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Title: Comparison of soft handover schemes for USTS

Document for: Information & Discussion

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1. Introduction

Soft handover even in low mobility environments is required so that the handover for USTS was issued at WG1 #14 in Oulu. Three candidates of soft handover schemes for USTS were mentioned in [1] and have been proposed in [2]. One is USTS mode to Normal, and the others are USTS to USTS. In this contribution, the latter of USTS to USTS handover schemes are investigated and compared with each other.

2. Proposed Soft Handover Schemes

Three candidates of soft handover have been proposed for USTS [2]. They are categorized by

Origin	Soft handover region	Target
a) USTS	Normal (origin) + Normal (target)	Normal
b) USTS	USTS (origin) + non-USTS (target)	USTS
c) USTS	USTS (origin)+non-USTS (target) ? non-USTS (origin)+USTS (target)	USTS

Normal mode means that Node B does not support USTS (R99 or R4). USTS means that Node B supports USTS (R5). In non-USTS, Node B supports USTS but timing synchronization is not kept any longer. If the target cell supports USTS, soft handover b) or c) can be operated in R5-Node Bs. In this contribution, the procedures and the considerations of soft handover b) and c) are investigated and compared.

In [2], the soft handover procedure for b) is described in detail. However, for the scheme c), there are only simple notes. In sections 2.1 and 2.2, the soft handover procedure for c) is explained and the differences with b) are mentioned.

2.1 Procedures

Figure 2.1 shows the handover procedure c) in two-cell layout. Both Node Bs are operated in USTS. UE1 and UE2 are operated in USTS with Node B #1 and Node B #2, respectively. Let us focus on UE0 with interest. When UE0 is operated in USTS with Node B #1, UE0 gets scrambling code (Scr11) and channelisation code (Ch3) from Node B #1. When UE0 enters into the handover process, the radio link in non-USTS mode with Node B #2 is set up. Note that only Node B #1 controls the transmit timing of UE0, which uses the same codes and is operated in USTS with Node B #1. While UE0 exists in the soft handover region, the reconfiguration process is required to assign new scrambling code (Scr21), channelisation code (Ch11) and timing adjustment for non-USTS to USTS transition in Node B #2. Also USTS

to non-USTS transition in Node B #1 is required to preserve the reliability from soft handover. The required timing adjustment for new USTS link can be obtained by RTPD and Tref in the same manner with b). Timing of non-USTS link in Node B #1 is acquired by the new USTS time adjustment and the time difference between Node B #1 and Node B #2. Finally, UE0 releases the radio link with Node B #1 when the UE0 does not need soft handover and soft handover process is completed. Figure 2.2 shows an example of the flow chart for soft handover c).
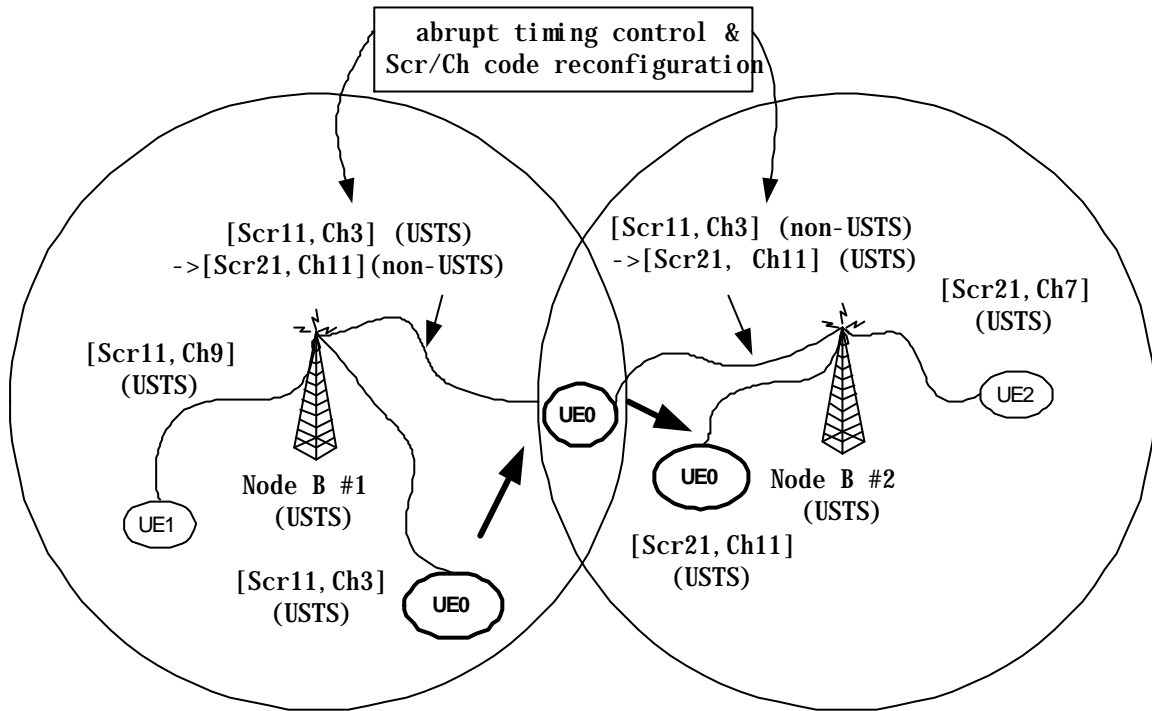

Figure 2.1 Two-way soft handover procedures for candidate c)

2.2 Considerations

The proposed soft handover schemes b) and c) need the timing adjustment and code assignment process, in order to operate in USTS mode at target Node B. The reason why both timing adjustment and code assignment are operated is to get performance gains from orthogonalty by USTS. The criterion that makes the reconfiguration process be operated is different in b) and c). In scheme b), it is whether UE exists inside handover region or out of the region. However, the reconfiguration process occurs inside the soft handover region in c). Even though the detailed procedures are beyond WG1's interests, UTRAN can select the proper timing for the reconfiguration process, because it selects the better frame between the two possible candidates within RNC, or knows the number of UEs in USTS mode at each Node B and pilot signal power of each UE from the reception of the measurement. The scheme c) can provide more reliable USTS link at target Node B, because the UE obtains better channel conditions during handover process. As well, there would be more interferences of a UE penetrating into target Node B without being timing alignment by USTS in b) comparing with c). That is because the timing change of target Node B always occurs outside the handover region. Such effects are more important in three-way soft handover. Figure 2.3 shows three-cell layout for candidate b). When a UE gets out of USTS area with Node B #1, it should be decided whether USTS would be operated with Node B #2 or Node B #3 in soft handover region. In addition, non-USTS link should be set-up with the other Node B to keep the soft handover. Therefore, the reconfiguration process needs for candidate b) in three-way soft handover

operation like scheme c). As well, there exist more chances to operate the soft handover in c) for three-cell situation than in b), which can reduce the interferences to target Node Bs and improve the link performances. Ping-pong effects can be reduced by hysteresis as a similar manner with the handover method in Release 99. As explained above, the handover c) may give more reliable performance. However, complexity is expected to increase because the reconfiguration process needs to happen at original Node B. If USTS to non-USTS transition in original Node B does not happen, then the scheme c) is the same with b) except the point that handover takes place inside the handover region. Thus, the scheme c) is a more general approach of soft handover for USTS.
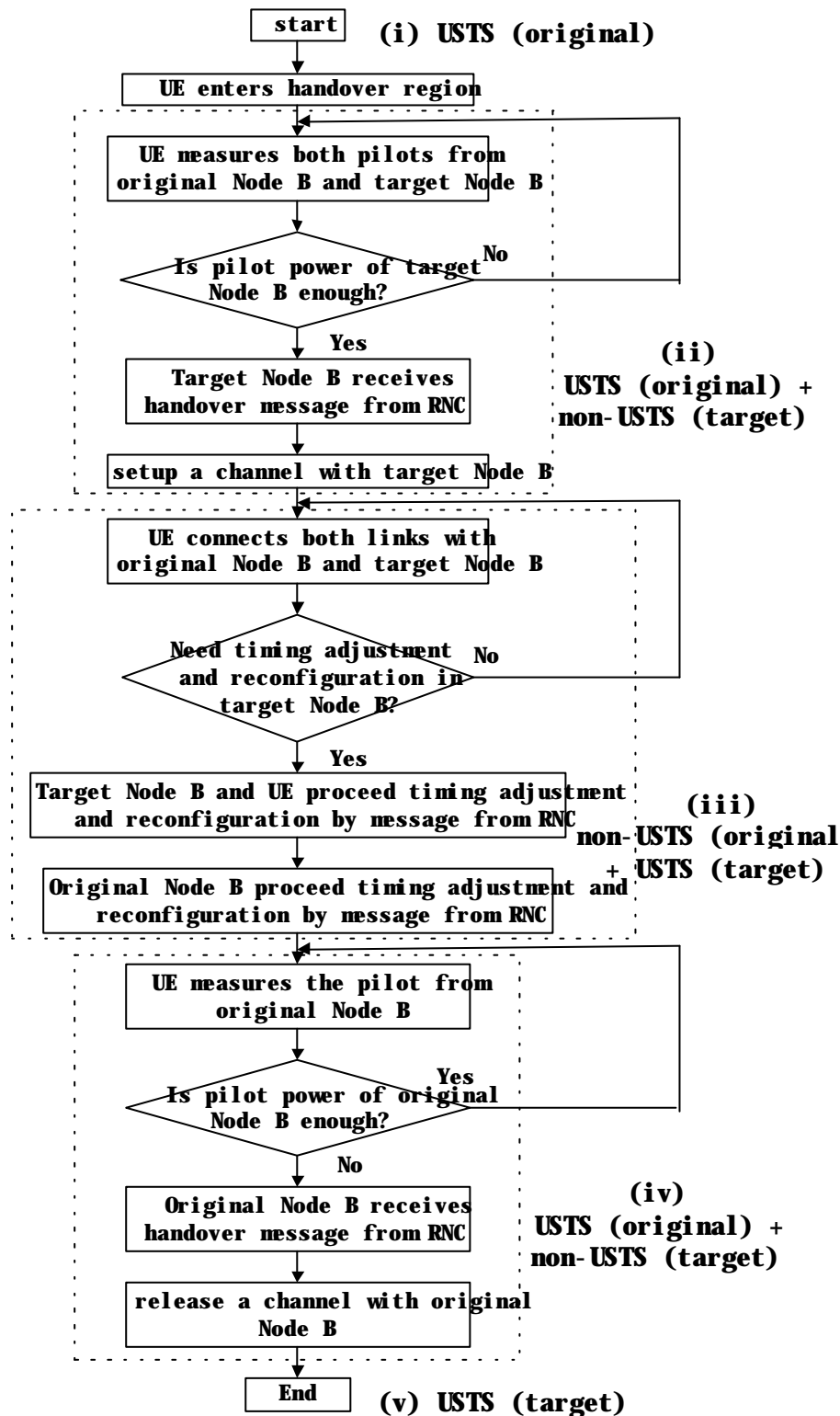
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                    ┌─────────┐
                    │  start  │   (i) USTS (original)
                    └────┬────┘
              ┌──────────┴──────────┐
              │ UE enters handover region │
              └──────────┬──────────┘
    ┌─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┼ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─┐
    │         ┌──────────┴──────────┐                          │
    │         │  UE measures both pilots from │
    │         │ original Node B and target Node B │◄───────────┤
    │         └──────────┬──────────┘                          │
    │                    │                                     │
    │              ◇ Is pilot power of target ◇  No            │
    │              ◇   Node B enough?        ◇ ───────────────►│
    │                    │ Yes                                 │
    │         ┌──────────┴──────────┐            (ii)          │
    │         │  Target Node B receives │      USTS (original) + │
    │         │ handover message from RNC │    non-USTS (target) │
    │         └──────────┬──────────┘                          │
    │         ┌──────────┴──────────┐                          │
    │         │ setup a channel with target Node B │           │
    │         └──────────┬──────────┘                          │
    └─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┼ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─┘
    ┌─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┼ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─┐
    │         ┌──────────┴──────────┐                          │
    │         │  UE connects both links with │◄────────────────┤
    │         │ original Node B and target Node B │             │
    │         └──────────┬──────────┘                          │
    │              ◇ Need timing adjustment ◇  No              │
    │              ◇ and reconfiguration in ◇ ─────────────────┤
    │              ◇    target Node B?      ◇                  │
    │                    │ Yes                                 │
    │    ┌───────────────┴───────────────┐                     │
    │    │ Target Node B and UE proceed timing adjustment │   (iii)
    │    │  and reconfiguration by message from RNC │  non-USTS (original
    │    └───────────────┬───────────────┘        + USTS (target)
    │    ┌───────────────┴───────────────┐                     │
    │    │ Original Node B proceed timing adjustment and │     │
    │    │  reconfiguration by message from RNC │             │
    │    └───────────────┬───────────────┘                     │
    └─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┼ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─┘
    ┌─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┼ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─┐
    │         ┌──────────┴──────────┐                          │
    │         │  UE measures the pilot from │◄─────────────────┤
    │         │     original Node B    │                       │
    │         └──────────┬──────────┘                          │
    │              ◇ Is pilot power of original ◇  Yes         │
    │              ◇    Node B enough?       ◇ ────────────────┤
    │                    │ No                                  │
    │         ┌──────────┴──────────┐            (iv)          │
    │         │  Original Node B receives │    USTS (original) + │
    │         │ handover message from RNC │    non-USTS (target) │
    │         └──────────┬──────────┘                          │
    │         ┌──────────┴──────────┐                          │
    │         │ release a channel with original │             │
    │         │          Node B       │                        │
    │         └──────────┬──────────┘                          │
    └─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┼ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─┘
                    ┌────┴────┐
                    │   End   │  (v) USTS (target)
                    └─────────┘
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Figure 2.2 An example of flow chart for the soft handover of candidate c)
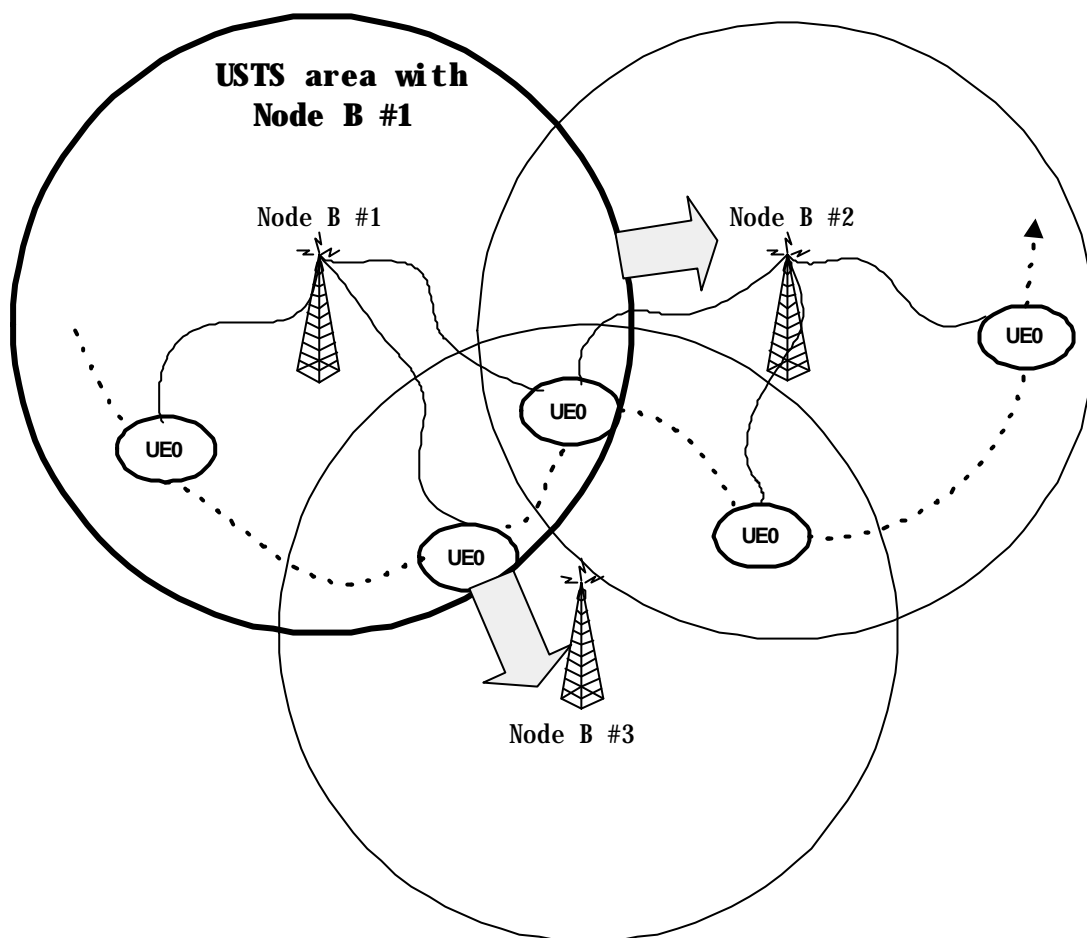
Figure 2.3 Three-way soft handover situations for candidate b)

3. Conclusions

We have discussed soft handover schemes for USTS, in which both original and target Node Bs are operated in USTS. The handover process of c) becomes seamless and general, and reduces interferences to target Node B. Thus, the scheme can give more reliable handover performance. However, the impacts on WG2/3 should be considered to clarify the handover procedures for standardization phase. At present, USTS is a study item, which deals with its feasibility. Thus, there is no reason to limit its study scope into a specific region. We propose that the texts in this contribution will be included in the study report for USTS.

4. References

[1]   TSG WG1#16 R1-00-1263, Feasibility study on USTS, SK Telecom.

[2]   TSG WG1#17 R1-00-1380, Study report for USTS, SK Telecom.