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

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

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)

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

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)

Fig. 4.1 Link Transfer Types

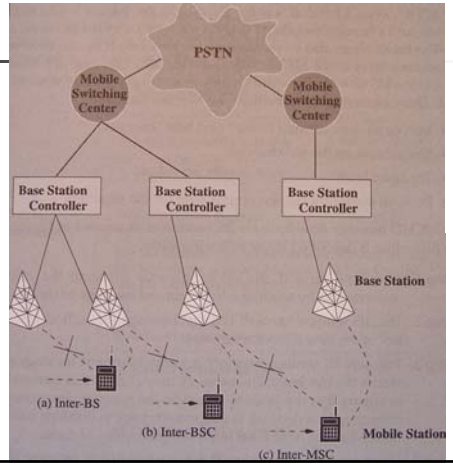
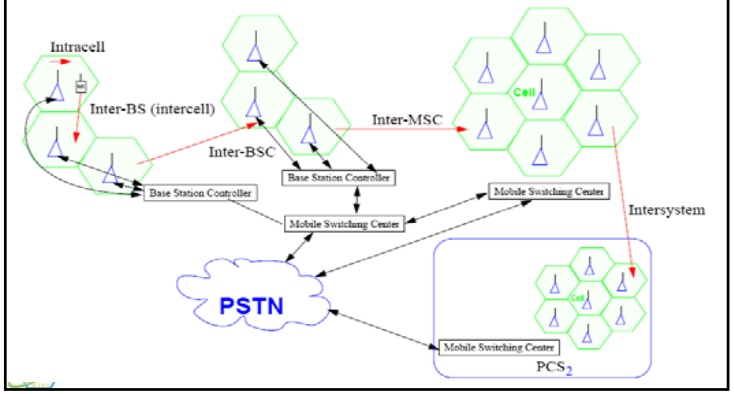


Fig. 4.1 Link Transfer Types



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- **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

4.2 **Hard Handoff**

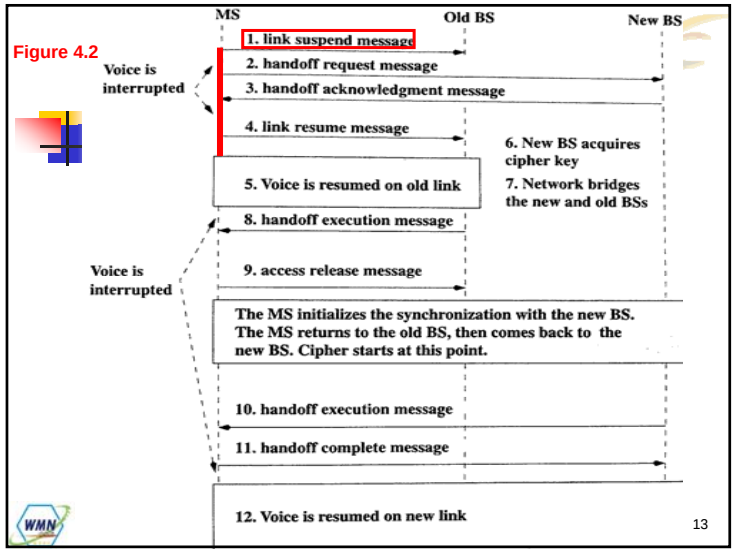
- Hard handoff
  - MCHO Link Transfer
  - MAHO/NCHO Link Transfer
  - Subrating MCHO Link Transfer

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 letter
  - Perform some other action appropriate for the situation

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



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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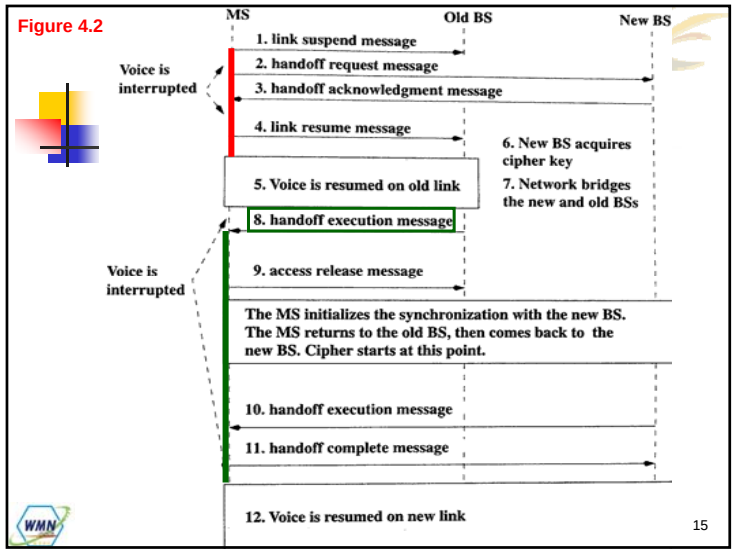

Cont.

- **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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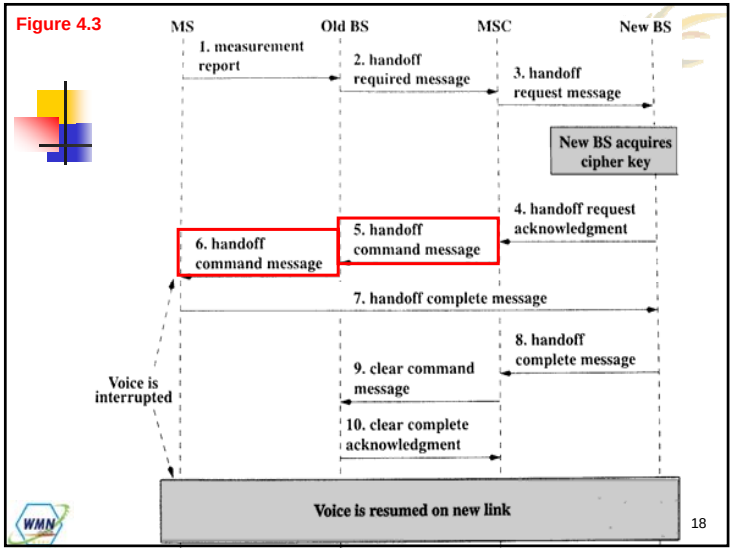
MAHO/NCHO Link Transfer(Fig. 4.3)

- **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

Figure 4.3



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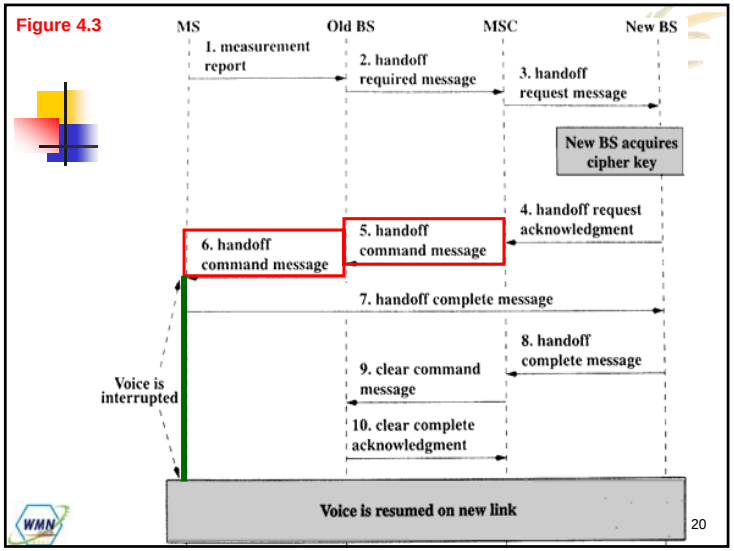
- **Step 4.** and **5.** The MSC sends the handoff command message with information regarding the new BS and RF channel to the old BS
- **Step 6.** The old BS commands the MS to transfer the link to new BS

Figure 4.3



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

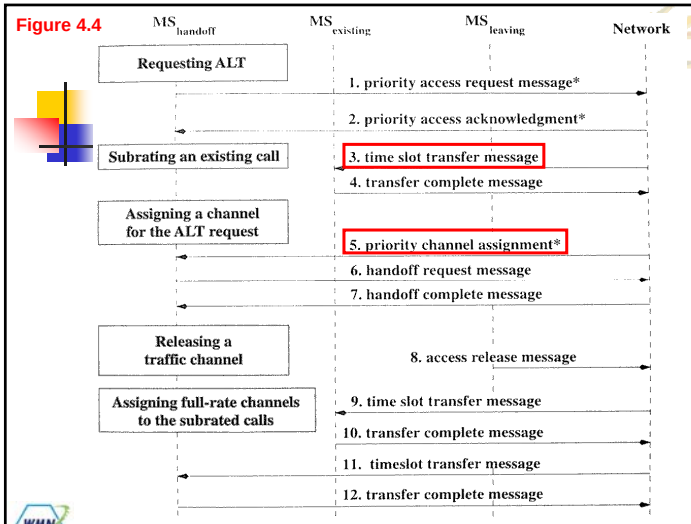
Subrating MCHO Link Transfer

- 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

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

Figure 4.4



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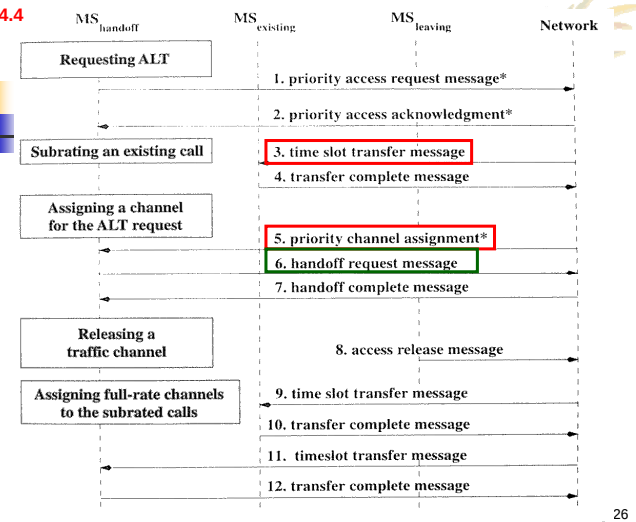
- **Step 3.** and **4.** An existing caller, $MS_{existing}$, receives a time slot transfer message and frees up a subrated channel.
- **Step 5.** The $MS_{handoff}$ is informed of newly available surated traffic channel via the priority channel assignment message
- **Step 6.** and **7.** The MS synchronizes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

Figure 4.4



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

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

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”

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.

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

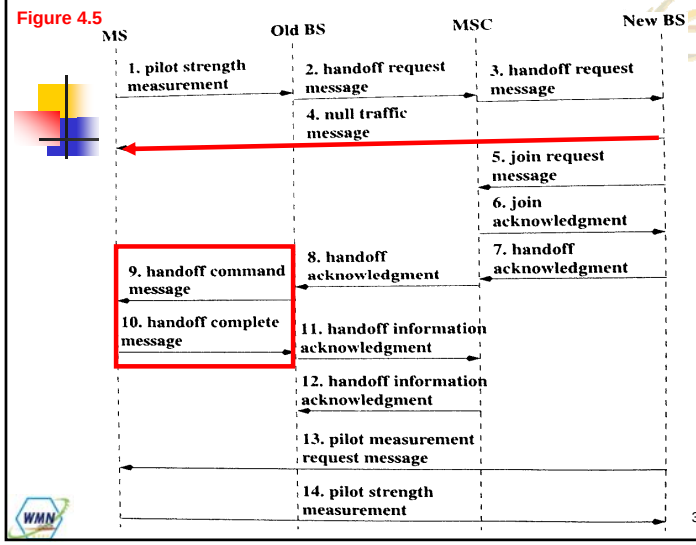
Adding a New BS

- 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

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

Figure 4.5



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- **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

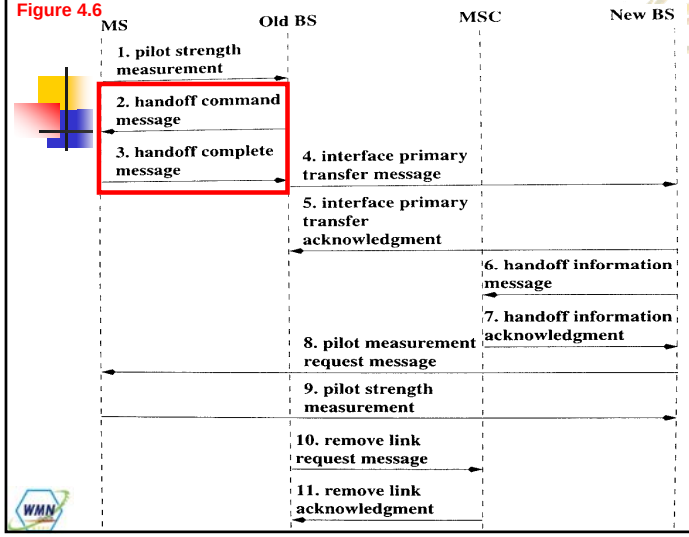
Dropping BS

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

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

Figure 4.6



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- **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