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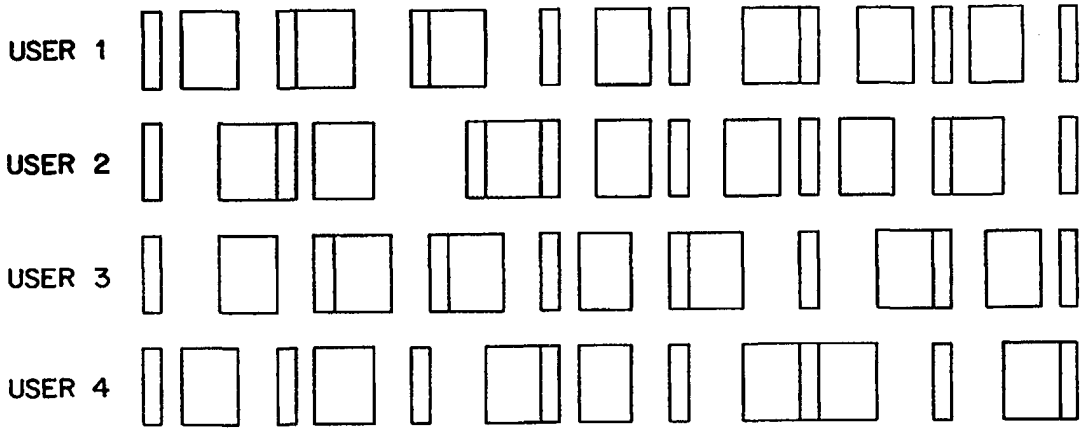

(57) Abstract

A method for altering transmission timings among a plurality of parallel discontinuous transmissions (50) is disclosed. In a DS–CDMA system having a plurality of discontinuous slot–wise transmissions (50), each transmission connection is offset by a predetermined amount in order to generate interference that is evenly spread in time between cells.

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TRANSMISSION TIMING OFFSET METHOD FOR DS-CDMA MOBILE TELEPHONE SYSTEMS

BACKGROUND OF THE INVENTION

Technical Field of the Invention

The present invention relates to code division multiple access (CDMA) mobile telephone systems, and more particularly, to a method for averaging interference over time between users utilizing discontinuous transmissions in a CDMA system.

Description of Related Art

In most digital mobile telephone systems, each physical channel carries a nominal information bit rate. If the information to be transmitted is less than this nominal bit rate, discontinuous transmission (DTX) may be used. Discontinuous transmission means that data is not transmitted over a user channel 100% of the time. The frame structure of a typical direct sequence code division multiple access (DS-CDMA) system consists of a repeating frame structure sequence containing a number of slots. The slots define the transmitter power control (TPC) cycle time. Discontinuous transmission may be done in one of two ways. In one method referred to as "frame-wise DTX", the system only transmits one-half of the slots from any frame when half the nominal bit-rate is used. Another method referred to as "slot-wise DTX" transmits one-half of the time during each slot of a frame. The slot-wise DTX method has the advantage that the interleaving depth will be kept at a maximum even for low bit rates.

In the forward link of a CDMA system, several connections are transmitted in parallel to different mobile stations from the base station. If several users are in a DTX mode, it is advantageous to avoid having the transmission timings coincide for these users. If the timings coincide, the interference with other cells will vary unevenly when spread in time which is detrimental to a DS-CDMA system. Ideally, the interference should be as evenly spread in time as possible. Thus, there exists a need to some how make the transmission on/off times between different users and the base station appear randomized.

One solution to this problem includes randomizing the timing of the data portion of each slot. This solution, illustrated in FIGURE 1, includes an offset for each connection that may typically be derived in a deterministic way from the CDMA code of the connection. However, this method increases the receiver complexity since detection timing is different for each slot. Thus, a number of different timings must be considered for each frame received over a connection. A simplified solution to this problem would be of great benefit in the manufacturing and cost of receivers for DS-CDMA systems.

SUMMARY OF THE INVENTION

The present invention overcomes the foregoing and other problems with a method for altering transmission timing offsets within a DS-CDMA mobile telephone system. Initially, a number of signals are transmitted over a plurality of parallel connections as slot-wise discontinuous transmissions between a base station and a mobile station. The transmission timings of each one of the plurality of connections is altered by a predetermined number of symbols such that the transmission beginning and ending periods are not the same between any two of the plurality of parallel connections.

The predetermined number of symbols may be calculated as a deterministic function of a short CDMA code number, or alternatively, may be a predefined value that is forwarded to the mobile station via a signaling channel from the base station. The desired effect may be achieved by limiting the predetermined value to the interval (0,N), where N is the number of symbols per slot of a frame.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention, reference is made to the following detailed description taken in conjunction with the accompanying drawings wherein:

FIGURE 1 illustrates a prior art solution to unevenly spread interference between cells;

FIGURE 2 illustrates the frame structure of a typical DS-CDMA system;

FIGURE 3 illustrates discontinuous slot-wise transmissions of a typical DS-CDMA frame structure; and

FIGURE 4 is an illustration of the randomization method of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, and more particularly, to FIGURE 2, there is illustrated the frame structure of a typical DS-CDMA system. Each DS-CDMA frame 10 consists of a plurality of slots 15. In a preferred embodiment the frames have a 10 ms length and include 16 slots 15 each. Note that the number of slots for the frame length is merely one example of a frame structure that may include any number of slots. The slots 15 in each frame 10 are not used for different users, but instead, define the transmitter power control (TPC) cycle time. During the forward communication link between a base station and a mobile station, there is typically one TPC symbol 20 transmitted with each time slot. Multiplexed pilot symbols may also be used to enable coherent detection in the reverse or forward link. Multiplexed pilot symbols are normally aligned with the TPC symbols 20. For continuous data transmissions, the data portion 25 of the time slot and the TPC/pilot symbols are continuously transmitted throughout the entire frame structure.

However, in certain circumstances, discontinuous transmission will be desired. This is due to the fact that in DS-CDMA systems, a reduction in radio resources, as occurs during discontinuous transmission, will translate into a decrease in a total interference in the system. This benefits the other connections at the same base station and surrounding base stations. One method of accomplishing this would utilize slot-wise discontinuous transmissions as illustrated in FIGURE 3. In a slot-wise discontinuous transmission, transmission only occurs for a part of the time in each time slot. Thus, the TPC/pilot symbols 20 and a part of the data portion 25 are transmitted for each slot 15, as shown in FIGURE 3.

Referring now to FIGURE 4, there is illustrated the method of the present invention wherein a plurality of slot-wise discontinuous transmissions 50 are offset in a manner such that an interference averaging effect is achieved. This is accomplished

by offsetting the entire connection timing of each user 55 by an integer number of symbols of the frame structure. While the preferred embodiment of the invention is described with respect to offsetting the timing by an integer number of symbols, the timing may also be offset by any amount in other embodiments. As can be seen in the figure, the connection of user 1 is unaffected and transmits in the fashion that it normally would for slot-wise discontinuous transmission. However, each of the users 2-4 are offset by some integer number of symbols, such that they are not starting and stopping transmissions at the exact same times as user 1 or as each other.

In the preferred embodiment the offsets may be determined from the CDMA code phase or CDMA code number of the connection number and may be limited to the interval $(0,N_s)$ where N_s is the number of symbols per slot. Alternatively, the offset may be predefined, for example, the first connection would have an offset of 0, the second connection would have an offset of one symbol, the third connection would have an offset of two symbols, etc. In this case, the mobile station would have to be informed of the offsets over a signaling channel.

This method provides a simple way of averaging the interference of different users on the forward link of a DS-CDMA system. The method does not noticeably increase the receiver complexity and the offset scheme is easily determined by the mobile station receiver or, in the case of a predefined offset, is transmitted to the receiver via a signaling channel. Receiver complexity is not increased since once the offset for a channel is determined it will always be the same. The scheme provides no additional dispersion of the receiver timings of different slots, and only information regarding one timing offset is needed by the receiver in order to properly demodulate the signal.

Although a preferred embodiment of the method and apparatus of the present invention has been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it is understood that the invention is not limited to the embodiment disclosed, but is capable of numerous rearrangements, modifications, and substitutions without departing from the spirit of the invention as set forth and defined by the following claims.

WHAT IS CLAIMED IS:

1. A method for achieving an interference average effect between a plurality of parallel connections, comprising the steps of:

transmitting a discontinuous transmission over each of the plurality of parallel connections; and

delaying each discontinuous transmission by a certain amount, wherein the discontinuous transmissions on at least one code channel within an individual connection of the plurality of parallel connections has the same timing delay.

2. The method of Claim 1 wherein the discontinuous transmission comprises a slot-wise discontinuous transmission.

3. The method of Claim 1 wherein the certain amount comprises an integer number of symbols.

4. The method of Claim 3 further including the step of determining a value for the integer number of symbols.

5. The method of Claim 4 wherein the step of determining further comprises the step of calculating the integer number of symbols from a CDMA code number.

6. The method of Claim 4 wherein the step of determining further comprises the step of calculating the integer number of symbols from a CDMA code phase.

7. The method of Claim 5 wherein the integer number of symbols is no greater than the number of symbols per slot of a frame.

8. The method of Claim 1 wherein the step of determining further involves the steps of:

predefining the certain amount; and

forwarding the certain amount to a mobile station via a signaling channel.

9. A method for transmitting in a DS-CDMA system, comprising the steps of:

transmitting a series of frames as a slot-wise discontinuous transmission over a plurality of parallel connections between a base station and a mobile station; and

altering transmission timing of slots defined within the frames such that a detection time at a receiver is the same for each slot in the same connection.

10. The method of Claim 9 wherein the step of altering the transmission timing further includes the steps of:

determining a value for an integer number of symbols; and

delaying each of the slot-wise discontinuous transmissions by the determined value for the integer number of symbols, wherein the timing delay is the same within an individual channel of the plurality of channels.

11. The method of Claim 10 wherein the step of determining further comprises the step of calculating the integer number of symbols from a CDMA code number.

12. The method of Claim 10 wherein the step of determining further comprises the step of calculating the integer number of symbols from a CDMA phase number.

13. The method of Claim 10 wherein the step of determining further involves the steps of:

predefining the integer value; and

forwarding the predefined integer value to a mobile station via a signaling channel.

14. The method of Claim 10 wherein the integer number of symbols is no greater than the number of symbols per slot of a frame.

15. A method for transmitting in a DS-CDMA system, comprising the steps of:

transmitting a series of frames as a slot-wise discontinuous transmission over a plurality of parallel connections between a base station and a mobile station;

calculating a value using a CDMA code, wherein the value is no greater than the number of symbols per slot of a frame; and

delaying each of the slot-wise discontinuous transmissions by the determined value, wherein the delay is the same for all transmission timings within an individual channel of the plurality of channels.

16. A method for transmitting in a DS-CDMA system, comprising the steps of:

transmitting a series of frames as a slot-wise discontinuous transmission over a plurality of parallel connections between a base station and a mobile station;

predefining an integer number of symbols;

forwarding the predefined integer number of symbols to a mobile station via a signaling channel from the base station; and

delaying each of the slot-wise discontinuous transmissions by the integer number of symbols, wherein the delay is the same for all transmission timings within an individual channel of the plurality of channels.

FIG. 1

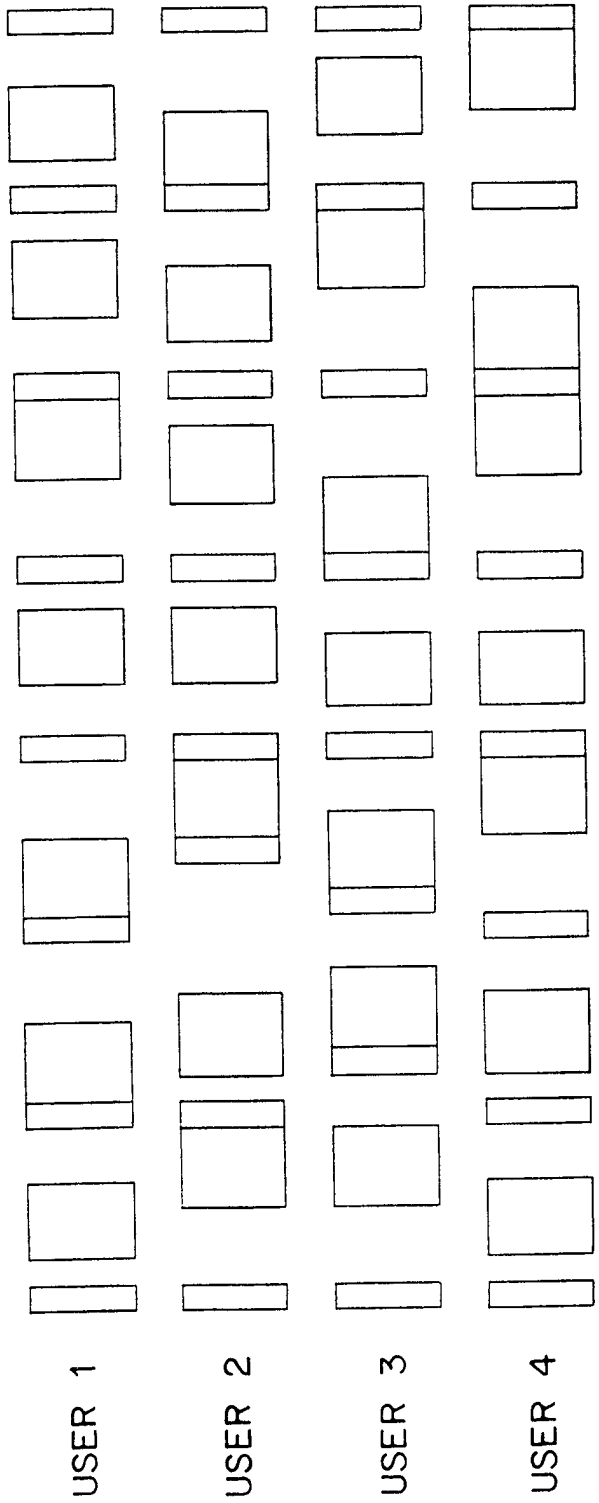


FIG. 2

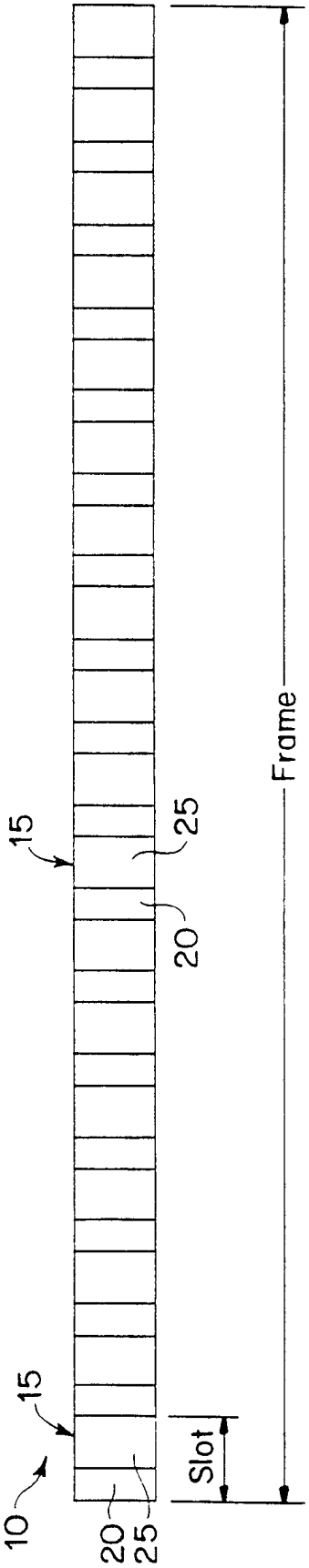


FIG. 3

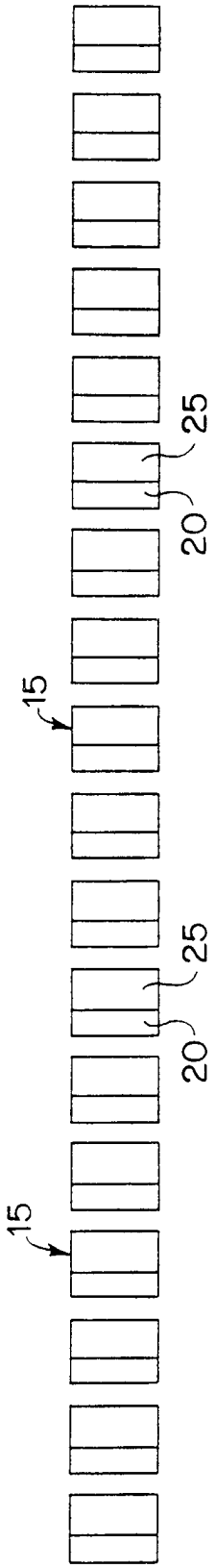
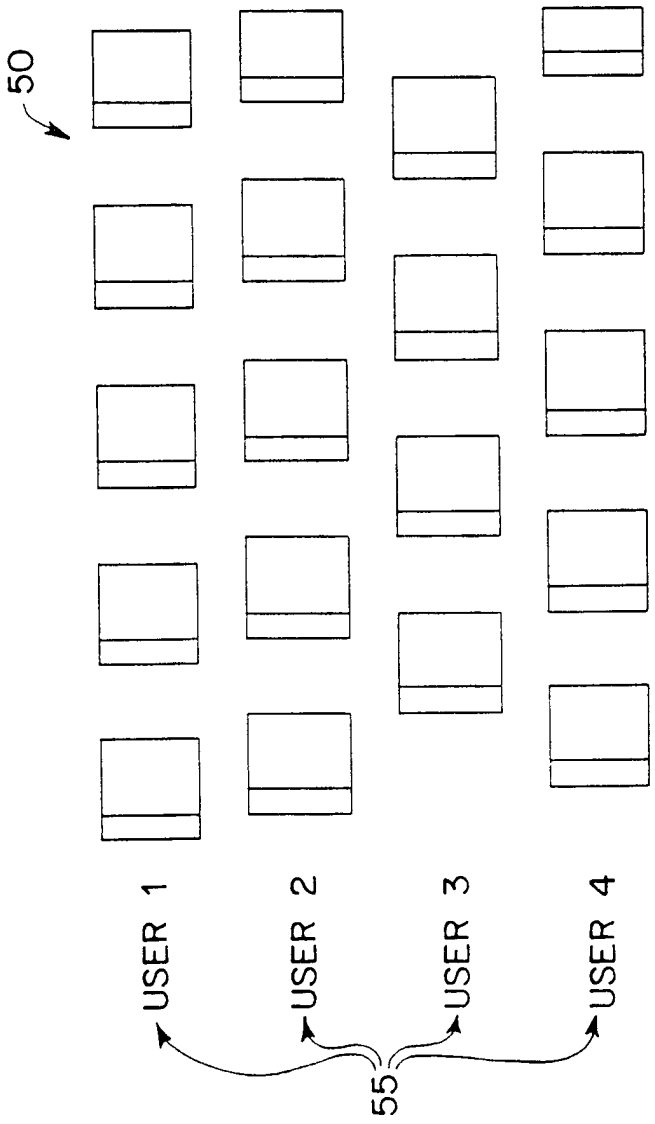


FIG. 4



INTERNATIONAL SEARCH REPORT

Intern ıal Application No
PCT/SE 97/01632

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04B7/26

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 6 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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No
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A	EP 0 633 676 A (OKI ELECTRIC INDUSTRY COMPANY) 11 January 1995 see page 2, line 24 - line 39 ---	1,9,15, 16
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A	WO 94 29981 A (ERICSSON) 22 December 1994 see page 6, line 22 - page 7, line 9 -----	1,9,15, 16

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