

MICROCELL FOR A SYNCHRONOUS SELECTIVE CALL SYSTEM AND METHOD THEREOF

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Field of the Invention

This invention relates to synchronous selective call systems. In particular, this invention relates to, but is not necessarily limited to, a microcell for a synchronous selective call system and a method thereof.

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Background of the Invention

A synchronous selective call system provides messages to selective call receivers on carrier signals transmitted at predetermined times. It is well known that such selective call receivers can save on power and receive the messages reliably when synchronised to the carrier signals. Synchronising is critical for multichannel selective call receivers to be able to receive messages on different carrier signals.

20 An example of a multichannel synchronous selective call system is Motorola's FLEX™ roaming system. The FLEX™ roaming system has a signalling protocol to specify how messages are encoded onto one hundred and twenty-eight message frames known collectively as a cycle. Cycles are continuously transmitted to form a FLEX™ carrier signal. This signalling protocol also specifies a signal parameter known as a collapse value. From the collapse value, a collapse cycle is derived to define a set of assigned message frames within which FLEX™ multichannel selective call receivers periodically look for information. In the communication environment of a FLEX™ roaming system, more than one carrier signal may be available to provide messages to multichannel selective call receivers.

30 Determining when and how a carrier signal is transmitted in the FLEX™ roaming system depends on the signalling protocol. However, transmission of messages can overload the FLEX™ roaming system especially with increasing use of multichannel selective call receivers. Furthermore, carrier signals are typically not transmitted with a constant volume of messages throughout the communication environment and there

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may be areas where less messages are received from the FLEX™ roaming system. In such areas, additional messages can be provided without burdening the FLEX™ roaming system as a whole.

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Summary of the Invention

It is an object of this invention to provide a microcell for a synchronous selective call system and a method thereof.

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According to one aspect of the invention, there is provided a microcell for a synchronous selective call system, said microcell providing a microcell selective call signal having one or more collapse cycles, each of said collapse cycles having one or more message frames respectively associated with one or more frame locations, said microcell comprising:

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a processor for partitioning a message into message pieces, wherein, in use, said processor places each of said message pieces into a plurality of said message frames, said plurality of said message frames being associated with at least one of each of said frame locations within said collapse cycles.

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Preferably, said processor can be adapted to select said plurality of said message frames from one or more of said collapse cycles.

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Suitably, said processor can be adapted to precess said message pieces when placing said message pieces into subsequent ones of said collapse cycles.

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Preferably, said processor can be adapted to set one or more positions in a message transmission matrix in response to transmission of each of said message pieces.

Suitably, said processor can comprise an encoder.

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Preferably, said processor can comprise a controller.

Suitably, said microcell can further comprise a transmitter to transmit said microcell selective call signal.

5 Preferably, said microcell can further comprise a receiver to receive at least one synchronizing signal from said synchronous selective call system.

10 Suitably, said microcell can further comprise a plurality of receiving units to receive said microcell selective call signal.

Preferably, said plurality of receiving units can be adapted to receive said message pieces using one or more non-assigned message frames.

15 According to another aspect of the invention, there is provided a method for processing a message in a microcell of a synchronous selective call system, said microcell providing a microcell selective call signal having one or more collapse cycles, each of said collapse cycles having one or more message frames respectively associated with one or more frame
20 locations, said method comprising the steps of:

partitioning a message into message pieces, and

25 placing each of said message pieces into a plurality of said message frames, said plurality of said message frames being associated with at least one of each of said frame locations within said collapse cycles.

30 Preferably, said step of placing can comprise the step of selecting said plurality of said message frames from one or more of said collapse cycles.

Suitably, said step of placing can comprise the step of precessing said message pieces when placing said message pieces into subsequent ones of said collapse cycles.

35 Preferably, said method can further comprise the step of setting one or more positions in a message transmission matrix in response to transmission of each of said message pieces.

Brief Description of the Drawings

5 In order to describe the invention and to put it into practical effect, reference will now be made to preferred embodiments as illustrated with reference to the accompanying drawings in which:

10 FIG. 1 shows a synchronous selective call system having a microcell in accordance with a preferred embodiment of the invention;

 FIG. 2 shows one cycle in a microcell selective call signal of the microcell of FIG. 1.

15 FIG. 3 is a block diagram of a transceiver of the microcell of FIG. 1; and

 FIGs. 4a and 4b are flow diagrams of a method for processing a message within the transceiver of FIG. 2;

20 FIGs. 5a and 5b are different embodiments of a message transmission matrix for the method of FIGs. 4a and 4b.

 FIG. 6 shows a timing diagram for transmission of message pieces of the message in the method of FIGs. 4a and 4b.
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Detailed Description of the Invention

30 In this detailed description, Motorola's FLEX™ roaming system is used only as an example of a synchronous selective call system.

 Referring now to FIG. 1, a FLEX™ roaming system 10 is shown having a microcell 11 in accordance with a preferred embodiment of the invention. A plurality of receiving units 12, such as multichannel selective call
35 receivers or pagers, is supported within a coverage area of FLEX™ roaming system 10. Microcell 11 has a transceiver 13 for receiving FLEX™ signals 14 such as FLEX™ synchronizing signals to synchronize

transmission of a microcell selective call signal 15. Microcell selective call signal 15, like FLEX™ signals 14, is cyclical with one hundred and twenty eight message frames in one cycle. Collapse value of microcell 11 can be the same or higher than that of FLEX™ roaming system 10. Information can
5 be encoded into microcell selective call signal 15 such that receiving units 12 can identify or distinguish such a signal from FLEX™ signals 14.

FIG. 2 shows structure of one cycle of microcell selective call signal 15. This cycle is divided into segments known in the FLEX™ signalling protocol
10 as collapse cycles. Each of these collapse cycles represents a set of message frames. The number of message frames in a collapse cycle is based on the collapse value specified for microcell 11. A collapse cycle 16 is exploded in FIG. 2 to show four message frames 17 based on a collapse value of two. Associated with each of message frames 17 is a frame
15 location. Hence, the four message frames 17 in collapse cycle 16 are respectively associated with four frame locations.

A block diagram of transceiver 13 is shown in FIG. 3. Transceiver 13 comprises a receiver 18 coupled to an antenna 19, a processor 20, a
20 transmitter 21 coupled to an antenna 22 and an input device 23. FLEX™ signals 14 are received via antenna 19 and microcell selective call signal 15 is transmitted via antenna 22. Processor 20 includes a controller (not shown) to control an encoder (not shown) for encoding messages received from input device 23. These messages are provided to processor 20 for
25 processing which includes encoding these messages to form microcell selective call signal 15.

To process a message for transmission on microcell selective call signal 15, reference will now be made to flow diagrams as shown in FIGs.
30 4a and 4b. These flow diagrams detail a method 30 for processing the message within transceiver 13.

Upon receiving the message to start 31, method 30 begins by partitioning the message into message pieces at step 32. Partitioning is
35 required when the message cannot fit into one message frame 17 of microcell selective call signal 15. Otherwise, when the message can fit into one message frame 17, partitioning is not required. Identification of each of

the message pieces is necessary so that receiving units 12 can put together the message upon receiving all the message pieces. Such identification can be encoded with techniques known in the art.

Following step 32, method 30 continues to step 33 at which processor 20 initialises variables including a collapse cycle frame count (CCFC), a message piece count (MPC), precess count (PC), a precess tracker (PT) and a precess number (PN). In addition, processor 20 keeps track of transmission of the message pieces with a message transmission matrix (MTM). The MTM has a plurality of matrix positions to track each of the message pieces.

Different embodiments of the MTM are shown in FIGs. 5a and 5b. The structure of the MTM depends on number of message pieces for the message and number of message frames 17 in one collapse cycle 16. The MTM keeps track of frame locations of a plurality of message frames 17 in which the message pieces are placed. In accordance with the invention, processor 20 places each of the message pieces into a plurality of message frames 17 which are associated with at least one of each of the frame locations within collapse cycles 16 of microcell selective call signal 15. FIG. 5a represents an MTM 60 for four message pieces when microcell selective call signal 15 has four message frames in one collapse cycle 16. FIG. 5b represents an MTM 65 for eight message pieces when microcell selective call signal 15 has eight message frames in one collapse cycle 16. It is to be noted that the invention is not restricted to the number of message pieces or message frames in one collapse cycle 16 as shown by the embodiments of MTMs 60,65.

Also shown in FIGs. 5a and 5b are dashed arrows 61,66 which indicate sequential placing of the message pieces in MTMs 60,65 relative to the frame locations of message frames 17.

Another variable that is initialised by processor 20 is total tries (TT). TT is derived by multiplying maximum collapse cycle frames (MCCF) for microcell selective call signal 15 and maximum message pieces (MMP). The MCCF specifies the total number of message frames in one collapse cycle 16 of microcell selective call signal 15 and the MMP specifies the total number of message pieces for the message. Application of these variables and an MTM will be apparent as method 30 is described in the subsequent steps following step 33.

At step 34, processor 20 gets a message piece to process for transmission. Processing of this message piece is based upon variables MPC, PC and MMP. Each time step 34 is encountered, MPC is
 5 incremented by one from its previous value. This effectively selects the message piece in a sequential order according to how the message is partitioned. At subsequent placement of the message pieces, this sequential order is altered by precessing such placement so that a frame location is now placed with a different message piece. The variable PC is
 10 incremented when precessing occurs to thereby keep track of precession of the message pieces. A message piece is selected by adding MPC and PC and taking a modulo of this adding to account for numbers larger than MMP. This modulo is given a variable label z where:

$$15 \quad z = \text{modulo} (MPC+PC, MMP)$$

When the message piece is selected, decision step 35 determines whether the message piece can be placed into a current message frame that is being constructed for transmission. The message piece is placed
 20 into the current message frame for transmission at step 36 with a "Yes" from decision step 35 and matrix position (CCFC, z) in the MTM is then set. Setting of the matrix position indicates that the message piece with modulo z has been transmitted in a frame location specified by CCFC.

Following decision step 35 or step 36, method 30 continues with
 25 incrementing CCFC by a value of one at step 37 to thereby point to a next frame location. In addition, MPC is also incremented to effectively allow a next message piece to be transmitted in the sequential order as explained above. PT is incremented to keep track of how many message frames 17 is required for precessing to occur from the beginning of transmission. TT is
 30 decremented to track number of attempts to send out each of the message pieces.

When these variables have been incremented or decremented at step 37, method 30 proceeds to decision step 38 at which processor 20 determines whether processing of the message pieces has reached the
 35 bottom right hand box in the MTM.

When at such a bottom right hand box, method 30 proceeds to step 39 at which the number of transmission attempts which are required to precess transmission with respect to the message piece is already known.

Method 30 then takes the number of transmission attempts required to do a precess (the number being stored in PT) and set PN to this number. Setting PN at step 39 enables method 30 to subsequently determine when to precess the message pieces in subsequent collapse cycles 16. Thereafter
 5 and also in step 39, PT is set to zero and PC is incremented. PT determines how many attempts are made from the last precessing of the message pieces. Step 39 represents the first time in which precessing of the message pieces takes place. PC is incremented again at step 39 because precessing occurs.

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Continuing on to decision step 40, method 30 checks whether PT is equal to PN to determine whether enough attempts have been made from the preceeding precessing such that precessing of the message pieces is once again needed. In this decision step 40, PT is counting the number of
 15 attempts since the last precessing. When PT equals PN, method 40 proceeds to step 41. In precessing, PT is reset to zero and PC is incremented by one so that the number of attempts can again be accumulated to determine when the next precessing is needed.

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Following decision step 40 or step 41, method 30 proceeds to decision step 42 to determine whether CCFC is equal to MCCF. With a "Yes", CCFC is reset to zero at step 43. Otherwise, with a "No" from decision step 42 or following step 43, method 30 continues with decision step 44. Processor 20
 25 determines at decision step 44 whether has the last message piece been transmitted in this current attempt. If "Yes", then MPC needs to be reset at step 45 to the first message piece. Otherwise with a "No", or upon resetting MPC at step 45, method 30 continues with step 46 at which processor 20 waits for a next message frame 17.

Processing a message piece to place in a message frame 17 by
 30 method 30 occurs in a period of time that is shorter in duration than a message frame 17. As a result, such processing is completed within the duration of the message frame and, therefore, method 30 will wait for the next message frame at step 46. In waiting at step 46, method 30 thereby maintains synchronisation of any transmitted microcell selective call signal
 35 15 with FLEX™ signals 14 of FLEX™ roaming system 10.

Upon receiving the next frame, processor 20 checks at decision step 47 whether TT is equal to zero. By decision step 47, processor 20 is determining whether all the message pieces have been transmitted in all positions of the MTM for microcell 11. Indirectly, decision step 47 also
 5 determines whether each of the message pieces has been placed into at least one of each of the frame locations within the collapse cycles of microcell selective call signal 15.

Hence, when TT is not equal to zero, method 30 returns to step 34 to continue processing any remaining message piece which has yet to be
 10 placed into any one of the frame locations of the collapse cycles of microcell selective call signal 15 for transmission.

When TT equals zero, method 30 proceeds to decision step 48 to determine whether an MTM position, specified by CCFC for a particular MPC, has been set. An MTM position set to "1" indicates that such a
 15 position has been used to transmit a message piece. In addition, decision step 48 also determines whether the message piece fits into the current frame. For an MTM position that is not set to "1" (that is, has a "0" value) and when the message piece can fit into the current frame, method 30 proceeds with a "Yes" to step 49 in which such a message piece is placed into the
 20 current frame for transmission. Steps 47 and 48 are meant to transmit any message piece which was not transmitted in a particular frame location because such a message piece could not be placed or be fitted into the current message frame following decision step 35.

Thereafter, from step 49 or with a "No" following decision step 48,
 25 method 30 proceeds to step 50 in which MPC is incremented. By incrementing MPC at step 50, a next message piece is then processed in subsequent steps of method 30. These subsequent steps start with decision step 51 in which processor 20 determines whether this next message piece is the last message piece. A "No" following decision step
 30 51 brings method 30 back to decision step 48 to process the next message piece as described above. Otherwise, a "Yes" from decision step 51 proceeds to step 52 in which the next message piece, being the last message piece, causes processor 20 to reset MPC to zero and increment CCFC. Resetting MPC to zero brings MPC back to indicate the first
 35 message piece.

Processor 20 then checks at decision step 53 whether CCFC, now incremented by one, is equal to MCCF. Processor 20 sets CCFC to zero at

step 54 with a "Yes " following decision step 53. From step 54, or with a "No" from step 53, method 30 proceeds to step 55 to check every matrix position in the MTM to determine whether every message piece has been transmitted in every frame location of the collapse cycles of microcell selective call signal 15. A "Yes" from decision step 55 indicates that the message has been completely transmitted and method 30 ends at step 56. Otherwise, method 30 proceeds back to step 46 to wait for the next frame and continue processing the message pieces of the message to thereby transmit each of these message pieces in every one of the frame locations of the collapse cycles of microcell selective call signal 15.

FIGs. 6a, 6b, 6c and 6d is a timing diagram for transmission of the message pieces.

FIG. 6a shows how three message pieces "A", "B" and "C" are transmitted in collapse cycles having four message frames 17 each and using method 30. As can be seen from FIG. 6a, precessing of the three message pieces occurs when placing these three message pieces into subsequent collapse cycles. Hence, the first frame location in collapse cycle 70 has message piece "B" and the first frame location in collapse cycle 71 has message piece "C".

FIG. 6b represents transmitted message frames 17 from FLEX™ roaming system 10. The shaded message frames 17 in FIG. 6b represent the message frames 17 that receiving units 12 would have to decode when monitoring for FLEX™ signals 14 from FLEX™ roaming system 10. When in a coverage area where FLEX™ signals 14 and microcell selective call signal 15 are both present, such receiving units 12 may monitor for microcell selective call signal 15 of microcell 11 as shown in FIG. 6c.

Referring to FIG. 6c, the shaded message frames 17 represent the message frames 17 which receiving units 12 monitor microcell selective call signal 15 to decode for information. Receiving units 12 may sample three for the four message frames 17 in a given one of the collapse cycles of microcell selective call signal 15. These three message frames 17 do not conflict with message frames 17 of FLEX™ signals 14 from FLEX™ roaming system 10. As can be seen in FIG. 6c, receiving units 12 would receive and decode message pieces "A", "B" and "C" of the message transmitted on microcell selective call signal 15 after 5 message frames 17.

FIG. 6d shows another technique for receiving units 12 to monitor microcell selective call signal 15. Receiving units 12 monitor only one of the three available message frames 17 in the collapse cycles of microcell selective call signal 15. As shown in FIG. 6d, receiving units 12 would receive and decode message pieces "A", "B" and "C" after nine message frames 17. This technique of monitoring microcell selective call signal 15 is slower than that shown in FIG. 6c. However, such a technique is more battery efficient as compared to the monitoring shown in FIG. 6c as receiving units are using only three message frames 17 to receive message pieces "A", "B" and "C".

Advantageously, method 30 enables the invention to effectively transmit a message within microcell 11 without burdening FLEX™ roaming system 10. A further advantage of the invention is that transmission of the message pieces of the message uses all the frame locations in the collapse cycles of microcell selective call signal 15 and this ensures that receiving units 12 can receive the message completely. In addition, receiving units 12 in this invention are advantageously adapted to receive the message pieces using non-assigned message frames. Use of non-assigned message frames is unlike conventional receiving units which only monitor assigned message frames to receive messages transmitted on FLEX™ signals 14.

Although the invention has been described with reference to a preferred embodiment, it is to be understood that the invention is not restricted to the preferred embodiment described herein.



Claims

We claim:

- 5 1. A microcell for a synchronous selective call system, said microcell providing a microcell selective call signal having one or more collapse cycles, each of said collapse cycles having one or more message frames respectively associated with one or more frame locations, said microcell comprising:
- 10 a processor for partitioning a message into message pieces, wherein, in use, said processor places each of said message pieces into a plurality of said message frames, said plurality of said message frames being associated with at least one of each of said frame locations
- 15 within said collapse cycles.
2. The microcell as claimed in Claim 1 wherein said processor is adapted to select said plurality of said message frames from one or more of said collapse cycles.
- 20 3. The microcell as claimed in Claim 1 wherein said processor is adapted to precess said message pieces when placing said message pieces into subsequent ones of said collapse cycles.
- 25 4. The microcell as claimed in Claim 1 wherein said processor is adapted to set one or more positions in a message transmission matrix in response to transmission of each of said message pieces.
- 30 5. The microcell as claimed in Claim 1 wherein said processor comprises an encoder.
6. The microcell as claimed in Claim 1 wherein said processor comprises a controller.
- 35 7. The microcell as claimed in Claim 1 and further comprising a transmitter to transmit said microcell selective call signal.



8. The microcell as claimed in Claim 1 and further comprising a receiver to receive at least one synchronizing signal from said synchronous selective call system.

5 9. The microcell as claimed in Claim 1 and further comprising a plurality of receiving units to receive said microcell selective call signal.

10 10. The microcell as claimed in Claim 9 wherein said plurality of receiving units is adapted to receive said message pieces using one or more non-assigned message frames.

15 11. A method for processing a message in a microcell of a synchronous selective call system, said microcell providing a microcell selective call signal having one or more collapse cycles, each of said collapse cycles having one or more message frames respectively associated with one or more frame locations, said method comprising the steps of:

20 partitioning a message into message pieces, and
 placing each of said message pieces into a plurality of said message frames, said plurality of said message frames being associated with at least one of each of said frame locations within said collapse cycles.

25 12. The method as claimed in Claim 10 wherein said step of placing comprises the step of selecting said plurality of said message frames from one or more of said collapse cycles.

30 13. The method as claimed in Claim 10 wherein said step of placing comprises the step of precessing said message pieces when placing said message pieces into subsequent ones of said collapse cycles.

35 14. The method as claimed in Claim 10 and further comprising the step of setting one or more positions in a message transmission matrix in response to transmission of each of said message pieces.



15. A microcell for a synchronous selective call system comprising a processor substantially as described herein with reference to and as illustrated by the accompanying drawings.

- 5 16. A method for processing a message in a microcell of a synchronous selective call system substantially as described herein with reference to and as illustrated by the accompanying drawings.