Handover

in

Mobile systems

Agenda

- Introduction
- Handover theory
- GSM Handover
- UMTS Handover
- Inter RAT Handover
- Handover and performance

Introduction

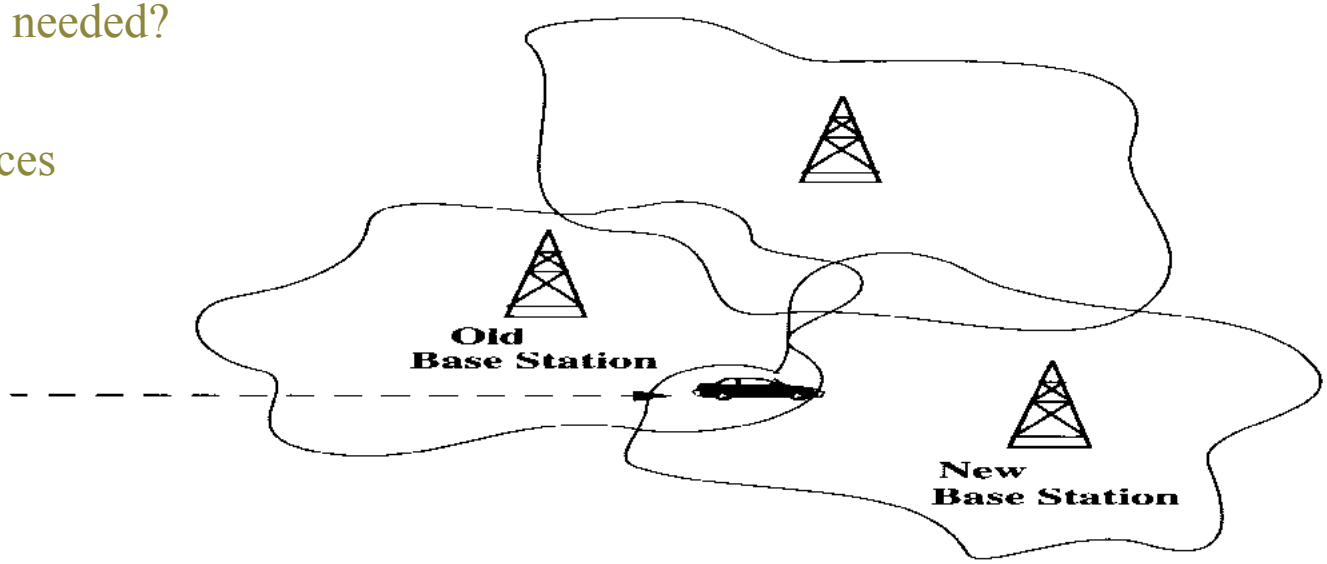
What is Handover (Handoff)?

- Changing the point of connection while communicating
- In another words:

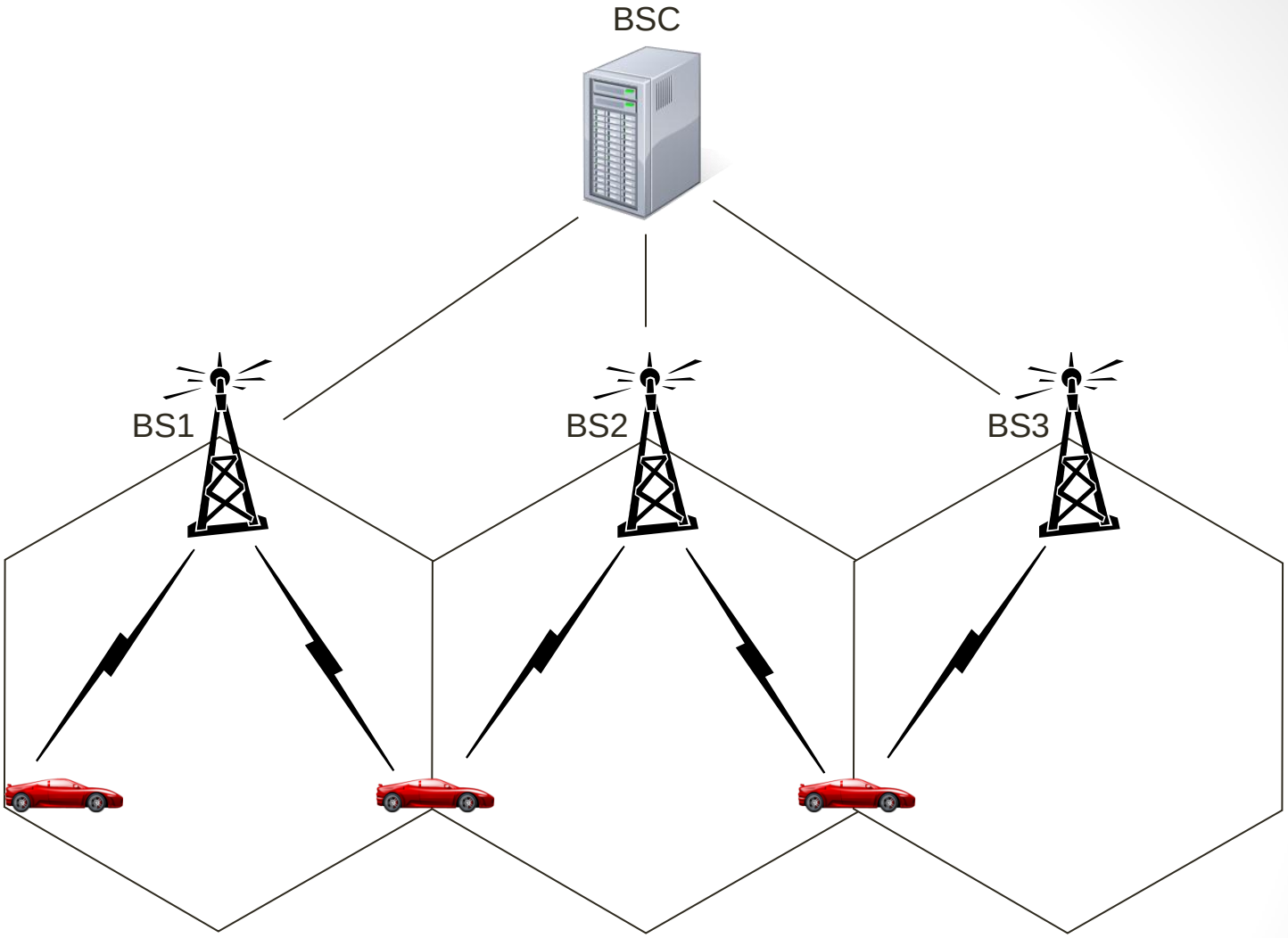
  When a mobile user travels from one area of coverage or cell to another cell within a call's duration the call should be transferred to the new cell's *base station*

Why handover is needed?

- Mobility
- User preferences



Introduction – Use Case 1



4. Conversation ended – still within BS3's coverage

Handover

- When will a handoff occur?
  - Initiated when received signal level drops below a certain threshold value.
  - Not as simple as it seems
  - Actually consider a time average of the received signal instead of the instantaneous level.

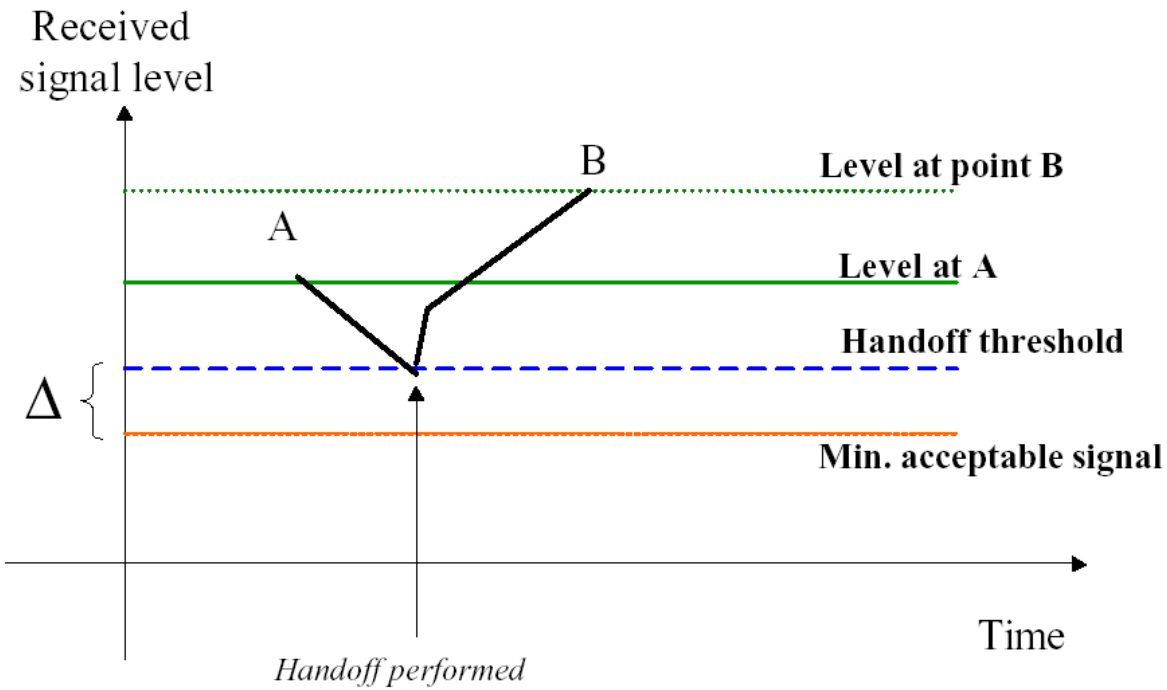
Handover Theory

- Define
  - P_{MIN_USABLE} as the minimum usable signal level
  - $P_{HANDOFF}$ as the threshold received signal level at which a handoff will be initiated
  - $\Delta = P_{HANDOFF} - P_{MIN_USABLE}$

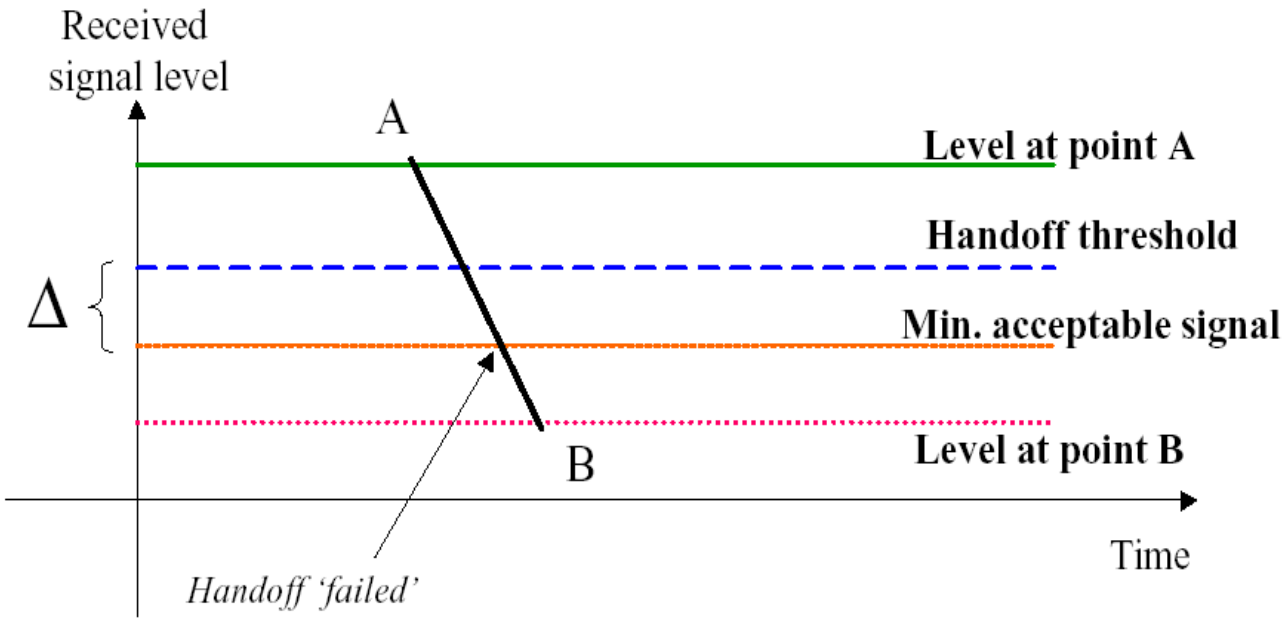
Handover

- Must optimize Δ.
  - Too large => too many handoffs
  - Too small => too many lost calls
- Value of Δ depends on
  - Environment
  - Expected mobile speeds
  - Time required to perform a handoff

Handover- Successful

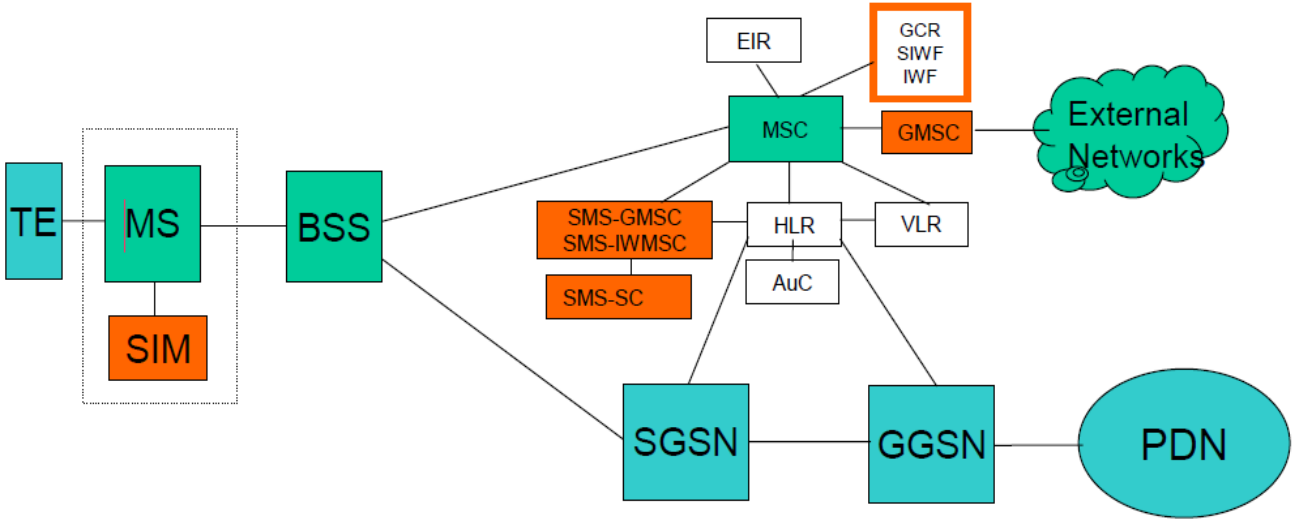


Handover- Unsuccessful



Handover in GSM

GSM/GPRS reference model

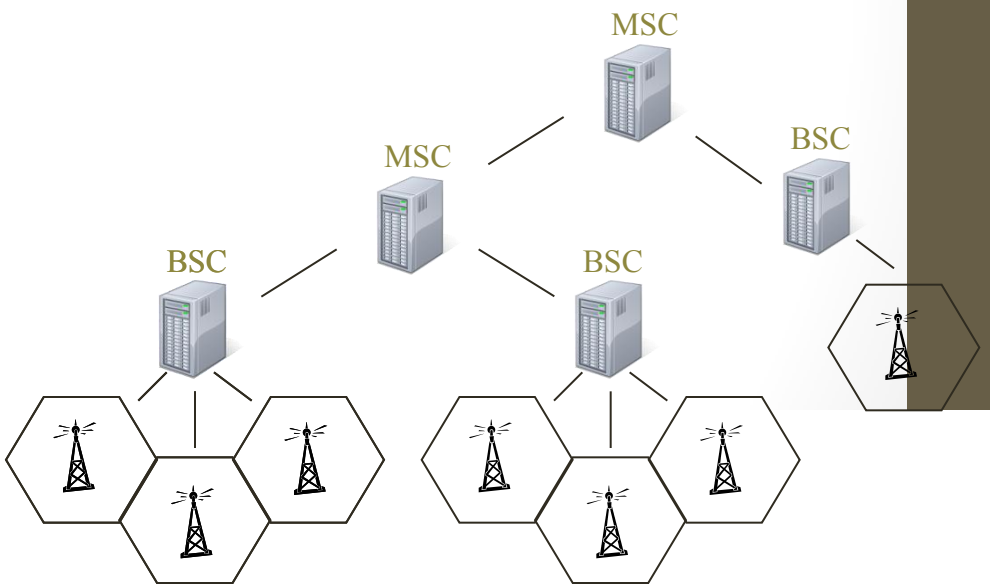


- TE – Terminal Equipment
- PDN – Public Data Network
- SGSN – Serving GPRS Support Node
- GGSN – Gateway GPRS support Node

Handover in GSM

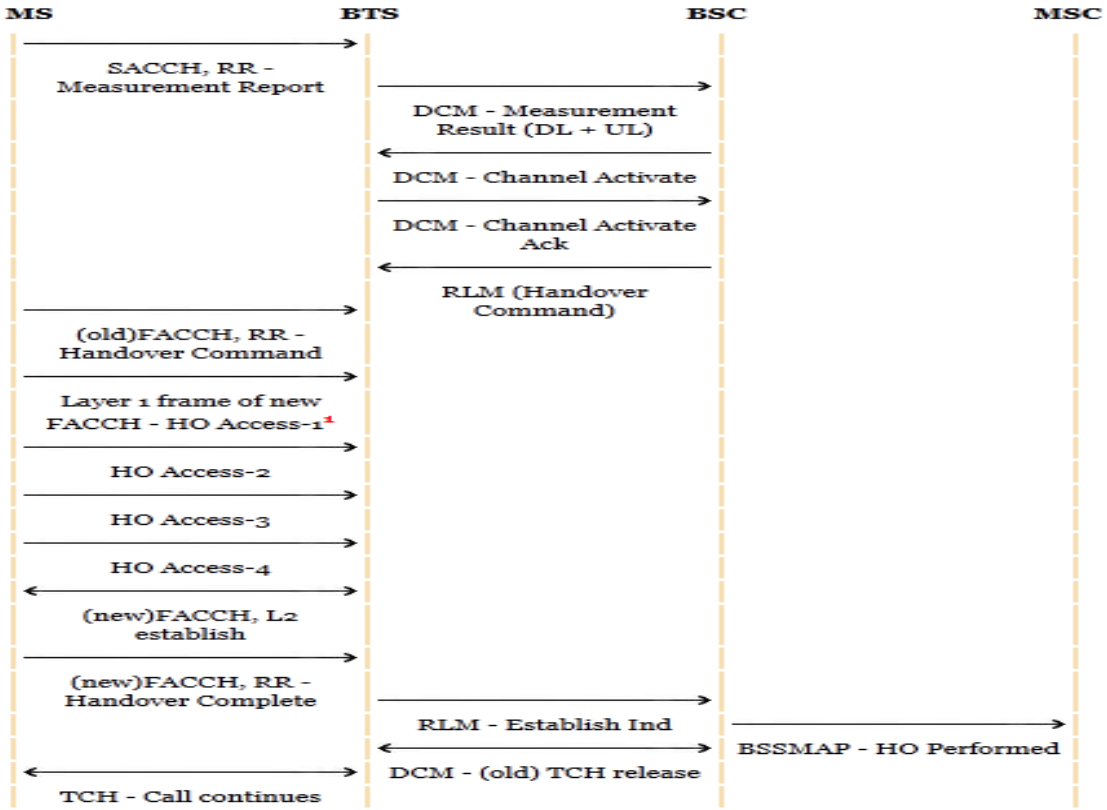
- Network-controlled, mobile terminal assisted handover
  - The network takes the handover decisions
  - The mobile terminal supervises and reports its signal quality

- Four types of handover
  - Intra BTS handover
  - Intra-BSC handover
  - Inter-BSC handover
  - Inter-MSC handover



Intra BTS Handover

- The ME remains attached to the BTS transciever.
- Changing just the frequency or the slot used by the ME

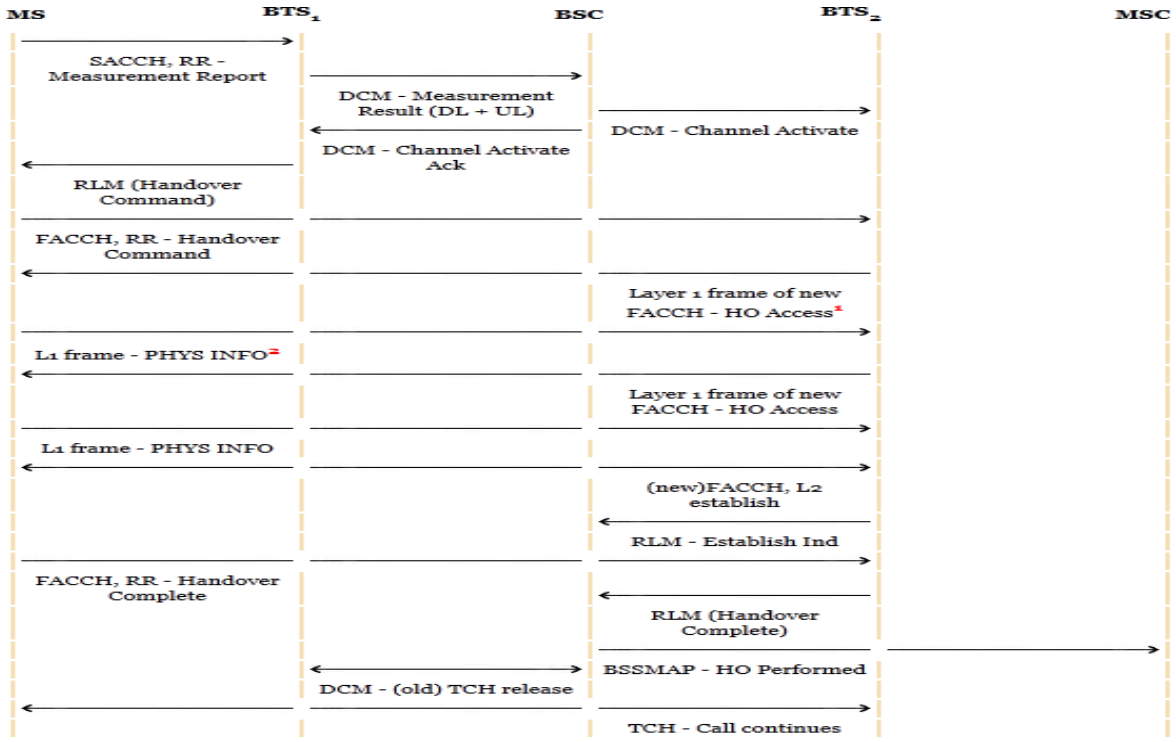


1: HO Access sent four times (indicating synchronised HO)

References: GSM Networks book by Heine, GSM book by Mouly and Pautet,

Intra BSC Handover

- Or named as Inter BTS Handover
- Occures when moving from one BTS coverage area into another BTS
- Both BTS are controlled by the same BSC
- The BSC assigns the new channel and slot for the ME.



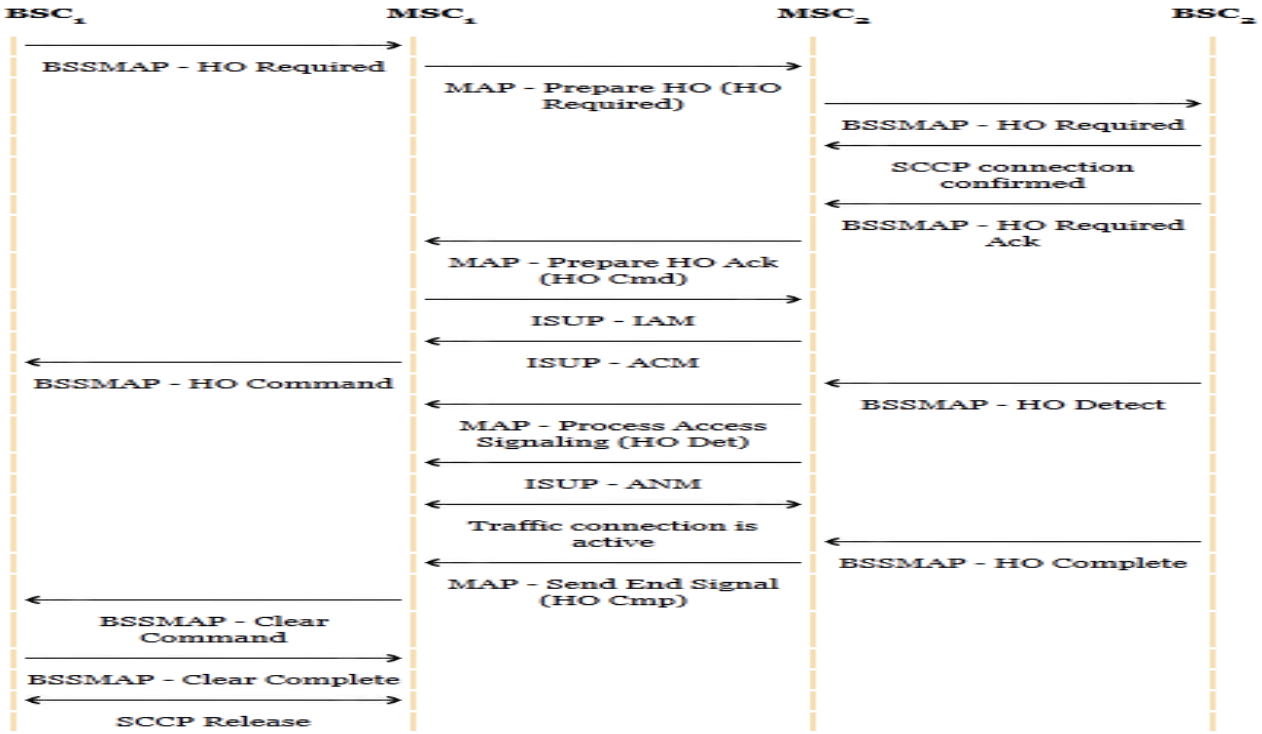
1: MS keep sending HO Access till it is not able to receive PHYS INFO
2: BTS keep sending PHYS INFO till MS does not start L2 establishment.

Inter BSC Handover

- Occures when moving from one BTS coverage area into another BTS.
- Both BTS are controlled by **different** BSC.
- This Handover is manged by the MSC

Inter MSC Handover

- Occures when moving from one BTS coverage area into another BTS.
- Both BTS are controlled by **different** BSC.
- Both BSC are controlled by **different** MSC.
- The two MSC negotiate to handle the handover.



Handover in UMTS

For purely inter W-CDMA technology, there are three basic types of handover:

- Hard Handover
- Soft Handover
- Softer Handover

Hard Handover

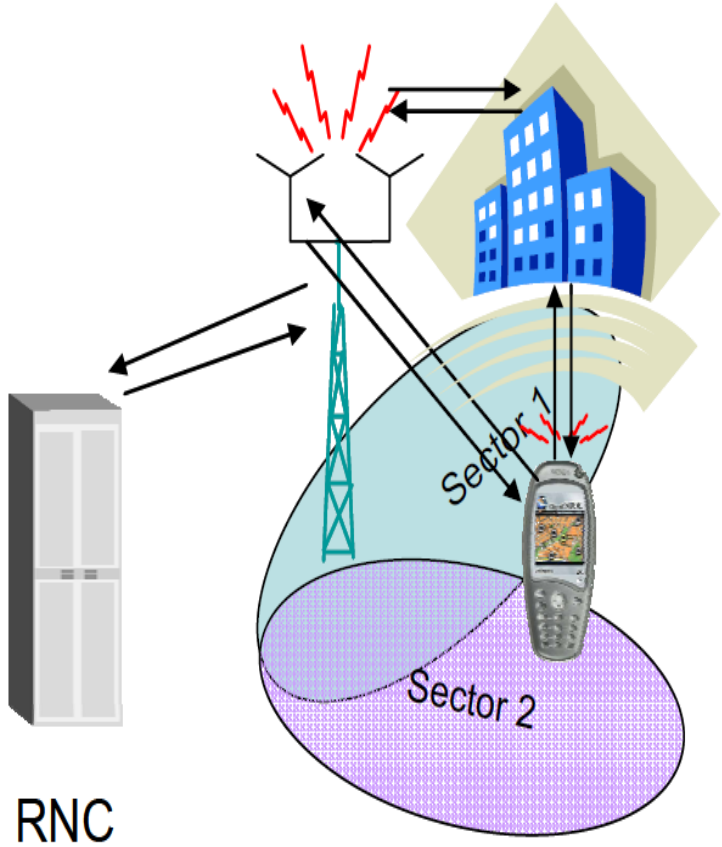
- Break Before Make
- The network decides a handover is required dependent upon the signal strengths of the existing link, and the strengths of broadcast channels of adjacent cells.
- The link between the existing NodeB and the UE is broken.
- A new link is established between the new NodeB and the UE.

Soft Handover

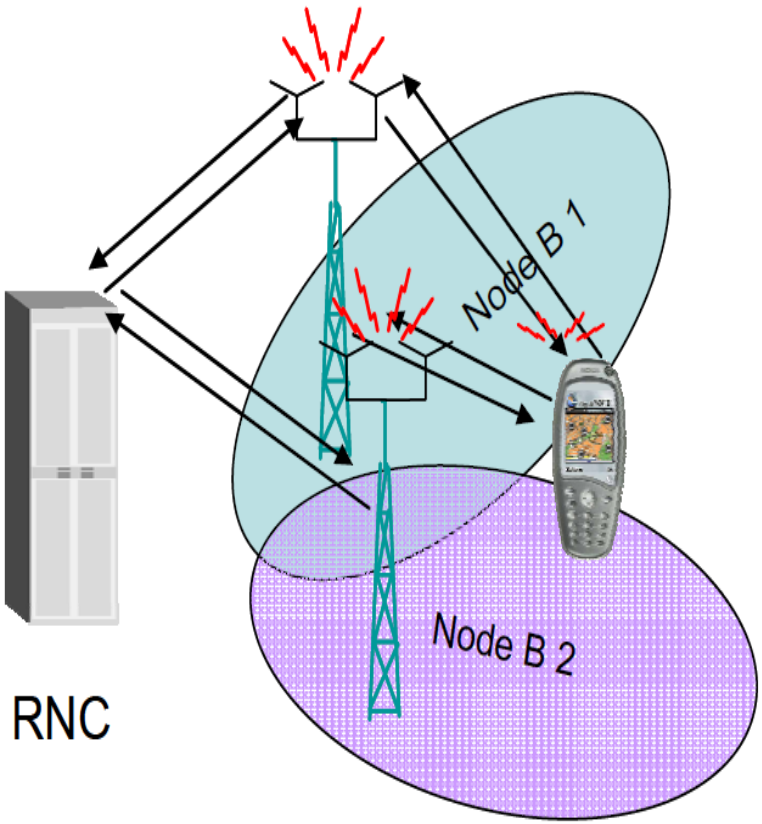
- Occures when the ME is moving in the overlaping coverage area.
- The ME communicate and recieve the signals from the NodeB's which their signals are overlaping.
- The rake reciever is needed in the UE (ME) to combine the two signals
- In the uplink , the best quality frame of the two signals is selected. The selection is made by the outer loop power control algorithm measurment.
- Negatives: It need to indicate rescources(capacity) on both NodeBs

Softer Handover

- Softer handover is a special case of soft handover where the radio links that are added and removed belong to the same Node B.
- In softer Handover , the NodeB can receive the signal in macro diversity with maximum ratio combining.
- In soft handover macro diversity with selection combining is selected.



Softer Handover



Soft Handover

Handover between GSM-WCDMA

- Limited UMTS coverage
- UMTS network busy whereas spare capacity is available on GSM network

- Two types of Inter RAT handover:

  1-GSM to UMTS

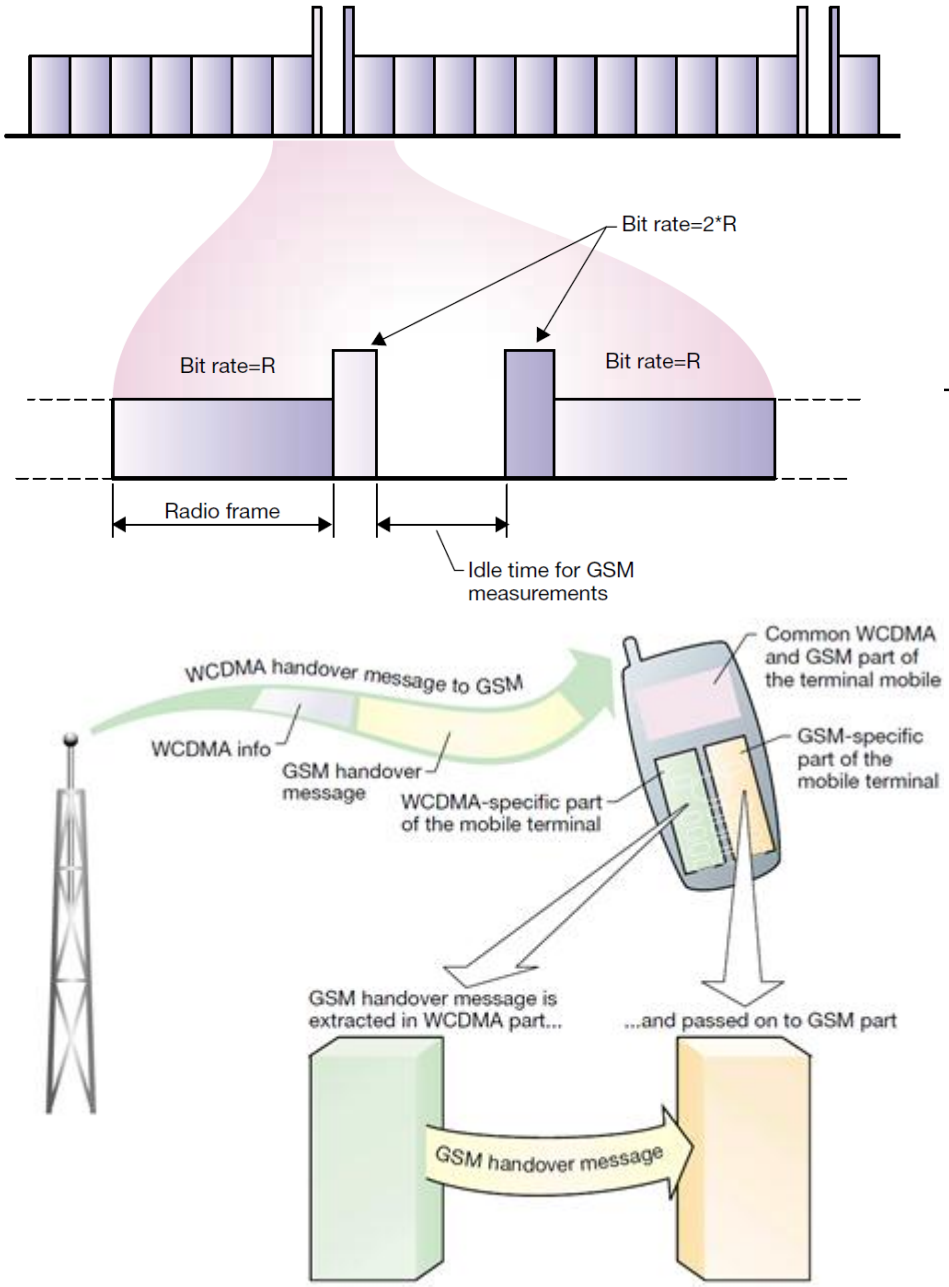
  2-UMTS to GSM

UMTS to GSM handover

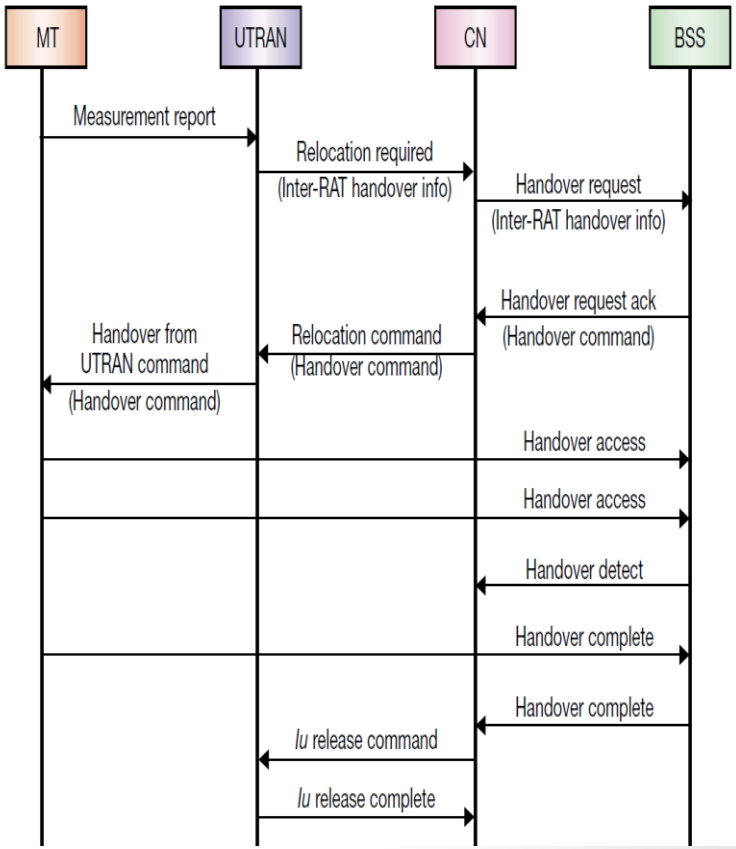
1- Compressed mode handover: Using compressed mode handover the UE uses the gaps in transmission that occur to analyse the reception of local GSM base stations. The UE uses the neighbour list provided by the UMTS network to monitor and select a suitable candidate base station. Having selected a suitable base station the handover takes place, but without any time synchronisation having occurred.

2- Blind handover: This form of handover occurs when the base station hands off the UE by passing it the details of the new cell to the UE without linking to it and setting the timing, etc of the mobile for the new cell. In this mode, the network selects what it believes to be the optimum GSM based station. The UE first locates the broadcast channel of the new cell, gains timing synchronisation and then carries out non-synchronised intercell handover.

Figure 2
Compressed mode creates gaps or idle spaces in time that WCDMA mobile terminals use to perform measurements on GSM cells.

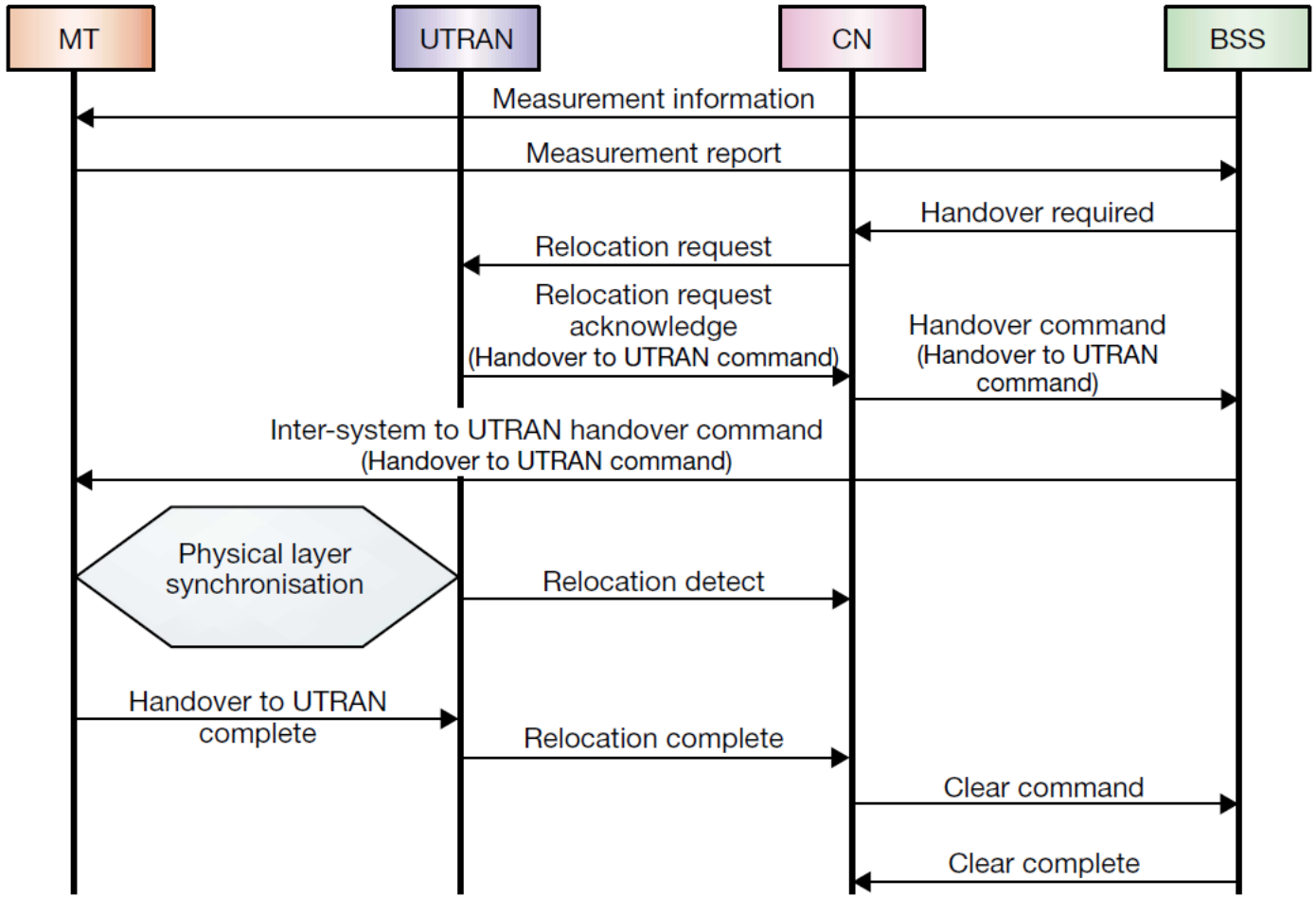


Handover from WCDMA to GSM.



GSM to UMTS

- ***Handover from GSM to UMTS :*** This form of handover is supported within GSM and a "neighbour list" was established to enable this occur easily. As the GSM / 2G network is normally more extensive than the 3G network, this type of handover does not normally occur when the UE leaves a coverage area and must quickly find a new base station to maintain contact. The handover from GSM to UMTS occurs to provide an improvement in performance and can normally take place only when the conditions are right. The neighbour list will inform the UE when this may happen.



Handover from GSM to WCDMA.

Handoff and performance

- Handoffs are expensive to execute, so unnecessary handoffs should be avoided.
- If the handoff criteria are not chosen appropriately, then in the overlapping region between the two BS coverage area boundaries, the call might be handed back and forth several times between them.
- If the criteria are too conservative, then the call may be lost before the handoff can take place.
- The handoff **decision-making criteria** become even more critical with the evolution to smaller cell sizes, which is happening to increase the capacity of systems and to reduce power requirements of MSs.
- Unreliable and inefficient handoff procedures will reduce the quality and reliability of the system.

Handoff Failures

- The reason of handoff failures
  - No channel is available on selected BS.
  - Handoff is denied by the network for reasons such as **lack of resources**. For example, no bridge or no suitable channel card; the MS has exceeded some limit on the number of handoffs that may be attempted in some period of time.
  - It takes the network too long to set up the handoff after it has been initiated.
  - The target link fails in some way during the execution of handoff.

Q&A

Thank You