3GPP TSG RAN Working group 1 meeting #3 TSGR1#3(99)-175
Eskilstuna, Sweden 22-26, March 1999

Agenda Item : **9.1**

Source : **SONY International (Europe) GmbH**

Title : **Slotted mode in UTRA FDD downlink**

Document for: **Decision**

1. Introduction

In the FDD mode of UTRA it is required that interfrequency and intersystem handover decisions are carried out using slotted transmission. Slotted transmission requires that half a frame is available for measurement and therefore to support all services during slotted mode the information transmitted must be transmitted in half the normal time (5ms). Both uplink and downlink slotted modes have been discussed for UTRA FDD mode, however, we shall only discuss here issues related to the downlink.

Several solutions have been proposed for the downlink slotted mode. In this contribution the advantages and disadvantages of the proposed solutions will be compared.

2. Proposed Solutions

2.1 Proposal 1 - Reduce processing gain

This method which is shown in Figure 1 is the original proposed method as presented in [1]. With this method either the spreading factor is reduced by a factor of 2 or the code rate is changed. To compensate the transmitted power is increased. The location of the idle period can vary. Figure 1 only shows the situation where the idle time is in the middle of the slot.

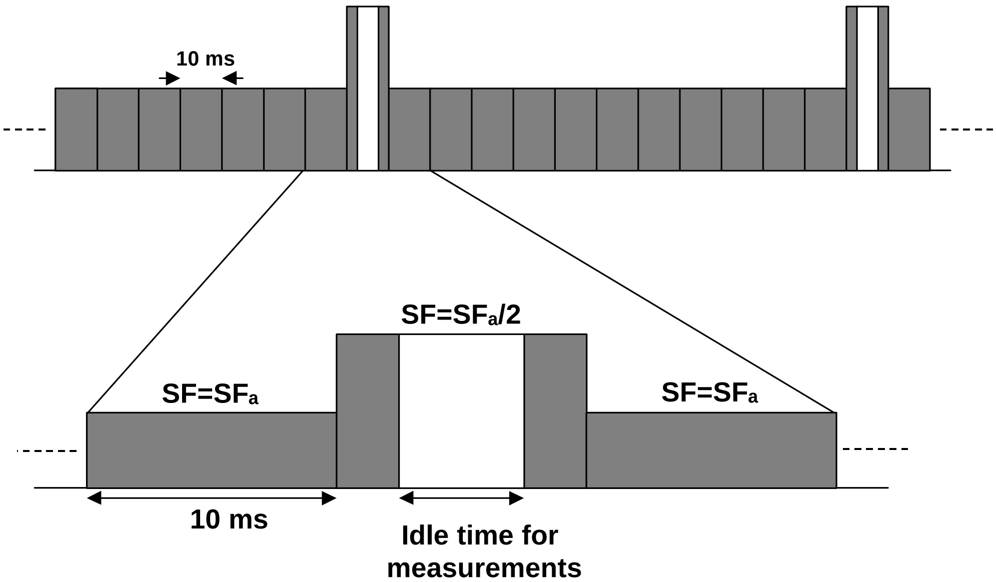

Figure 1 Slotted Mode - Reduction of Processing Gain

There are two drawbacks to reducing the spreading factor:

i) The number of available codes is decreased, which increases the downlink code shortage problem.

ii) Not all services are able to use slotted mode, since the lower spreading factor at the higher location in the code tree may not always be available.

2.2 Proposal 2 - Reduce spreading factor and change to different scrambling code

To solve the increased code shortage problem, caused by reducing the processing gain in slotted mode, it has been proposed to use codes from a non-orthogonal code set [2]. To obtain this non-orthogonal code set a number of different scrambling codes have been proposed.

The rule for determining these new scrambling codes can be explained by examining Figure 2. If the present physical channel is presently being spread by the $c_{4,3}$ channelisation code and scrambled by code C_1 for normal transmission, it would be spread by channelisation code $c_{2,2}$ and scrambled by scrambling code $C_{1,2}$ in slotted mode. If however, the present physical channel is presently being spread by the $c_{4,4}$ channelisation code and scrambled by scrambling mode C_1 for normal transmission, it will be spread by channelisation code $c_{2,2}$ and scrambled by scrambling code $C_{1,1}$ in slotted mode.

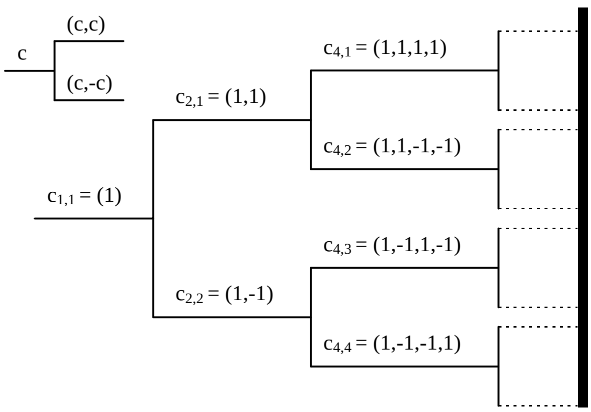

Figure 2 Channelisation code tree

There are two drawbacks to this proposal:

i) The use of the different scrambling code with the higher power (needed for the reduced spreading factor) causes interference to all other users during the slotted frame.

ii) When using this approach in conjunction with multicode reception more scrambling code generators are used in the mobile station. This case is illustrated by the following example:

Lets say mobile 1 is using spreading $c_{4,3}$ and $c_{4,4}$ (multicode reception) and scrambling code $C_{1.}$

When mobile 1 switches to slotted mode it will use spreading $c_{2,2}$ with scrambling $C_{2,1}$ and

Spreading $c_{2,2}$ with scrambling code $C_{2,2}$.

2.3 Proposal 3 - Constant spreading factor and parallel additional scrambling code

This idea which was originally presented by Philips [3] uses a parallel additional scrambling code as seen in Figure 3. It is important to note that the processing gain of the data streams carried by the primary and secondary scrambling remains fixed. (i.e the spreading factor is not reduced in the slotted frame.)

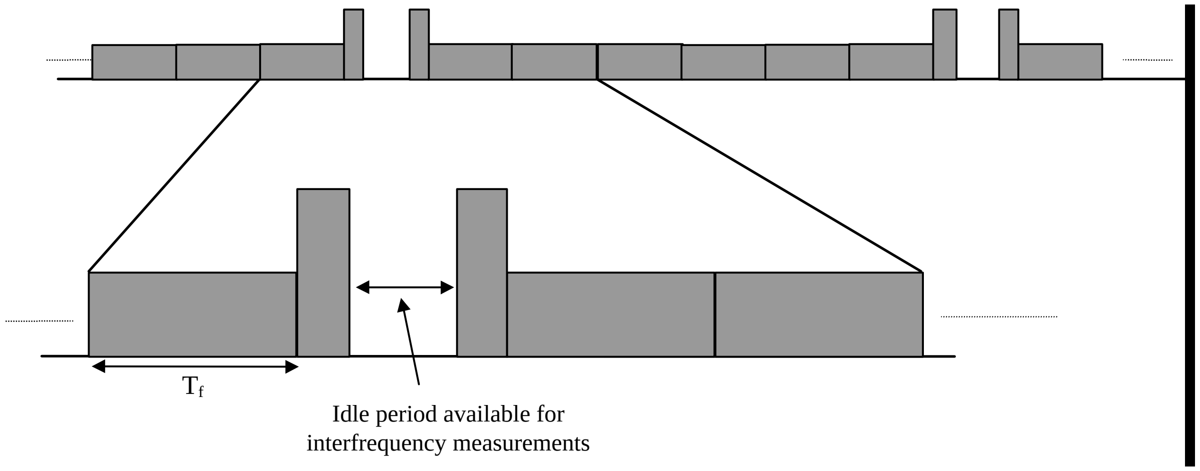

Figure 3 Slotted mode using parallel additional scrambling code

When this is compared to proposal 2 (see Figure 4), it can be seen that the power of the non-orthogonal codes (which are transported by the different scrambling code) are twice the power of the non-orthogonal codes in proposal 3 (see Figure 3). The non-orthogonal codes are shown by the white sections.

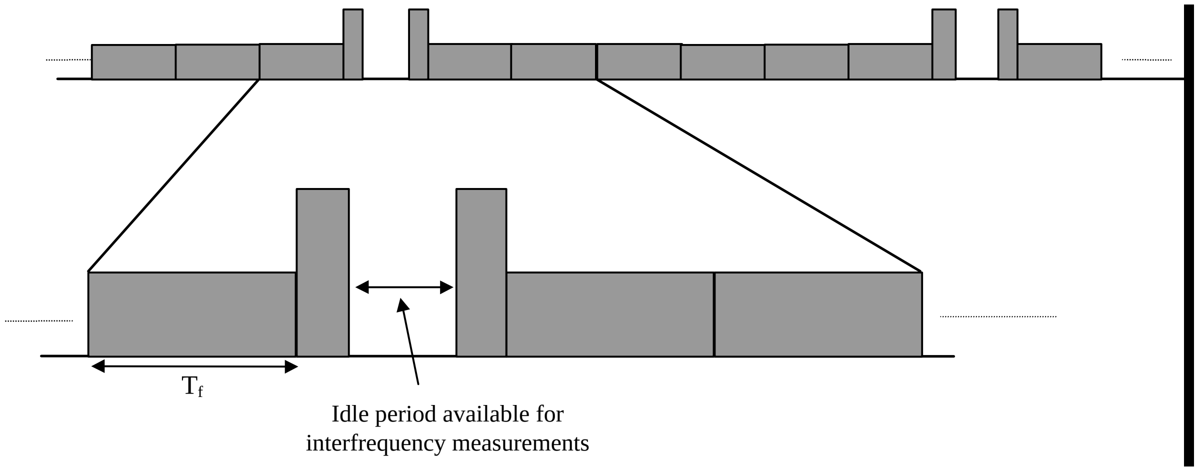

Figure 4 Slotted mode using different scrambling code

Further to this, as the data in the slotted mode is transmitted by two scrambling codes there is greater flexibility in assigning the power levels and codes to each of the scrambling codes. This issue was also highlighted in [3].

The only disadvantage of this proposal is that an extra scrambling code generator will be used at the mobile station.

3. Summary

The advantages and disadvantages of the different approaches are summarised in Table 1.

As can clearly be seen from the table, proposal 3 offers the best solution since interference is reduced compared to proposal 2, there are also no code shortage problems and flexibility in allocating the power levels is improved.

Table 1 - Summary of the advantages and disadvantages of the different proposals

	Advantage	Disadvantages
Proposal 1 - Reduction of spreading factor.		- Increase code shortage problem. - Certain services may not be able to support slotted mode. - Reallocation of orthogonal code resource during slotted frame.
Proposal 2 - Reduction of spreading factor and different scrambling code.	- No code shortage Problem. - All services supported.	- Increased interference during slotted frame. - Reloading of scrambling code generator at the start and end of slotted frame. - Additional scrambling code generator used for multicode reception.
Proposal 3 - Fixed spreading factor and additional parallel scrambling code.	- No code shortage problem. - All services supported. - Decreased interference compared to proposal 2. - Greater flexibility in assigning power levels of scrambling codes.	- Additional scrambling code generator used for single code and multicode operation.

It is important to note that a UMTS mobile will contain a number of scrambling code generators since they are also needed for soft and softer handover.

4. Recommendations

Due to the reduction of interference and increase of flexibility, proposal 3 should also be included as an option for slotted mode as proposal 2 is at the moment in [4]. Furthermore, simulations should be performed for these proposals to clarify the impact on the system performance.

[1] XX.04-07.1 “UTRA FDD, multplexing, channel coding and interleaving description”, ETSI SMG2 UMTS-L1 meeting #10, Jan 18th, Espo, Finland.

[2] “Slotted mode concept usage in UTRA / FDD”, Tdoc SMG2 UMTS-L1 538 / 98, Ericsson.

[3] “Use of multiple downlink scrambling code”, Tdoc SMG2 UMTS L1 532 / 98, Philips Consumer Communications / Philips Research Laboratories.

[4] “FDD, multiplexing, channel coding and interleaving description”, TSGR1#2(99)050, TSG-RAN working Group 1 meeting #2, Yokohoma 22-25, Feburary 1999.