



Wireless and Mobile Network Architecture



Chapter 4: Handoff Management Radio Link Transfer

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Outline

- Introduction
- Link Transfer Types
- Hard Handoff
- Soft Handoff
- Summary



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Introduction

- This chapter identifies a link transfer procedure as either *hard handoff-oriented* or *soft handoff oriented*
- **Hard handoff**
 - MS connects with only one BS at a time
 - A short period of interruption during handoff
 - Be used in TDMA and FDMA system



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Cont.

- **Soft handoff**
 - MS receives/transmits the same signals from/to multiple BSs simultaneously
 - More complicated than hard handoff
- Mobile-controlled handoff (**MCHO**)
- Network-controlled handoff (**NCHO**)
- Mobile-assisted handoff (**MAHO**)



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4.1 Link Transfer Types

Some operations must take place for a link transfer:

- The radio link must be transferred from the old BS to the new BS
- **Bridge** the link to the new BS into the existing call
- Drop the link to the old BS



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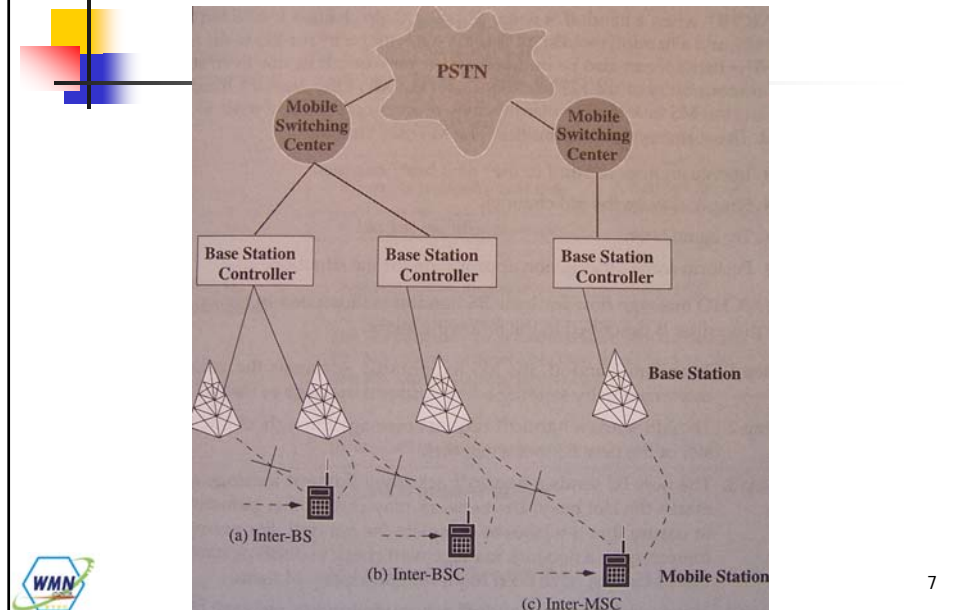
Link Transfer Types

- **Intracell handoff**
 - Perform between **two time slots** or **channel** in the same BS
 - In TDMA system, also called time slot transfer(TST)
- **Intercell handoff** or **Inter-BS handoff**
 - Fig. 4.1(a)
- **Inter-BSC handoff**
 - Fig. 4.1(b)



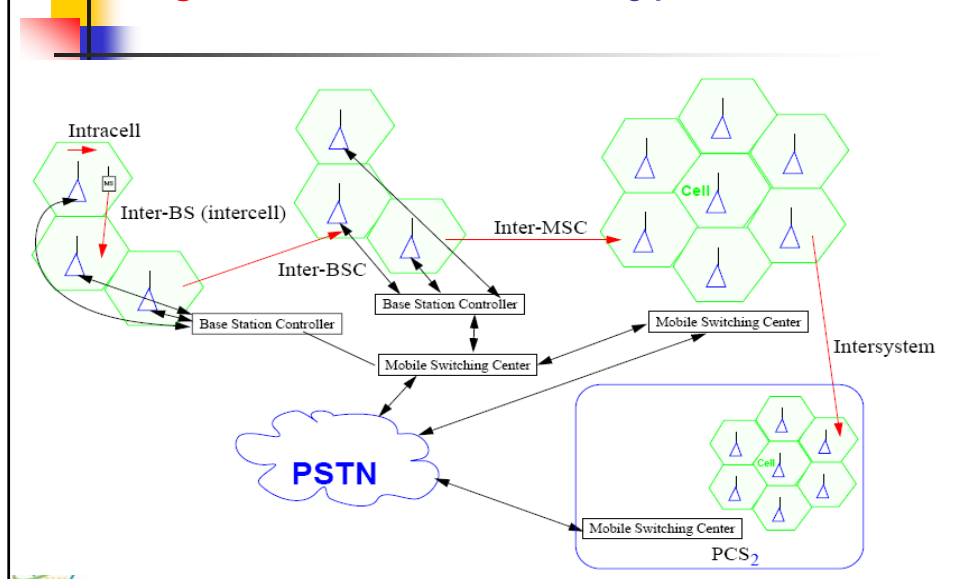
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Fig. 4.1 Link Transfer Types



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Fig. 4.1 Link Transfer Types





Cont.

- **Intersystem handoff or Inter-MSC handoff**
 - Fig. 4.1(c)
- **Intersystem handoff between two PCS networks**
 - Between two BSs connected to different MSCs homing to different PCS networks



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4.2 Hard Handoff

- Hard handoff
 - MCHO Link Transfer
 - MAHO/NCHO Link Transfer
 - Subrating MCHO Link Transfer



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MCHO Link Transfer

- A new radio channel is selected by the MS
- A **handoff request message** is transmitted by the MS to the new BS (Initiated by the MS)
- When handoff failure, the MS may choose to
 - Initiate another handoff to the next best channel
 - Simply stay on the old channel
 - Try again later
 - Perform some other action appropriate for the situation



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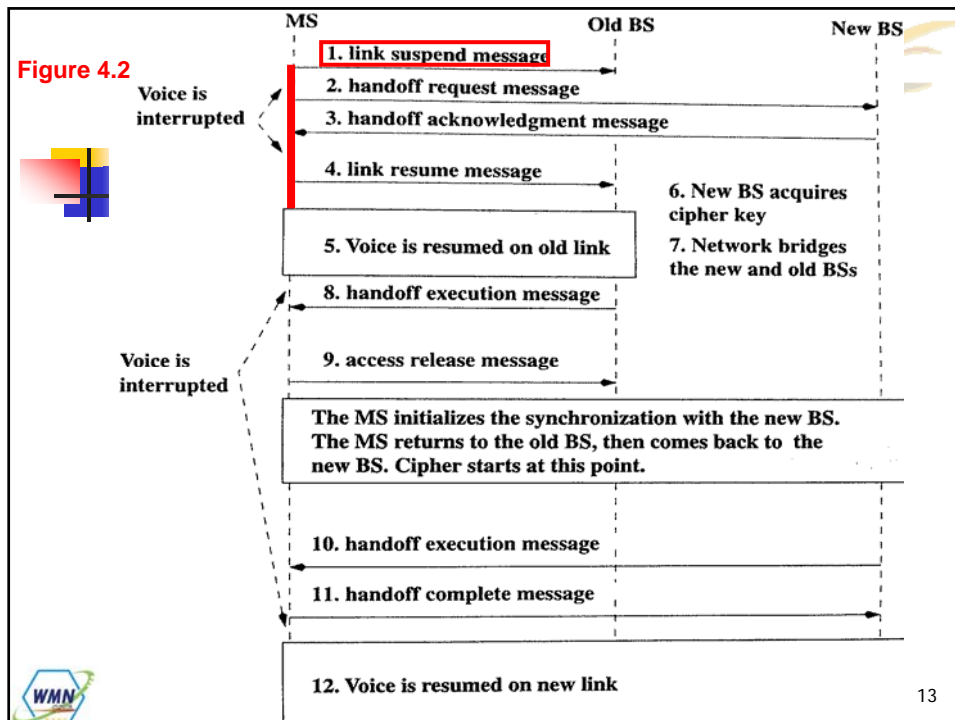


MCHO Link Transfer(Fig. 4.2)

- **Step 1.** To initiate handoff
 - The MS temporarily suspends the voice conversation by sending a **link suspends message** to the old BS
- **Step 2.** The MS sends a **handoff request message** through an idle time slot of the new BS to the network
- **Step 3.** The new BS sends a **handoff acknowledgment message** and marks the slot busy



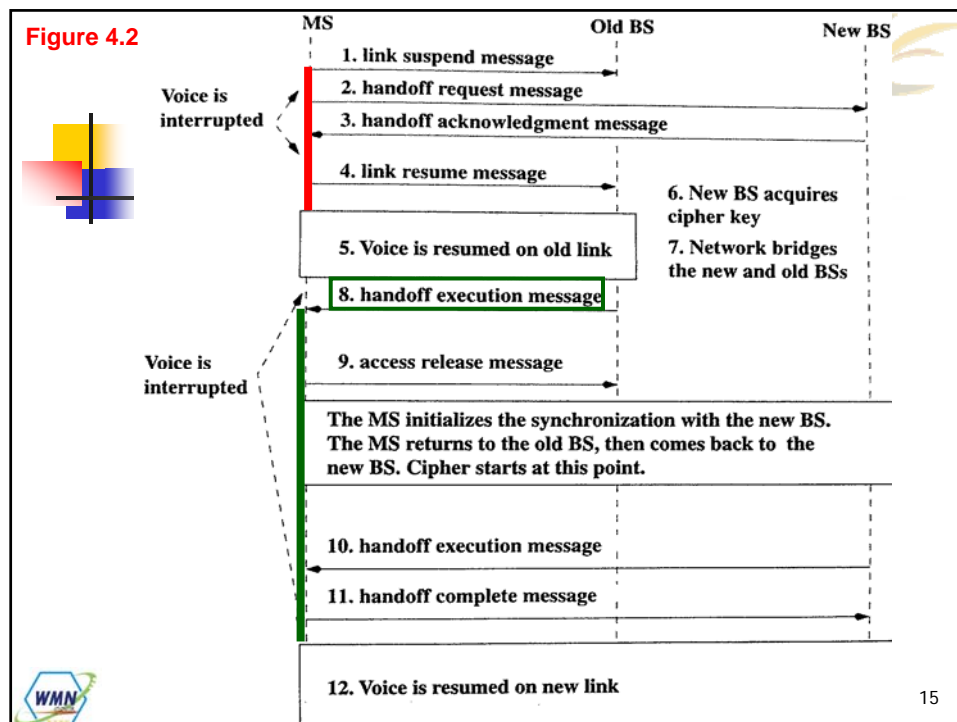
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Cont.

- **Step 4.** MS returns to the old assigned channel by sending a **link resume message** to the old BS
- **Step 5.** MS continues voice communication while the network prepares for the handoff
- **Step 6.** The new BS check this call
 - If it is an **intra-BS handoff**, the new BS sends a **handoff acknowledge message** and reconfigures itself to effect the handoff.
 - If it is an **inter-BS handoff**, the new BS acquires the **cipher key** from the old BS through the MSC

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Cont.

- **Step 7.** The MSC insert a **bridge** into the conversation path and bridges in the new BS
- **Step 8.** and **10.** The networks informs the MS to execute the handoff by sending **handoff execution message**
- **Step 9.** The MS releases the old channel by sending an **access release message** to the old BS

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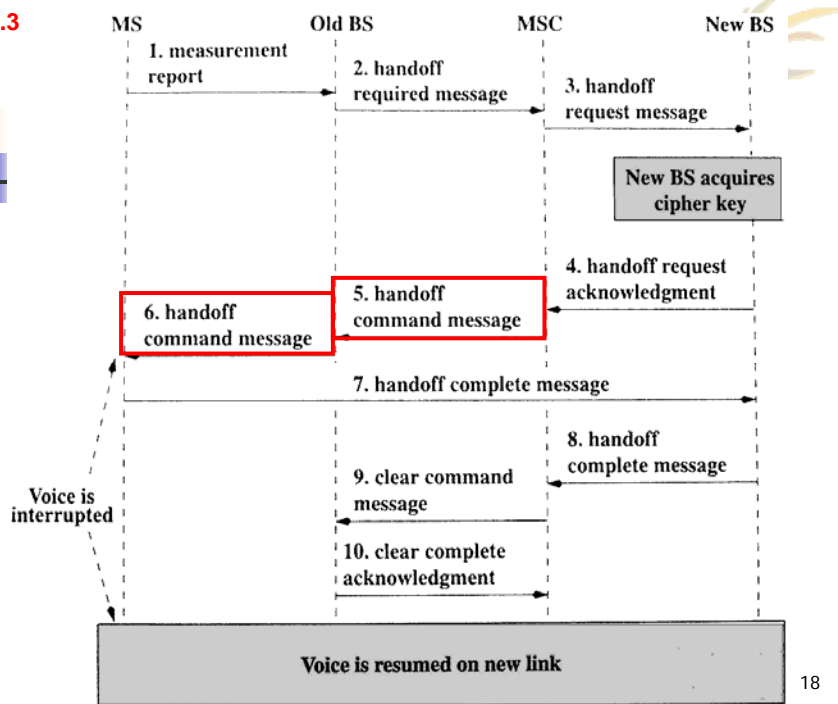
MAHO/NCHO Link Transfer(Fig. 4.3)

- **Step 1.** The MS transmits the radio link **measurement report** to the old BS
- **Step 2.** When handoff is required, the old BS sends a **handoff required message** to the MSC
- **Step 3.** The MSC sends **handoff require message** to the new BS that supplied by old BS



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Figure 4.3



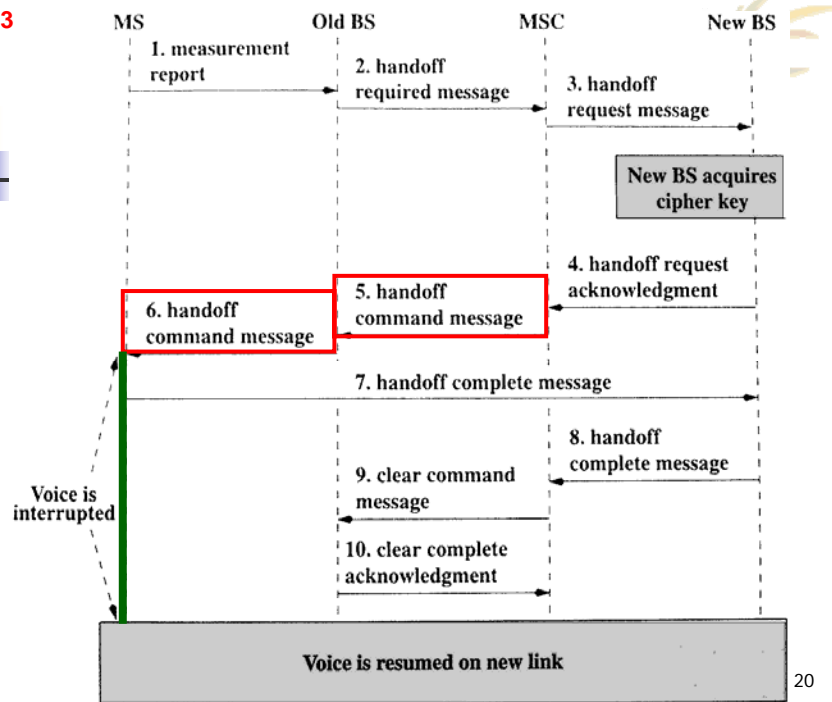
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Cont.

- **Step 4. and 5.** The MSC sends the **handoff command message** with information regarding the new BS and RF channel to the old BS
- **Step 6.** The old BS commands the MS to transfer the link to new BS

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Figure 4.3



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Cont.

- **Step 7.** The MS **tunes to new RF channel** and sends **handoff complete message** to the **new BS**
- **Step 8. and 9.** The MSC clears the link to the old BS by the **clear command message**
- **Step 10.** The handoff procedure is complete when the old BS acknowledges the clear command message



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Subrating MCHO Link Transfer

- The procedure of subrating a full-rate channel into subrated channels for a handoff request consists of three parts:
 - Requesting the handoff
 - Subrating an existing call
 - Assigning the newly created subrated channel to the MS requesting the handoff

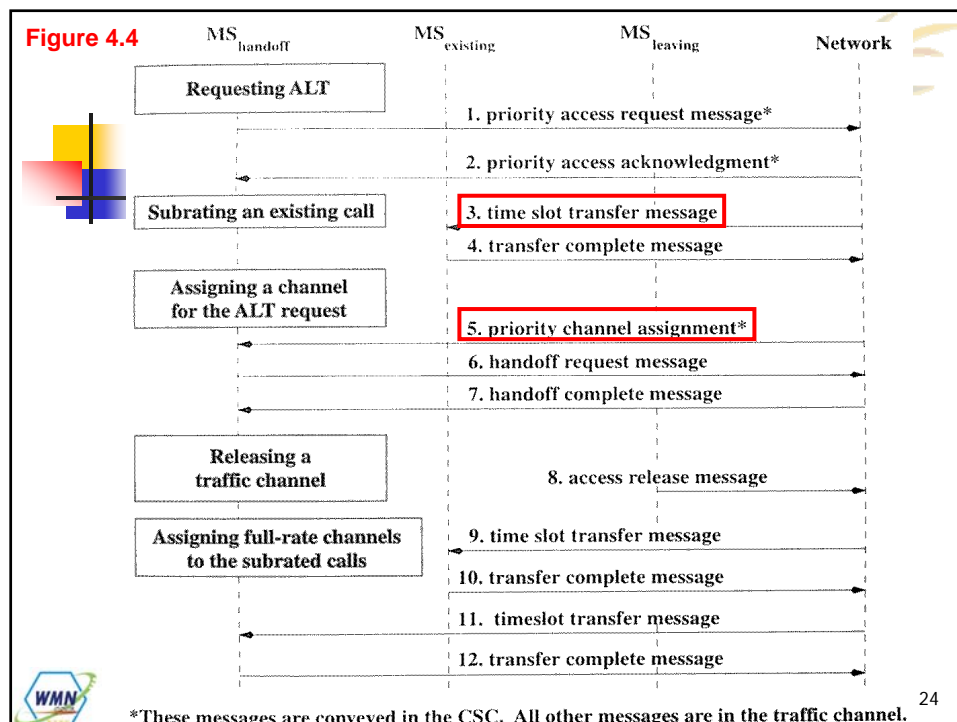


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Subrating MCHO Link Transfer (Fig. 4.4)

- **Step 1.** When $MS_{handoff}$ detects need to handoff
 - If an idle channel is found, the **link transfer follow the MCHO procedure**
 - If no traffic channels are available, the MS synchronizes to a common signaling channel (CSC) and transmit a **priority access message**
- **Step 2.**
 - The new BS responds **priority channel assignment message** or **priority access acknowledge message**.
 - The MS must continue to monitor the CSC for a **priority channel assignment message**

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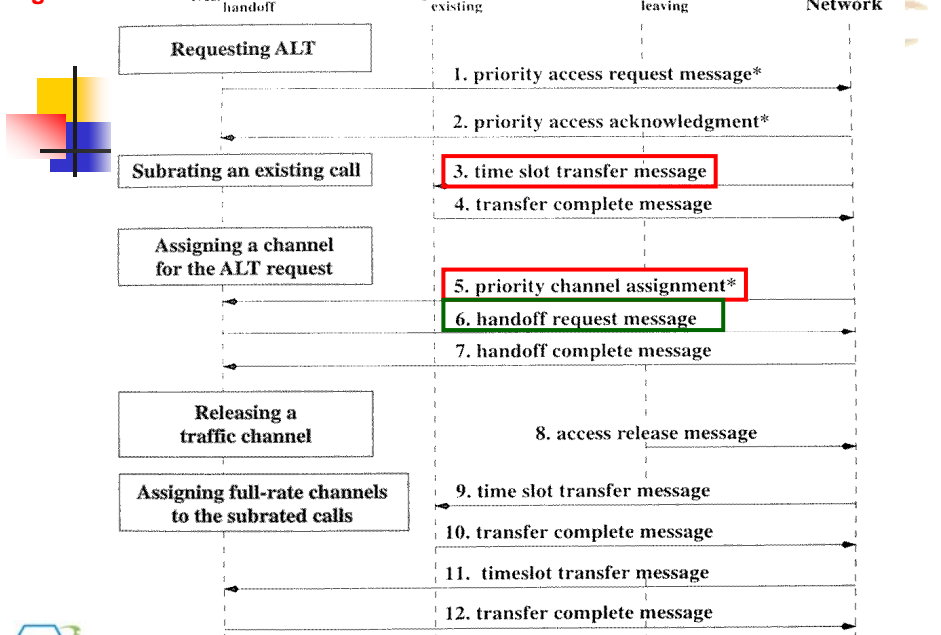
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Cont.

- **Step 3. and 4.** An existing caller, $MS_{existing}$, receives a **time slot transfer message** and frees up a subrated channel.
- **Step 5.** The $MS_{handoff}$ is informed of newly available subrated traffic channel via the **priority channel assignment message**
- **Step 6. and 7.** The MS synchronizes to the available channel and transmits **handoff request message** and receives **handoff complete message** from network

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Figure 4.4



*These messages are conveyed in the CSC. All other messages are in the traffic channel.

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Cont.

- **Step 8.** The MS_{leaving} releases a channel
 - If this channel is full-rate channel, this channel is not made available for access this time, and two subrated channels are switched backed to full-rate channel
- **Step 9-12.** The released full-rare channel is assigned to either MS_{existing} or MS_{handoff} via **time slot transfer** and **transfer complete message**



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4.3 Soft Handoff

- Code division multiple access (CDMA) direct sequence spread spectrum technology
 - The information-bearing signal is multiplied with another digital signal that may carry a unique orthogonal code.
 - pseudo-noise sequence (PN sequence)
 - The mixed signal looks very similar to a noise signal, but contains the information signal embedded in its code
 - The mixing operation is called “spreading”



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CDMA

- To recover the information-bearing signal, the receiving end must use the same PN sequence to “despread” the mixed signal.
- The CDMA allows many users to share a common frequency/time channel for transmission
 - The user signal are distinguished by spreading them with different PN sequences.



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Soft Handoff

- An MS may simultaneously receive/send the same information from/to several BSs by CDMA scheme
- Two procedure within MAHO soft handoff,
Adding a new BS and **Drop a BS**



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Adding a New BS

- CDMA BSs transmit *pilot signals* that assist MSs to track/synchronize the BS downlink signal
- If the pilot signal strength of a surrounding BS, the new BS, exceed a threshold, the link between the MS and the new BS is established



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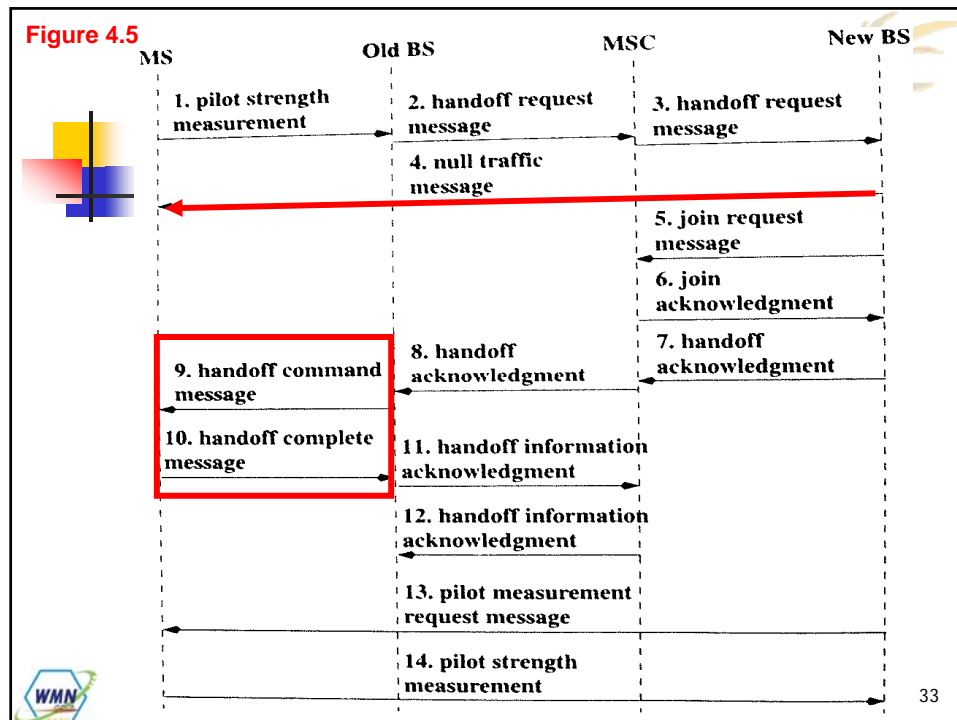


Adding a New BS (Fig. 4.5)

- **Step 1.** The MS sends a *pilot strength measurement* message to the old BS, indicating the new BS to be added
- **Step 2. and 3.** The old BS sends a *handoff request message* to the MSC. If the MSC accept the request, it sends the handoff request message to the new BS
- **Step 4.** The new BS sends a *null traffic message* to the MS to prepare the establishment of the communication link



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Cont.

- **Step 5. and 6.** The new BS sends a **join request message** to the MSC
- **Step 7-10.** The new BS sends a handoff acknowledge message to the old BS via MSC. The old BS indicate the MS to add a link to the new BS by exchanging **handoff command** and **handoff complete message**
- **Step 11-14.** The old BS and the MSC conclude this procedure by exchanging the required handoff information

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Dropping BS

- If the signal strength on the link between a BS and the MS falls below a predetermined threshold, the MS remove the BS



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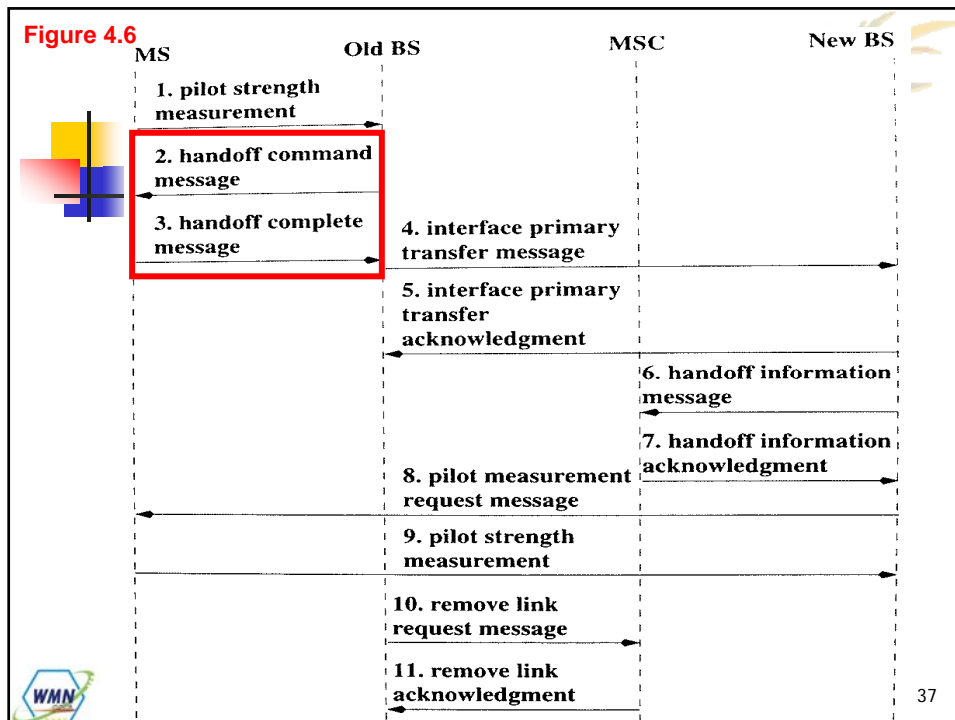


Dropping BS (Fig. 4.6)

- **Step 1-3.** The MS send a **pilot strength message** to the old BS to remove the BS with the failing link
- **Step 4. and 5.** The old BS sends the **call record information** to the new BS by exchanging the **interface primary transfer message** pair



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Cont.

- **Step 6-9.** The new BS and MSC exchanging the **handoff information message** pair to indicate the **failing link to be dropped**.
- **Step 10. and 11.** The MSC and old BS exchange the **remove link message** pair to remove the bridge between the new and the old BSs.



4.4 Summary

- PCS handoff management for inter-BS radio link transfer
- Hard handoff for MCHO, MAHO/NCHO, MCHO under TDMA system
- Soft handoff for MAHO under CDMA system

