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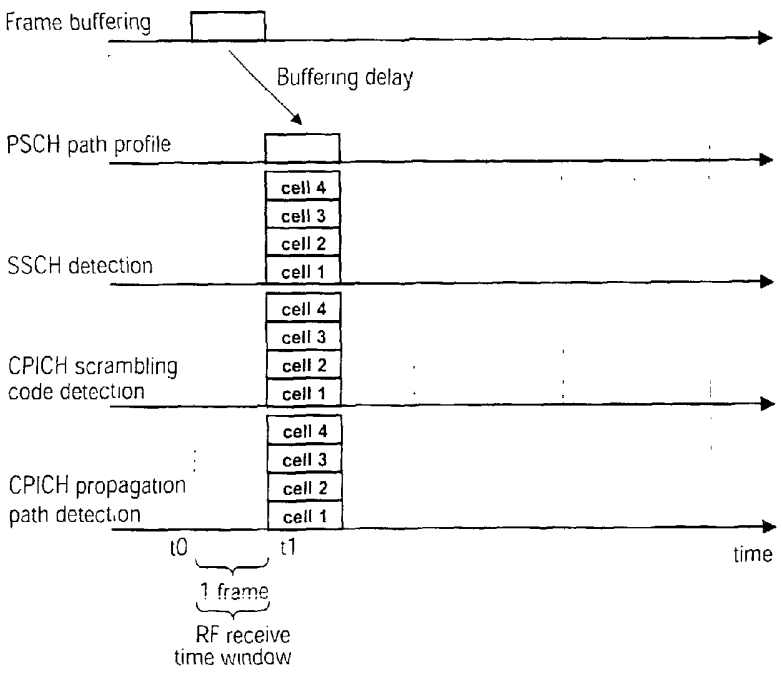
(54) Title: METHOD OF CONNECTING AN UMTS MOBILE RADIO TO A NETWORK



(57) Abstract: To achieve a shortening of the initial synchronization time and/or extension of the stand-by time with a method of connecting an UMTS mobile radio to a network, the UMTS mobile radio receives and stored in one or more time-limited RF receive windows the signals that are subsequently evaluated when the HF receiver is switched off.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Method of connecting an UMTS mobile radio to a network

The invention relates to a method of connecting an UMTS mobile radio to a network, more particularly of shortening the initial synchronization time and/or extending the standby time of an UMTS mobile radio, the UMTS mobile radio, when its HF receiver is switched on, receiving signals from the base stations around it on various physical channels of the UMTS (Universal Mobile Telecommunication System), which signals are particularly used for initial synchronization, neighbor cell measurement and paging reception and occur in certain frames of the UMTS.

Such a method is known from technical specification 3 GPPTS 25.214 V3.10.0 (2002 to 2003), more particularly Annex C, p.49, and from the title WCDMA for UMTS, Radio Access For Third Generation Mobile Communications, Harri Holma, Antti Toskala, John Wiley & Sons, Ltd., Chichester, New York, Weinheim, Brisbane, Singapore, Toronto.

Contrary to the GSM system, UMTS has CDMA (code-division multiple access). The information is then always simultaneously available in the various physical channels. The various physical channels are particularly used for the initial synchronization, for the neighbor cell measurement and the paging reception. The channels are in particular:

- PSCH primary synchronization channel
- SSCH secondary synchronization channel
- CPICH common pilot channel
- PICH paging indication channel
- PCH paging channel,

where further channels are added for further functions which, however, may be ignored in this context.

With mobile radios the standby time, that is the period of time up to the necessary recharging of the battery, is an important property of use. Mobile radios usually switch to an energy-saving mode when there is no active speech or data connection. However, the mobile radio is to periodically receive information from the network to be informed of an incoming call and to establish changes of base stations in the environment.

For this purpose the high-frequency (HF) receiver of the mobile radio is to be switched on. The standby time is determined by the power consumption of the HF receiver. The power consumption of the HF receiver is high compared to the other systems of the mobile radio. The shorter the HF receiving windows are the longer will be its availability.

The time necessary for an initial synchronization of the mobile radio is to be short so that the mobile radio, once it has changed its location, finds a network connection in minimal time and goes to the standby mode.

In UMTS mobile radios the greater part of the signal processing functions is usually implemented in real-time hardware. Due to the high data rate at the input of the digital baseband receiver of the UMTS mobile radio, the incoming data are processed as they come in (on the fly). Only the final results of the respective bills are stored. All processing steps which need information from previous steps are executed sequentially. During this time the HF receiver is to be switched on. Since the sequential processing requires a long time, the RF receive window is to be equally long. Due to the high power consumption when the HF receiver is switched on, the standby time is reduced accordingly. This holds both for the initial synchronization and for the neighbor cell measurement and paging reception to be executed during the standby time.

It is an object of the invention in a method of the type defined in the opening paragraph to shorten the initial synchronization time and/or lengthen the standby time.

The above object is achieved by the features of the characterizing part of claim 1.

In a time-limited receive window the signals of all interesting channels are received simultaneously and stored. At the beginning of the receive window the HF receiver is switched on. At the end of the receive window the HF receiver is switched off. The evaluation of the stored signals then takes place when the HF receiver is switched off, thus in a time in which the power consumption of the mobile radio is comparatively low. All in all this leads to a lengthening of the standby time. The digital signal processing thus takes place off-line.

In addition to the shortening of the initial synchronization time and the lengthening of the standby time there are the following further advantages:

a) since the same receiving data are used for the various processing steps, it is very simple to keep intermediate results consistent, which is problematic with a real-time

hardware solution because the channel conditions may change significantly between the processing steps;

b) because of the off-line processing and data buffering, the digital signal processing can clearly be scaled more flexibly and planned and executed in time than in conventional UMTS mobile radios. This allows to carry out the processing efficiently in dependence on the respective conditions.

The RF receive window preferably has the time length of a frame of the UMTS. This frame is 10 ms long. The RF receive window, however, may also have a variable length of time in dependence on the receiving conditions.

These and other aspects of the invention are apparent from and will be elucidated with reference to the embodiments described hereinafter.

In the drawings:

Fig. 1 shows the idealized time ratios with a usual UMTS initial synchronization;

Fig. 2 shows the time ratios with an initial synchronization according to the invention;

Fig. 3 shows the usual time ratios periodically recurring during the standby time for a paging signal and a neighbor cell measurement for UMTS;

Fig. 4 shows the ratios occurring during the standby time with a method according to the invention;

Fig. 5 shows a further possibility where it is assumed that the respective mobile radio is not called by the paging signal and that the measuring period of the neighbor cell measurement is longer than the paging period.

In Figs. 1 to 4 only three relevant neighbor cells are assumed to simplify the drawing. In practice, up to 32 neighbor cells are to be captured.

The basic method for the initial synchronization in conventional UMTS mobile radios is the following (compare Fig. 1):

1. The user switches the mobile radio on at a random instant t0. In a first step the primary synchronization channel (PSCH) is evaluated to find all propagation paths of all the base stations or cells respectively in the environment. This first step is made in any one of the predefined UMTS frames that lasts 10 ms. With the data information transmitted over the

PSCH it is not possible yet to distinguish the various base stations and establish the start of the UMTS frame.

2. Therefore, propagation paths that seem to be effective as regards their power are selected from the number of propagation paths found in the first step. Based on this selection the scrambling code group and the position in time of the frame i.e. the frame timing of the base station that belongs to the selected paths is identified in the secondary synchronization channel (SSCH). The evaluation of the SSCH starts around instant t1 after the first frame and lasts again 1 frame up to instant t2.

3. In a third step the selected paths are identified as regards their timing and as regards the scrambling code group of the respective base station (cell 1) via the common control channel, the so-called common pilot channel (CPICH).

4. In a fourth step, beginning at instant t3, all the paths occurring in a certain time interval are detected with the aid of the CPICH. The paths found are struck off a path list and earmarked. Then said steps are executed for further paths of the neighboring base stations (cell 2, cell 3, cell 4) which lasts until instant t5. At instant t4 the initial synchronization has then been carried out. During the period of time T between instant t0 and t4 the HF receiver of the mobile radio is to be switched on. This time ideally lasts at least 7 frames i.e. 70 ms. In practice this may even be several minutes if the mobile radio in switched-off mode is brought within range of remote base stations.

In contrast to this, the initial synchronization according to the suggested solution is carried out in the following way (compare Fig. 2).

The user switches the UMTS mobile radio on at a random instant. After a certain build-up time at instant t0 a memory of the mobile radio receives all the information occurring in a single frame of the PSCH, SSCH, CPICH of the accepted four cells (compare frame buffering in Fig. 2). This takes place in the period of time t0 to t1, within a single frame i.e. 10 ms. At the instant t1 the HF receiver switches off. The period of time Ta between t0 and t1 is the receive window. The stored information is evaluated after the instant t1 in the mobile radio while the HF receiver is switched off.

Comparison of the Figs. 1 and 2 shows that with the method shown in Fig. 2 the necessary receive window is shorter by a factor of 7 than with the method shown in Fig. 1.

In the standby mode most components of an UMTS mobile radio are normally switched off to save current. They are activated periodically for receiving pagings i.e. call

announcements and system measurements with respect to neighbor cells. The basic method in the commercial UMTS receivers is in essence the following (compare Fig. 3):

1. The mobile radio periodically resynchronizes in the standby mode with the current base station or cell of the network determined during the previous initial synchronization. In the following example this is cell 1. Generally, not always a complete initial synchronization is carried out because this complete initial synchronization is not necessary, but only a path search is made on the CPICH (compare Fig. 3, CPICH propagation path detection on serving cell). This operation lasts 1 frame i.e. 10 ms.

2. Subsequently, the paging reception is executed (compare Fig. 3 paging reception), which takes place on a higher-order paging channel, on the paging indication channel (PICH) and on the special paging channel, the so-called paging channel (PCH). The PICH relates to a group of mobile radios and the PCH then pages a single mobile radio from this group. The PCH completely contains the concrete identification number of the mobile radio to be paged.

A measurement of the neighbor cells cell 2, cell 3, cell 4 starts simultaneously with the evaluation of the paging signals on the channels PICH, PCH. The paging period lasts at least 8 frames (not shown in Fig. 3). In the method shown in Fig. 3 the HF receiver is to be switched on for at least four frames in a paging period that contains eight frames.

In the method according to the invention, on the other hand, the procedure is as follows (compare Fig. 4):

1. The HF receiver is switched on at a defined instant t0' shortly before the necessary information of the PCH is transmitted by the base station.

2. After a build-on time of the receiver the complete information of a frame of the UMTS signal is received and stored in the mobile radio. This is effected between the instants t0' and t1' (compare fig. 4 frame buffering).

3. The HF receiver is again switched off after the end of one frame, at t1'. The frame situated between t0' and t1' is stored. The information contained therein and dealing with the respective channels can then further be processed while the HF receiver is switched off (compare Fig. 4 processing time window).

4. The information contained in the PICH may be ignored because the necessary information is also available on the PCH.

The received data are used for resynchronization with the serving cell of the network. By means of the data received between t0' and t1' also the necessary UMTS system measurements of the neighbor cells are evaluated.

The comparison of the examples of embodiment described (compare Figs. 3, 4) shows that with the method according to the invention shown in Fig. 4 the RF receive window is shorter by a factor of 4 than with the method shown in Fig. 3, which means a considerable lengthening of the standby time. The proposed solution allows the shortening of the RF receive window by the number of the neighbor cells. If, in addition, the gap between the PICH signal and the PCH signal is ignored, a further reduction of the switch-on time of the HF receiver can be achieved if the UMTS measuring period for the neighbor cell measurements is longer than the paging period (compare Fig. 5).

In Fig. 5 are shown a paging period PP which comprises 8 to 512 frames and a measuring period MP used for the neighbor cell measurement, which lasts 8 paging periods. PICH and PCH signals occur in each paging period. HF receive time windows (RF receive windows) are found in each PICH signal and only in one PCH signal of the measuring period MP. Further to the respective RF receive window, as also found in fig. 4, the post-synchronization with the serving cell (compare Fig. 5 CPICH propagation path detection on serving cell), the paging evaluation (compare Fig. 5 paging processing) and the neighbor cell measurement (compare Fig. 5, CPICH system measurements on neighbor cells). The RF receive windows are 533 µs long at the most in PICH. The RF receive window has the length of a frame in PCH. After storage, the signals are processed off-line, as is described. The total RF receive time is 10 ms + 7 x 533 µs i.e. 13.73 ms. Compared with the 8 frames (80 ms) which are needed for a full PCH reception, this is a further saving by the factor of 80/13.73 = 5.82.

The RF receive windows need not have the time length of one frame. They may also be shorter or longer or variable. For example, the RF receive window may be selected to be as long as the longest individual processing step lasts to completely store this information for the next evaluation.

CLAIMS

1. A method of connecting an UMTS mobile radio to a network, more particularly of shortening the initial synchronization time and/or extending the standby time of an UMTS mobile radio, the UMTS mobile radio, when its HF receiver is switched on, receiving signals from the base stations around it on various physical channels of the UMTS (Universal Mobile Telecommunication System), which signals are particularly used for initial synchronization, neighbor cell measurement and paging reception and occur in certain frames of the UMTS, characterized in that the signals lying in one or more RF receive windows are received by the UMTS mobile radio and storaed and after storage of the signals of the RF receive windows the HF receiver is switched off and in that, subsequently, when the HF receiver is switched off the stored signals are evaluated in the UMTS mobile radio.

2. A method as claimed in claim 1, characterized in that the RF receive window has at most the time length of the individual processing step that lasts longest.

3. A method as claimed in claim 1 or 2, characterized in that the RF receive window at most has the time length of one frame of the UMTS.

4. A method as claimed in any one of the preceding claims, characterized in that the RF receive windows have a variable time lengt in dependence on the receive conditions.

5. A method as claimed in any one of the preceding claims, characterized in that for an initial synchronization the HF receiver is switched on at a random instant and in that after a build-up time a frame of the UMTS signal from the base stations is received and stored.

6. A method as claimed in any one of the preceding claims, characterized in that in the standby mode of the UMTS mobile radio the HF receiver is periodically switched on at defined instants to receive paging signals (PICH, PCH) and carry out a neighbor cell

synchronization while the defined instants are shortly before the reception of the necessary PCH (paging channel) information.

7. A method as claimed in any one of the preceding claims, characterized in that the PICH (paging indication channel) is ignored i.e. its information is not received and stored if the PCH (paging channel) is received and stored in the received frame.

8. A method as claimed in any one of the preceding claims, characterized in that the moment when a measuring period in which particularly the neighbor cell measurement takes place longer than the paging period, the PCH is received and stored and evaluated only once per measuring period and otherwise in each paging period only the PICH is stored and evaluated.

9. A mobile radio that receives signals from the neighboring base stations when its HF receiver is switched on, which signals occur in certain frames, characterized in that the mobile radio receives and stores the signals situated in one or more RF receive windows and the HF receiver is switched off after the signals of the RF receive window or RF receive windows are stored and in that, subsequently the stored signals are evaluated in the mobile radio while the HF receiver is switched off.

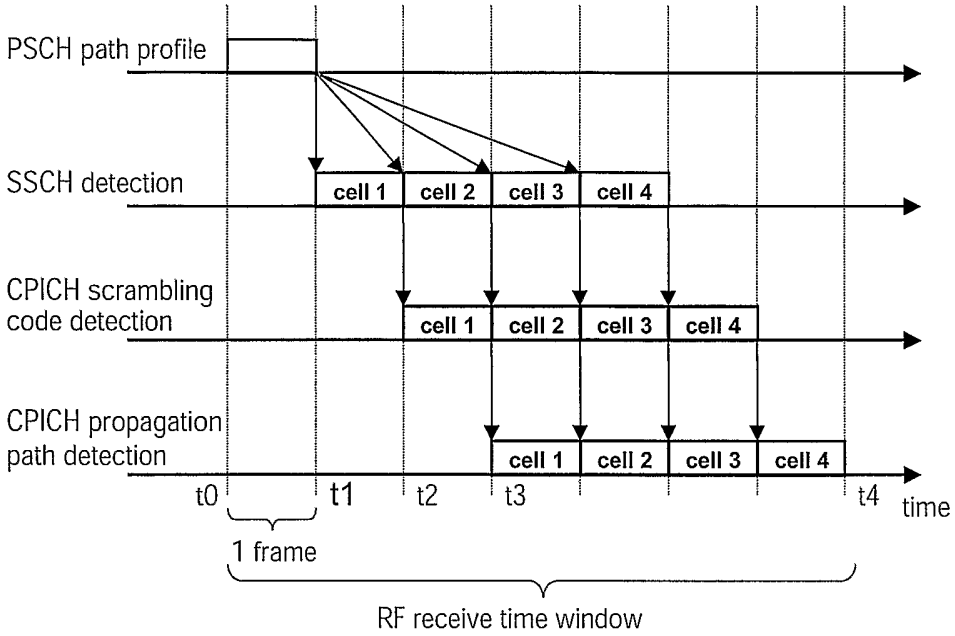
PSCH path profile
SSCH detection
cell 1
cell 2
cell 3
cell 4
CPICH scrambling code detection
CPICH propagation path detection
t0
t1
t2
t3
t4
time
1 frame
RF receive time window

FIG.1

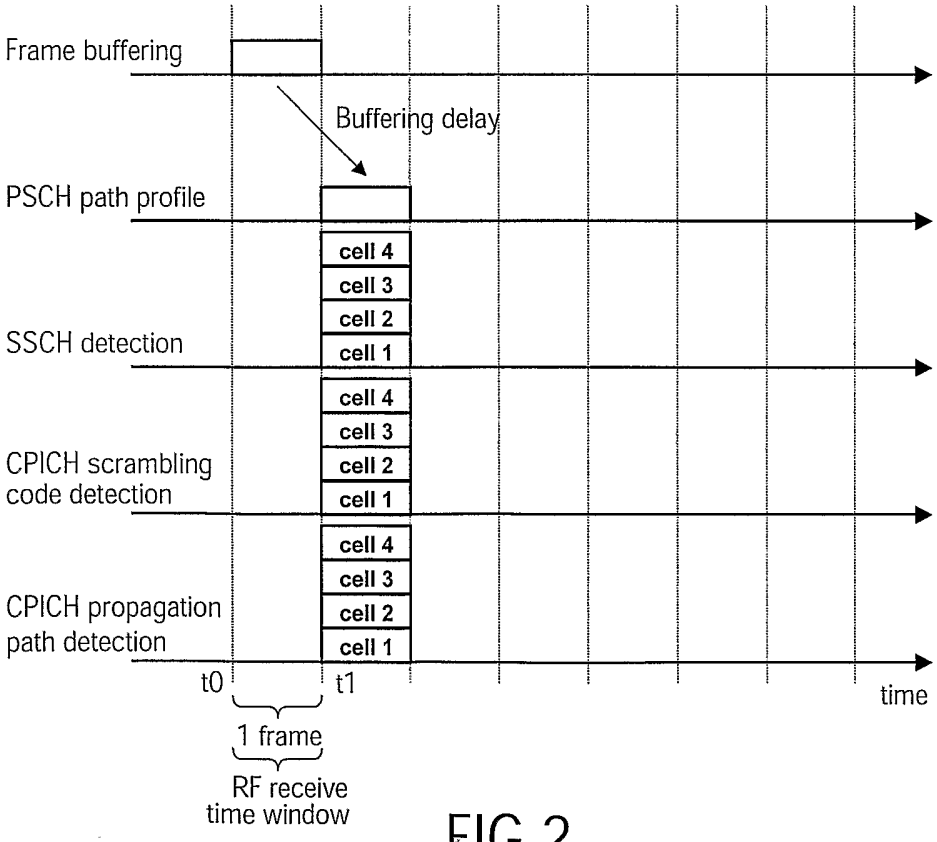
Frame buffering
Buffering delay
PSCH path profile
SSCH detection
CPICH scrambling code detection
CPICH propagation path detection
cell 4
cell 3
cell 2
cell 1
t0
t1
time
1 frame
RF receive time window

FIG.2

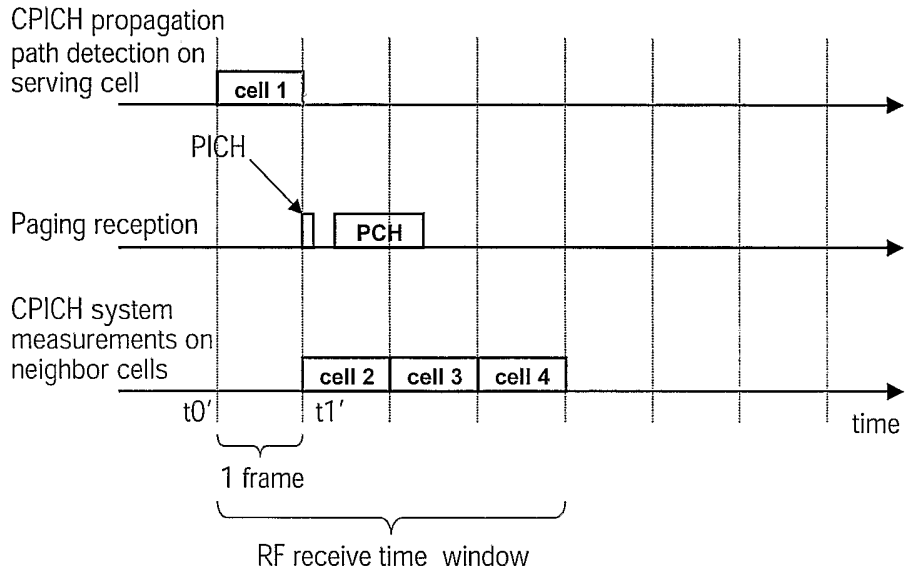
CPICH propagation path detection on serving cell
cell 1
PICH
Paging reception
PCH
CPICH system measurements on neighbor cells
cell 2
cell 3
cell 4
t0'
t1'
time
1 frame
RF receive time window

FIG.3

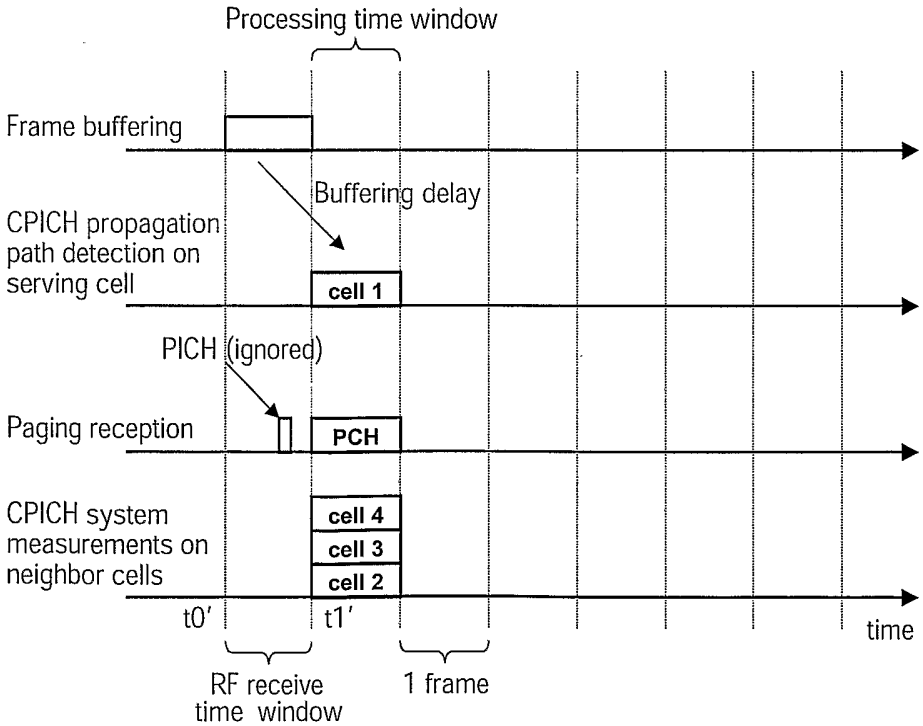
Processing time window
Frame buffering
Buffering delay
CPICH propagation path detection on serving cell
cell 1
PICH (ignored)
Paging reception
PCH
CPICH system measurements on neighbor cells
cell 4
cell 3
cell 2
t0'
t1'
time
RF receive time window
1 frame

FIG.4

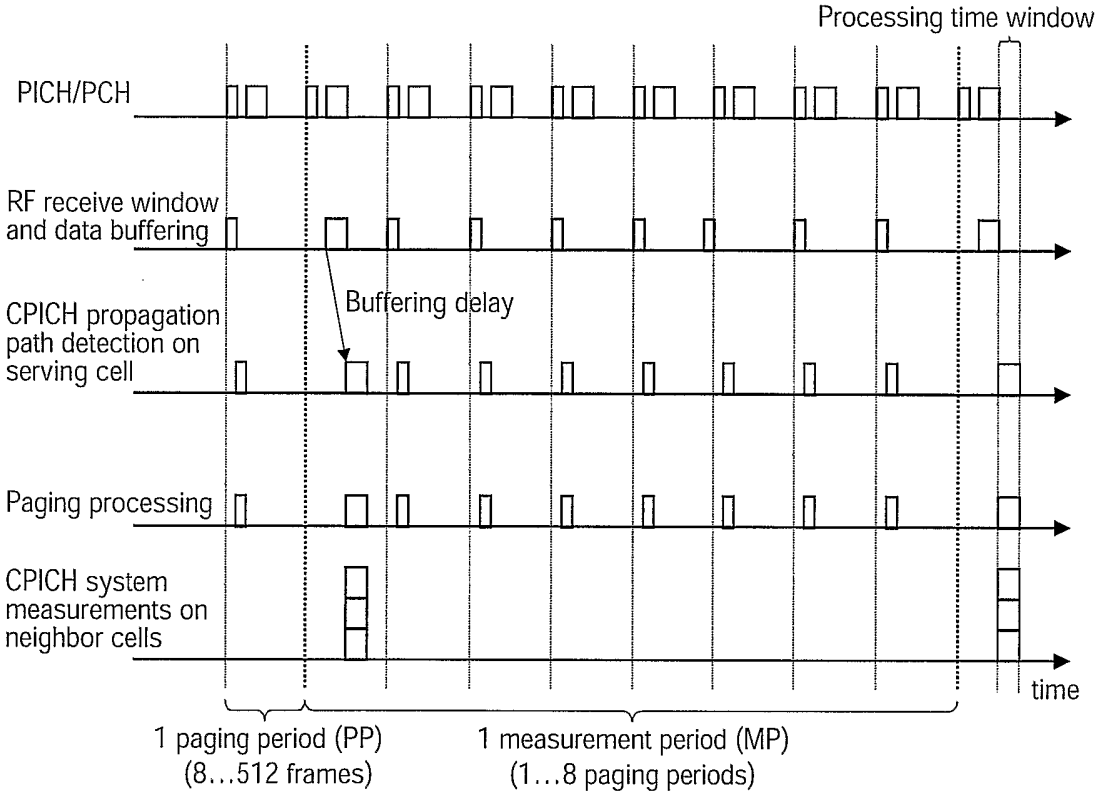
Processing time window
PICH/PCH
RF receive window and data buffering
Buffering delay
CPICH propagation path detection on serving cell
Paging processing
CPICH system measurements on neighbor cells
time
1 paging period (PP) (8...512 frames)
1 measurement period (MP) (1...8 paging periods)

FIG.5

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04B1/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 00 67399 A (SAMSUNG ELECTRONICS CO LTD) 9 November 2000 (2000-11-09) page 1, line 9 - line 12 page 1, line 24 - line 35 page 5, line 13 - line 15 ---	1
Y	US 6 151 353 A (HARRISON DANIEL DAVID ET AL) 21 November 2000 (2000-11-21) column 10, line 25 - line 27 column 10, line 27 - line 30 figure 4 ---	1
A	3GPPTS 25.214 V3.10.0-ANNEX C, page 49 XP002259257 cited in the application the whole document --- -/--	1-9

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Date of the actual completion of the international search	Date of mailing of the international search report
27 October 2003	10/11/2003

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Internation lication No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WANG Y-P E ET AL: "Cell search in W-CDMA" , IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, IEEE INC. NEW YORK, US, VOL. 18, NR. 8, PAGE(S) 1470-1482 XP002224578 ISSN: 0733-8716 the whole document	1-9

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INTERNATIONAL SEARCH REPORT

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