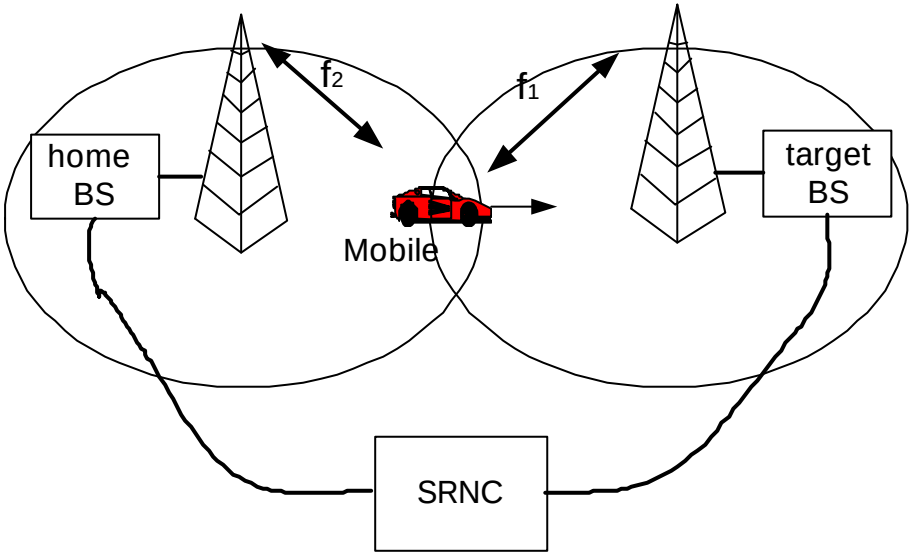
TSGR1#19(01)253

Seamless Inter-frequency Hard Handover

ETRI

Purpose of proposal

? To guarantee the seamless interfrequency hard handover both in uplink and in downlink



f_2 : currently communicating frequency

f_1 : new frequency

Seamless handover : loss of frame does not exist before and after handover

When is the inter-frequency hard handover necessary?

- Case 1) Hot-spot scenarios, where a cell uses more carriers than the surrounding cells
- Case 2) Hierarchical cell structures, where macro, micro, and pico layers are on different frequences.
- Case 3) Handovers between different operators
- Case 4) Handover between different systems, that is,
  TDD -> FDD, GSM -> FDD

  (FDD -> TDD, FDD -> GSM handover does not relate with our proposal)

Inefficiency of inter-frequency HO based on current 3GPP's spec. (When UTRAN knows the frame offset)

? Even though the UTRAN knows the frame offset before handover execution, there is an inefficiency in the uplink, since at least one TTI block will be lost and in the worst case several blocks may be lost due to the following reasons.

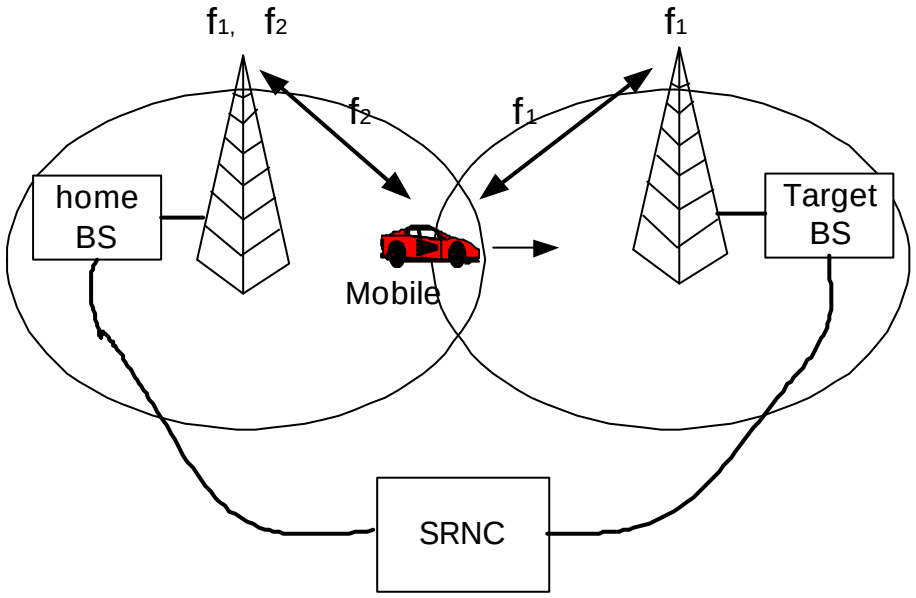
- The target BS should find the uplink signal after frequency change of UE and it takes at least a few msec
- If the cell coverage of target BS is large, then the uplink handover search window size increases (for example, 1024 chips for 40 Km cell coverage). In this situation, the search time may be several ten's of msec or above and is depends on the capability of uplink searcher of target BS
- Initial transmit power of UE after frequency change should only rely on the open loop power estimate so that the received power may be large in some cases but may be small in other cases. This can cause additional synchronization delay in the target BS

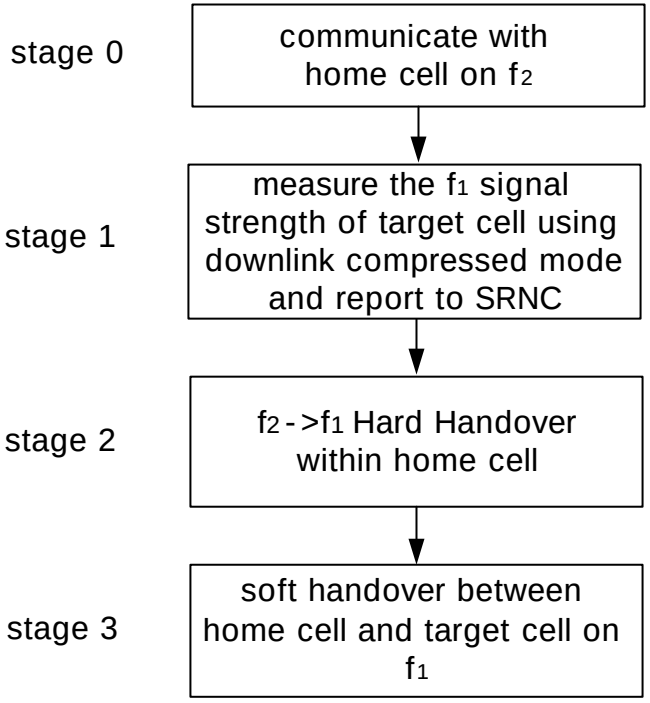
Inefficiency of inter-frequency HO based on current 3GPP's spec. (When UTRAN does not know the frame offset)

- There is TTI disconnection in downlink as well as in uplink
- Many contribution papers dealt with this problem, but no obvious solution does not proposed yet.

- **There is an inefficiency in interfrequency hard handover based on the current specification whether the UTRAN knows the frame offset or does not know.**

Intra cell hard and intercell soft handover (existing method)

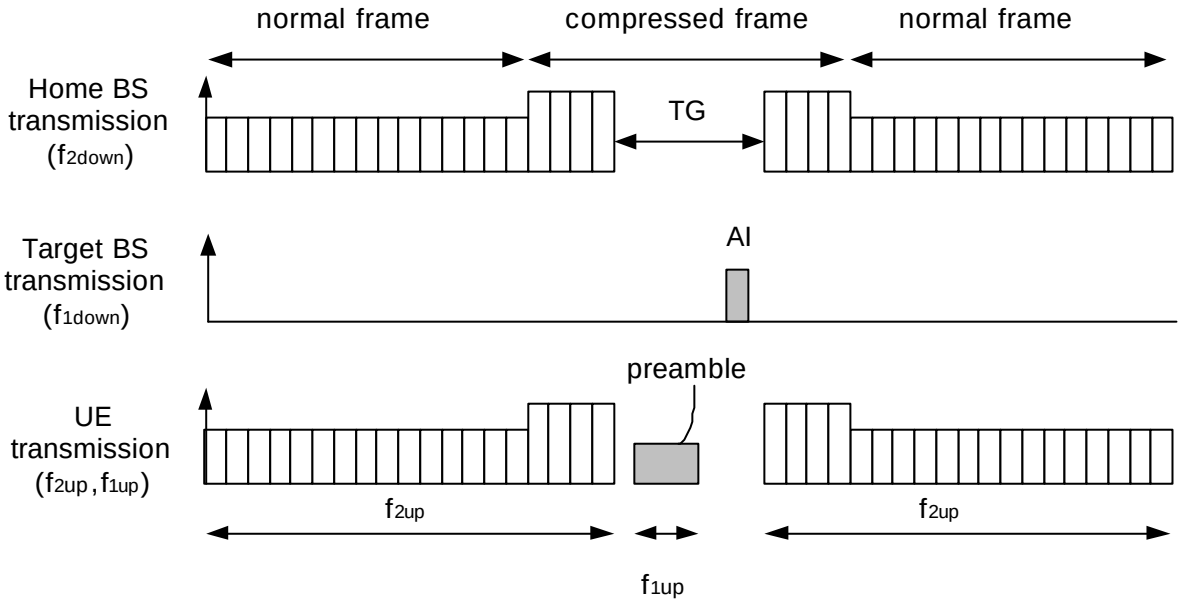




f_1 : primary frequency allocation (FA) common to the WCDMA network

Proposed method

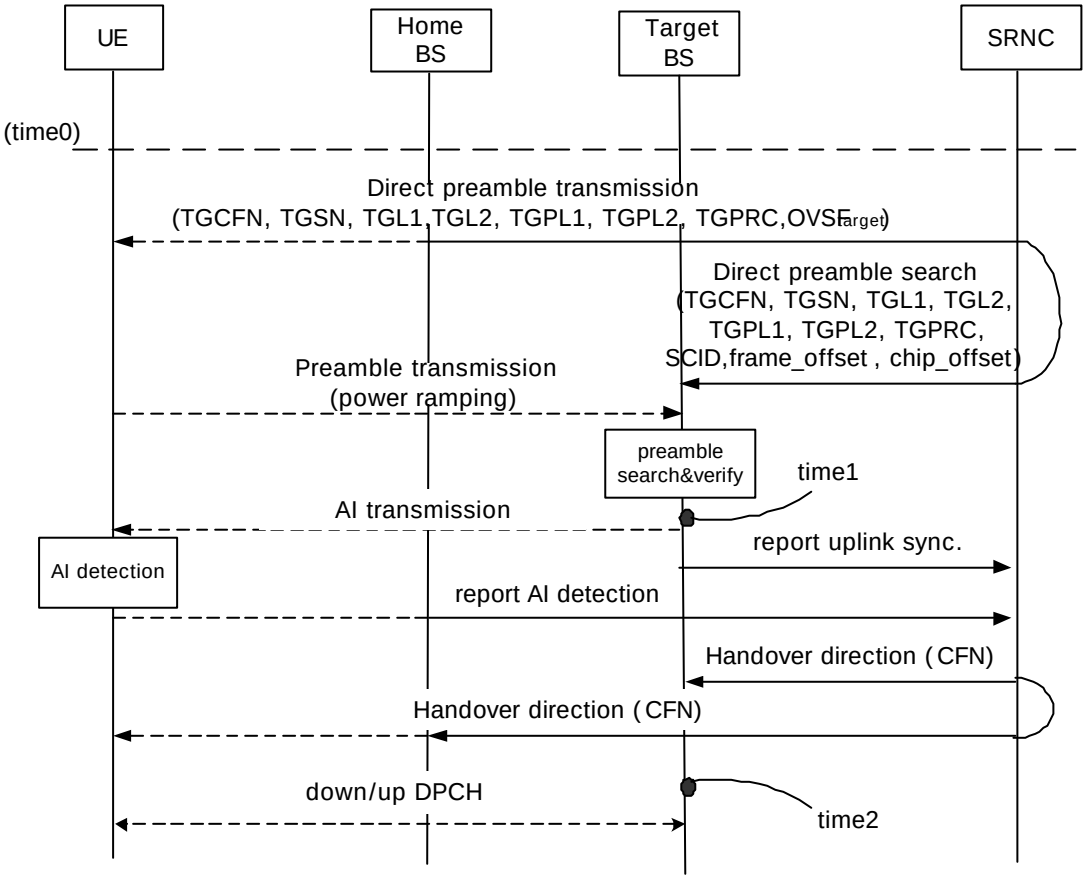
? The UE transmits uplink preamble with new frequency using the uplink compressed mode before handover execution and the target BS responds with AI



? Preamble is unmodulated pilot (DPCCH) and preamble scrambling code is the same as that of uplink DPCH of normal transmission

? The channelization code for AI is the $OVSF_{target}$ which to be used for channelization code for DPCH in the new down link.

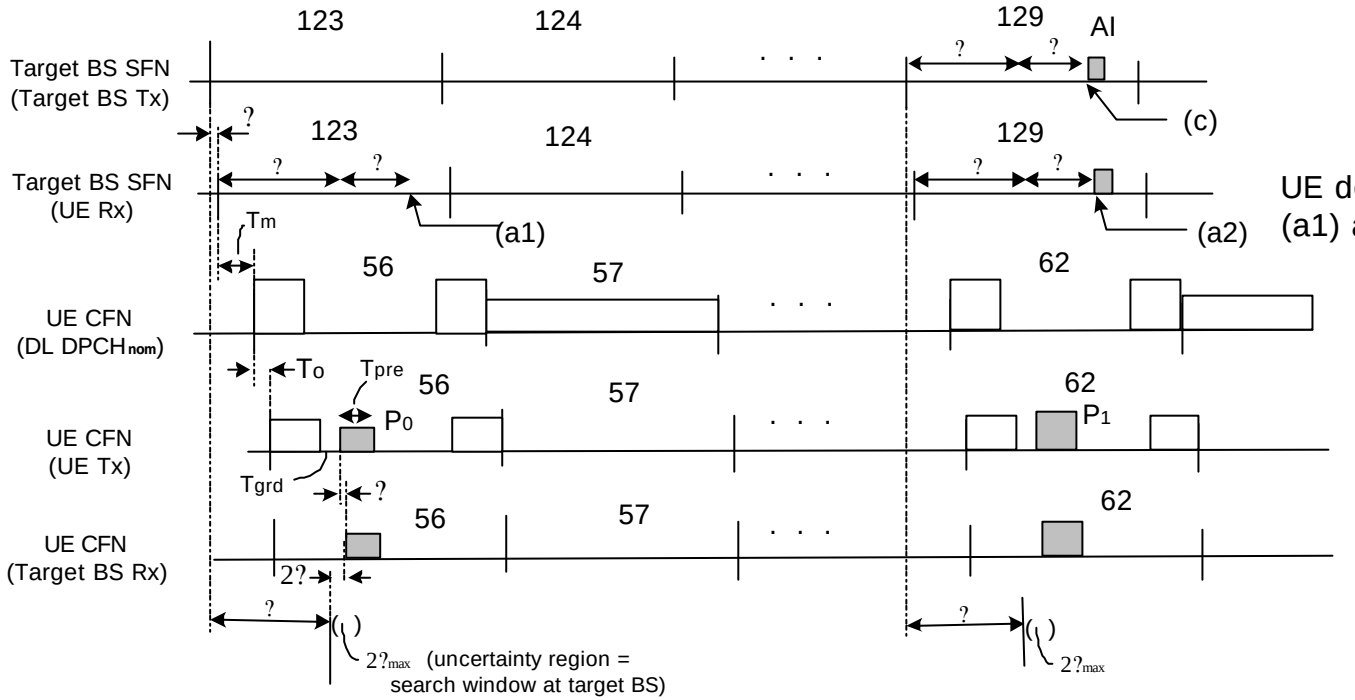
Example of signaling procedure (frame offset is known)



time0=>
: UE and Home BS are communicating using old frequency f_2
: UE has acquired new downlink P-CCPCH frame boundary of the target BS
: Target BS has the resource to support the UE at f_1 link
: SRNC knows the frame offset as well as chip offset and had been reported $OVSF_{target}$ from target BS which to be used in new radio link
: Target BS does not get the uplink synchronization from the UE

Timing diagram (frame offset is known)

frame_offset=67, TGCFN=56,TGPL1=TGPL2 = 6, TGL2 = 0



UE demodulates AI in position (a1) and (a2)

?? = Tm+TGSNx2560+To+Tgrd

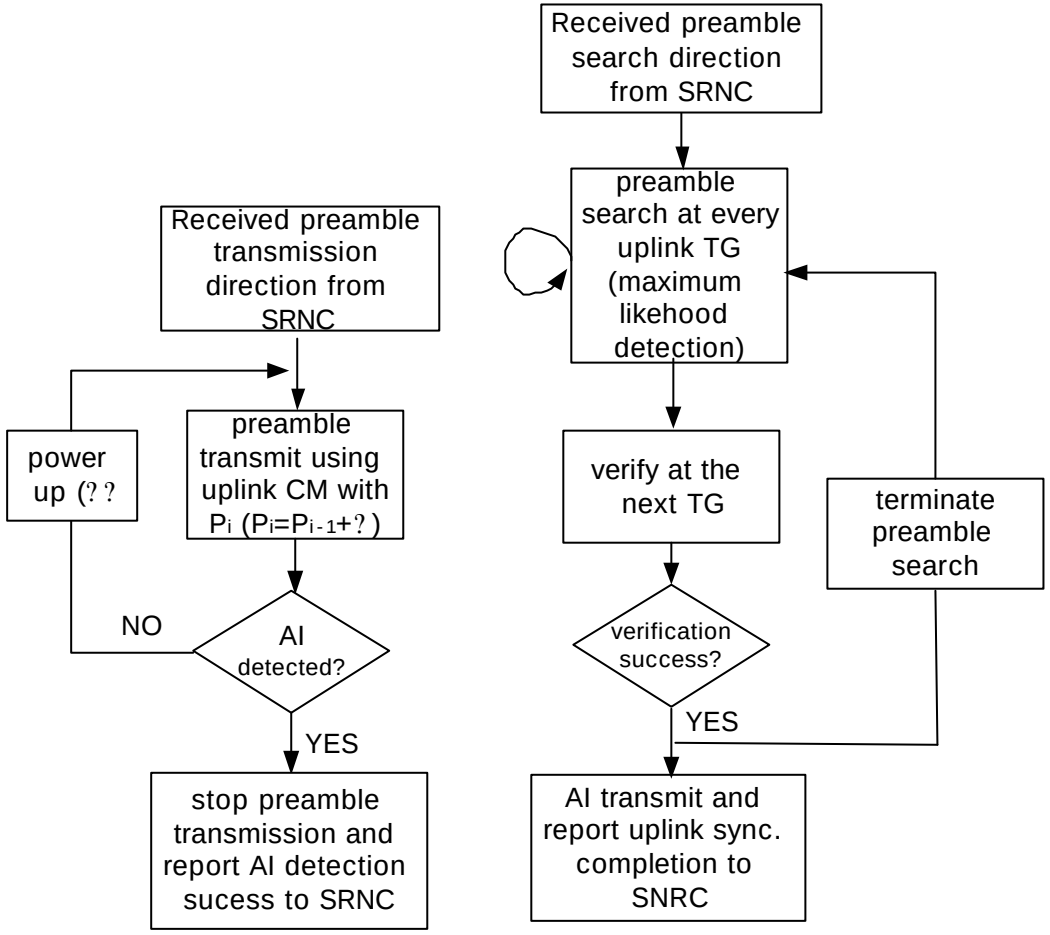
? > 2?max+Tpre

P0 : first preamble Tx power

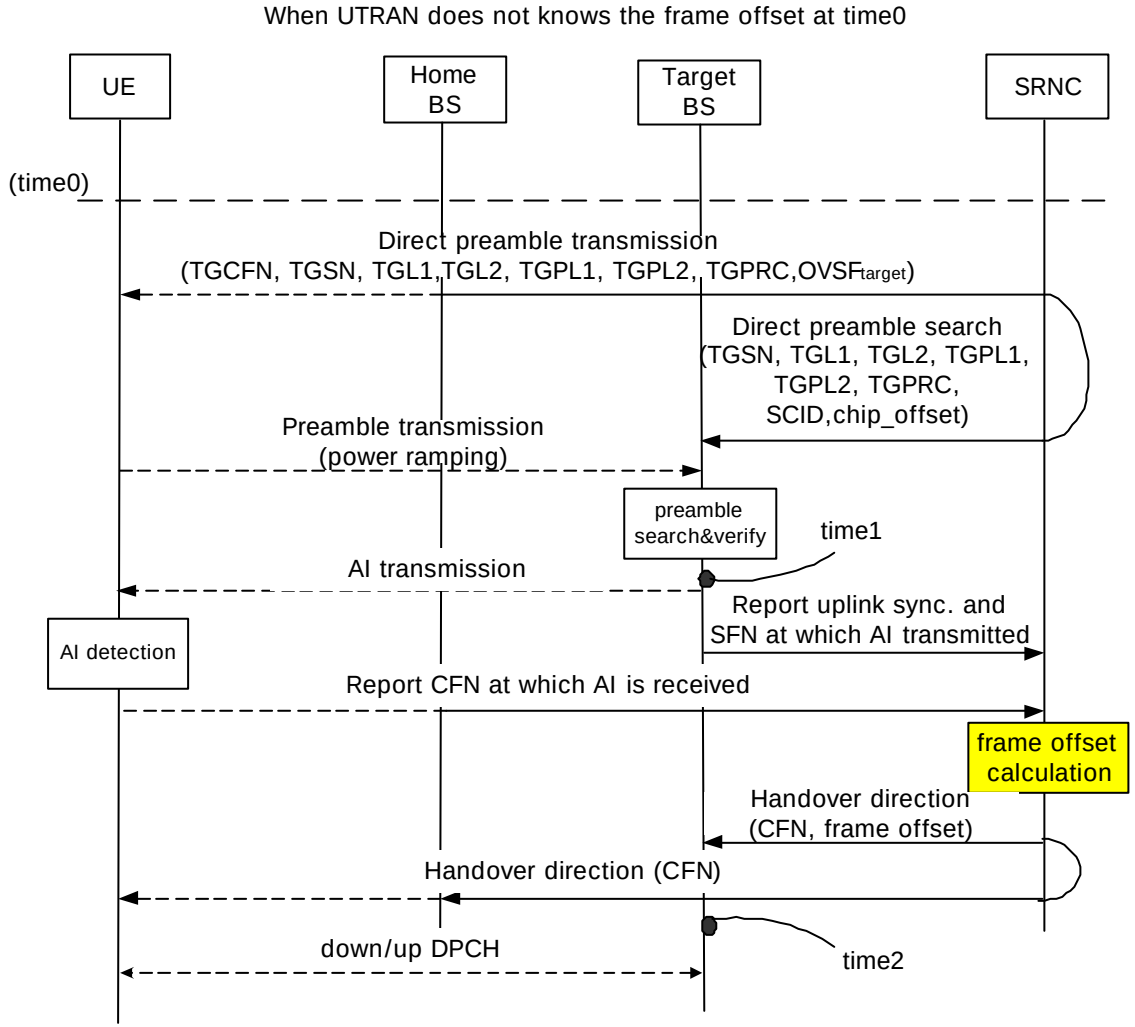
P1 : second preamble Tx power (=Po+?)

? ? should be defined in 3GPP spec.

UE and target BS operations (frame offset is known)

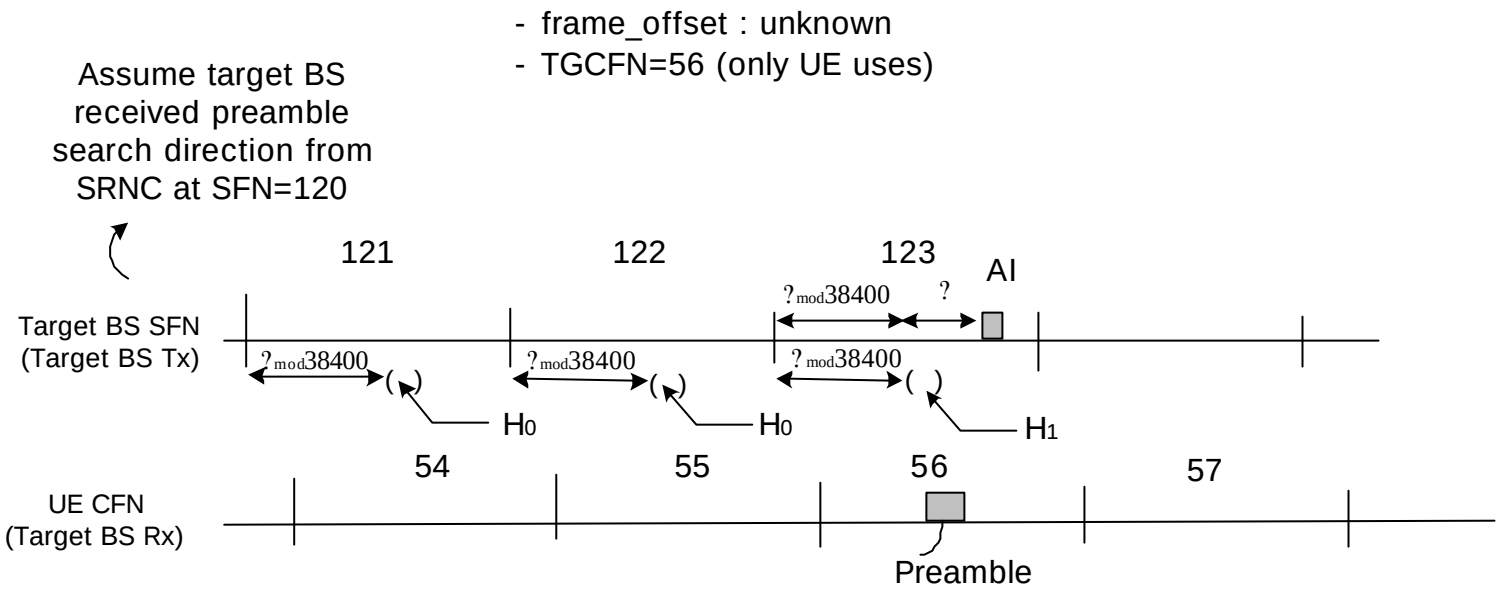


Signaling procedure (frame offset is unknown)



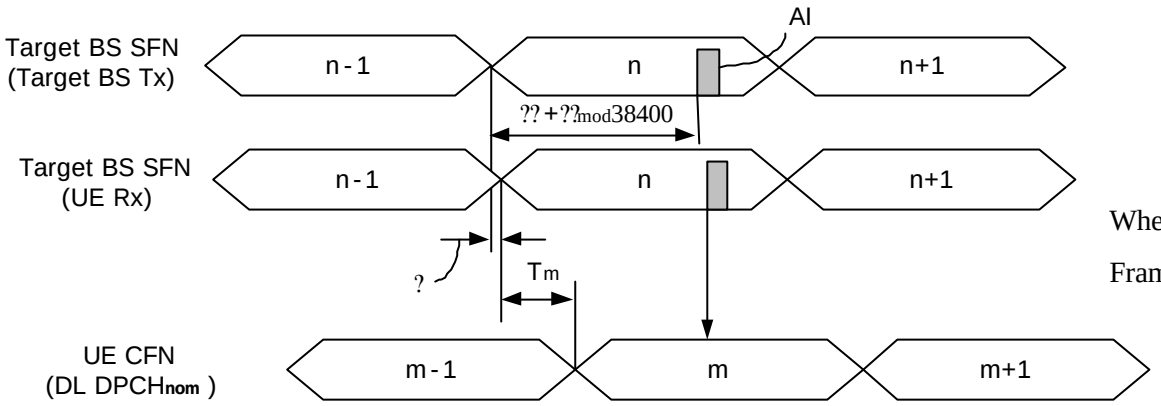
time0=>
: UE and Home BS are communicating using old frequency f_2
: UE has acquired new downlink P-CCPCH frame boundary of the target BS
: Target BS has the resource to support the UE at new f_2 link
: SRNC knows the chip offset but **not knows frame offset** and had been reported $OVSF_{target}$ from target BS which to be used in new radio link
: Target BS does not get the uplink synchronization from the UE

Timing diagram (frame offset is unknown)



- Target BS searches the preamble at every frame after receiving preamble search direction message from the SRNC
- There are one correct hypothesis window (H_1) and T-1 incorrect ones (H_0s)
- The duration between adjacent TGs should be uniform (T is the duration)

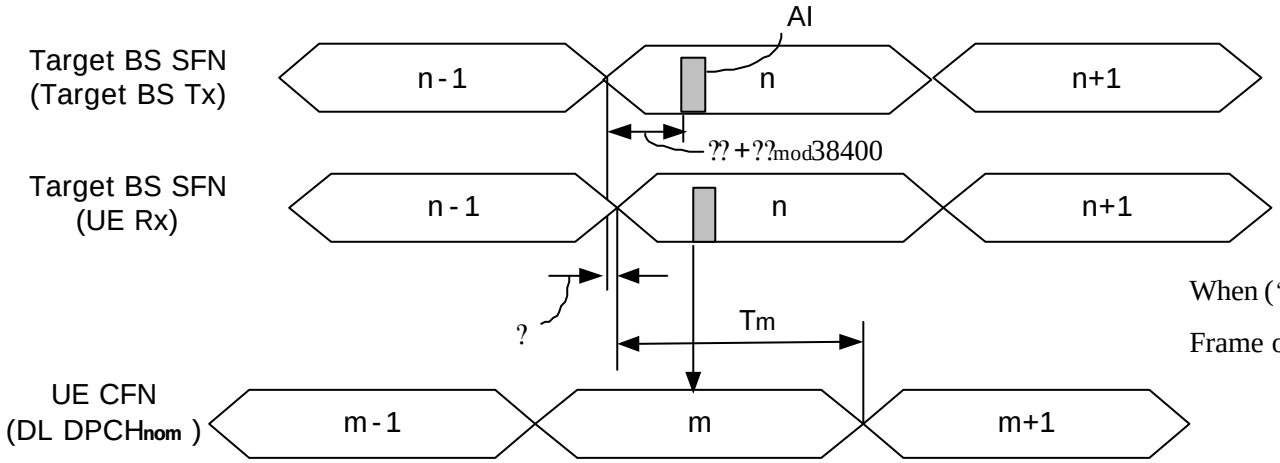
Frame offset calculation at SRNC



When $(?+?)_{mod}38400$? chip offset (Tm)

Frame offset = $(SFN\text{-}CFN)_{mod}256$

$= (n-m)_{mod}256$

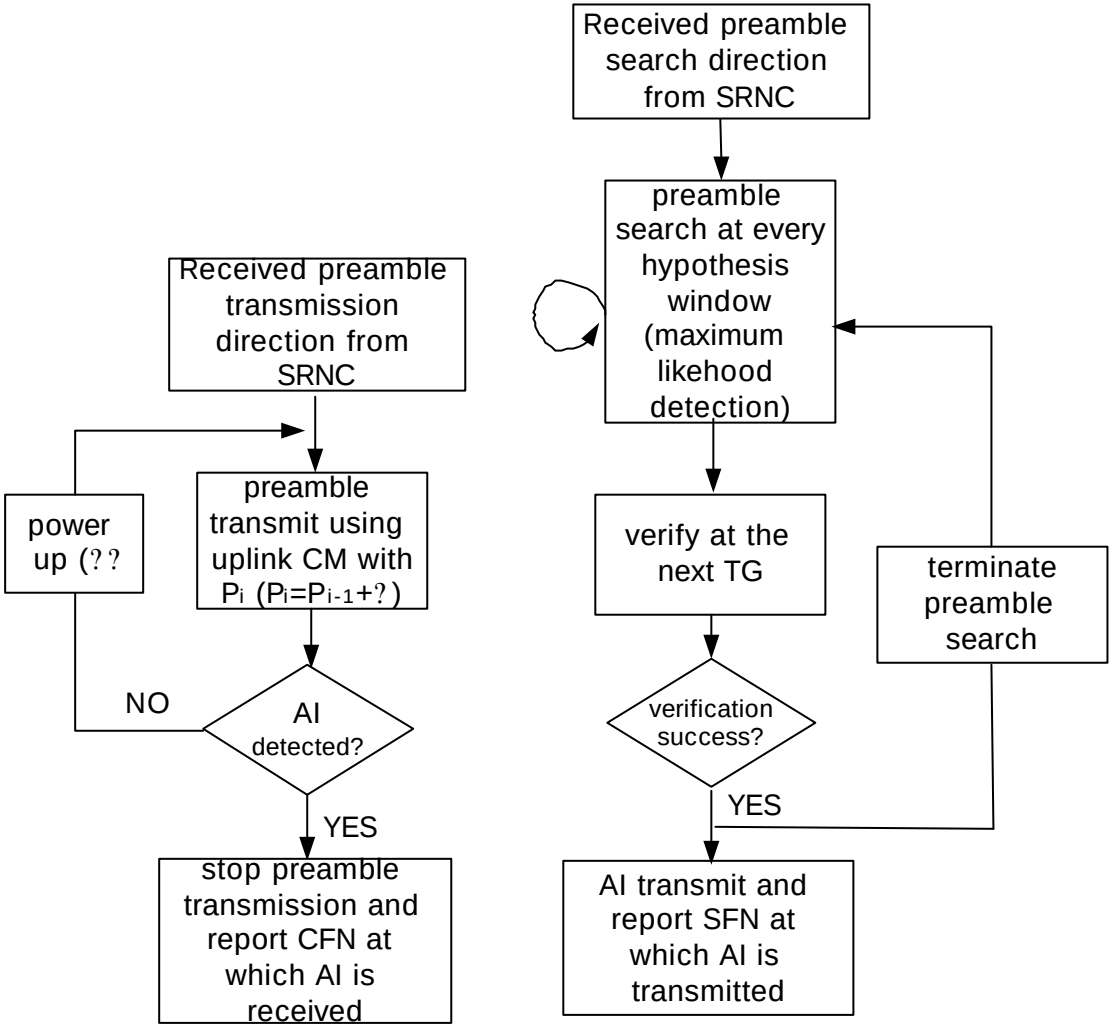


When $(?+?)_{mod}38400$ < chip offset (Tm)

Frame offset = $(SFN\text{-}CFN\text{-}1)_{mod}256$

$= (n-m-1)_{mod}256$

UE and target BS operations (frame offset is unknown)

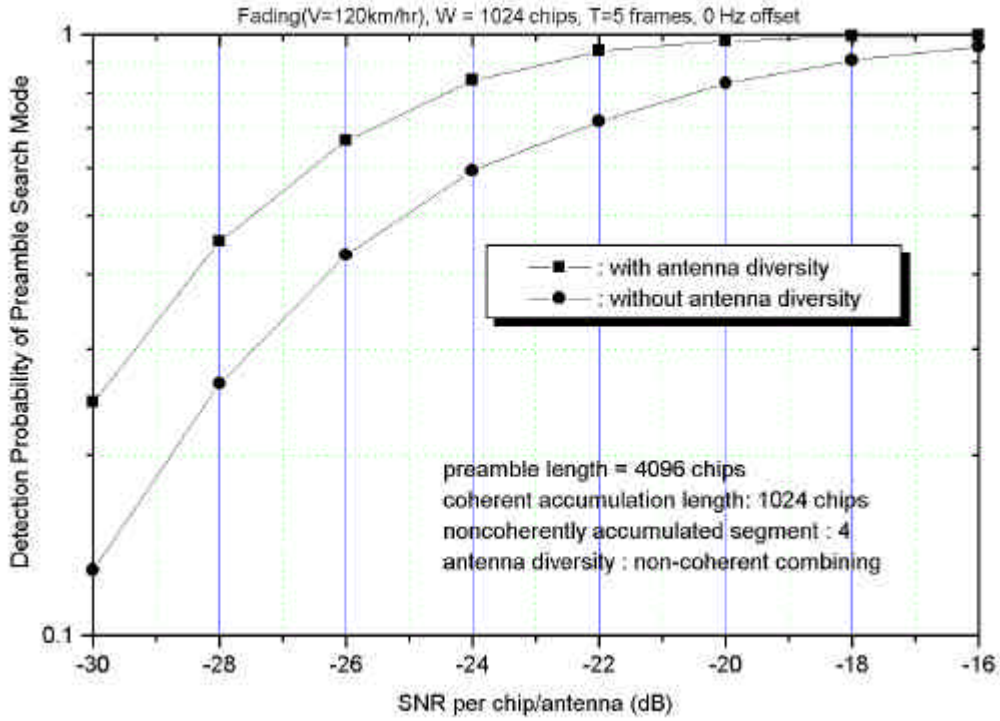


Simulation condition in the uplink

- Preamble length : 4096 chips
- Search window size at the preamble search mode: 1024 chips
- coherent integration length : 1024 chips
- noncoheretly accumulated segment : 4 segments
- False alarm probability at the preamble verification mode : 10^{-5}
- Period of TG (T) : 5 msec
- Single path fading channel (Jake's model) and other user interference is modeled as additive Gaussian
- Optimal sampling (that is, one sample per chip and no pulse shaping)
- Frequency offset is 0 Hz

Detection probability of preamble search mode

? Maximum likely hood selection is assumed



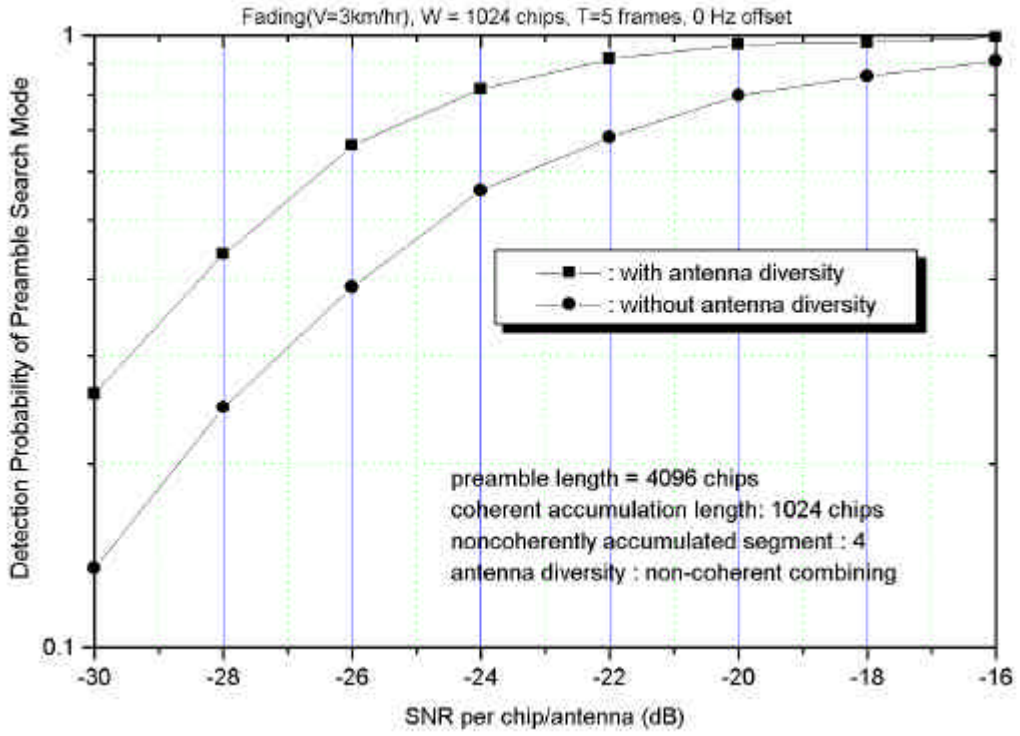
Aggregated detection probability of preamble search mode

- From the previous figure, if we assume
  - with antenna diversity
  - The initial received SNR of target BS at power ramping starting point is -30 dB
  - power ramping step size is 2 dB
  - False alarm probability of preamble verification mode “0” and detection probability is “1”. Then

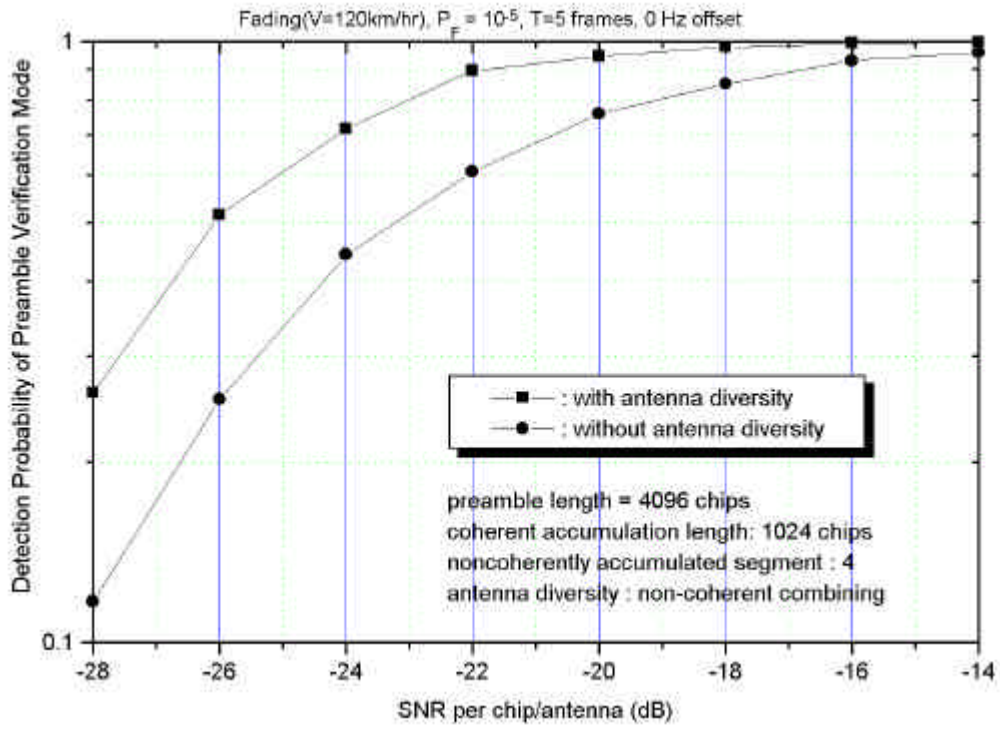
SNR/chip	-30	-28	-26	-24	-22	-20
P_D(PS) for given SNR	0.24	0.45	0.67	0.84	0.94	0.977
Aggregated P_D(PS)	0.24	0.582	0.862	0.977	0.99955	0.999989

- The –20 dB of SNR per chip means 1% of uplink capacity.
- And if we consider that the duty cycle of preamble transmission is 0.0213 (= 4096/(38400x5) in this example), the capacity loss of uplink is negligible

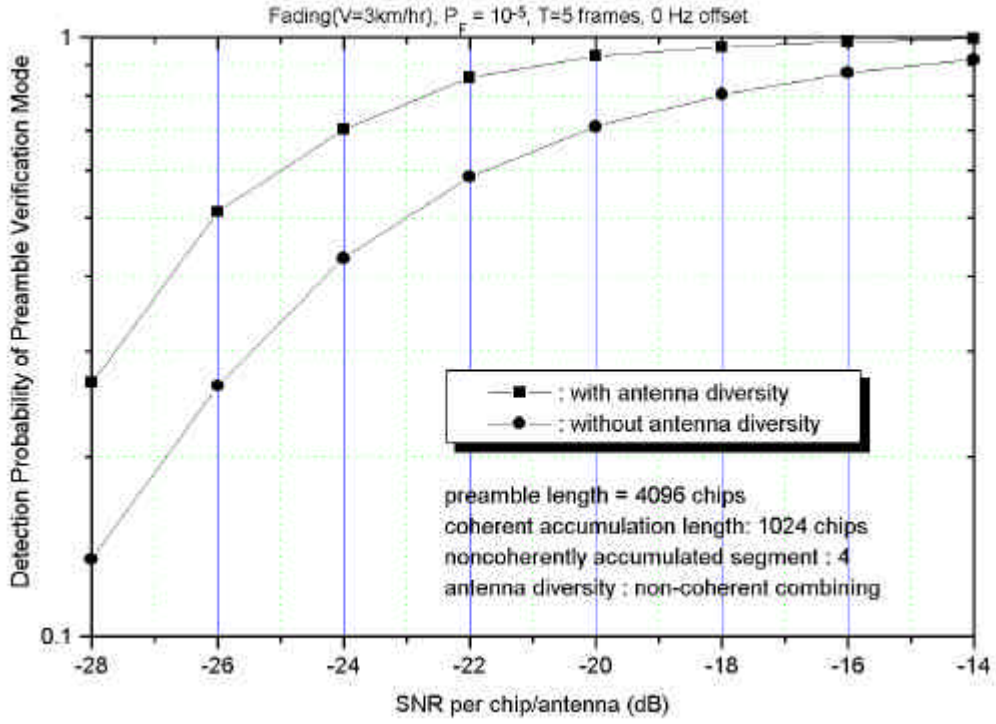
Detection probability of preamble search mode (cont'd)



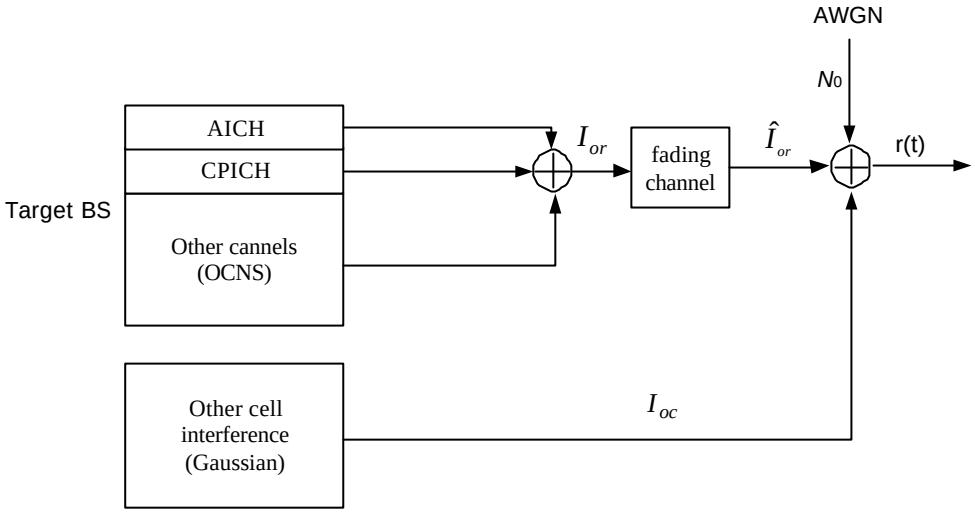
Detection probability of preamble verification mode



Detection probability of preamble verification mode (cont'd)

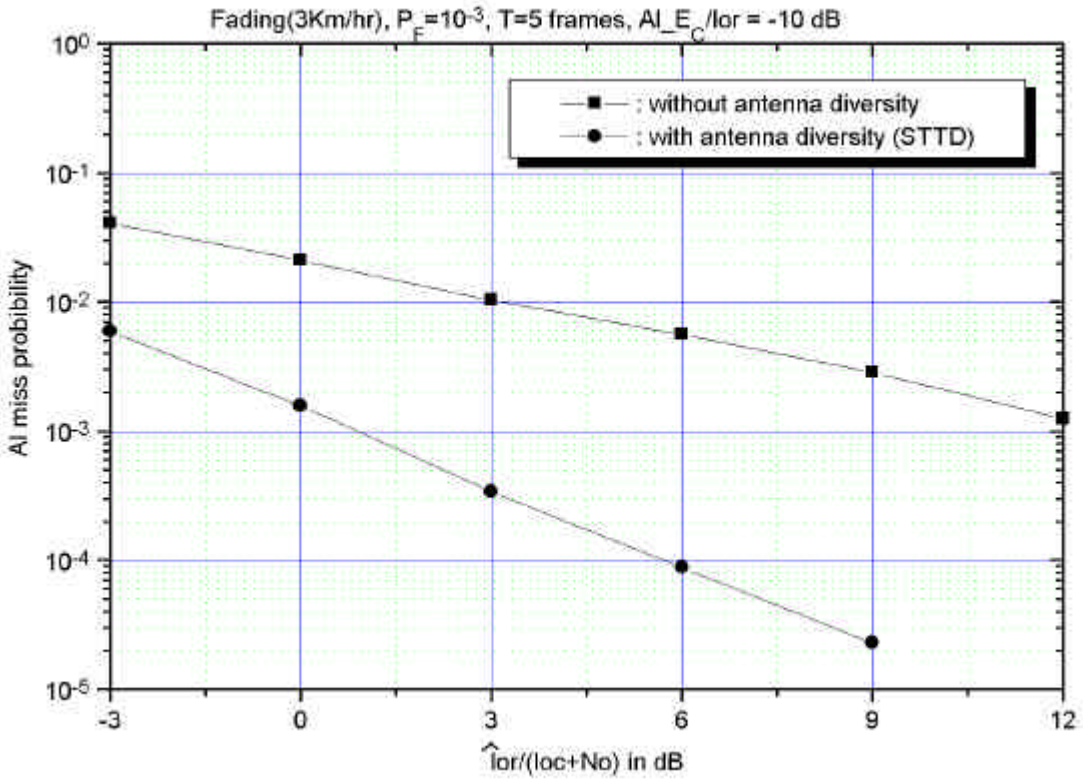


Simulation condition for AI detection mode in downlink

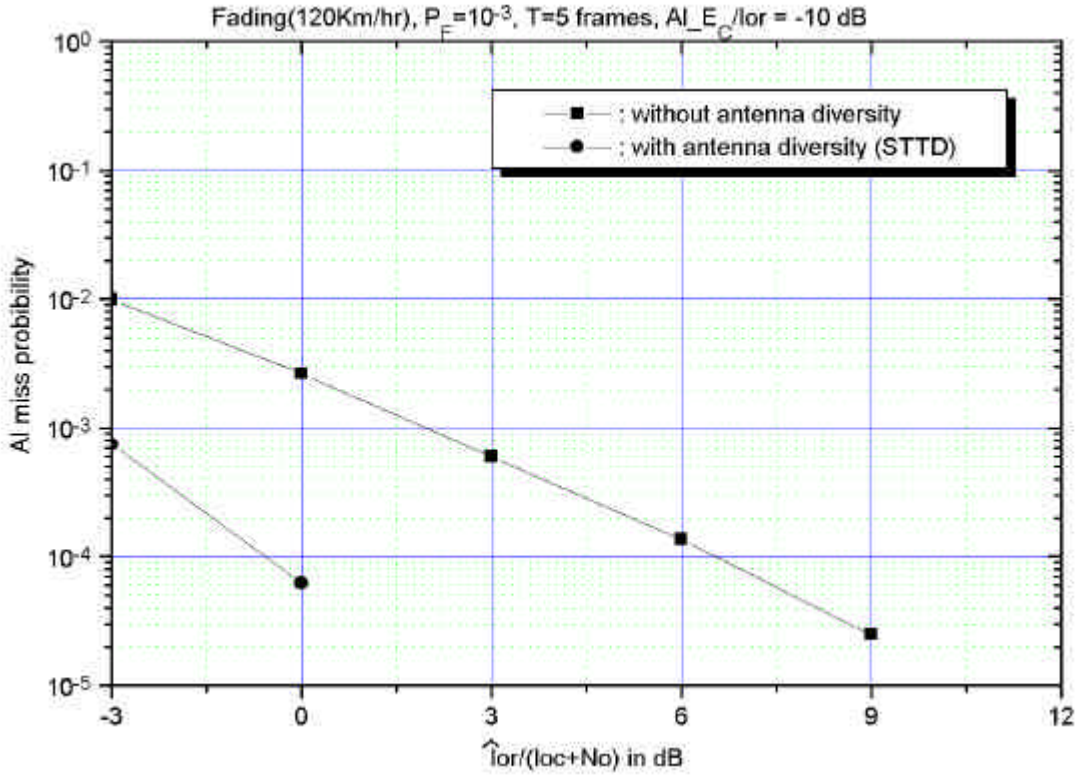


- AI length : 4096 chips
- AICH_Ec/Ior : test dependent
- CPICH_Ec/Ior : -10 dB (fixed)
- Detection method : coherent detection based on channel estimates using CPICH
- Channel estimation : 512 chips coherent integration of CPICH channel
- $\hat{I}_{or}/(I_{oc}+N_0)$: test dependent
- Single path fading channel (Jake's model)
- Optimal sampling
- Frequency offset is "0" Hz
- When the Tx diversity is employed, the power is evenly distributed.

Detection probability of AI



Detection probability of AI



Enhancement of AI detection performance

- Retransmission of AI can significantly reduce the AI miss probability
- It is possible to repeat all the attempt when handover miss event occurs.
- But as we can see from the simulation results, the AI detection performance is good especially for the STTD encoding in spite of no retransmission of AI.
- The influence of AI transmission to downlink capacity is negligible because the AI is transmitted only one (or two in case of retransmission) for an UE which is preparing the interfrequency hard handover.

Conclusions (Advantages of proposed method)

- The target BS can acquire the uplink synchronization using the preamble before the handover execution so that there is no loss of frame in the uplink.
- The UTRAN(SRNC) can calculate the frame offset before the handover execution so that there is no loss of frame (TTI disconnection) in the downlink as well as in the uplink even though the UTRAN does not know the frame offset.
- By using the power ramping strategy for transmitting the preamble, the initial DPCH transmit power from the UE after frequency change can be adjusted.

Conclusions (proposal)

- In this contribution, it is shown that there is a room for radio link performance improvement in inter frequency hard handover, and a possible solution is identified.
- Considering the room for improvement, we propose to make a work item for the enhancement of interfrequency hard handover for Release 5.