METHOD AND APPARATUS FOR ESTABLISHING A COMMUNICATION LINK

Technical Field

This invention relates generally to communication systems, and more specifically to a method and apparatus for initiating a communication link from a portable radio to a base station.

Background

Personal communication systems (PCS) operate using various protocols and standards of operation. These communication systems are often implemented in more than one country each having a separate governing body overseeing communication standards and regulations. In order for a communication system to be implemented into a country, the system must adhere to the standards specific to that country. Cordless telephone second generation (CT2) communication systems operate in accordance with a document entitled "MPT1375 Common Air Interface Specification" (CAI), Version prI-ETS 300 131, dated 31st January 1994, which is published by the European Telecommunications Standards Institute and is hereby incorporated by reference. The CAI establishes a time-division multiplexed protocol having alternating one millisecond receive and transmit frames separated by guard time segments and is a standard adopted by most of the European community.

In a typical CT2 system, the communication protocol standard includes four main burst structures, called multiplex 3 (MUX3), multiplex 2 (MUX2), and multiplex 1 (MUX1) which is further subdivided into either multiplex 1.4 or 1.2 (MUX1.4 or MUX1.2). MUX3 is utilized mainly for communication link initiation (link establishment and re-establishment) between a portable radio and a base station. The MUX2 protocol employs a synchronization and data information exchange multiplex and is used primarily for communication link establishment and for link initiation from the base station. The MUX1 protocol is used primarily for voice/data communications, signaling information, and control messages between the portable to the base.

The current CAI protocol provides the following method for a portable radio to initiate a communication link to a base station. The portable selects a free channel and begins to transmit a non-synchronous link request using the MUX3 data format which has a transmit-to-receive ratio of 10:4. The base scans all frequencies in search of a link request. Because a base cannot synchronize to a portable, the structure of MUX3 is such that a base may examine slices of the transmitted data for the link request. Once the link request is recognized, the base begins to transmit a link grant to the portable in the MUX2 format. The portable synchronizes to the base's MUX2 transmission, recognizes the link grant, and terminates its MUX3 transmissions. The portable then begins to transmit in the MUX2 format using the base's synchronization. At this point a link is established in the MUX2 format, as well as the subsequent MUX1.2 format and MUX1.4 format, which has a transmit-to-receive ratio of 1:1.

When a base initiates a link to a portable, it foregoes the MUX3 format and uses the MUX2 format immediately. The portable scans all frequencies in search of an incoming call poll. Because the portable synchronizes to base transmissions, the MUX2 format can be read directly. Once the portable recognizes the poll, it responds with a link request in MUX2 which is subsequently answered by the base with a link grant. At this point a link is established in the MUX2 format, as well as the subsequent MUX1.2 format and MUX1.4 format, which has a transmit-to-receive ratio of 1:1.

When a portable initiates a link, it addresses a specific base or service (a specific grouping of bases) using a unique identification code which only the targeted base or service will recognize. Likewise, when a base initiates a link it addresses a specific portable using a unique identification code which only the targeted portable will recognize. Though it is possible for a base to target more than one portable by interleaving different codes, it must target each portable individually with the portable's unique code. This can become a problem, especially in a public base environment where thousands of portable radios, each having their own unique identification, code may be used.

In the United States the MUX3 format violates the transmit-to-receive ratio rule established by the Federal Communications Commission (FCC) which requires a frame length for unlicensed PCS equipment of

10ms/N (where N is an integer $\geq$ 1). Accordingly, the use of MUX3 for CT2 portable initiated calls must be avoided. Furthermore, non-synchronous transmissions, such as MUX3, create interference which can degrade performance and/or traffic capacity. A system using synchronous transmissions would reduce interference and improve system capacity. Hence, there is a need for an apparatus and method that provides and supports a synchronous link initiation from a portable to a base.

Brief Description of the Drawings

FIG. 1 is a drawing of a communication system in accordance with the present invention.

FIG. 2 is a protocol format in accordance with the present invention.

FIG. 3 is a flowchart of the preferred embodiment in accordance with the present invention.

FIG. 4 is a second flowchart in accordance with the present invention.

Detailed Description of the Preferred Embodiment

Referring now to FIG. 1 of the accompanying drawings, a communication system 100 is shown. The system 100 is preferably a CT2 system and is comprised of base stations 102 and 112 each having coverage areas, or cells, 110 and 114 respectively. Also included in the CT2 system 100 is a plurality of handsets 104, 106, and 108 located within coverage area 110. In the preferred embodiment of the invention, a communication link is to be initiated from at least one portable (104, 106, and/or 108) to the base station 102. The communication link shall be established without the use of the MUX3 protocol format.

Since the base 102 cannot synchronize to a portable and MUX3 must be avoided, it is necessary to facilitate portable link initiation in MUX2 using the base's synchronization. Synchronization provides a means to distinguish between the transmit and receive time frames. Since the portables 104, 106, 108 cannot maintain the base's synchronization without receiving data from the base 102, a 'marker' is transmitted from the base which allows the portables 104, 106, 108 to gain synchronization before initiating a link. In order for the portables 104, 106, 108 to differentiate

between the base they are attempting to contact, for example base 102, and other bases, such as base 112, the marker includes the base's unique identification code. To overcome the necessity of the base 102 transmitting the portable's unique code (one for every portable it may encounter), the base preferably includes a generic code in the marker which will invite portables 104, 106, 108 to gain synchronization. The generic code is a code that is recognizable by all handsets that allows them to initiate link requests in MUX2. The generic code may comprise binary data, such as a 10 bit code. All portables 104, 106, 108 will recognize the generic code for the purposes of synchronization but will use a portable identification code unique to each portable for link initiation. Once invited to synchronize by the base's marker, the portables 104, 106, 108 will transmit link requests in MUX2 using their respective portable identification codes.

Since all portables 104, 106, 108 may equally respond to the marker, it is possible that portables may experience collisions (all respond at the same time thus corrupting the data they transmit). When this occurs each portable 104, 106, and 108 will cease transmissions and wait a random amount of time as determined by a counter. The portables 104, 106, and 108 then re-attempt synchronization and link initiation at different times with a greatly reduced probability of collision. The count time is a random length of time controlled by software for the individual portable 104, 106, 108 and may vary for each collision occurrence.

The base 102 will verify that the portable's identification code is valid, cease transmission of the marker, and return a link grant to the portable with the shortest count time, possibly portable 104. At this point a link is established in the MUX2 format, as well as the subsequent MUX1.2 format or MUX1.4 format, which has a transmit-to-receive ratio of 1:1. If the base 102 continues to transmit the marker and does not respond with a link grant, the portable 104 will discontinue link requests after a time-out and resume searching for another marker.

Additionally, the base's marker may include a sequencing code which forces portables 104, 106, 108 to enter a queue for access, thus reducing the chance of collision. The sequencing code continually increments, and rolls over, to allow the portables 104, 106, 108 to compare this code with preferably the least significant portion of their respective unique portable identification code. When a portable detects a match, it transmits a link

request in response. Since the least significant portion of one portable's code has a high probability of being different from another portable's code, collisions are greatly reduced. The range and rate of change of the sequencing code is such that no significant delay results from the matching activity and link initiation time is not noticeably impacted.

An example of a base transmission is shown in FIG. 2 of the accompanying drawings. An information stream 200 is transmitted by the base with protocol format 208. The information stream includes an invitation, or marker, 202. The marker 202 includes the generic code, also known as channel marker link identity (CMLI) for inviting a handset to request a link. The CMLI in this example is set to binary code $FD. Also included within marker 202 is the sequence code (in this case 1) that provides an order line up (or queue) for the handset. Other general information is transmitted in an information and status code word (CIS) block 204 as defined in the CAI protocol. When the next transmission of an invitation occurs, the same generic invitation (CMLI) is sent, but the sequence code gets incremented as shown in block 206. So, the handset can synchronize to the marker 202 and wait until the sequence code, which is periodically updated preferably by a counter, matches a predetermined portion of the handset's own unique identification code. It is not essential that the whole handset identification code be compared to the sequence code, only a portion of the handset identification code, such as the four least significant bits, may be used in the comparison. Verifying the four least significant bits provides enough uniqueness without being cumbersome and time consuming to the process of link initiation. This speeds up the time to complete the link initiation while still providing a reduced collision rate. Also included but not shown in blocks 202, 204 is information such as a local area identifier (LAI) indicating the cell within which the base is located and a unique base identification code (LID). The base typically uses a 1 millisecond transmit/1millisecond receive (1ms TX/ 1ms RX) frame as shown by format 208. A synchronization pattern 210 is interleaved within the TX frames 212 with three TX frames 212 typically making up an invitation block such as 202 and CIS block 204. The information contained in blocks 202 and 204 may be spread throughout information (info.) portions 214 of the TX frames 212 and transmitted along with the synchronization (sync.) pattern 210.

A flowchart showing the preferred method for initiating a communication link from a portable is shown in FIG. 3 of the accompanying drawings. Flowchart 300 begins with a base station, also known as a cordless fixed part (CFP), transmitting a marker using a synchronization pattern at step 302. The marker includes both a generic code for inviting a handset to initiate a link, as well as a sequence code for placing the handset in queue in step 304. In step 306, the CFP waits for a link request and the flowchart 300 proceeds to step 308 which was started at the initiation of the flowchart. At step 308 the handset, or cordless portable part (CPP), scans for a synchronization pattern. Once a synchronization pattern is detected the CPP compares the sequence code to a portion of the CPP's own identification (ID) code, unique to each CPP in step 310. If the sequence code does not match the CPP identification code the routine returns to step 310, (the CPP still synchronized to the same marker), where the sequence code is incremented prior to being checked again at step 312. This sequencing loop (steps 310, 312) basically forces the CPP to "wait its turn".

Once the sequence code matches the identification code (or a predetermined portion of the identification code) in step 312 the portable sends a link request in MUX2 to the base at step 314. A time out feature monitors the CPP at step 316 to determine if too much time has elapsed from the start of the routine without any response from the CFP. When the time out has elapsed, the CPP discontinues the link request at step 318 and returns to step 308 to find a new marker and re-synchronize.

When the time out has not expired at step 316, a check for collisions with other CPP link requests is done at step 320. If a collision takes place at step 320, the CPP discontinues the link request and waits for a random count at step 322 generated in software prior to returning to step 310. Back at step 310 the CPP is still synchronized to the same marker but checks the next current sequence code.

If no collision takes place at step 320, the CFP sends a link grant in MUX2 to the CPP in step 324. The link grant is confirmed in step 326, and if no link was granted, the CPP sends another link request by returning to step 314. Once the link grant is sent from the CPP at step 324, the CFP ceases to transmit a marker at step 328 and a link is established between the CPP and the CFP at step 330. Thus, a link is established between a

portable and a base station with the portable initiating the link request in a synchronous format.

It can be seen by those skilled in the art that the invention as described above is not so limited. For example, the base's marker may employ synchronization words to differentiate between polling and call initiation. Polling is the process by which the base alerts or informs handsets to an incoming call. The use of different synchronization words allows portable radios, or handsets, to ignore 'markers' when scanning frequencies for incoming calls and concentrate on polling. The ability to ignore markers when not initiating a link allows a handset to scan more quickly, reduce its scan time and increase its battery life.

A suggested sequence for implementing call initiation from a handset while in the polling environment with the use of synchronization words is shown in FIG. 4 of the accompanying drawings. Initially, in step 402 the handset is not engaged in link initiation and thus disables its ability to recognize marker synchronization words and enables its ability to recognize polling synchronization words. The handset then scans for a polling synchronization word in step 404. If the polling synchronization word is detected in step 406, the handset answers the incoming call in step 408. If no polling synchronization word is detected in step 406, the handset determines if a user is initiating a call from the handset in step 410. If no call is being initiated, the handset returns to step 404 to scan for polling synchronization words. If a call is initiated in step 410, the handset disables its ability to detect polling synchronization words and enables its ability to detect marker synchronization words in step 412. The handset then scans for a marker in step 414 and continues to scan until a marker is detected. Once a marker is detected in step 416, an outgoing call can be made by the handset in step 418. The call ends at step 420 and the routine is started over at step 402.

The apparatus and method for initiating a communication link as described by the invention provides the advantage of employing a synchronous protocol that allows for greater traffic capacity and reduced interference as compared to a non-synchronous protocol that limits channel availability. The handset is not required to scan for free channels when initiating a link and the base does not have to scan for link initiations from the handsets. Because of the reduction in required scanning, faster

communication links between the handset and the base are established. Overall transmissions from the handsets are reduced since handsets only transmit when a valid base is available, thus reducing interference and preserving battery life. Because, the base assigns the channel and includes it in the marker, a more efficient use of spectrum within a cell is provided. Counters as described by the invention are preferably controlled by software and provide collision resolution of link requests. Collisions are further avoided by the use of the sequencing codes which place the handsets in queue. While the preferred embodiment of the invention describes link initiation from a handset using MUX2, any communication system employing a synchronization and data information exchange multiplex may apply the apparatus and method as described by the invention. Modifications to existing systems can be provided by software, and thus the cost to implement the invention is negligible. The method for initiating a link request as described by the invention is compatible with existing CAI data structures and protocol.

What is claimed is:

Claims

1. A method for establishing a communication link between a portable radio and a base station in a communication system, comprising the steps of:

at the base station:

transmitting a synchronization pattern comprising a marker, the marker including a generic code and a sequence code;

at the portable radio:

scanning for the marker;

detecting the marker;

synchronizing to the base station based on the synchronization pattern;

recognizing the generic code in the marker;

sending a link request including a portable identification code to the base station employing a synchronization and data information exchange multiplex in response to recognizing the generic code when the sequence code matches a predetermined portion of a unique portable identification code associated with the portable radio; and

granting a link from the base station in response to the link request.

2. The method of claim 1, further comprising the steps of:

detecting at the portable radio if more than one link request has been sent;

waiting a predetermined time when more than one link request has been sent; and

sending another link request from the portable after the predetermined time has expired.

3. The method of claim 1, further comprising the step of comparing the sequence code to the portable identification code at the portable radio.

4. The method of claim 3, further comprising the steps of :

decrementing the sequence code when the predetermined portion of the portable identification code does not match the sequence code; and

repeating the comparing step.

5. The method of claim 1, further compising the step of verifying at the base station that the portable identification code is valid.

6. The method of claim 1, further comprising the steps of :

ceasing to transmit the marker once the link has been granted from the base station; and

establishing the communication link between the portable radio and the base station.

7. The method of claim 1, wherein the step of sending the link request includes sending the portable identification code to the base station employing a MUX2 protocol in a cordless telephone second generation system.

8. A communication system comprising:

a base station for transmitting synchronization data including a marker, the marker including a sequence code;

a portable radio for detecting the marker and gaining synchronization with the base station in response to the synchronization data, the portable radio including a portable identification code; and

the portable radio initiating a communication link request to the base station using a synchronization and data information exchange multiplex in response to the marker, when synchronization is achieved and the sequence code matches a portion of the portable identification code.

* C L M S *

9. The communication system of claim 8, wherein the marker includes a generic code for prompting the portable radio to initiate the communication link request.

10. The communication system of claim 9, wherein the communication system is a cordless telephone second generation system and the synchronization and data information exchange multiplex is MUX2.

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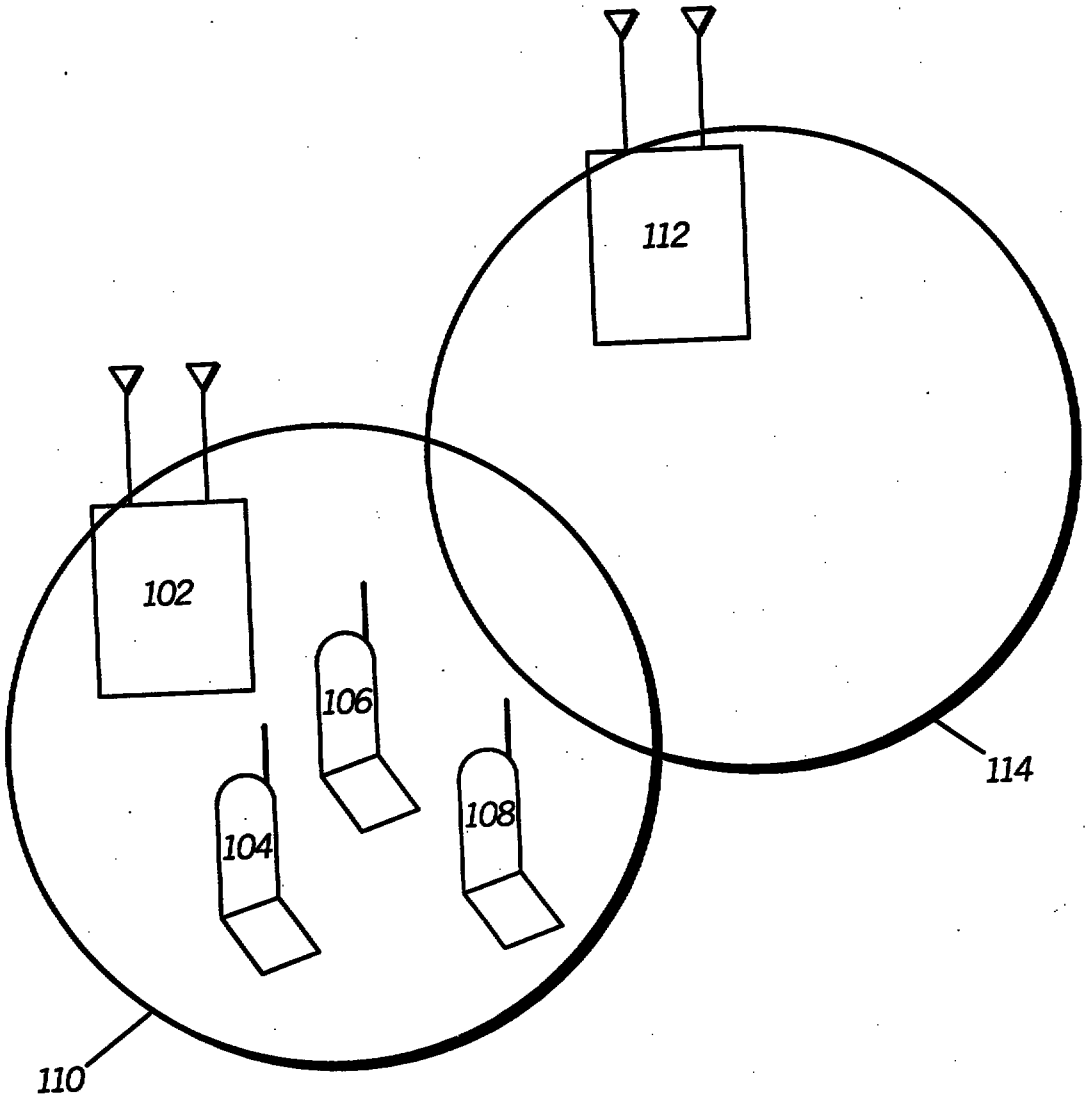
REPLACED

METHOD AND APPARATUS FOR ESTABLISHING A COMMUNICATION LINK

Abstract of the Disclosure

A portable radio (104) initiates a communication link using a synchronous protocol format. A base station (102) generates a synchronization pattern (200) which includes a marker. The marker (202) includes a generic code that invites portables to make link requests. The portable radio (104) synchronizes to the marker (202) and recognizes the generic code that indicates base availability. The portable radio (104) sends a link request in response to the generic code to initiate the communication link, and the base station (102) grants a link in order to establish the communication link.

FIG.1



100

FIG.2

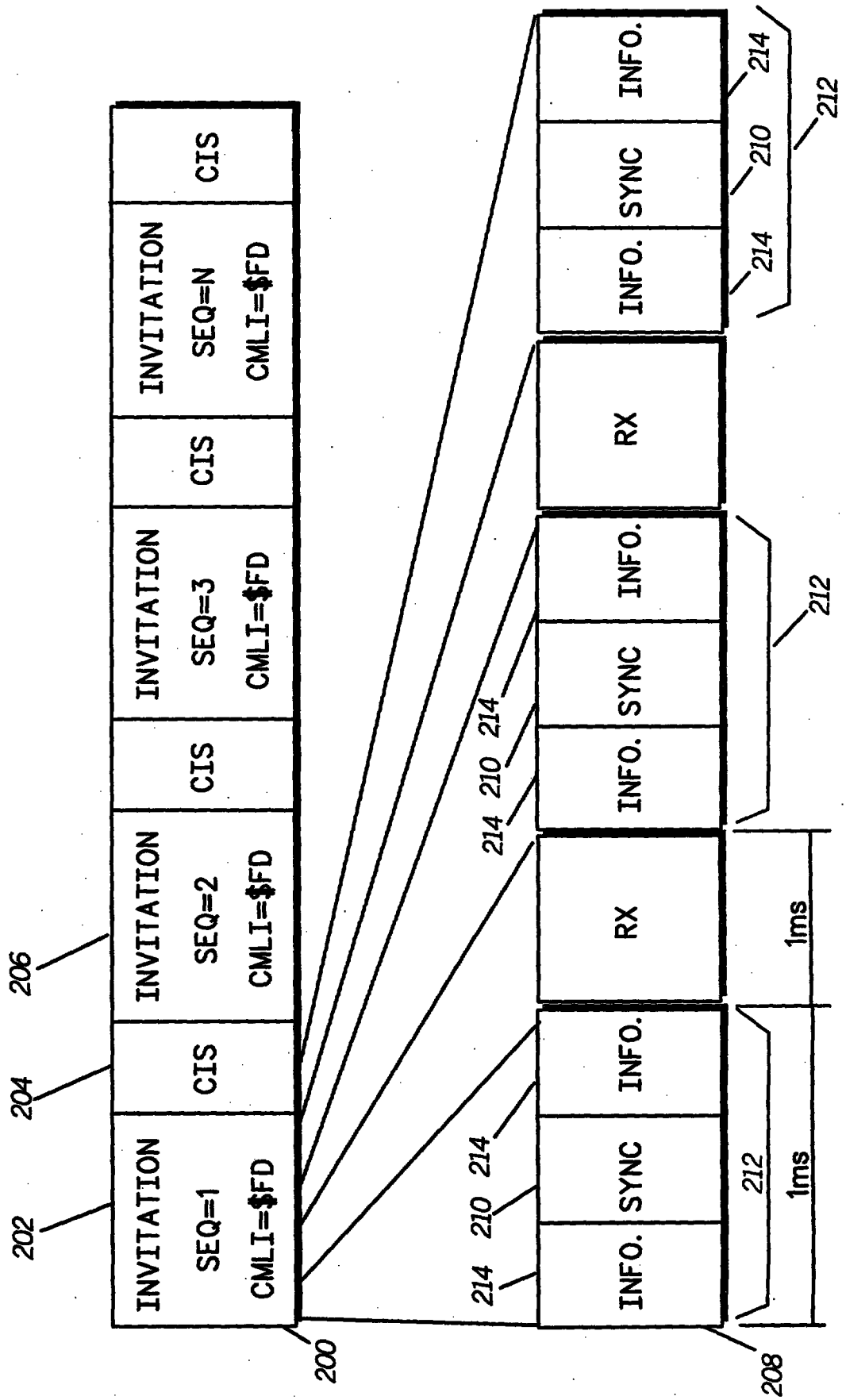

INVITATION
SEQ=1
CMLI=$FD
CIS
INVITATION
SEQ=2
CMLI=$FD
CIS
INVITATION
SEQ=3
CMLI=$FD
CIS
INVITATION
SEQ=N
CMLI=$FD
CIS
INFO.
SYNC
INFO.
RX
INFO.
SYNC
INFO.
RX
INFO.
SYNC
INFO.
1ms
1ms
200
202
204
206
208
210
212
214

FIG.3

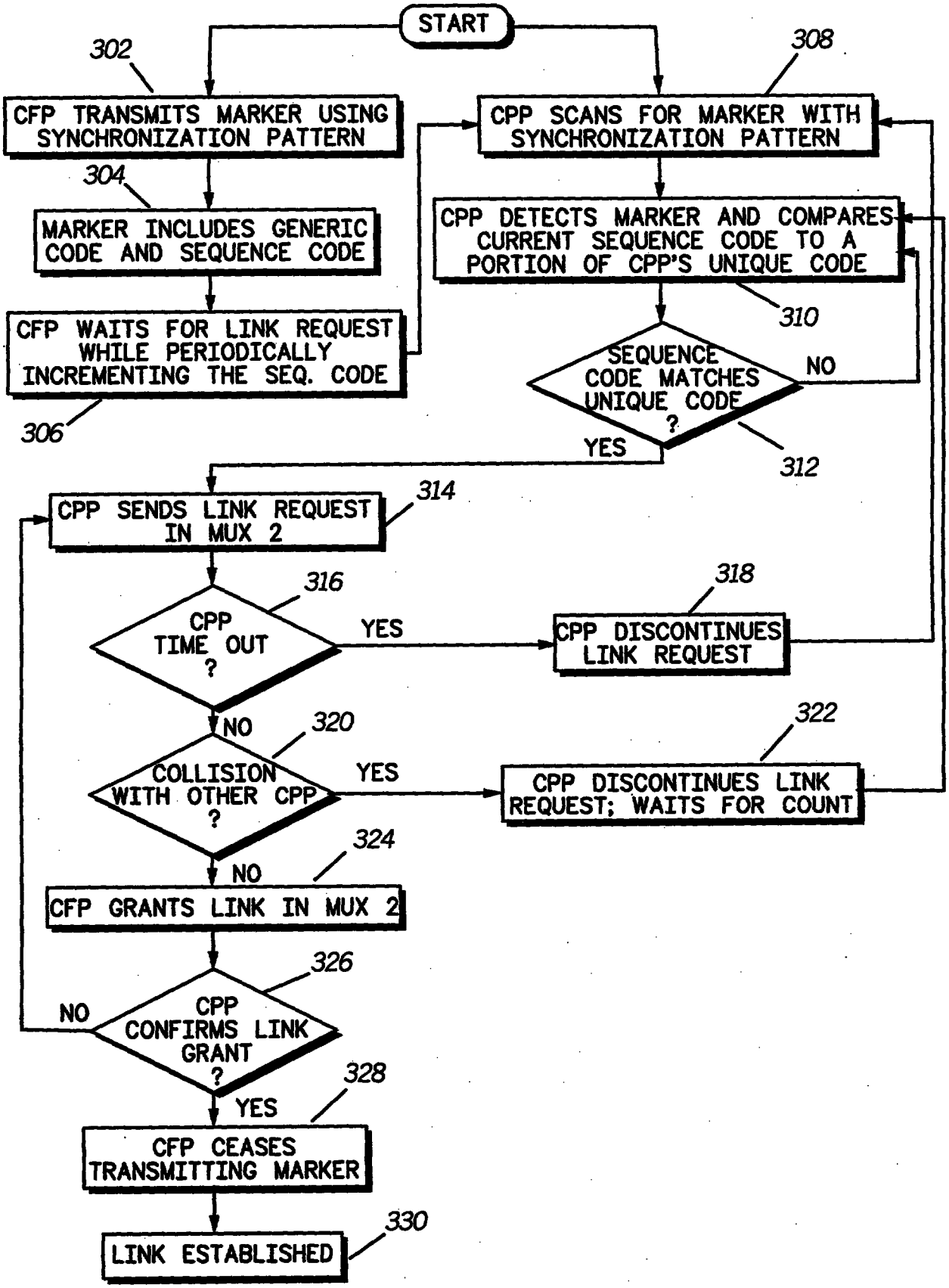
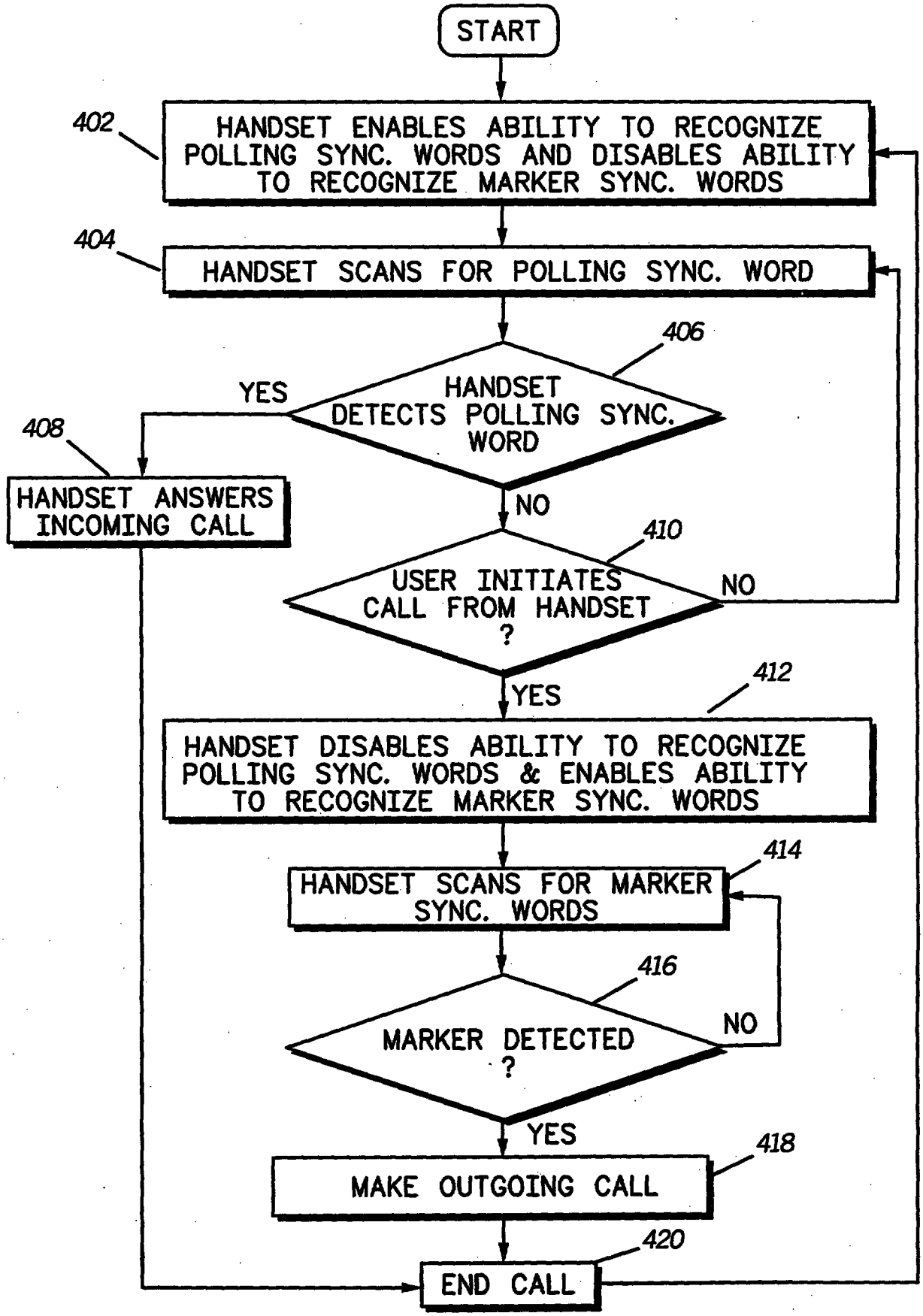

START
302
CFP TRANSMITS MARKER USING SYNCHRONIZATION PATTERN
304
MARKER INCLUDES GENERIC CODE AND SEQUENCE CODE
CFP WAITS FOR LINK REQUEST WHILE PERIODICALLY INCREMENTING THE SEQ. CODE
306
308
CPP SCANS FOR MARKER WITH SYNCHRONIZATION PATTERN
CPP DETECTS MARKER AND COMPARES CURRENT SEQUENCE CODE TO A PORTION OF CPP'S UNIQUE CODE
310
SEQUENCE CODE MATCHES UNIQUE CODE ?
NO
YES
312
CPP SENDS LINK REQUEST IN MUX 2
314
316
CPP TIME OUT ?
YES
318
CPP DISCONTINUES LINK REQUEST
NO
320
COLLISION WITH OTHER CPP ?
YES
322
CPP DISCONTINUES LINK REQUEST; WAITS FOR COUNT
NO
324
CFP GRANTS LINK IN MUX 2
326
NO
CPP CONFIRMS LINK GRANT ?
YES
328
CFP CEASES TRANSMITTING MARKER
LINK ESTABLISHED
330

FIG.4


START
402
HANDSET ENABLES ABILITY TO RECOGNIZE POLLING SYNC. WORDS AND DISABLES ABILITY TO RECOGNIZE MARKER SYNC. WORDS
404
HANDSET SCANS FOR POLLING SYNC. WORD
406
HANDSET DETECTS POLLING SYNC. WORD
YES
NO
408
HANDSET ANSWERS INCOMING CALL
410
USER INITIATES CALL FROM HANDSET ?
NO
YES
412
HANDSET DISABLES ABILITY TO RECOGNIZE POLLING SYNC. WORDS & ENABLES ABILITY TO RECOGNIZE MARKER SYNC. WORDS
414
HANDSET SCANS FOR MARKER SYNC. WORDS
416
MARKER DETECTED ?
NO
YES
418
MAKE OUTGOING CALL
420
END CALL

THIS SHEET HAS BEEN REPLACED

REPLACEMENT SHEET
Date : 28 FEB 1996

METHOD AND APPARATUS FOR ESTABLISHING A COMMUNICATION LINK

Abstract of the Disclosure

A portable radio (104) initiates a communication link using a synchronous protocol format. A base station (102) generates a synchronization pattern (200) which includes a marker. The marker (202) includes a generic code that invites portables to make link requests. The portable radio (104) synchronizes to the marker (202) and recognizes the generic code that indicates base availability. The portable radio (104) sends a link request in response to the generic code to initiate the communication link, and the base station (102) grants a link in order to establish the communication link.

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Figure 3

REPLACEMENT SHEET
Date: 11 JUL 1996

METHOD AND APPARATUS FOR ESTABLISHING A COMMUNICATION LINK

A portable radio (104) initiates a communication link using a synchronous protocol format. A base station (102) generates a synchronization pattern which includes a marker. The marker includes a generic code that invites portables to make link requests. The portable radio (104) synchronizes to the marker and recognizes the generic code that indicates base availability. The portable radio (104) sends a link request in response to the generic code to initiate the communication link, and the base station (102) grants a link in order to establish the communication link.

Fig. 1