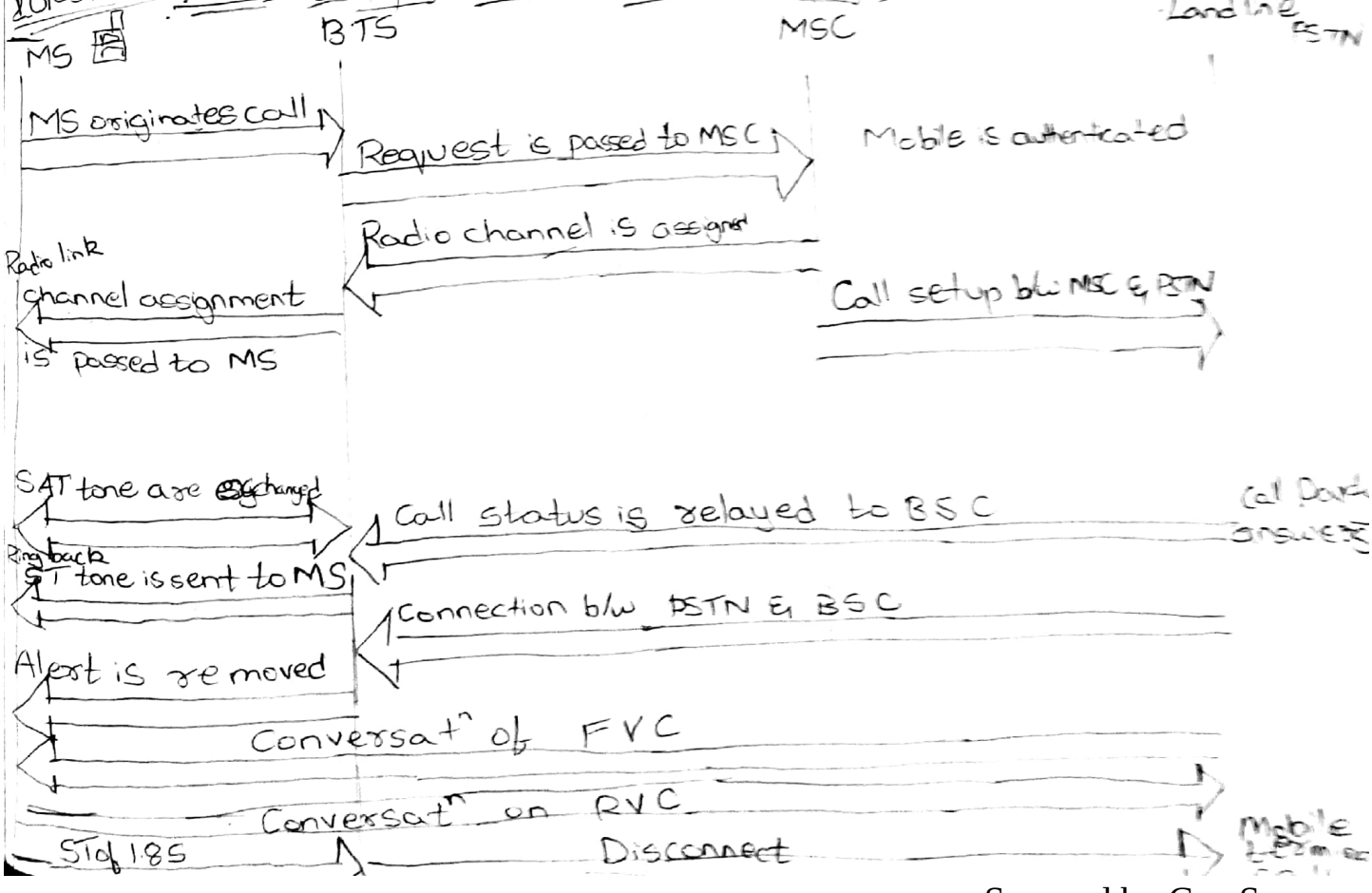
i. Alerts mobile of incoming call.
ii. Sent by BS to determine the mobile is still active in system
iii Used to change mobile RF o/p power
iv. Used to inform the user that a procedural error has been made in placing a call
v. Used to check the operat^n of mobile.
vi. Used to disconnet a call
vii. Stop alerting/ringing
viii. Base stat^n requires a dialed 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

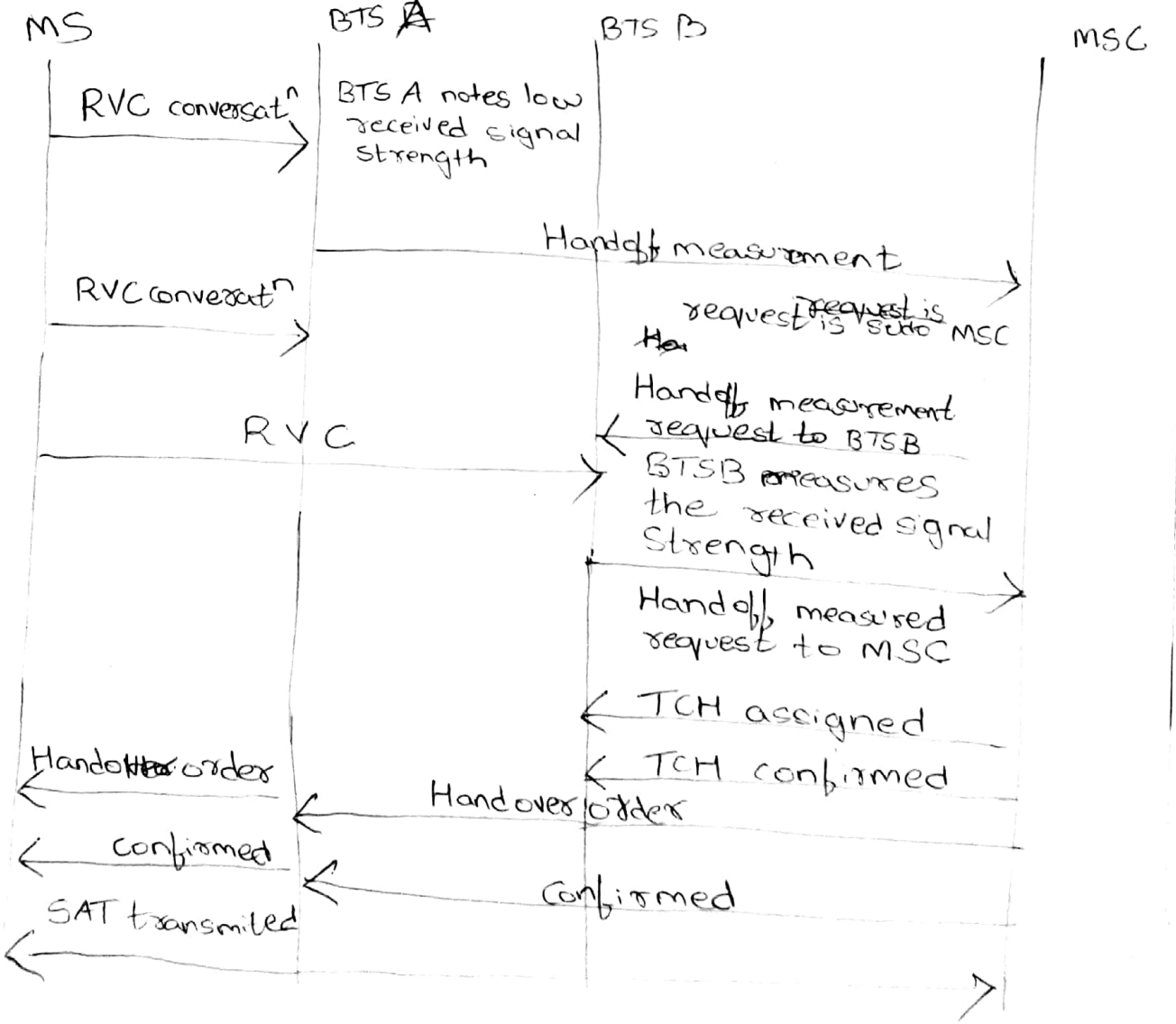
20/03/2021 AMPS n/w operat^n for mobile to landline call



- 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 calledup party answers, alert ringback signal is removed. & a conversatn ensues on f/o & r/v voice channels.
- Either the called up party or MS may terminate the call

— Handoff Operations

- An HoO occurs in a cellular sty when a MS moves to another cells

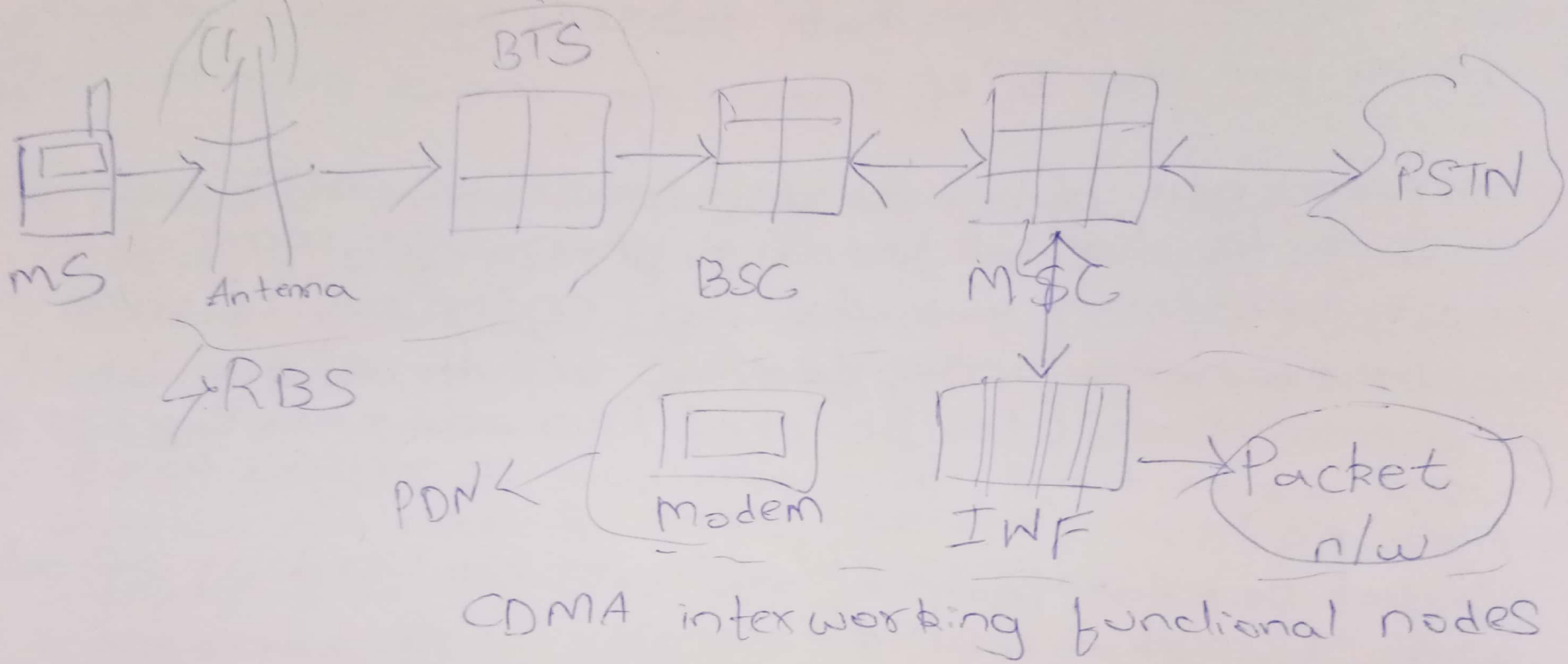


- The signal depicts the handshaking operation that to be place for handoff to occur.
- In this case a MSC connected to 2 or more BS within a geographic area.
- Consider that BSA is handing an active call from a MS within its area of coverage
- However MS is in transit & is moving away from BS A & towards BS B's coverage area
- BSA constantly monitors the received signal power from MS
- When signal from MS goes below a predetermine threshold level, BSA sends handoff measurment request to MSC.
- The MSC req. that all the BS that are able to Rx Tx^n from specified MS, monitor its power level
- It is dertermined 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 its newly prescribed o/p power.
- As before mobile Rx^s BS-Bs SAT & returns it
- If everything goes well handoff is confirmed.

23/03/2021

II>. 2 G

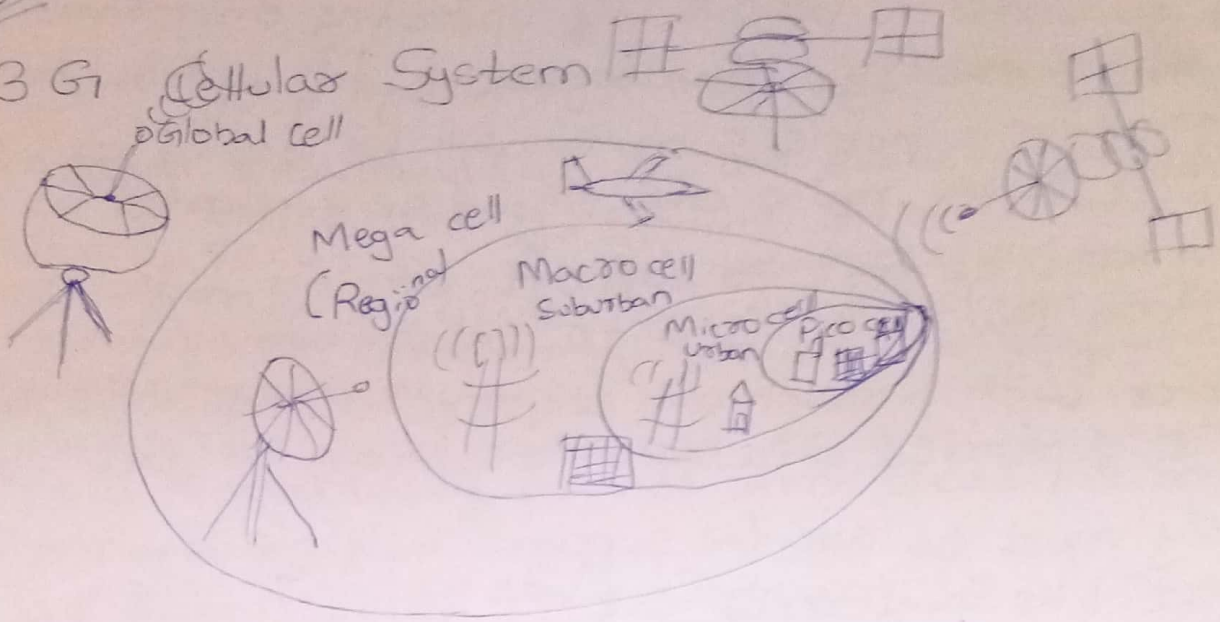
- The most basic diff. is that the 1G sys used analog mod. tech. for the Tx of subscribers vocice over the traffic chnl.
- In subsequent gen. of cellular sys, convert a users voice analog sig. to digital form & then use some form of dig. mod. to transmit the dig. encoding of voice msg.
- This conversion to a dig. format result in the ability of a comm. link (traffic chnl.) to accomodate more than one user at a time. This attribute is refferd 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 s/y.
- By using dig. encoding for user traffic, digital encryption may be employed to proved security & privacy for mobile user n/w. This was not possible in 1G cellular s/y.
- Dig. encoding & mod. allows for use of error detect & correct coured coury. The use of which to some extent combats the ~~power~~ type of fading & nose effect to radio chnl.
- The ability of 2G cellular s/y to suport more than one user per radio channel. is through the use of adv. dig. muxing tech.
- TDMA s/y (GSM) use time slots to allocate a fixed periodic time, subs. has excl. use of perticular chnl.
- The GSM s/y (TDMA) uses a Tx format with 8 time slots & hence the s/y can support 8 users per channel. simultaneously.
- CDMA cellar s/y uses a dig. mod. tech known as spread spectrum.
- In this s/y at Tx, 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 same special code is used to recover the original bit streams.
- The special code used to perform this encoding/decoding fn. has unique prop. that each Rx sig. looks like noise to a Rx that doesnot share the same code as the Tx & sig.
- Hence in synch. s/y, many radio sig. can be simul. Tx in same radio chnl. w/o interfering with each other.



CDMA interworking functional nodes

6/03/2021

1. 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	100s of kbps to Mbps	100s of kbps to Mbps	144 kbps	384 kbps	2 Mbps
Max. mobile Speed	N/A	N/A	500 km/h	100 km/h	10 km/h

3G char. by cell size & Data

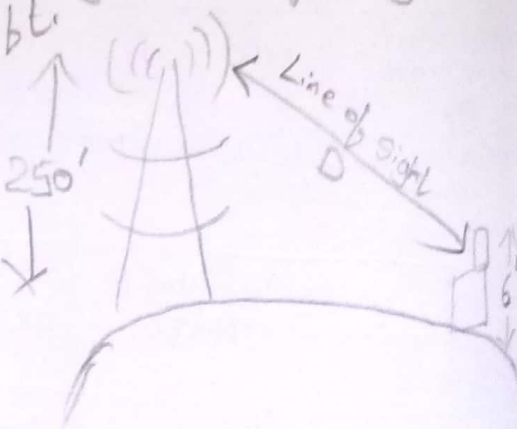
- The term 3G mobile s/y is used to represent a no. of cellular s/y & their associated stds, that have the ability to support high data rate services, adv. multimedia services (voice, data & video) & global roaming.
- These stds. are being fecilitated by ITU & other regional bodies aroud the world.
- 3G mobile n/w need to be abled 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^n etc) i.e. anywhere a mobile subs. might be located except for the most sevior radio envi. should be supported by 3G s/y
- 3G s/y must be able to support varying data rates by providing BW on demand to subscriber.
- 3G char. with hirarchical cell str. in corr. size, mobility rate & supported data rate is shown in table.
- 3G s/y must be able to support multiple simultaneous connect^n like conference call, IP addressing & be backward compatible with 2G n/w

1. Assume that T_x^g ant. for 1st 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^n & a R_x^g ant. of height 6 ft.

$$D = \sqrt{2R_e}\left(\sqrt{h_t} + \sqrt{h_r}\right) \; ; \; R_e = 6,350 \text{ km}$$

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

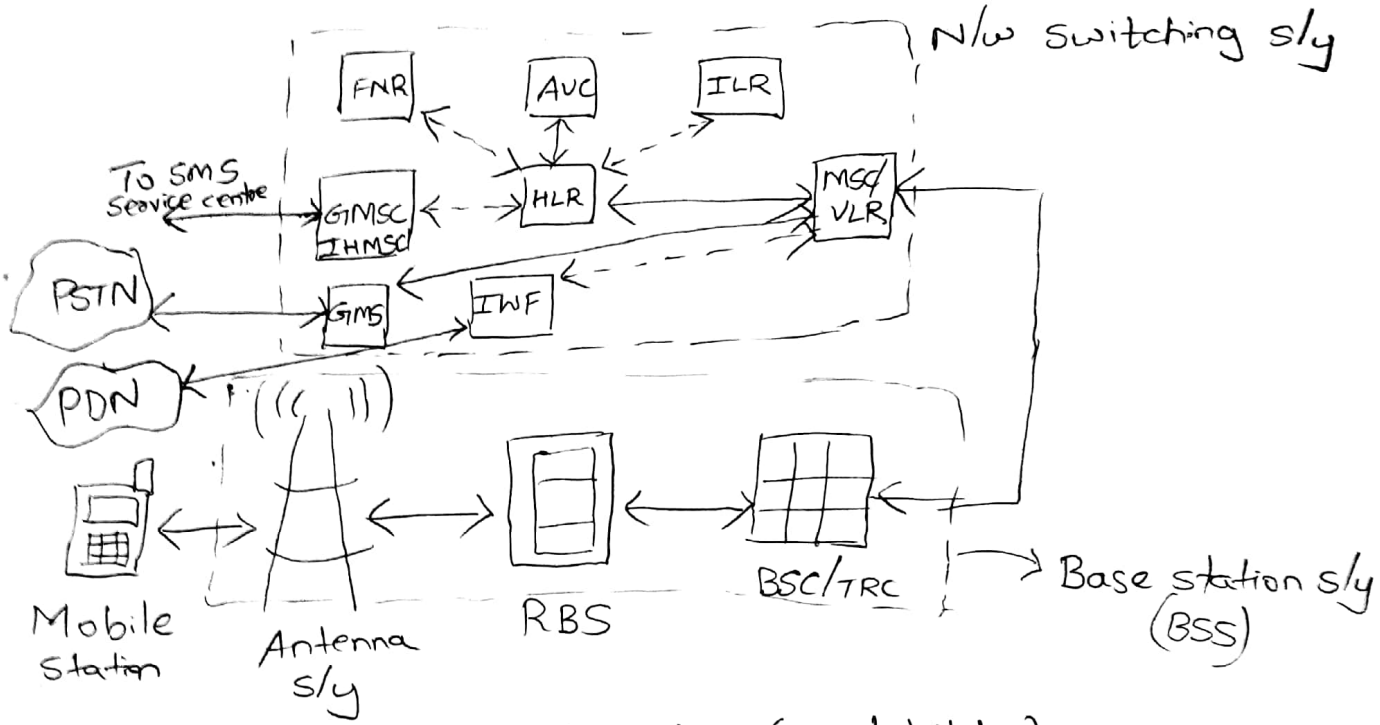


2. Which 2 components of AMPS provide air interface
BTS, MS
3. Explain the purpose of AMPS supervisory audio tone
27/03/2021
4. Describe the seq. of events when AMPS s/y is first turned
5. What is the purpose of SID no.
6. What is the diff. b/w mobile originated & mobile terminated
7. What event triggers AMPS hand off operat^n.
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 chan
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/l mobile with w/l access comm? tech.
- A converged broadband w/l s/y will evolve in response to the issues in BW efficiency, dynamic BW allocation, quality of service, security, digital transreceiver tech, self organising n/w, future concerns related to all IP archetecture & connectivity for anyone anywhere at anytime mobile n/wing.
- 4G mobile n/w data rates are expected to reach over 20 Mbps & eventually provide ATM speed w/l connectivity

→ Common Cellular S/y Components



- FNR - Flexible Number Register (portability)
- AUC - Authentication centre (Authorisat^n)
- 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 Ckt /
- PDN - Public Data N/w
- BSC - Base Station Control
- TRC - Transcoder Controlere (Vocoding/rate)
- GMSC - Gatway MSC