G 364: Mobile and Wireless Networking

CLASS 22, Wed. Mar. 31 2004

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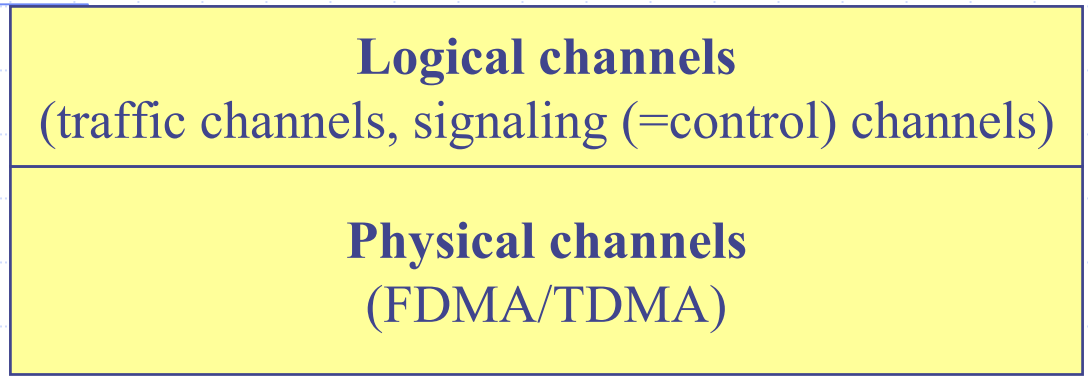
M-W, 11:40am-1:20pm, 109 Rob

Logical vs. Physical Channels

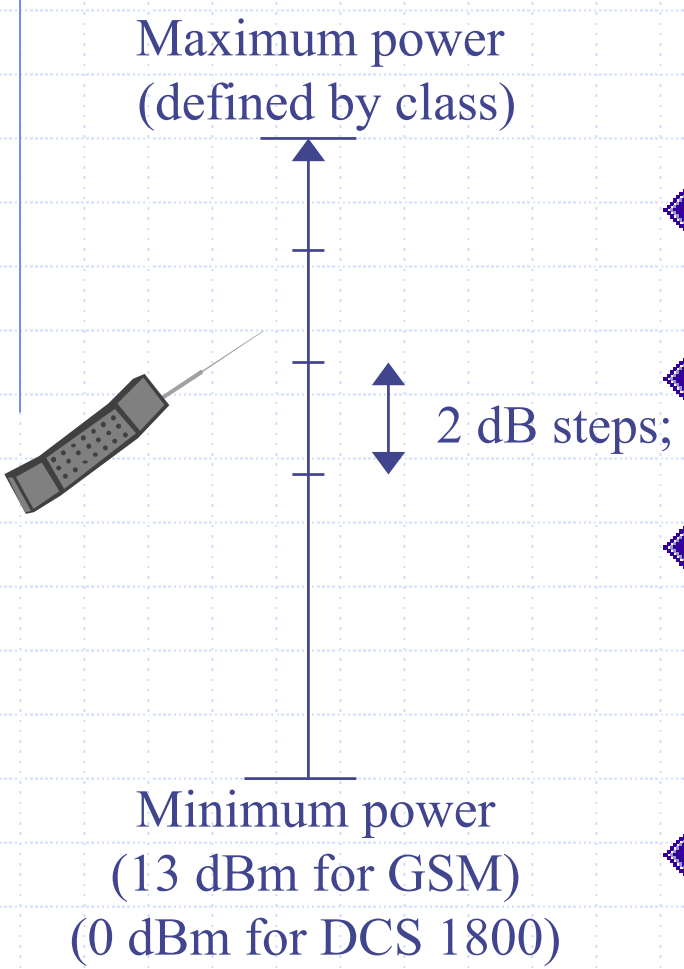


- Physical channels
  - Time slots @ given frequencies
  - Issues: modulation, slot synchronization, multiple access techniques, duplexing, frequency hopping, etc
- Logical channels
  - Built on top of physical channels
  - Issue: which information is exchanged between MS and BSS

GSM Logical Channels

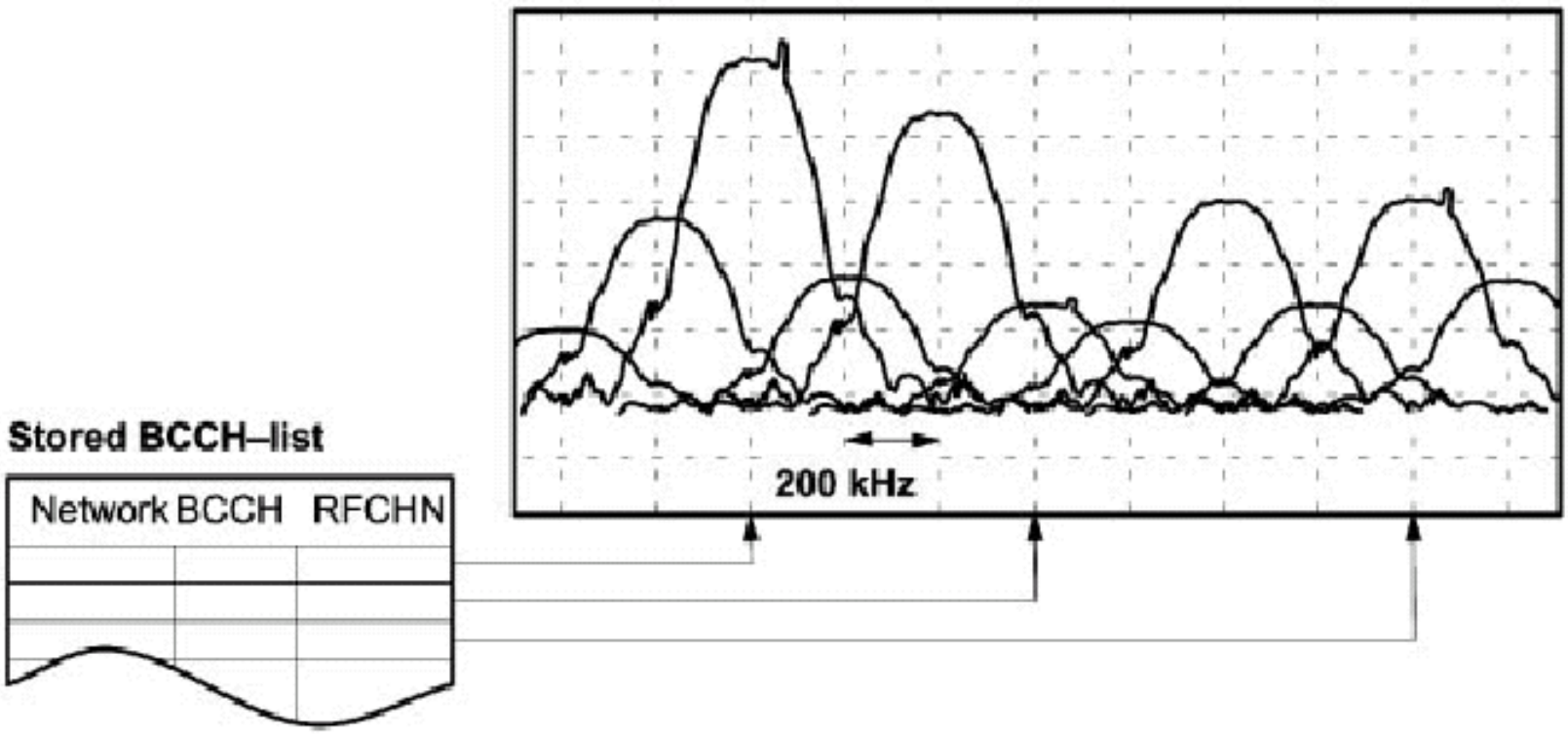
Traffic channel (TCH)	TCH/F	TCH full rate	MS←→BSS
	TCH/H	TCH half Rate	MS←→BSS
Broadcast channel *(same information to all MS in a cell)*	BCCH	Broadcast control	BSS→MS
	FCCH	Frequency Correction	BSS→MS
	SCH	Synchronization	BSS→MS
Common Control channel (CCCH) *(point to multipoint channels)* *(used for access management)*	RACH	Random Access	MS→BSS
	AGCH	Access Grant	BSS→MS
	PCH	Paging	BSS→MS
Dedicated Control channel (DCCH) *(point-to-point signalling channels)* *(dedicated to a specific MS)*	SDCCH	Stand-alone Dedicated control	MS←→BSS
	SACCH	Slow associated control	MS←→BSS
	FACCH	Fast associated control	MS←→BSS

Power Control



- MS has ability to reduce/increase power
  - Up to its power class maximum
- Maximum one 2dB step every 60ms
- Uplink power measures taken by BTS
- Notified back to MS
  - Power level values: 0-15
    - 0 = 43 dBm (20 W)
    - 15 = 13 dBm (20 mW)
- Algorithm: manifacturer specific

MS Powering Up



First operation when MS turned ON: spectrum analysis

(either on list of up to 32 Radio Frequency Channel Numbers of current network)

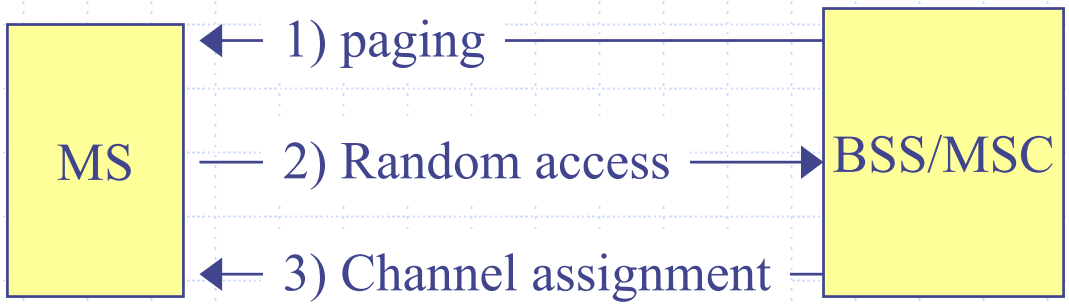
(or on whole 124 carriers spectrum)

Tuning

- MS listens on strongest beacon for a pure sine wave (FCCH)
  - Coarse bit synchronization
  - Fine tuning of oscillator
- Immediately follows SCH burst
  - Fine tuning of synchronization (64 bits training sequence)
  - Read burst content for synchronization data
- Finally, MS can read BCCH (Broadcast Control CHannel)

Paging, 1

- Paging
  - Needed to wake-up MS from IDLE state when incoming call arrives to MS
- MS asks for a channel

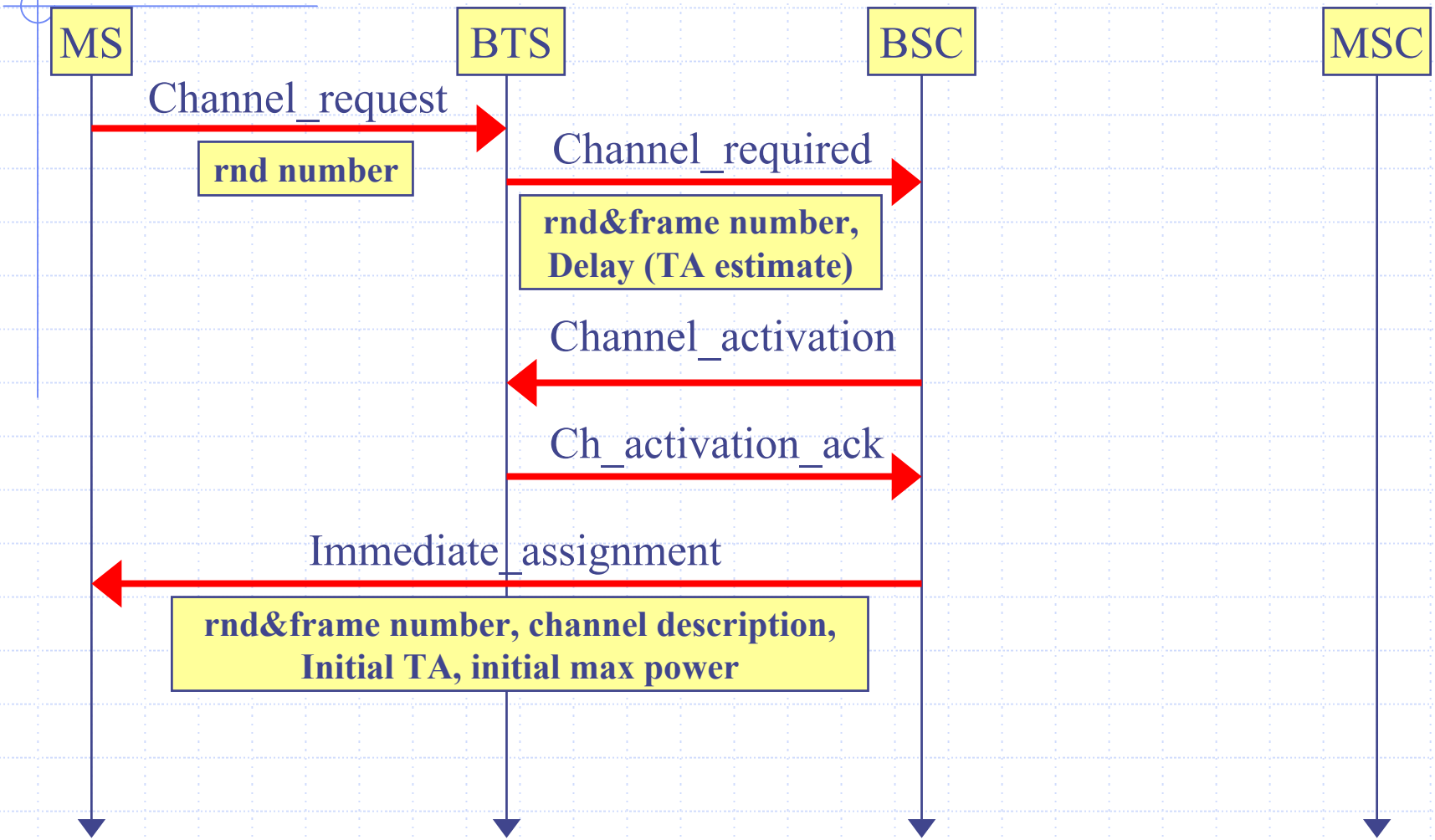


Paging channel: PCH
Access Grant Channel: AGCH
Random Access Channel: RACH
} PAGCH
CCCH
Common Control CHannel

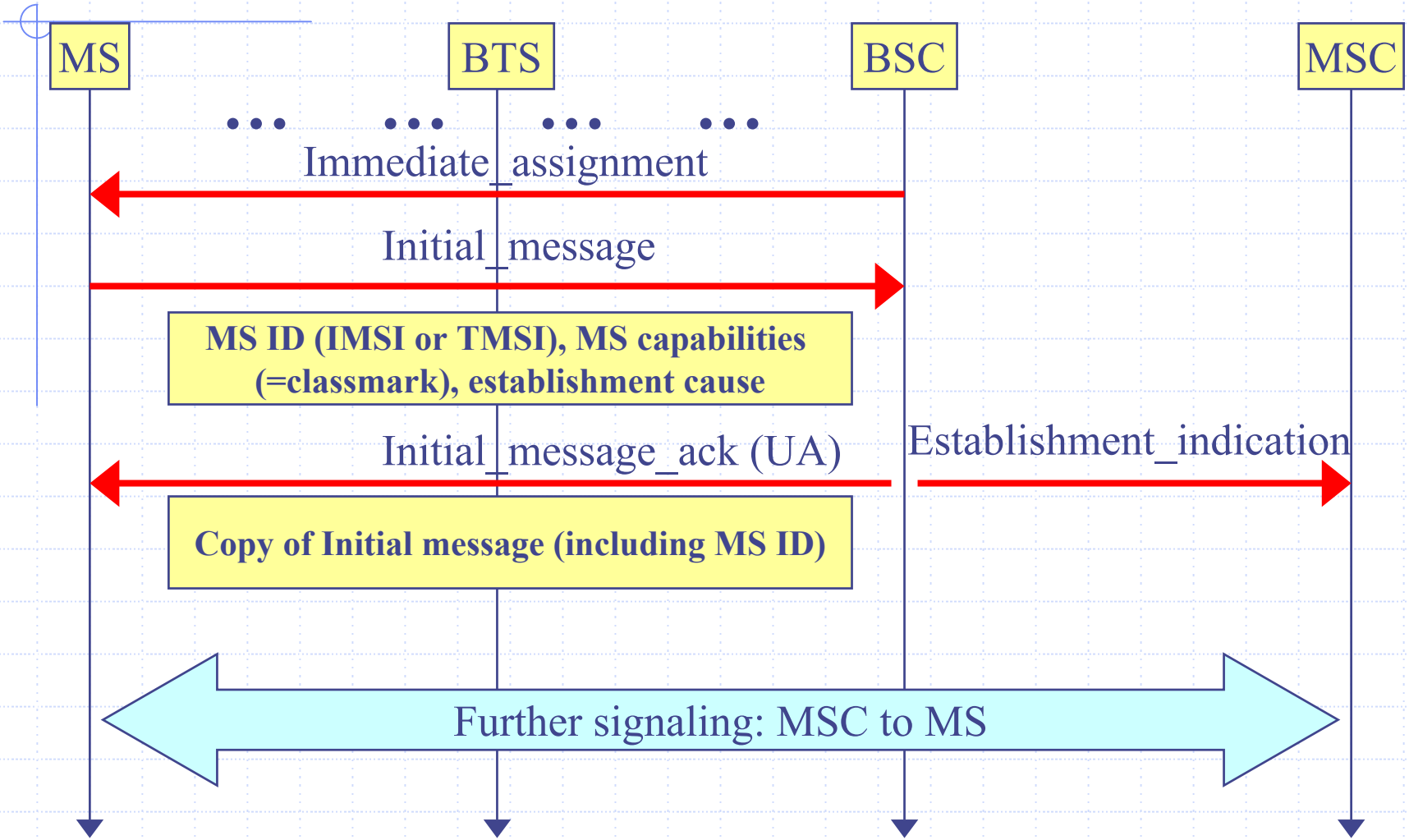
Paging, 2

- Paging message generated by MSC (receives incoming call)
- Transferred to subset of BSC
  - Paging limited to user's location area
  - Paging message contains:
    - List of cells where paging should be performed
    - Identity of paged user
- Paging message coded in 4 consecutive bursts over the air interface
- Paging for more MSs may be joined in one unique paging message

Access Signaling, 1



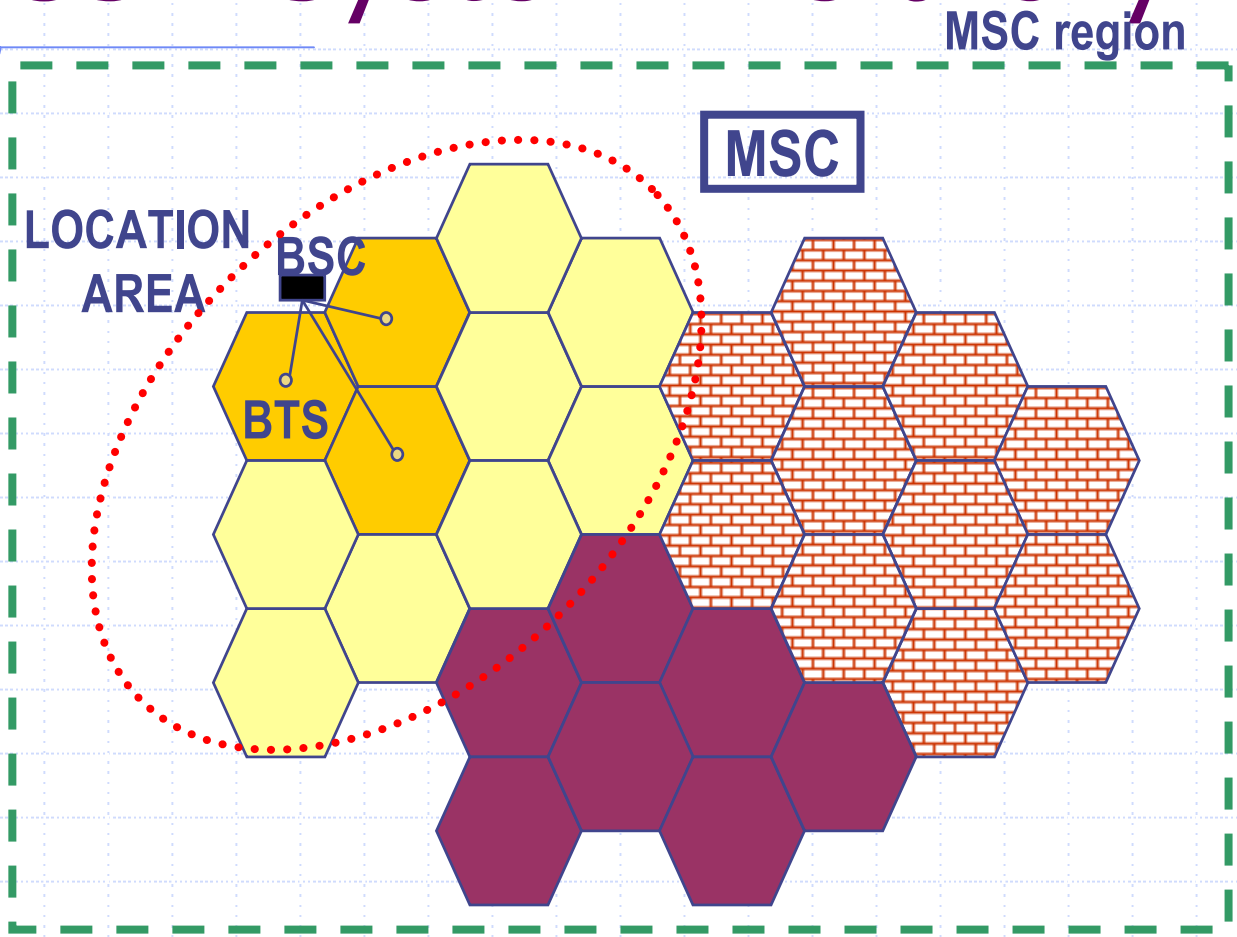
Access Signaling, 2



GSM Mobility Management

- Major task: Update the location of a MS (for delivering incoming calls)
- A mobile service area is partitioned in Location Areas (LAs)
- LA is a group of Base Transceiver Stations (BTSs)
- Mobility management = location tracking/update of the MS from an LA to another

GSM System Hierarchy



MSC: Mobile Switching Center
LA: Location Area
BSC: Base Station Controller
BTS: Base Transceiver Station

Hierarchy: MSC region → n x Location Areas → m x BSC → k x BTS

Location Update

- Called registration
- Initiated by MS:
  - BTSs broadcast their LA address to the MS
  - If LA AD is different from the one with the MS, MS send a registration message to the network (signaling: Chapter 10)
  - Location information about the current LA of a MS is stored in HLR (permanent) and VLR (temporary)

GSM Mobility Databases

- Two main issues
  - Fault tolerance: Need for failure restoration procedures, especially for HLR
  - Database overflow: The VLR may overflow (MSs move “en masse” to its controlled area). Causes failure of registration, i.e., the user cannot be provided service (VLR overflow)

GSM Basic Location Update

- Location update procedures handle:
  - Inter-LA movements
  - Inter-MSC movements
  - Inter-VLR movements (no overflow is considered for the moment)
- MS cannot distinguish between types of movement (same format of messages)

Inter-LA Movements

- MS moves from LA1 to LA2 (Figure 11.2)
- Nine message exchanges between MS and MSC + ten between MSC and VLR (GSM 4.08)
- Four major steps

Inter LA: Step 1

- MS requires a location update (LU) to MSC via BTS
- Message includes: current LA address, MSC and VLR (last two are the same) + MS TMSI (temporary mobile system identity)

Inter-LA: Step 2

- MSC forward the LU request to VLR via a TCAP message (signaling, SS7)
- TCAP includes
  - Address of the MSC
  - TMSI of the MS
  - Previous LA identification (LAI)
  - Target LAI
  - +

Inter LA: Steps 3 and 4

- VLR notices that LA1 and LA2 belong to the same MSC
- VLR updates the temporary LAI entry for MS
- VLR acknowledges the MS via the MSC

Inter-MSC Movements

- The two LAs belongs to two different MSCs of the same VLR (Figure 11.3)
- Six steps procedure
- Step 1 and 2: The LU request is sent by the MS to the network as for the Inter-LA movement case

Inter-MSC: Step 3

- VLR notices that LA1 belongs to MSC1 and that LA2 belongs to MSC2 ≠ MSC1
- VLR updates the LAI and MSC field of the MS record and derive the HLR address from its recorded IMSI
- VLR sends a message to HLR that includes IMSI of MS, address of MSC2, address of VLR, +

Inter-MSC: Steps 4, 5 and 6

- Step 4
  - HLR identifies MS (via IMSI)
  - MS record is updated (new MSC)
  - Ack is sent to VLR
- Steps 5 and 6
  - Ack is sent to MS

Inter-VLR Movements

- The two LAs belongs to MSCs connected to different VLRs (Figure 11.4)
- Without considering authentication, we have a 8 step procedure
- Step 1: LU request is sent from MS to VLR2 (as for Inter-LA movements)

Inter-VLR: Steps 2 and 3

- VLR2 does not have an entry for MS (the IMSI of the MS is not known)
- The LU request contains the address of VLR1
- VLR2 sends a message to VLR1 with the received TSMI
- VLR1 sends IMSI of MS to VLR2 (difference with IS-41 where IMSI is sent over the air)

Inter-VLR: Steps 4 and 5

- VLR2 creates a record for MS
- Sends a registration message to HLR (step 3 of Inter-MSC case)
- HLR updates record of MS, included the entry for the new VLR
- HLR sends an ack back to VLR2

Inter-VLR: Steps 6, 7 and 8

- Step 6: VLR2 generates a new TMSI and sends it to the MS
  - In GSM the TMSI is changed periodically to avoid fraudulent use
- Steps 7 and 8: The obsolete record of the MS in VLR1 is deleted

Basic Call Origination

- Call origination is a four steps process (Figure 11.5)
- Step 1: MS sends a call origination request to MSC
- Step 2: MSC forwards the request to VLR (signaling)
- Step 3: VLR checks the "u1"'s profile and messages the MSC to grant the call request
- Step 4: The MSC sets up the trunk (PSTN call setup procedure)

Basic Call Termination, CT

- Call termination to a GSM subscriber is a six steps process (Figure 11.6) that requires routing information from the serving VLR
- Step 1: When the MS ISDN number (MSISDN) is dialed by a PSTN user, call is routed to a GMSC by SS7

CT, Steps 2 and 3

- Step 2: GMSC interrogates HLR for routing information
- Message includes MSISDN +
- Step 3: HLR asks the VLR for the MS roaming number (MSRN)
- Message include IMSI, MSC number +
- The MSC number is updated by the Inter-MSC and Inter-VLR procedure and it is needed for setting up the trunk

CT, Steps 4, 5 and 6

- Step 4: VLR creates MSRN by using the MSC number stored with the MS information
- Step 5: MSRN is sent to GMSC via HLR
- Step 6: MSRN provides address of MS's MSC
- SS7 message is sent by the GMSC to the MS's MSC to set up the trunk

Assignments

- Read chapters 10 and 11 of the textbook
- Updated information on the class web page:

  www.ece.neu.edu/courses/eceg364/2004sp