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(54) **Title:** TA UPDATE IN ADAPTIVE ANTENNA SYSTEMS

(57) **Abstract:** A method and a system is disclosed for improving transmission of timing advance messages to a mobile station, in a network employing adaptive antenna systems. In a typical embodiment each TA-message is dedicated to one mobile and sent in the adaptive antenna beam that covers the area where the desired mobile is located.

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TA update in adaptive antenna systems

TECHNICAL FIELD

The present invention relates to communication systems and more exactly to a method and system for transfer of timing advance updating messages to mobile phones in a network employing adaptive antennas.

BACKGROUND

In a mobile phone system mobiles, which communicate with a base station are often located at different distances from the base station. That means the time it takes for information sent by the mobile station (MS) to arrive at the base station is different. Each mobile station is allocated a timeslot, i.e. it is only allowed to transmit during a specific period of time. This is necessary since if two mobile stations were to transmit at the same time it would not be possible for the base station to decode the transmissions. Therefore it is important that the transmissions from the mobile stations arrive at the base station, aligned with the timeslot structure there, i.e. that they do not overlap due to different time delays.

The issue is solved by letting the mobile stations transmit special information sequences, which are used by the base station to calculate an individual time delay. The individual time delay calculated is used to order the mobile stations to offset their transmissions in time such that their transmissions arrive at the base station aligned to the timeslot structure. The message sent to the mobile stations is called a timing advance message (TA-message).

Figure 1 shows the standard mapping of the Timing Advance (TA) messages onto a multi-frame structure. An Enhanced General Packet Radio Service multi-frame, EGPRS, or General Packet Radio Service GPRS multiframe, consists of 52 Time Division Multiple Access (TDMA) frames, which are divided into 12 Radio Link Control/Medium Access Control (RLC/MAC) blocks plus 4 single bursts. When either GRPS or EGPRS is referred to, hereafter (E)GPRS is used for short.

In an (E)GPRS network several mobile stations can be multiplexed on the same packet data channel (PDCH). The maximum number of mobile stations that can share a PDCH is 16. Every TA-message is interleaved and divided into 4 bursts, which are spread over 2 multi-frames. Each one of the TA-messages contain timing advance information for all mobile stations, but the timing advance information is only updated for 4 mobile stations in each TA-message. Hence 4 TA-messages must be sent in order to update all mobile stations. Thus a mobile station is only required to listen to every 4:th TA-message, however if the mobile station isn't able to decode the message it tries to retrieve the information from the next. The transmission of all TA-messages takes approximately 2 seconds.

An adaptive antenna system is defined to be a system that is able to change its characteristics to changes in the network. Such a system has several interesting properties. One of the most important features on an adaptive antenna system is that the base station is able to detect the direction to the mobile station and can thus transmit dedicated information in an antenna beam towards a desired mobile station. An antenna beam is defined as any signal transmission covering only a part of a cell, and a cell is defined as the total coverage area of a base station. An international application WO 01/31810 A1 is also related to the basic problem of simultaneously transmitting information to mobile stations located in different beams. However the number of mobile stations concerned and the coding of the information sent is different in that application compared to the present one.

All mobile stations assigned to the same Packet Data Channel (PDCH) will be assigned a unique Timing Advance Index (TAI) during the Packet Uplink or Packet Downlink Assignment. The TAI tells the mobile when to transmit its access burst, which is used by the network to calculate the timing advance. The update of the timing advance is sent to the mobile station in the next TA message sent after the burst is received on the uplink. For instance, a

mobile that transmits its burst on T1 (see Figure 1) will receive the updated value in TA message 2.

The timing advance procedure is thoroughly described in the document having the title "Overall description of the GPRS radio interface" [1].

Problems with existing solutions

The timing advance message contains information for several mobile stations. In an adaptive antenna system the cell is covered by several narrow beams whereof one is activated at a time. Hence, a problem is encountered since the mobile stations, which should be updated, could be located in different antenna beams. The standard facilitates other possibilities to transmit the TA information to the MS, i.e. in a RLC/MAC control block with the power control or ack/nack message. However, this solution requires that the TA information first is transferred to the Packet Control Unit (PCU) in the Base Station Controller (BSC) to be packaged in the control block and hence requires more signalling between Base Tranceiver Station (BTS) and PCU. The continuous TA update is controlled solely by the BTS, which is an advantage.

SUMMARY OF THE INVENTION

In a first embodiment of the invention an extra antenna with a beam that covers the whole cell is used to transmit the TA-update messages. In a second embodiment of the invention one TA-message is sent in each adaptive antenna beam. In a third embodiment of the invention the four bursts, which constitutes the TA-messages are distributed over the adaptive antenna beams. In a fourth embodiment of the invention the timing advance update information for all mobile stations that are located in the same beam is contained within the same TA-message. This is done by considering the beam affiliation of the mobile station in the initial set-up process. In a fifth embodiment of the invention the TA-messages for the mobile stations, which are assigned several timeslots, are sent in different beams. The best received TA-message is then used for all timeslots that the mobile station is assigned.

In a sixth embodiment of the invention each TA-message is dedicated to just one mobile station and is sent in the beam where the mobile station is located. it is also possible to combine the six versions of the invention.

SHORT DESCRIPTION OF THE DRAWINGS

The invention, together with further objects and advantages thereof, may be best understood by making reference to the following description taken together with the accompanying drawings, in which:

FIG. 1 illustrates the position of the timing advance messages in a GPRS or EGPRS multi-frame structure;

FIG. 2 illustrates updating of timing advance in one beam at a time;

FIG. 3 illustrates a timing advance information assignment, where the beam location is taken into account;

FIG. 4 illustrates a split interleaved timing advance message with sending one burst in each beam;

FIG. 5 illustrates a split interleaved timing advance message dividing the message and sending two bursts in one beam and two in another; and

FIG. 6 illustrates timing advance for the different packet data channels being updated in different beams.

DETAILED DESCRIPTION

Six different embodiments have been defined. In order to illustrate the ideas a four-beam antenna system is used for five of the embodiments. However, for all solutions the extension to antenna systems with more beams is also discussed.

Sector antenna

In a first embodiment a separate sector antenna could be used to do the update of the timing advance (TA). For every TA-burst the transmission is switched to the sector antenna thereby avoiding the problem that mobile stations are located outside the coverage area of the narrow beams.

The advantage with this embodiment is that TA-update works the same way as in a sector antenna system, hence, in which of the narrow beams the mobile stations are located does not need to be considered.

Arbitrary number of beams

The number of antenna beams does not have to be considered in this solution, i.e. the solution described above works for any number of beams.

One beam at a time

In a second embodiment no regard is taken to the beam affiliation of the mobile stations when the Timing Advance Index (TAI) is assigned. The TA-messages are sent in one beam at a time, e.g. TA message 1 in beam 1, TA message 2 in beam 2, and so on.

The advantage of this embodiment is that it is simple to implement. The mobile stations will at least receive four good bursts.

Arbitrary number of beams

The second embodiment would work as intended for antenna systems with up to four beams. If there are more beams than TA messages (i.e. four) it will not be possible to send one TA message in each beam. It might hence happen that a mobile station has to wait for more than four TA messages before it receives an update in the beam where it is located.

TAI assignment with mobile station beam consideration

In this embodiment the TA-message is sent in one beam at a time as in the previous embodiment. However, when the timing advance index, TAI, is assigned, the beam in which the mobile station is located is then considered.

E.g. all mobile stations located in beam 1 are assigned TAI between 0-3 i.e. they will be updated in TA message 2. Mobile stations located in beam 2 are assigned TAI between 4-7 and are updated in TA message 3 and so on.

Hence, TA message 2 is transmitted in beam 1 (where all the concerned mobiles are located), TA message 3 in beam 2 and so on.

The advantage of this embodiment is that the mobiles will receive four good bursts without delay

Arbitrary number of beams

Since there are four TA messages that can be assigned to different beams the solution would work for antenna systems with up to four beams.

Embodiment with split interleaving bursts

Version 1:

The TA-message is interleaved over four bursts. If one burst is transmitted in each beam the mobile stations will receive one good burst no matter in which beam there messages are situated. The other 3 bursts, which are transmitted in the "wrong" beam, might give enough extra information to decode the interleaved message.

The embodiment of version 1 has the advantage that the mobiles are guaranteed one good burst without delay.

Version 2:

Send two bursts in each beam. Send the bursts for TA-message 1 in beams 1 and 3. For TA message 2, send the bursts in beams 2 and 4 and so on. The reason for sending in every second beam is that if the mobile station wanting

to receive the message is not located in the right beam it will be located in a neighbouring beam which is the next best thing. One TA-message will be distributed over two beams. The mobile station will hence receive two good bursts and two bad bursts. Since the message is transmitted with a robust code (CS1) chances are that it can be decoded anyway.

This embodiment has the advantages that the mobile station receives two good bursts plus two bursts in a neighbouring beam.

Embodiment with arbitrary number of beams

Version 1:

For up to 4 beam systems at least one burst per TA message is sent in the beam where the MS is located. For systems with more beams the bursts of more than one TA message would be needed to cover all beams. E.g. for an eight beam system the bursts of TA 1 could be sent in beams 1-4 and the bursts of TA 2 in beams 4-8. This of course implies an extra update delay.

Version 2:

As in version 1 but e.g. for an eight beam system all four TA messages would be needed to transmit 2 bursts in each beam.

Multi-slot synergy

In (E)GPRS the mobile stations are in many cases assigned several timeslots. The timing advance value is however the same for all timeslots. If the timing advance is updated in different beams for different packet data channels, the mobile station could use the best received update value for all timeslots. The method works best if all mobile stations are assigned four packet data channels (PDCH). If less than four PDCH are assigned to a mobile station, the beam affiliation has to be considered when assigning the PDCH. Otherwise the TA update for the MS might be directed to a beam where the MS is not located.

Advantages: The mobile stations will receive four good bursts without delay.

Arbitrary number of beams

The solution works as long as the mobile station is assigned as many or more PDCH as there are antenna beams. The upper limit is eight beams since a mobile station can not be assigned more than 8 PDCH.

Embodiment with one MS per TA message

If only one mobile station needs to be updated for every TA message the beam pointing towards that mobile station can be used. This means that e.g. TAI= 0, 4 ,8 and 12 can be used for four mobile stations multiplexed on the same PDCH. If more than four MS are assigned to the same PDCH the first four should be assigned as described above. The fifth (and higher number MS) should if possible be updated in a TA message sent in the beam where they are located initially. If they should move out of that beam their TA update will be delayed.

Advantages of this embodiment having one MS per TA-message is that the TA message can always be sent to the MS in the right beam.

Arbitrary number of beams

For this solution there is no limitation to the number of antenna beams. Since each TA message is dedicated to one MS it can be sent in the beam where the MS is located.

Advantages of the Invention

The general advantage of all solutions is that continuous TA-update with minimum delay is made possible in adaptive antenna systems. By minimising the delay with which the TA-update message is received by the mobile station the issue of using old TA values, resulting in overlap of timeslots and bad quality, is mitigated.

REFERENCES

[1] 3GPP TS 43064.610 V6.1.0 (2003-09) Overall description of the GPRS radio interface.

CLAIMS

1. A method for adjusting transmission timings for mobile stations in a radio network using a standardised multi-frame structure in a (E)GPRS system, **characterised by** the steps of:

using an adaptive antenna system having narrow beams, each individual beam covering a part of a network cell;

updating mobile stations by sending a timing advance (TA) message using the narrow beams of the adaptive antenna system.

2. The method according to claim 1, **characterised by** a further step of:

updating mobile stations by sending a timing advance (TA) message in one beam at a time.

3. The method according to claim 1, **characterised by** a further step of:

sending the bursts of the TA message in each beam, thereby securing that the mobile stations as soon as possible obtain at least one good burst within minimum time period.

4. The method according to claim 1, **characterised by** a further step of:

sending two bursts in each beam, thereby sending bursts for TA message 1 in beams 1 and 3 and TA message 2 in beams 2 and 4 and so on, whereby a mobile station will receive two good bursts out of a standard of four.

5. The method according to claim 1, **characterised by** a further step of:

if a mobile is assigned several timeslots, and these timeslots are to update its timing advance values in different beams, the mobile station

uses the best received update value for all timeslots and shares an update message being sent in a correct beam between timeslots.

6. The method according to claim 1, **characterised by** the further step of:

creating an assignment of mobile stations present such that all the mobile stations in one beam can be updated with a same TA message.

7. The method for adjusting transmission timings for mobile stations in a radio network, **characterised by** any combination of claims 2 to 6.

8. A method for adjusting transmission timings for mobile stations in a radio network using a standardised multi-frame structure in a (E)GPRS system, **characterised by** the steps of:

using an additional antenna having a beam which covers a whole cell for transmitting TA-update messages to the individual mobile stations.

9. A system for adjusting transmission timings for mobile stations in a radio network using a standardised multi-frame structure in a (E)GPRS system, **characterised in** that

the system uses an adaptive antenna providing narrow beams, each individual beam covering a part of a network cell;

mobile stations are individually updated by sending timing advance (TA) by using the narrow beams of the adaptive antenna.

10. The system according to claim 9, **characterised in** that

mobile stations are individually updated by sending timing advance (TA) messages in one beam at a time.

11. The system according to claim 9, **characterised in** that

the TA messages are interleaved over their four bursts by sending one burst in each beam, thereby securing that the mobile stations as soon as possible obtain at least one good burst within minimum time period.

12. The system according to claim 9, **characterised in** that

two bursts are transmitted in each beam, thereby sending bursts for TA message 1 in beams 1 and 3 and TA message 2 in beams 2 and 4 and so on, whereby a mobile station will receive two good bursts out of a standard of four.

13. The system according to claim 9, **characterised in** that

if a mobile is assigned several timeslots, it is made sure that these timeslots should update its timing advance values in different beams, whereby the mobile stations then use the best received update value for all timeslots and share an update message being sent in a correct beam between timeslots.

14. The system according to claim 9, **characterised in** that

an assignment of mobile stations present is created such that all the mobile stations in one beam can be updated at a same time.

15. The system for adjusting transmission timings for mobile stations in a radio network, **characterised in** that the system constitutes any combination of claims 10 to 14.

16. A system for adjusting transmission timings for mobile stations in a radio network using a standardised multi-frame structure in a (E)GPRS system, **characterised in** that

an additional antenna having a beam which covers a whole cell is used for transmitting TA-update messages to the individual mobile stations.

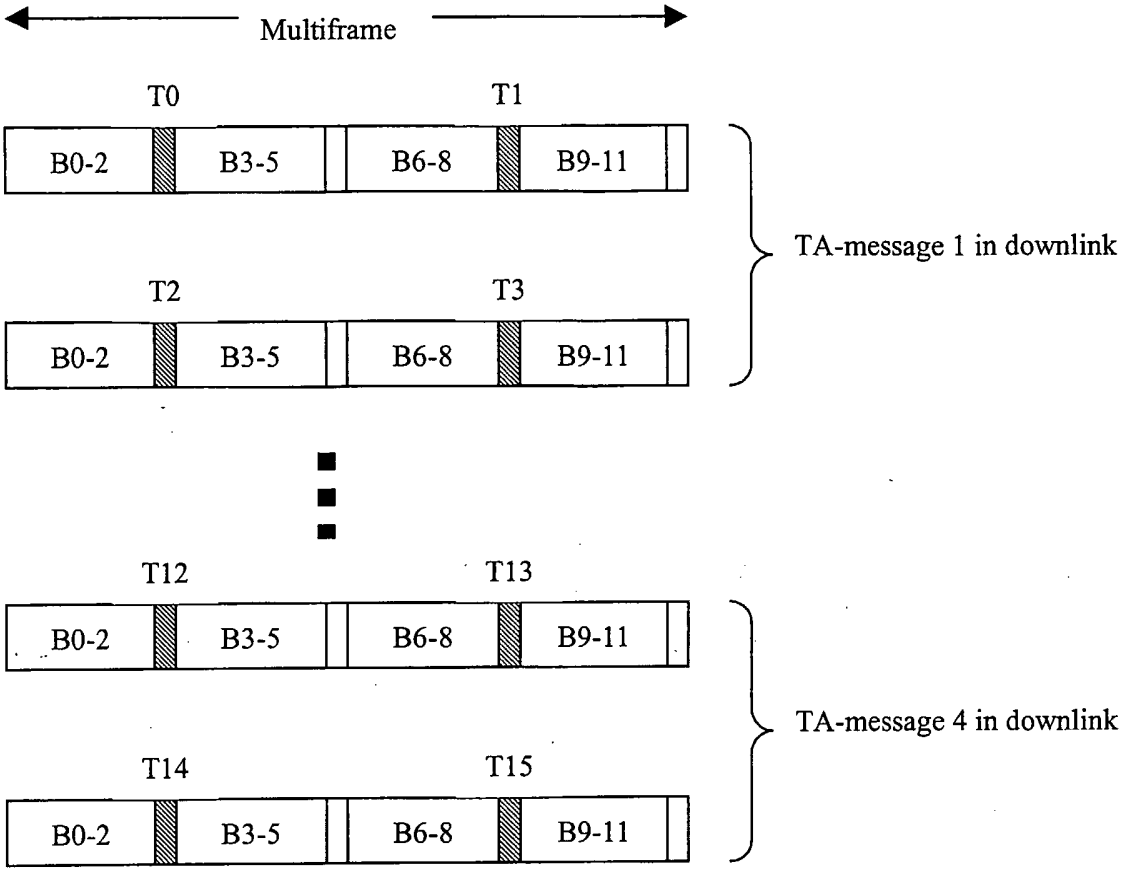

Multiframe
T0
T1
B0-2
B3-5
B6-8
B9-11
TA-message 1 in downlink
T2
T3
B0-2
B3-5
B6-8
B9-11
T12
T13
B0-2
B3-5
B6-8
B9-11
TA-message 4 in downlink
T14
T15
B0-2
B3-5
B6-8
B9-11

Fig. 1

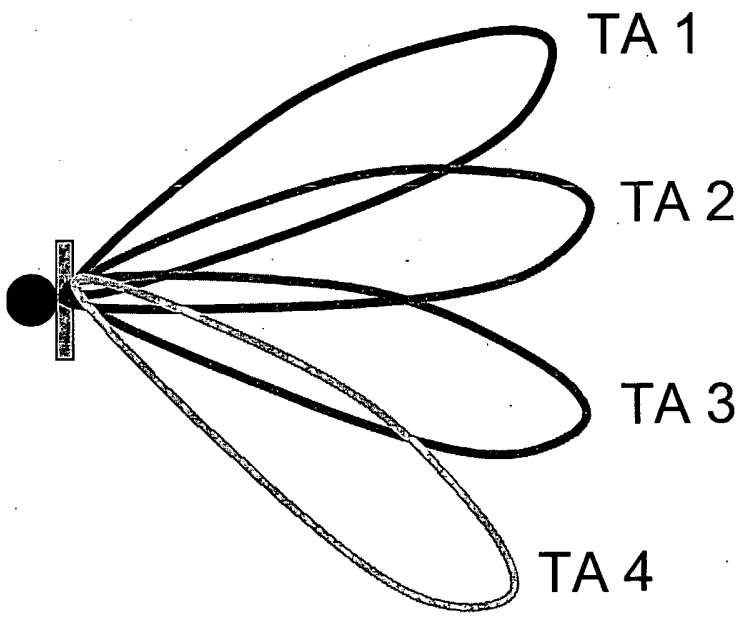

TA 1
TA 2
TA 3
TA 4

Fig. 2

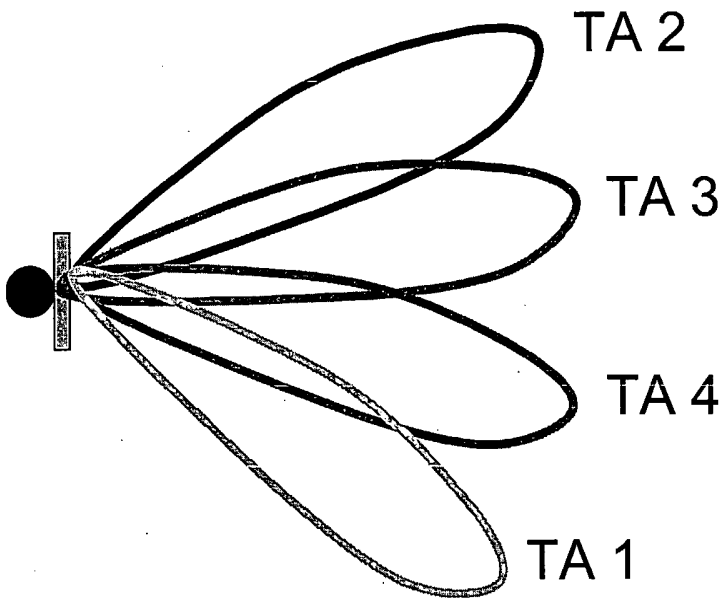


Fig. 3

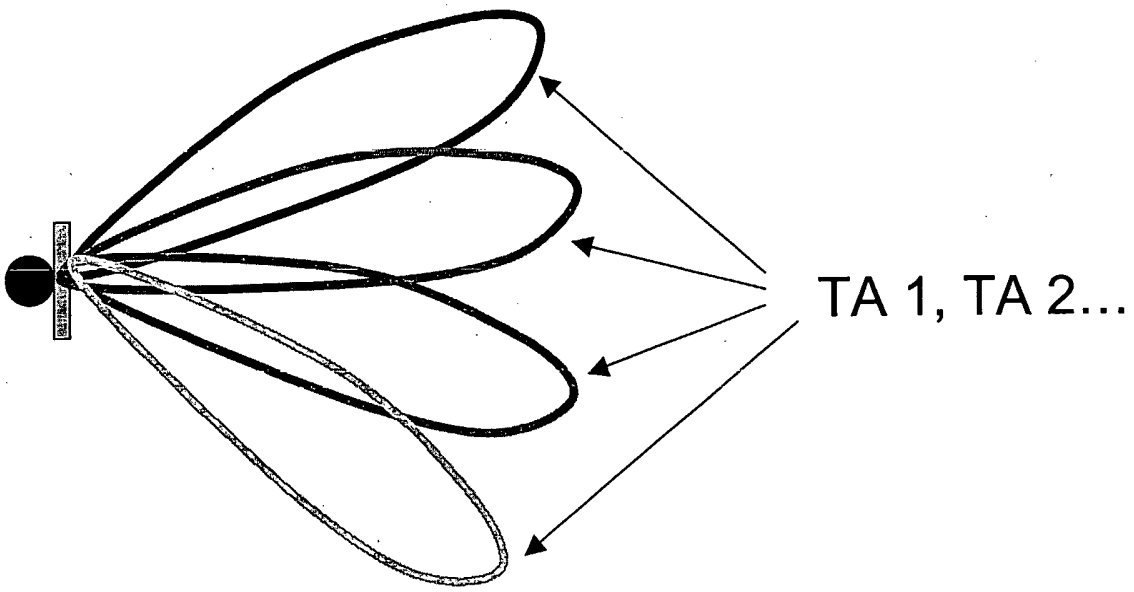


Fig. 4

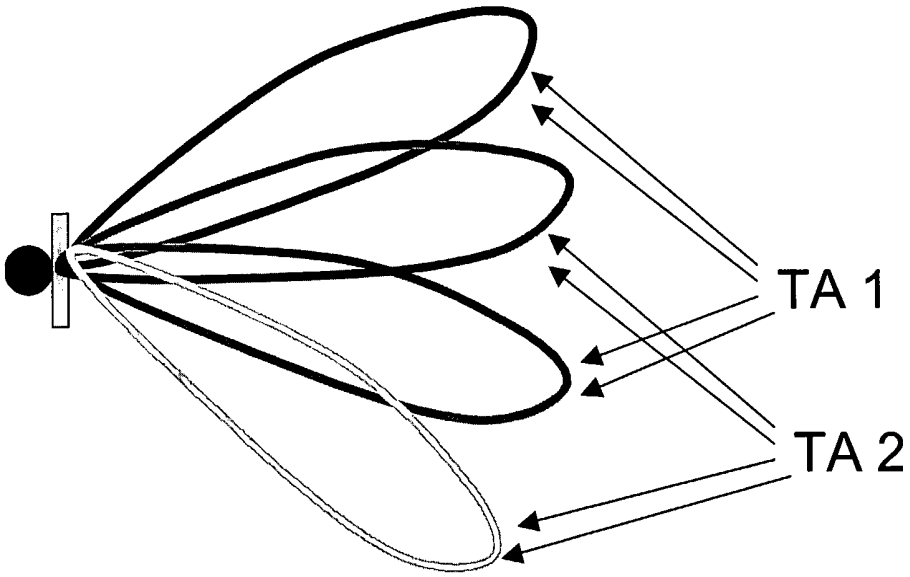


Fig. 5

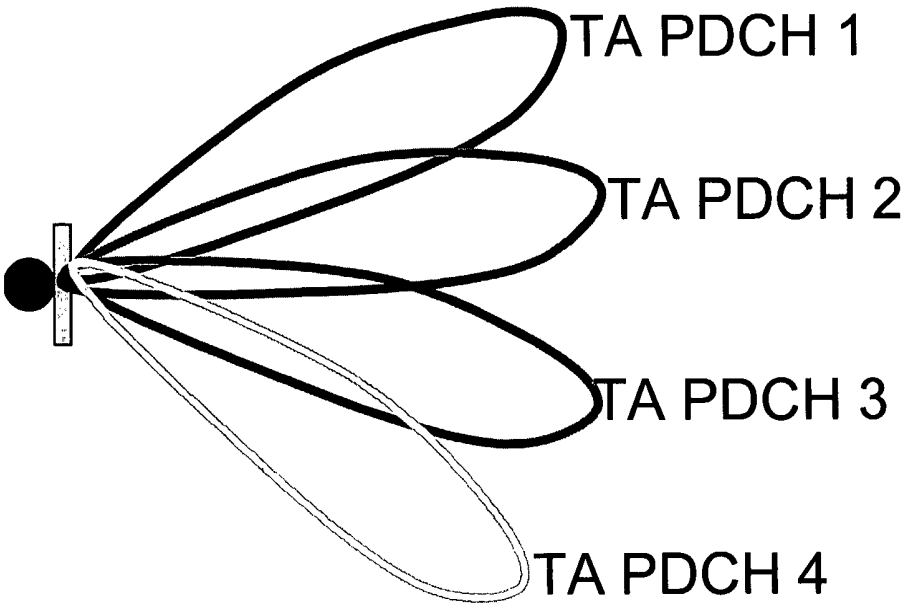


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 2004/000840

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04B 7/04
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)

IPC7: H04B, H04Q

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

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	WO 0131810 A1 (TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)), 3 May 2001 (03.05.2001), abstract	1-16
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X	US 6697640 B1 (MARCUS KATZ ET AL), 24 February 2004 (24.02.2004), column 7, line 51 - column 8, line 61, figure 4	1-16
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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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
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 December 2004	11-01-2005

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

International application No.
PCT/SE 2004/000840

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	General Packet Radio Service (GPRS) 3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access 3GPP TS 43.064 V6.1.0 (2003-08) Stage 2 Release 6 see section 6.5.7 -- --------	1-16

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