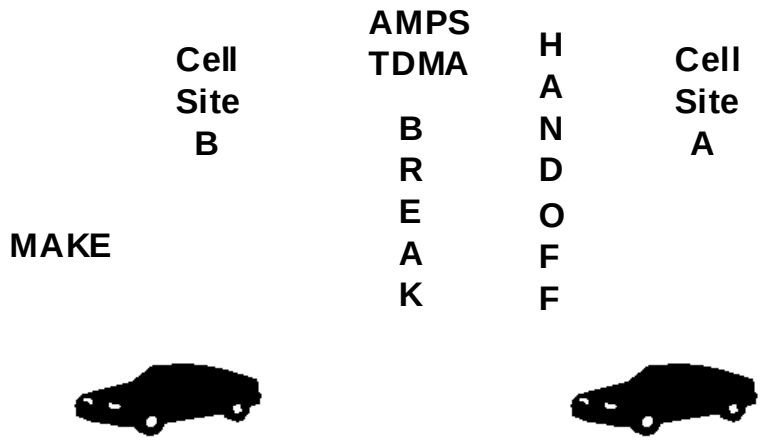
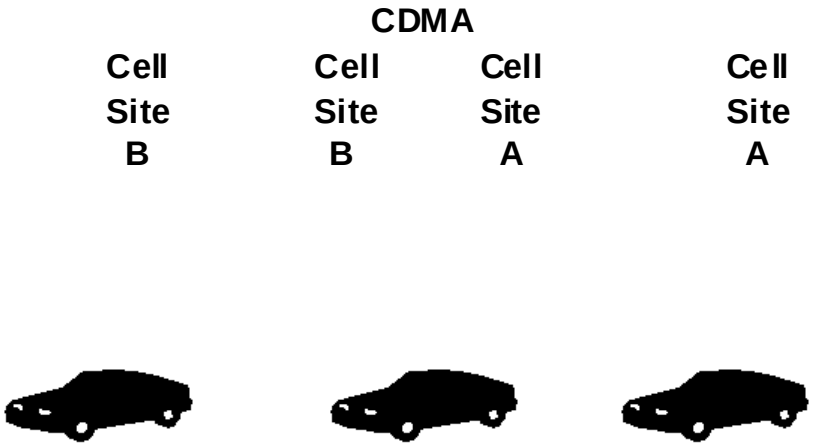
Handoffs

in CDMA

CDMA vs. AMPS/TDMA Handoffs

- AMPS/TDMA Handoffs
  - Break-before-make
  - AMPS takes approximately 200 ms
  - TDMA takes between 400-600 ms
  - Can diminish call quality
  - Increased chance of dropped calls
- CDMA Handoffs
  - Make-before-break
  - Directed by the mobile not the base station
  - Undetectable by user
  - Improvescall quality





Handoff Phases

- Handoff Initiation
  - AMPS handoff trigger is always initiated by the base station
  - TDMA handoff trigger is always initiated by the base station, but the mobile station may help in the process
  - CDMA trigger is always initiated by the mobile station
    - Pilot Strength Measurement Message (PSMM)
- Target Selection
  - AMPS/TDMA uses one or two (TDMA only) mechanisms
    - Location Receivers (LCRs) in neighboring base stations
    - TDMA can also do mobile measurements of neighboring control channels (MAHO)
  - CDMA currently uses one mechanism (MDHO)
    - Mobile measurement of neighboring pilot channels
- Handoff Completion
  - TDMA/AMPS voice path is always switched
  - CDMA voice path is broken only for hard handoff

CDMA Handoff

While in the Idle State

Idle Handoff

During a Call

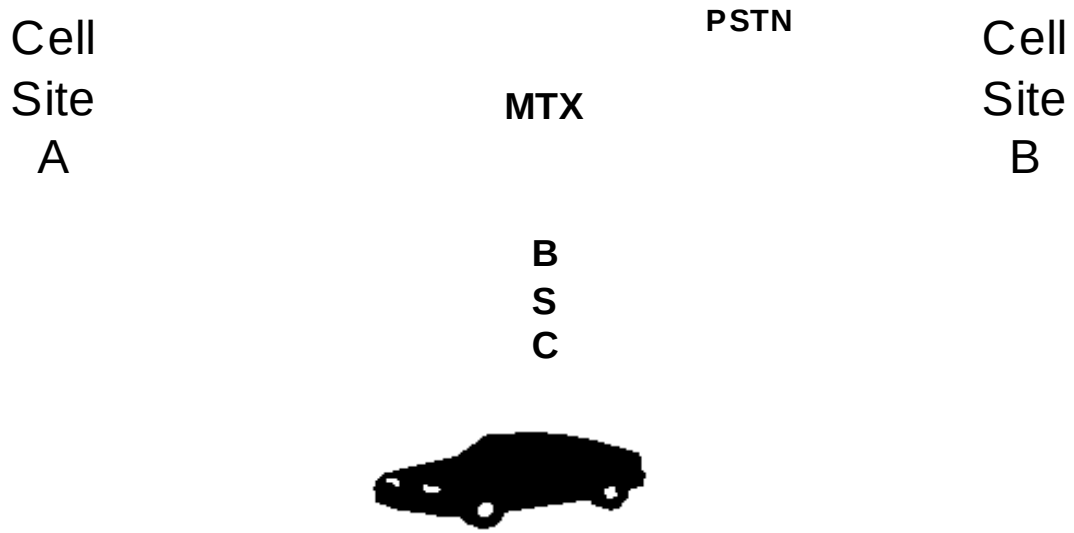
Soft Handoff

Softer Handoff

CDMA-to-CDMA Handoff

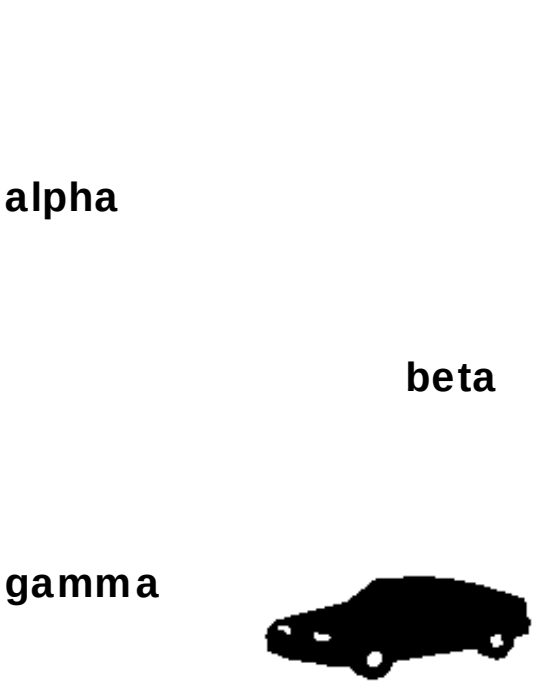
CDMA-to-Analog Handoff

Soft Handoffs



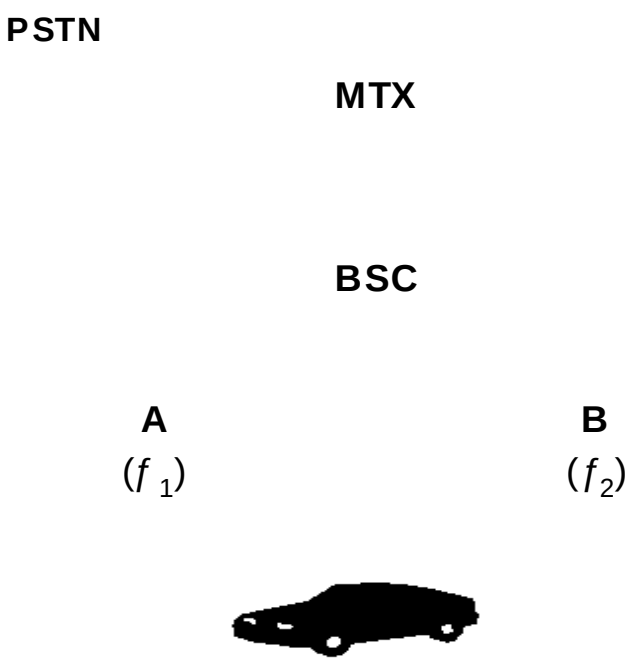
- Soft Handoff: the mobile station starts communications with a target base station without interrupting communications with the current serving base station.
- Can involve up to three cells simultaneously and use all signals
  - Mobile station compares frames from each cell, and uses the best one
- Eliminates “Ping-Pong” effect and chances of dropped calls

Softer Handoffs

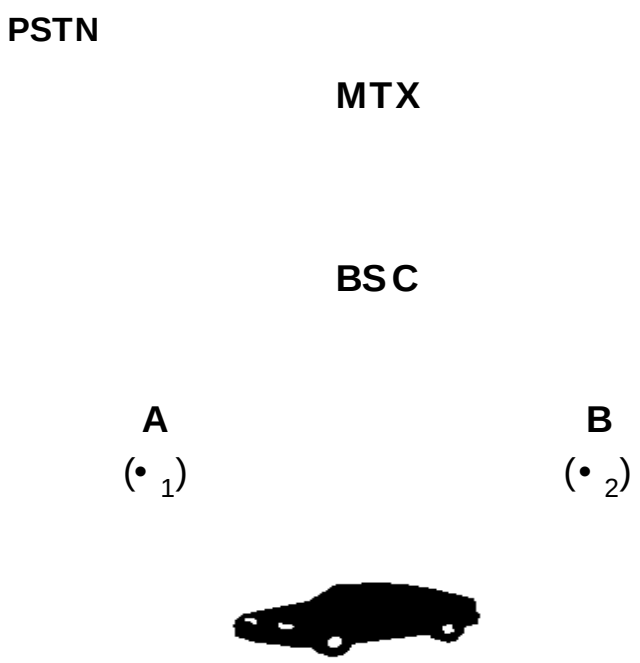


- Handoff is between sectors of the same cell
- Communications are maintained across both sectors until the mobile station transition has completed
- May happen frequently
- MTX is aware but does not participate
- All activities are managed by the cell site
- Signals received at both sectors can be combined for improved quality

CDMA to CDMA Hard Handoffs



- Between cells operating on different frequencies



- Between cells with traffic channels whose frames are staggered differently
  - *avoid frame staggering*

CDMA to CDMA Hard Handoff cont.



- Between cells that could be on the same frequency and have the same frame alignment, but which are subordinated to different MTSOs
  - This type of hard handoff would become a soft handoff if the frames received at both cells could be delivered quickly to the same BSC for comparison, either by interconnecting both BSCs or both BTSs with an ATM link *(implementation would require HW & SW modifications)*

CDMA to Analog Handoff

- The mobile station is directed from a forward traffic channel to an analog voice channel
- Radio link continuity is *not* maintained
- Two types of handoff:
  - Intra-system - occurs while the mobile station is traveling within the system
    - Load balancing
    - Improve voice quality
    - No CDMA service
  - Inter-system - occurs while the mobile station is traveling into another system that has no CDMA service
    - Messaging will tell the mobile station to select AMPS
    - Currently, the mobile station cannot handoff back from AMPS to CDMA (until the end of the call, when the mobile station reacquires the system) because the necessary signaling messages not supported)

Pilot Sets



- Pilot sets:
  - Active Set Pilots associated with the forward traffic channels assigne to the mobile station (max 6 pilots)
  - Candidate Set Pilots not currently in the Active Set, but received by t mobile station with sufficient strength to indicate that the correspond Traffic Channels can be successfully demodulated (max 5 pilots)
  - Neighbor Set Pilots not currently on the Active or Candidate Sets, tha are likely handoff candidates (at least 20 pilots)
  - Remaining Set All other possible pilots in the current system, on the current CDMA frequency assignment
- All pilots in a pilot set have the same frequency assignment
- These sets can be updated during handoff by the base station

Pilot Sets

  - Pilot Channels are identified by their offsets relative to the zero offset pilot PN sequence. Pilot offsets are grouped into disjoint sets describing their status with regard to pilot searching.

- The following three sets of pilot offsets are defined for a mobile station in the Mobile Station Idle State:
- **Active Set**: The pilot of the Forward CDMA channel whose paging is being monitored.
- **Neighbor Set**: The offsets of the Pilot Channels that are likely candidates for idle handoff. The members of the Neighbor Set are specified in the Extended Neighbor List Message.
- **Remaining Set**: The set of all possible pilot offsets in the current system (integer multiples of PILOT_INC) on the current CDMA frequency assignment, excluding the pilots in the Neighbor Set and the Active Set.
- The following four sets of pilot offsets are defined for a mobile station in the Mobile Station Control on the Traffic Channel:
- **Active Set**: The pilots associated with the Forward Traffic Channels assigned to the mobile station. The mobile station must support a Traffic Channel Active Set size of N6m = 6 pilots.
- **Candidate Set**: The pilots that are not currently in the Active Set but have been received by the mobile station with sufficient strength to indicate that the associated Forward Traffic Channels could be successfully demodulated. The mobile station must support a Traffic Channel Candidate Set size of N7m = 5 pilots.
- **Neighbor Set**: The offsets of the Pilot Channels that are not currently in the Active Set or in the Candidate Set. The mobile station must support a Neighbor Set size of at least N8m = 20 pilots.
- **Remaining Set**: The set of all possible pilot offsets in the current system (integer multiples of PILOT_INC) on the current CDMA frequency assignment, excluding the pilots in the Neighbor Set, the Candidate Set, and the Active Set.

Pilot Set Initialization
(While in the Idle or In An Active Call)

Active	Pilot whose Paging Channel is being monitored or associated with the assigned Forward Traffic Channel
Candidate	Empty
Neighbor	Pilots specified in the most recently received Extended Neighbor List Message (AGE set at NGHBR_MAX_AGE)
Remaining	Any other possible pilot in the system

Pilot Set Initialization (While in the Idle or In An Active Call) cont.

- **Initialization of the Active Set**
- The mobile station supports a maximum Active Set size of N6m = 6 pilots, and keeps track of the strength of all pilots in this set.
- When the mobile station first goes into the Idle State, it initializes the **Active Set** to contain only the pilot associated with the Paging Channel being monitored.
- When the mobile station is first assigned a Forward Traffic Channel, it initializes the **Active Set** to contain only the pilot associated with the assigned Forward Traffic Channel.
- **Initialization of the Candidate Set**
- The mobile station supports a maximum Candidate Set size of N7m = 5 pilots and **initializes** this set to contain no pilots.
- **Initialization of the neighbor Set**
- The mobile station supports a minimum Neighbor Set size of N8m = 20 pilots.
- The mobile station maintains an AGE counter for each pilot in the Neighbor Set. When the mobile is in the Idle State it **initializes** the Neighbor Set to contain all the pilots specified in the most recently received Extended Neighbor List Message; and sets the AGE counter for each pilot in this set to **NGHBR_MAX_AGE**.

Pilot Set Initialization (While in the Idle or In An Active Call) – cont.

- If the mobile station is in the Idle State and receives an **Extended Neighbor List Message** on the Paging Channel it reinitializes the Neighbor List.
- When the mobile station is first assigned a Forward Traffic Channel, it **initializes** the Neighbor Set to contain all the pilots specified in the most recently received Extended Neighbor List Message; and sets the AGE counter for each pilot in this set to **NGHBR_MAX_AGE**.

Pilot Set Maintenance (While In An Active Call)

Active	Pilots listed the most recently received Extended Handoff Direction Msg
Candidate	Pilots whose strength exceeds T_ADD
Neighbor	Pilots specified in the most recently received Neighbor List Update Message (or whose AGE is still less than NGHBR_MAX_AGE)
Remaining	Any other possible pilot in the system

Pilot Set Maintenance (While In An Active Call) cont.

- **Maintenance of the Active Set**
  - When the mobile station receives an Extended Handoff Direction Message, it **replaces** the Active Set with the pilots listed in the message.
- **Maintenance of the Candidate Set**
- The mobile station adjusts the Candidate Set list whenever any of the following events occur:
  - If the mobile station detects that the strength of a pilot in the Neighbor or Remaining Set exceeds T_ADD, it **moves** the pilot from that set into the Candidate Set.
  - If the mobile station processes an Extended Handoff Direction Message which does not list a pilot that is currently in the current Active Set, and the handoff drop timer corresponding to that pilot has not expired, it **moves** this pilot from the Active Set into the Candidate Set.
  - If the mobile station processes an Extended Handoff Direction Message which lists a pilot [that is] in the current Candidate Set, it **moves** the pilot from the Candidate Set into the Active Set.
  - If the handoff drop timer corresponding to a Candidate Set pilot expires, the mobile station **deletes** the pilot from the Candidate Set.
  - If the mobile station adds a pilot to the Candidate Set and the resulting Candidate Set size exceeds N7m = 5, the mobile station **deletes** from the Candidate Set the pilot whose handoff drop timer is closest to expiration. If more than one such pilot exists, the mobile station deletes one such pilot that has the lowest strength. If no pilot in the Candidate Set has an enabled handoff drop timer, the mobile station deletes from the candidate set one of the pilots that has the lowest strength.

Pilot Set Maintenance (While In An Active Call) cont.

- **Maintenance of the neighbor Set**
- When the mobile station **moves** a pilot **from the Active Set or Candidate Set** to the Neighbor Set, it initializes the corresponding AGE counter to **zero**.
- When the mobile station **moves** a pilot **from the Remaining Set** to the Neighbor Set, it initializes the corresponding AGE counter to **NGHBR_MAX_AGE**.
- The mobile station adjusts the Neighbor Set list whenever any of the following events occur:
  - If the mobile station receives a **Neighbor List Update Message**, it performs the following actions:
    - » Increments AGE for each pilot in the Neighbor Set
    - » **Deletes** from the Neighbor Set all pilot whose age exceeds NGHBR_MAX_AGE
    - » **Adds** to the Neighbor Set each pilot named in the message, if it is not already in the Candidate Set or Neighbor Set, and initializes the corresponding AGE counter to **NGHBR_MAX_AGE.** If the mobile station can store only additional new pilots, and more than pilots were sent in the Neighbor Update List Message, the mobile station stores the first new pilots listed in the message.
  - If the handoff drop timer of a pilot in the Candidate Set expires, the mobile station **adds** it to the Neighbor Set.
  - If the mobile station processes an Extended Handoff Direction Message in which a pilot [that is currently] in the Active Set is not listed, and the corresponding handoff drop timer has expired, the mobile station **moves** this pilot from the Active Set into the Neighbor Set.
  - If the mobile station detects that the strength of a Neighbor Set pilot exceeds T_ADD, it **moves** it into the Candidate Set.
  - If the mobile station processes an Extended Handoff Direction Message which lists a pilot that is in the current Neighbor Set, it **deletes** the pilot from the Neighbor Set.
  - If the mobile station adds a pilot to the Neighbor Set and the resulting Neighbor Set size exceeds N8m = 20, the mobile station **deletes** from the Neighbor Set the pilot whose AGE is the largest. If more than one such pilot exists, the mobile station deletes one such pilot that has the lowest strength.

Pilot Set Maintenance (While In An Active Call) cont.

Maintenance of the Remaining Set

All other pilots (with offsets that are multiples of the PILOT_INC) which are not already in one of the other sets, fall in the Remaining Set.

Pilot Set Maintenance (While In An Active Call) cont.

- **Handoff drop timers**
- The mobile station maintains a **handoff drop timer** for each pilot in the active set and Candidate Set.
- The mobile station **sets** the timer whenever the strength of the corresponding pilot becomes less than T_DROP. For the active set, the mobile station starts the timer even if the timer has previously expired.
- The mobile station **resets and disables** the timer if the strength of the pilot exceeds T_DROP. If T_DROP equals zero, the mobile station considers the timer expired within 100 ms of enabling it. Otherwise, the mobile station will consider the timer expired within 10% of the timer expiration value shown in the following table, corresponding to T_TDROP. If T_TDROP changes, the mobile station begins using the new value for all handoff drop timers within 100 ms. The mobile station indicates the status of the handoff drop timer for all pilots in the Active Set and Candidate Set when transmitting a Pilot Strength Measurement Message.

Pilot Strength Measurement Message (PSMM)

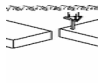


- The Pilot Strength Measurement Message is used by the mobile station to direct the Base Station Controller (BSC) in the handoff process
- With this message the mobile station reports the strength of the pilots associated with forward traffic channels currently being demodulated (and whether it would like to continue to receive traffic from them), as well as pilots from the neighbor and remaining list which are being received with sufficient strength so that traffic could be demodulated from them successfully
- In the drawing above:
  - the mobile station is demodulating traffic and deriving its time reference from cell A
  - the mobile station is still demodulating traffic from cell B (that is, it is in soft handoff with cell B), but the pilot from cell B has become too weak to be useful
  - the pilot from cell C has become sufficiently strong and the mobile station would like to start receiving traffic from this cell
- The mobile station sends a PSMM requesting update of its Active Pilot set

Pilot Strength Measurement Message (PSMM)

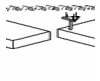
- The mobile station assists the base station in the handoff process by measuring and reporting the strengths of received pilots.
- The mobile station uses a searcher element to compute the strength of a pilot by adding the ratios of received pilot energy per chip, Ec, to total received spectral density (noise and signals), I0, of, at the most, usable multipath components, where is the number of demodulating elements supported by the mobile station.
- The mobile station reports the strengths of received pilots to the base station using a Pilot Strength Measurement Message (PSMM).
- A Pilot Strength Measurement Message will be sent under one of the following conditions:
  - If the mobile station finds a sufficiently strong pilot (in the Neighbor or Remaining Set) that is not associated with any of the Forward Traffic Channels currently being demodulated.
  - If the strength of a pilot that is associated with one of the Forward Traffic Channels being demodulated drops below a specified threshold.
  - If the mobile station receives a Pilot Measurement Request Order sent by the base station.

Extended Handoff Direction Message



A

B



EHODM



C (EHODM)



- The Extended Handoff Direction Message is used by the Base Station Controller (BSC) to tell the mobile station on which base stations the BSC has allocated traffic channels for that user
- In the drawing above
  - provided that there are suficient resources available, the BSC allocates a traffic chanel for the mobile station on cell C, and starts sending traffic to the mobile station on it
  - mixed with the traffic, the BSC sends an EHODM for the mobile station with the new list of authorized Active Pilots set (from cells A and C)
  - the mobile station continues demodulating traffic & deriving its time reference from cell A
  - the mobile station stops demodulating traffic from cell B
  - the BSC sends a Channel Assignment Message telling the mobile station the Walsh Code to use to decode the traffic comming from cell C
  - the mobile station begins demodulating traffic from cell C
  - the BCS sends a Neighbor List Update message to the mobile station

System Parameters Message (Paging Channels)

Field	Length (bits)				
MSG_TYPE ('00000001')	8	HOME_REG	1	PWR_REP_THRESH	5
PILOT_PN	9	FOR_SID_REG	1	PWR_REP_FRAMES	4
CONFIG_MSG_SEQ	6	FOR_NID_REG	1	PWR_THRESH_ENABLE	1
SID	15	POWER_UP_REG	1	PWR_PERIOD_ENABLE	1
NID	16	POWER_DOWN_REG	1	PWR_REP_DELAY	5
REG_ZONE	12	PARAMETER_REG	1	RESCAN	1
TOTAL_ZONES	3	REG_PRD	7	**T_ADD**	**6**
ZONE_TIMER	3	BASE_LAT	22	**T_DROP**	**6**
MULT_SIDS	1	BASE_LONG	23	**T_COMP**	**4**
MULT_NIDS	1	REG_DIST	11	**T_TDROP**	**4**
BASE_ID	16	**SRCH_WIN_A**	**4**	EXT_SYS_PARAMETER	1
BASE_CLASS	4	**SRCH_WIN_N**	**4**	EXT_NGHBR_LIST	1
PAGE_CHAN	3	**SRCH_WIN_R**	**4**	GLOBAL_REDIRECT	1
MAX_SLOT_CYCLE_INDEX	3	**NGHBR_MAX_AGE**	**4**	RESERVED ('0)	1

System Parameters Message (Paging Channels)

- **SRCH_WIN_A** – Search window size for the Active Set and the Candidate Set. Windows size parameter corresponding to the number of PN chips that the personal station is to search for pilots in the Active Set and Candidate Set. The mobile station centers this window around the earliest arriving usable multipath component of the pilot.
- **SRCH_WIN_N** – Search window size for the Neighbor Set. Window size parameter corresponding to the number of PN chips that the personal station is to search for pilots in the Neighbor Set. The mobile station centers this window around the pilot's PN sequence offset.
- **SRCH_WIN_R** – Search window size for the Remaining Set. Window size parameter corresponding to the number of PN chips that the personal station is to search for pilots in the Remaining Set. The mobile station centers this window around the pilot's PN sequence offset.
- **NGHBR_MAX_AGE**– Neighbor Set maximum AGE. The base station sets this field to the maximum AGE value, beyond which mobile stations are to drop members from the Neighbor Set

System Parameters Message (Paging Channels)

- **T_ADD** – Pilot detection threshold. Value used by the mobile stations to trigger the sending of Pilot Strength Measurement Messages initiating the handoff process. The base station sets this field to the pilot detection threshold expressed as an unsigned number equal to
- int (-2 x log10 (Ec / I0))
- **T_DROP** – Pilot drop threshold. Value used by the mobile stations to start the handoff drop timer for pilots in the Active Set and Candidate Set. The base station sets this field to the pilot drop threshold expressed as an unsigned number equal to
- int (-2 x log10 (Ec / I0))
- **T_COMP** – Active Set versus Candidate Set comparison threshold. Mobile stations transmit a Pilot Strength Measurement Message when the strength of a pilot in the Candidate Set exceeds that of a pilot in the Active Set by this margin. The base station sets this field to the “Candidate Set pilot to Active Set pilot rate” threshold in units of 0.5 dB.
- **T_TDROP** – Drop timer value. Timer value after which an action is taken by mobile stations for a pilot that is a member of the Active Set or Candidate Set, and whose strength has not become greater than T_DROP. If a pilot is a member of the Active Set, a Pilot Strength Measurement Message is issued. If the pilot is a member of the Candidate Set, it is moved to the Neighbor Set. The base station sets this field to the T_DROP value corresponding to the drop time value to be used by the mobile stations.

In-Traffic System Parameters Message (Forward Traffic Channels)

Field	Length (bits)
MSG_TYPE (‘00000001’)	8
ACK_SEQ	3
MSG_SEQ	3
ACK_REQ	1
ENCRYPTION	2
SID	15
NID	16

SRCH_WIN_A	4
SRCH_WIN_N	4
SRCH_WIN_R	4
T_ADD	6
T_DROP	6
T_COMP	4
T_TDROP	4
NGHBR_MAX_AGE	4
RESERVED (‘0000’)	4

Pilot Strength Measurement Message (PSMM) (Reverse Traffic Channels)

Field	Length (bits)	
MSG_TYPE (‘00000101’)	8	
ACK_SEQ	3	
MSG_SEQ	3	
ACK_REQ	1	
ENCRYPTION	2	
REF_PN	**9**	Pilot from which the mobile station derives its time reference
PILOT_STRENGTH	**6**	
KEEP	**1**	
Zero or more occurrences of the following record:		
PILOT_PN_PHASE	**15**	All pilots in the Active and Candidate Sets
PILOT_STRENGTH	**6**	
KEEP	**1**	
RESERVED (‘0’s)	0 - 7 (as needed)	

Pilot Strength Measurement Message (PSMM) (Reverse Traffic Channels)

- **REF_PN** – Time reference PN sequence offset. The mobile station sets this value to the PN sequence of the pilot it uses to derive its time reference, relative to the zero offset pilot PN sequence, in units of 64 PN chips.
- **PILOT_STRENGTH** – The mobile station sets this field to , where PS is the strength of the pilot used by the mobile station to derive its time reference. If this value is less than 0, the mobile station sets this field to ‘000000’. If this value is greater than ‘111111’, the mobile station sets this field to ‘111111’.
  - **NOTE:** The mobile station uses a searcher element **to compute the strength** of a pilot by adding the ratios of received pilot energy per chip, Ec, to total received spectral density (noise and signals), I0, of, at the most, usable multipath components, where is the number of demodulating elements supported by the mobile station.
- **KEEP** – Keep pilot indicator. If the handoff drop timer corresponding to the pilot used by the mobile station to derive its time reference has expired, the mobile station sets this field to ‘0’; otherwise, it sets this field to ‘1’.

Pilot Strength Measurement Message (PSMM) (Reverse Traffic Channels)

The mobile station includes one occurrence of the following three-field record for each pilot in the **Active Set** and for each pilot in the **Candidate Set**, other than the pilot identified by the REF_PN field.

- **PILOT_PN_PHASE** – Pilot measured phase. The mobile station sets this field to the phase of the pilot PN sequence relative to the zero offset pilot PN sequence of this pilot, in units of one PN chip.
- **PILOT_STRENGTH** –The mobile station sets this field to , where PS is the strength of the pilot identified in the previous field. If this value is less than 0, the mobile station sets this field to ‘000000’. If this value is greater than ‘111111’, the mobile station sets this field to ‘111111’.
- **KEEP** – Keep pilot indicator. If the handoff drop timer corresponding to this pilot has expired, the mobile station sets this field to ‘0’; otherwise, it sets this field to ‘1’.
- **RESERVED** - 0 to 7 zeroes, as needed, to make the length of the entire message an integer number of octets.

Extended Handoff Direction Message (Forward Traffic Channels)

Field	Length (bits)
MSG_TYPE('00010001')	8
ACK_SEQ	3
MSG_SEQ	3
ACK_REQ	1
ENCRYPTION	2
USE_TIME	**1**
ACTION_TIME	**6**
HDM_SEQ	**2**
SEARCH_INCLUDED	**1**
SRCH_WIN_A	0 or 4
T_ADD	0 or 6
T_DROP	0 or 6
T_COMP	0 or 4
T_TDROP	0 or 4
HARD_INCLUDED	**1**
FRAME_OFFSET	**0 or 4**
PRIVATE_LCM	**0 or 1**
RESET_L2	**0 or 1**
RESET_FPC	**0 or 1**
RESERVED ('0')	0 or 1
ENCRYPT_MODE	0 or 2
NOM_PWR_EXT	0 or 1
NOM_PWR	0 or 4
NUM_PREAMBLE	**0 or 3**
BAND_CLASS	0 or 5
CDMA_FREQ	0 or 11
ADD_LENGTH	3
Additional fields	**8 x ADD_LENGTH**
One occurrence of the following record for each member of the new Active Set:	
PILOT_PN	**9**
PWR_COMB_IND	**1**
CODE_CHAN	**8**
RESERVED ('0's)	0 - 7 (as needed)

Extended Handoff Direction Message (Forward Traffic Channels)

- **USE_TIME** – Use action time indicator. This field indicates whether an ACTION_TIME is specified in this message. If an ACTION_TIME is specified in this message, this field is set to ‘1’. Otherwise, the base station sets this field to ‘0’.
- **ACTION_TIME** – Action time. If the USE_TIME field is set to ‘1’, the base station sets this field to the System Time, in units of 80 ms (modulo 64), at which the handoff is to take effect. If the USE_TIME field is set to ‘0’ the base station sets this field to ‘000000’.
- **HDM_SEQ** – Extended Handoff Direction Message sequence number. This field is used by the mobile station in the Power Measurement Report Message to identify the order in which the reported pilot strengths are sent. this field is set to the Extended Handoff Direction Message sequence number, LAST_HDM_SEQ.
- **SEARCH_INCLUDED** – Pilot search parameters included. If the mobile station is to change its pilot search parameters, the base station sets this field to ‘1’. Otherwise, the base station sets this field to ‘0’.
- **HARD_INCLUDED** – Hard handoff parameters included. If the mobile station is to change FRAME_OFFSET, PRIVATE_LCM, RESET_L2, ENCRYPT_MODE, NOM_PWR_EXT, NOM_PWR, NUM_PREAMBLE, BAND_CLASS, or CDMA_FREQ the base station sets this field to ‘1’. Otherwise, the base station sets this field to ‘0’.

Extended Handoff Direction Message (Forward Traffic Channels)

- **FRAME_OFFSET** – Frame offset. The Forward and Reverse Traffic Channel frames are delayed FRAME_OFFSET x 1.25 ms relative to system timing. If HARD_INCLUDED is set to ‘1’, the base station includes this field and sets it to the Forward and Reverse Traffic Channel frame offset. Otherwise, the base station omits this field.
- **PRIVATE_LCM** – Private long code mask indicator. This field is used to change the long code mask after a hard handoff. If HARD_INCLUDED is set to ‘1’, the base station includes this field and sets it as described below; otherwise, the base station omits this field. If the field is included and the private long code mask is to be used after the handoff, the base station sets this field to‘1’. Otherwise, the base station sets this field to ‘0’.
- **RESET_L2** – Reset acknowledgement procedures command. This field is used to reset acknowledgement processing in the mobile station. If HARD_INCLUDED is set to ‘1’, the base station includes this field and sets it as described below; otherwise, the base station omits this field. If the field is included and the mobile station is to reset its acknowledgement procedures, the base station sets this field to ‘1’. Otherwise, the base station sets this field to ‘0’.
- **RESET_FPC** – Reset Forward Traffic Channel Power Control. If HARD_INCLUDED is set to ‘1’, the base station includes this field and sets it to ‘0’ if the Forward Traffic Channel power control counters are to be maintained after completion of the handoff. If the counters are to be initialized to zero, then the base station sets this field to ‘1’. Otherwise, the base station omits this field.
- **NUM_PREAMBLE** – Number of Traffic Channel preamble frames. If HARD_INCLUDED is set to ‘1’, the base station includes this field and sets it to the number of Traffic Channel preamble frames that the mobile station is to send when performing a handoff; otherwise, the base station omits this field
  .
- One occurrence of the following three-field record is included for each member of the mobile station’s new Active Set:
- **PILOT_PN** – Pilot PN sequence offset index. The base station sets this field to the pilot PN sequence offset for this pilot in units of 64 PN chips.
- **PWR_COMB_IND** – Power control symbol combining indicator. If the Forward Traffic Channel associated with this pilot will carry the same closed-loop power control subchannel bits as that of the previous pilot in this message, the base station sets this field to ‘1’. Otherwise, the base station sets this field to ‘0’. For the first occurrence of this record in the message, the base station sets this field to ‘0’.
- **CODE_CHAN** – Code channel index. The base station sets this field to the code channel index in the range 1 to 63 inclusive that the mobile station is to use on the Forward Traffic Channel associated with this pilot.

Handoff Completion Message

Field	Length (bits)
MSG_TYPE (‘00001010’)	8
ACK_SEQ	3
MSG_SEQ	3
ACK_REQ	1
ENCRYPTION	2
LAST_HDM_SEQ	**2**
One occurrence of the following field for each member of the new Active Set:	
PILOT_PN	**9**
RESERVED (‘0’s)	0-7 (as needed)

Handoff Completion Message

- **LAST_HDM_SEQ** – Extended Handoff Direction Message sequence number. The personal station sets this field to the value of the HDM_SEQ field from the Extended Handoff Direction Message that determined the current Active Set.
- **PILOT_PN** – Pilot PN sequence offset. The mobile station includes one occurrence of this field for each pilot in the current Active Set. The mobile station sets this field to the pilot PN sequence offset, relative to the zero offset pilot PN sequence in units of 64 PN chips, for this pilot. If the Active Set contains more than one pilot, the mobile station includes the pilot offsets in the same order as in the Extended Handoff Direction Message that determined the current Active Set.

Neighbor List Update Message (Forward Traffic Channels)

Field	Length (bits)
MSG_TYPE (‘00001000’)	8
ACK_SEQ	3
MSG_SEQ	3
ACK_REQ	1
ENCRYPTION	2
PILOT_INC	**4**
One occurrence of the following field for each pilot in the composite Neighbor Set:	
NGHBR_PN	**9**
RESERVED (‘0’s)	0 – 7 (as needed)

Neighbor List Update Message (Forward Traffic Channels)

- **PILOT_INC** – Pilot PN sequence offset index increment. The mobile station searches for Remaining Set pilots at pilot PN sequence offset index values that are multiples of this value. The base station sets this field to the pilot PN sequence increment, in units of 64 PN chips, that the mobile station is to use for searching the Remaining Set. The base station should set this field to the largest increment such that the pilot PN sequence offsets of all its neighbor base stations are integer multiples of that increment.
- **NGHBR_PN** – Neighbor pilot PN sequence offset index. The base station includes one occurrence of this field for each pilot in the *composite* neighbor list put together by the BSC with the neighbors of all the base stations with which the mobile station is currently in soft handoff. The base station sets this field to the pilot's PN sequence offset, in units of 64 PN chips.

Power Measurement Report Message (Reverse Traffic Channels)

Field	Length (bits)
MSG_TYPE (‘00000110’)	8
ACK_SEQ	3
MSG_SEQ	3
ACK_REQ	1
ENCRYPTION	2
ERRORS_DETECTED	5
POWER_MEAS_FRAMES	10
LAST HDM SEQ	2
NUM_PILOTS	**4**
NUM_PILOTS occurrences of the following field:	
PILOT_STRENGTH	**6**
RESERVED (‘0’s)	0-7 (as needed)

Fields used to report the number of frames received by the mobile station (bad and total)

Fields used to report the strength of all the pilots in the current Active Set

Power Measurement Report Message (Reverse Traffic Channels)

- **LAST_HDM_SEQ** – Extended Handoff Direction Message sequence number. If an Extended Handoff Direction Message has been received during this call, the mobile station sets this field to the value of the HDM_SEQ field from the Extended Handoff Direction Message that determined the current Active Set. If no Extended Handoff Direction Message has been received during this call, the mobile station sets this field to ‘11’.
- **NUM_PILOTS** – Number of pilots reported. The mobile station sets this field to the number of pilots in the current Active Set.
- **PILOT_STRENGTH** – Pilot strength. The mobile station includes one occurrence of this field for each pilot in the Active Set. If the Active Set contains more than one pilot, the mobile station includes the pilot strengths in the same order as in the Extended Handoff Direction Message that determined the current Active Set.
- The mobile station sets each occurrence of this field to , where PS is the strength of the pilot, measured as described in the following note. If this value is less than 0, the mobile station shall set this field to ‘000000’. If this value is greater than ‘111111’, the mobile station shall set this field to ‘111111’.
  - **NOTE:** The mobile station uses a searcher element **to compute the strength** of a pilot by adding the ratios of received pilot energy per chip, Ec, to total received spectral density (noise and signals), I0, of, at the most, usable multipath components, where is the number of demodulating elements supported by the mobile station.

THE END