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(54) Title: MOBILE STATION WITH TWO TRANSCEIVERS AND INTER-FREQUENCY METHODS PERFORMED THEREWITH

(57) Abstract: A mobile station for a wireless cellular or PCS system has two tunable transceivers, each having its own antenna, which can be tuned independently of each other to operating frequencies of base stations of the system. The two-transceiver arrangement enables the performance of an inter-frequency soft handover method, without using a compressed mode, and an inter-frequency signal quality measurement method without using a slotted mode. Because the two antennas are spaced apart in distance, orientation or polarization, baseband signals of the transceivers are combined when the transceivers are tuned to the same operating frequency, to exploit an antenna diversity effect. Both inter-frequency methods are such that just prior to the commencement of the method, both transceivers are tuned to the same current operating frequency and are in communication with a current base station of the system, and at an intermediate stage in the method, one of the transceivers is tuned to another operating frequency while the other transceiver remains in communication with the current base station at the current operating frequency.

Mobile station with two transceivers and inter-frequency methods performed therewith

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to inter-frequency methods performed in or between wireless cellular systems and/or personal communications systems (PCS), wherein a mobile station while communicating with a base station over an RF link at a current operating frequency is required to tune to another operating frequency. One such method has the purpose to accomplish a handover of the communication with the mobile station to an RF link at the new operating frequency to which the mobile station tunes, termed herein an "inter-frequency handover". Another such method has the purpose of allowing the mobile station to measure signal quality at a set of candidate frequencies different than the current operating frequency, termed herein "inter-frequency signal quality measurement". The latter method provides information for handover decisions. The present invention also relates to the structure of a mobile station as it relates to performance of inter-frequency methods.

2. Description of the Related Art

A method for performing an inter-frequency handover is known from A. Baier et al., "MULTI-RATE DS-CDMA RADIO INTERFACE FOR THIRD-GENERATION CELLULAR SYSTEMS", Seventh IEE European Conference on Mobile and Personal Communications, 13-15 December, 1993, pp. 255-260.

Handovers are employed in wireless cellular systems and in PCS to allow mobile stations to travel from the coverage area of one base station to another while maintaining a call. While handovers are usually employed to transfer an ongoing communication with the mobile station from a current to a new base station, it is also possible to hand over a communication with the mobile station from one RF link to another of the same base station.

In a Code Division Multiple Access (CDMA) system a handover of a mobile station between base stations can be either a soft handover, in which during a transient period the mobile station simultaneously maintains communications with both the current and new base stations at the same frequency and receives the same data via both base stations, and a

hard handover, where the mobile station switches from current links to new links generally at a new frequency and/or of a new network without such a transient period in which current and new RF links are simultaneously maintained.

Unfortunately, inter-frequency handovers are subject to dropped calls causing annoyance and inconvenience to the parties to the dropped calls.

One method of improving the reliability of an inter-frequency handover is to use a transient compressed mode in which the data transmitted to the current base station at the current frequency F1 is squeezed into the first halves of frames by doubling the instantaneous symbol rate R_{INFO} while allowing the mobile station to tune to and establish communication at the new frequency F2 in the second halves of frames. While the compressed mode allows for a more gradual inter-frequency handover similar to a soft handover, there may be a deterioration of the bit error (BER) during the time that this mode is employed due to the doubling of the instantaneous symbol rate. Since the chip rate R_{CHIP} of the Pseudo Noise (PN) spreading code is held constant, the doubling of the symbol rate R_{INFO} results in a halving of the spreading factor R_{CHIP}/R_{INFO} in each half of the frame, which is typically compensated by increasing the power level of transmissions in compressed mode is increased accordingly notwithstanding that this temporary increase in power level of transmissions in the compressed mode increases the background interference applicable to all users.

Slotted mode methods are known wherein idle slots, usually but not necessarily a frame in duration, are presented in the communication between the mobile station and a base station at a current operating frequency to allow time for the mobile station to tune to another candidate operating frequency, and make a signal quality measurement. Such slots are preceded and succeeded by active half frames in which the instantaneous symbol rate is usually doubled to compensate for the lack of communication content in the slots. The power level is also typically increased during the active half frames to compensate for halving of the spreading factor.

It is also known that reliability of transmission from and reception by a mobile station can be improved by antenna diversity, wherein the transceiver of the mobile station is coupled to two or more spaced apart antennas.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the present invention to provide a mobile station with structure or functionality to participate in an inter-frequency soft handover in or between wireless cellular systems and/or PCS, without the use of a compressed mode;

It is a further object of the present invention to provide a mobile station with structure or functionality to perform inter-frequency signal quality measurement in wireless cellular systems and/or PCS, without the use of a slotted mode;

It is a further object of the present invention that the structure or functionality with which a mobile station is provided to participate in or perform the aforementioned inter-frequency methods can also be used to improve the reliability and/or quality of its communications when the inter-frequency methods are not being participated in or performed by the mobile station.

The present invention is based on the insight that providing the mobile station with two independently tunable transceivers, rather than the usual one transceiver, enables the mobile station to participate in an inter-frequency soft handover without a compressed mode and/or perform an inter-frequency signal quality measurement without a slotted mode, and when the two transceivers, which are coupled to respective antennas which antennas are spaced apart in distance, orientation or polarization, are tuned to the same operating frequency, the communications to and from the mobile station can be improved by the antenna diversity effect.

In accordance with the present invention, a mobile station so equipped is configured for steering a mobile station side of an inter-frequency method wherein just prior to the commencement of the method, both transceivers are tuned to the same current operating frequency and are in communication with a current base station of the system, and at an intermediate stage in the method, one of the transceivers is tuned to another operating frequency while the other transceiver remains in communication with the current base station at the current operating frequency.

The present invention also pertains to a stored program for a mobile station for steering the aforementioned method and to a method of operation of a mobile station.

When the inter-frequency method is a soft handover, during the intermediate stage the one of the transceivers which is tuned to another operating frequency, referred to herein as a new operating frequency, establishes an RF link for communication at the new operating frequency, and after the intermediate stage the other transceiver is tuned to the new operating frequency. On the other hand, when the inter-frequency method is a soft handover, during the intermediate stage the one of the transceivers which is tuned to another operating

frequency is used to make a signal quality measurement, and after the intermediate stage this one of the transceivers is tuned back to the current operating frequency. Outside of the intermediate stages of these inter-frequency methods, both transceiver are tuned to the same frequency, and the antenna diversity effect is exploited. One method of exploiting the antenna diversity effect is by combining the baseband signals received from each transceiver and by linking the baseband signals to be transmitted by each transceiver.

Other objects, features and advantages of the present invention will become apparent upon perusal of the following detailed description when taken in conjunction with the appended drawing, wherein:

BRIEF DESCRIPTION OF THE DRAWING

Figure 1 schematically shows a mobile station, which is arranged with two transceivers in accordance with the present invention, in conjunction with a pair of wireless cellular networks, each having a respective local base station with which the transceivers of the mobile station can communicate;

Figures 2A, 2B, and 2C show the mobile station, and local base stations of Figure 1 and respectively generally depict the communication links with the mobile station just prior to, during, and just after an inter-frequency soft handover performed in accordance with the present invention;

Figures 3A, 3B, and 3C show the mobile station, and local base stations of Figure 1 and respectively generally depict the communication links with the mobile station just prior to, during, and just after an inter-frequency signal quality measurement performed in accordance with the present invention;

Figure 4 depicts the communications to and from the mobile station over the time interval spanning from just prior to to just after the inter-frequency soft handover, wherein time intervals A, B, and C generally correspond to the link depictions shown in Figures 2A, 2B, and 2C, respectively;

Figure 5 is a general schematic showing the structure of a mobile station in accordance with the present invention, including first and second identical but independently controllable RF sections; and

Figure 6 is a schematic of one of the identical RF sections of Figure 5.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is described herein with respect to a Direct Sequence Code Division Multiple Access (DS-CDMA) wireless cellular or PCS network of the type (e.g. CDMA 2000) that utilizes plural operating frequencies, such that there could be a handover requiring a mobile station to change from one operating frequency to another. Inter-frequency handovers may also be required in other wireless cellular or PCS systems utilizing more than one radio channel, and the principles of the present invention are equally applicable thereto. These other systems include AMPS (Analog Mobile Phone System), TDMA (Time Division Multiple Access), GSM (Global System for Mobile Communications), the Japanese PDC (Personal Communication Device) system, and the UMTS (Universal Mobile Telephone System) third generation (3G) systems under consideration.

Referring first to Figure 1, there is shown an inter-frequency soft handover capable wireless cellular or PCS mobile station 10 which has a first antenna 12 coupled to a first transceiver 14 and a second antenna 13 coupled to a second transceiver 15. Transceivers 14 and 15 are tunable and are operable independently of each other with respect to transmission and reception. Further, antennas 12 and 13 are sufficiently spaced apart in distance and/or orientation or polarization in a manner that, when desired, one of transceivers 14 and 15 can be receiving RF while the other is transmitting RF at a different operating frequency. The spacing and relative orientation or polarization of the antennas 12 and 13 is also sufficient that an antenna diversity effect occurs when the transceivers 14 and 15 are tuned to the same frequency and transmit or receive the same signals. This antenna diversity effect is exploited by a diversity exploitation means 16. One mode of operation thereof is to combine the baseband signals received from transceivers 14 and 15, and to link the baseband signals supplied to transceivers 14 and 15 for transmission. For example the received baseband signals would be added together and the same baseband signals would be supplied to each transceiver for transmission. Another mode of operation of diversity exploitation means 16 is to use only the strongest received signal from transceivers 14 and 15 and supply a baseband signal to only the transceiver from which the strongest signal has been received.

Mobile station 10 also includes an inter-frequency method steering means 17, with part 17a for steering a soft handover and part 17b for steering an inter-frequency signal quality measurement. The operation of the inter-frequency method steering means 17 will become more apparent as the discussion proceeds.

Mobile station 10 is capable of roaming, including while on a call, from the wireless coverage area of a first base station 22 of a Direct Sequence Code Division Multiple

Access (DS-CDMA) network 20 to the wireless coverage of a second base station 32, which may be of the same network, or of a different DS-CDMA different network 30 as illustrated, such that an "inter-frequency" handover is required. By this is meant that the call must be switched or transferred from a bi-directional link L1 of mobile station 10 with local base station 22 of network 20, which is at an operating frequency F1, to a bi-directional link L2 of mobile station 10 with local base station 32 of network 30, which is at an operating frequency F2. As generally illustrated, transceivers 14 and 15 are independently operable at either frequency F1 or F2, such that each could independently operate over link L1 or link L2. However, the course of events in an inter-frequency handover is more apparent from Figures 2A through 2C. As shown in Figure 2A, just prior to an inter-frequency handover both transceivers 14 and 15 are operating over link L1 at frequency F1 to the current local base station 22, taking advantage of the antenna diversity effect e.g. by adding the signals received by both transceivers 14 and 18 or using only the one signal having the better signal quality. Then, as shown in Figure 2B, after receiving a handover command from local base station 22, transceiver 15 is tuned to frequency F2 and begins to operate over link L2 to the new local base station 32. Once the communication between transceiver 15 and new local base station 32 is stabilized, transceiver 14 is also switched to frequency F2, yielding the position shown in Figure 3C, wherein both transceivers 14 and 15 are operating over link L2 at frequency F2 to the new local base station 32, taking advantage of the antenna diversity effect.

As is well known, prior to receiving a handover command from local base station 22 specifying base station 32 as the recipient of the handover, it is necessary for mobile station 10 to make inter-frequency signal quality measurements, e.g. of pilot strength, at other candidate operating frequencies, including F2, and send this information to the current base station 22. The availability of two independently tunable transceivers 14 and 15 eliminates the need for a slotted mode wherein idle slots appear sandwiched between leading and trailing active frame portions or partial frames, and the mobile station makes signal quality measurements during the slots. Idle slots, and the attendant increase of instantaneous symbol rate in the leading and trailing frame portions, are not needed. Inter-frequency signal quality measurements can be made using one of the transceivers, e.g. transceiver 15, to tune to the candidate frequency and measure pilot strength while the other transceiver, e.g. transceiver 14, remains in communication with the current base station at the current operating frequency. Thus as shown in Figure 3A, just prior to an inter-frequency handover both transceivers 14 and 15 are operating over link L1 at frequency F1 to the current local base station 22, taking advantage of the antenna diversity effect e.g. e.g. by adding the signals

received by both transceivers 14 and 15 or using only the one signal having the better signal quality. Then, as shown in Figure 2B, transceiver 15 is tuned to frequency F2 and measures the strength of the pilot received at that frequency from base station 32, as an indication of signal quality. Once the signal quality measurement has been made, transceiver 15 is switched back to frequency F1, yielding the position shown in Figure 3C, wherein both transceivers 14 and 15 are again operating over link L1 at frequency F1 to the current local base station 22, taking advantage of the antenna diversity effect.

Returning to Figure 1, at the level of detail shown the networks 20 and 30 appear conventional. For purposes of illustration the network 20 is shown as comprising two base stations 22, 24, a base station controller 26 which controls the plurality of base stations 22, 24, and a network controller 28 which controls network 20. Similarly, network 30 is shown as comprising two base stations 32, 34, a base station controller 36 which controls the plurality of base stations 32, 34, and a network controller 38 which controls network 20. The network controllers are coupled by a communication link 40, and also each network controller is coupled to the public switched telephone network (PSTN) 42.

Figure 4 depicts communications in more detail between mobile station 10 and local base stations 22 and 32, wherein BS1 corresponds to base station 22 and BS2 corresponds to base station 32. As shown, there is initially a sequence of a first downlink data frame DL_Data_1, a first uplink data frame UP_Data_1, a second downlink data frame DL_Data_2, and a second uplink data frame UP_Data_2, between current local base station 22 and transceivers 14 and 15, representing e.g. time division duplex voice traffic, and a downlink handover command Handover_Cmd from base station 22 to transceivers 14 and 15 specifying the frequency F2 and otherwise identifying the new base station 32. As is conventional, the handover decision has been made in infrastructure system 20 utilizing the inter-frequency signal quality measurements previously provided by mobile station 10, and base station 32 is also made aware of the impending handover via the link 40 between systems 20 and 30. At this point, transceiver 15 switches its operating frequency to F2 and sends requests for acknowledgement RACH to the new base station 32, which ultimately replies with a signal Info, after which transceiver 18 sends an uplink signal Handover_Com to the new base station 32 that the handover is complete. Until the time that the completion of the handover is signaled, transceiver 14 has remained in communication with current base station 22 and has continued to receive and send data, e.g. as illustrated, the sequence of a third uplink data frame UP_Data_3, a third downlink data frame DL_Data_3, a fourth uplink data frame UP_Data_4, a fourth downlink data frame DL_Data_4, a fifth uplink data frame

UP_Data_5, a fifth downlink data frame DL_Data_5, and a sixth uplink data frame UP_Data_6. Then, while transceiver 14 tunes to frequency F2, the transceiver 15 receives a seventh downlink data frame DL_Data_7. Thereafter, there is a final sequence of a seventh uplink data frame UP_Data_7, an eighth downlink data frame DL_Data_8, an eighth uplink data frame UP_Data_8, and a ninth downlink data frame DL_Data_9, between new local base station 32 and transceivers 14 and 15, again representing e.g. time division duplex voice traffic.

The mobile handset 10 illustrated schematically in Figure 5, wherein the first transceiver 14 generally comprises the combination of a first RF section 42 and a baseband section 50 and the second transceiver 15 generally comprises the combination of a second RF section 46, identical to first RF section 42, and the baseband section 50. Baseband section 50 includes a digital signal processor (DSP) 50a, a microprocessor 50b, a non-volatile memory or ROM 50c, at least a portion of which is programmable, in which is stored firmware constituting programs and data for operation of DSP 50a and microprocessor 50b, including for steering the mobile station side of an inter-frequency soft handover, and inter-frequency signal quality measurements preceding the handover, and a volatile random access memory for temporary storage, primarily of data. Received and demodulated signals R are supplied from RF sections 42 and 46 to baseband section 50 via analog-to-digital converters 50e and 50f, respectively and DSP 50a performs despreading and decoding operations on the demodulated signals respectively, in a well known manner by application of the relevant pseudo noise (PN) code sequence, at the relevant phase. Similarly, spread spectrum encoded signals T produced by DSP 50a are supplied to first RF section 42 and second RF section 46 via digital-to-analog converters 50g and 50h respectively in order to be modulated on a carrier and transmitted. Further, command signals C, such as tuning commands, are supplied from baseband section 50 to first RF section 42 and second RF section 46 via digital-to-analog converters 50i and 50j, respectively.

Mobile station 10 further comprises in communication with baseband section 50, a numeric keypad 51, and a driver 52 for a display 53, e.g. an LCD screen, a microphone 54 and speaker 55. Microphone 54 communicates with baseband section 50 via an analog-to-digital converter 50k and baseband section 50 communicates with speaker 55 via digital-to-analog converter 50l.

An RF section corresponding to the identical, but independently controllable first and second RF sections 42, 46, is shown in Fig. 6. The RF section comprises a diplexer 60 coupled to the applicable antenna 12 or 13, which receives from the output of a power

amplifier 62 an RF spread spectrum communication signal to be transmitted by the antenna and supplies an RF spread spectrum communication signal to the input of a low noise amplifier 64 which has been received by the antenna. A modulator 66, preferably having a zero IF structure (not shown), receives a baseband spread spectrum communication signal from baseband section 50, and an RF carrier signal from voltage controlled oscillator or frequency synthesizer 68 and supplies an RF spread spectrum communication signal to the input of power amplifier 64. Similarly, a demodulator 67, preferably also having a zero IF structure (not shown), receives an RF spread spectrum communication signal from the output of low noise amplifier 64 and an RF carrier signal from oscillator or synthesizer 68 and supplies the baseband spread spectrum communication signal R to baseband section 50.

It should now be appreciated that the objects of the present invention have been satisfied. While the present invention has been described in particular detail, it should also be appreciated that numerous modifications are possible within the intended spirit and scope of the invention. In interpreting the appended claims it should be understood that:

a) the word "comprising" does not exclude the presence of other elements or steps than those listed in a claim;

b) the word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements.

c) any reference signs in the claims do not limit their scope; and

d) several "means" may be represented by the same item of hardware or software implemented structure or function.

CLAIMS:

1. A mobile station for a wireless cellular or PCS system (20), said mobile station (10) comprising two tunable transceivers (14, 15) which can be tuned independently of each other to operating frequencies of base stations (22, 32) of the system.

2. The mobile station as claimed in Claim 1, further comprising two antennas (12, 13) coupled to said two transceivers (14, 15), respectively, which antennas are spaced apart in distance, orientation or polarization, and diversity effect means (16) for selectively combining baseband signals received by the transceivers (14, 15) and for selectively linking baseband signals supplied to the transceivers (14, 15) to be transmitted in order to exploit an antenna diversity effect when the transceivers (14, 15) are tuned to the same operating frequency.

3. The mobile station as claimed in Claim 1 or 2, further comprising means (17) for steering a mobile station side of an inter-frequency method wherein just prior to the commencement of the method, both transceivers (14, 15) are tuned to the same current operating frequency and are in communication with a current base station (22) of the system, and at a stage in the method, one of the transceivers (15) is tuned to another operating frequency while the other transceiver (15) remains in communication with the current base station (22) at the current operating frequency.

4. The mobile station as claimed in Claim 3, wherein the inter-frequency method is such that during said stage the one of the transceivers (15) which is tuned to another operating frequency, referred to herein as a new operating frequency, establishes an RF link (L2) for communication at the new operating frequency, and after said stage the other transceiver (14) is tuned to the new operating frequency.

5. The mobile station as claimed in Claim 3, wherein the inter-frequency method is such that during said stage the one of the transceivers (15) which is tuned to another

operating frequency is used to make a signal quality measurement (17b), and after said stage said one of the transceivers (15) is tuned back to the current operating frequency.

6. A stored program for a mobile station (10) for a wireless cellular or PCS system (20), which mobile station has two tunable transceivers (14, 15) which can be tuned independently of each other to operating frequencies of base stations (22, 32) of the system, said program being configured for steering a mobile station side of an inter-frequency method wherein just prior to the commencement of the method, both transceivers (14, 15) are tuned to the same current operating frequency and are in communication with a current base station (22) of the system (20), and at a stage in the method, one of the transceivers (15) is tuned to another operating frequency while the other transceiver (14) remains in communication with the current base station (22) at the current operating frequency.

7. The stored program as claimed in Claim 6, wherein the inter-frequency method is such that during said stage the one of the transceivers (15) which is tuned to another operating frequency, referred to herein as a new operating frequency, establishes an RF link (L2) for communication at the new operating frequency, and after said stage the other transceiver (14) is tuned to the new operating frequency.

8. The stored program as claimed in Claim 6, wherein the inter-frequency method is such that during said stage the one of the transceivers (15) which is tuned to another operating frequency is used to make a signal quality measurement (17b), and after said stage said one of the transceivers (15) is tuned back to the current operating frequency.

9. The stored program as claimed in any one of Claims 6 to 8, wherein the mobile station (10) includes two antennas (12, 13) coupled to said two transceivers (14, 15), respectively, which antennas (12, 13) are spaced apart in distance, orientation or polarization, and the stored program is further configured for selectively combining baseband signals received by the transceivers (14, 15) and for selectively linking baseband signals supplied to the transceivers to be transmitted in order to exploit an antenna diversity effect (16) when the antennas are tuned to the same operating frequency.

10. An method of operation of a mobile station (10) for a wireless cellular or PCS system (20), which mobile station (10) has two tunable transceivers (14, 15) which can be

tuned independently of each other to operating frequencies of base stations (22, 32) of the system, said method of operation being a mobile station side of an inter-frequency method wherein just prior to the commencement of the method, both transceivers (14, 15) are tuned to the same current operating frequency and are in communication with a current base station (22) of the system, and at a stage in the method, one of the transceivers (15) is tuned to another operating frequency while the other transceiver (14) remains in communication with the current base station (22) at the current operating frequency.

11. The method of operation as claimed in Claim 10, wherein the inter-frequency method is such that during said stage the one of the transceivers (15) which is tuned to another operating frequency, referred to herein as a new operating frequency, establishes an RF link (L2) for communication at the new operating frequency, and after said stage the other transceiver (14) is tuned to the new operating frequency.

12. The method of operation as claimed in Claim 10, wherein the inter-frequency method is such that during said stage the one of the transceivers (15) which is tuned to another operating frequency is used to make a signal quality measurement (17b), and after said stage said one of the transceivers (15) is tuned back to the current operating frequency.

13. The method of operation as claimed in any one of Claims 10 to 12, wherein the mobile station (10) includes two antennas (12, 13) coupled to said two transceivers (14, 15) , respectively, which antennas (12, 13) are spaced apart in distance, orientation or polarization, and the method of operation is further configured for selectively combining baseband signals received by the transceivers (14, 15) and for selectively linking baseband signals supplied to the transceivers (14, 15) to be transmitted in order to exploit an antenna diversity effect when the transceivers (14, 15) are tuned to the same operating frequency.

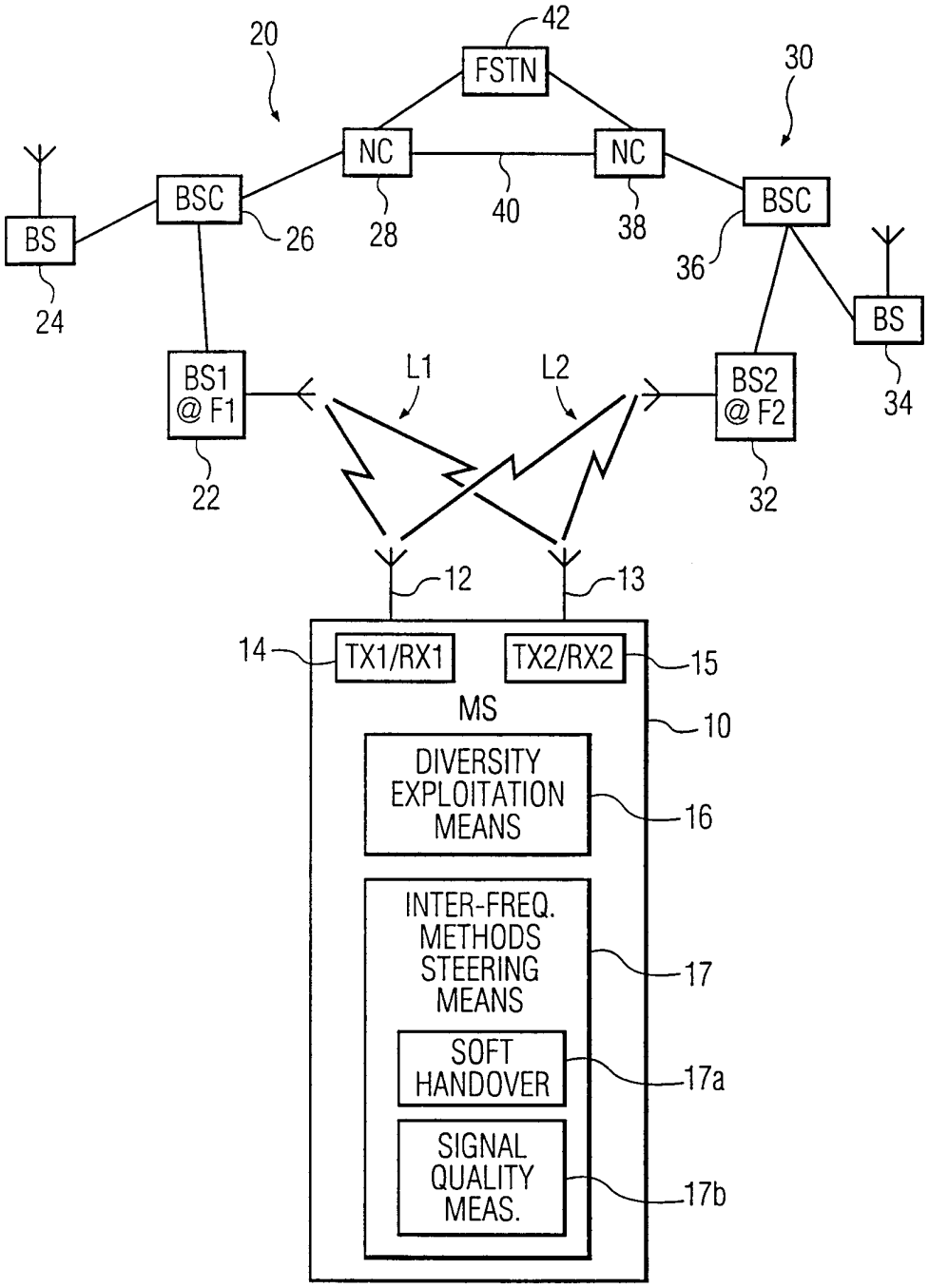

20
42
FSTN
30
NC
NC
BSC
BSC
BS
26
28
40
38
36
BS
24
BS1
@ F1
L1
L2
BS2
@ F2
34
22
32
12
13
14
TX1/RX1
TX2/RX2
15
MS
10
DIVERSITY
EXPLOITATION
MEANS
16
INTER-FREQ.
METHODS
STEERING
MEANS
17
SOFT
HANDOVER
17a
SIGNAL
QUALITY
MEAS.
17b

FIG. 1

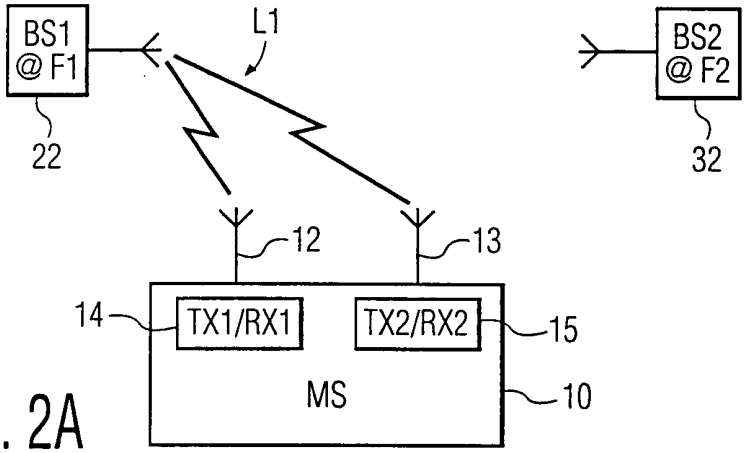


FIG. 2A

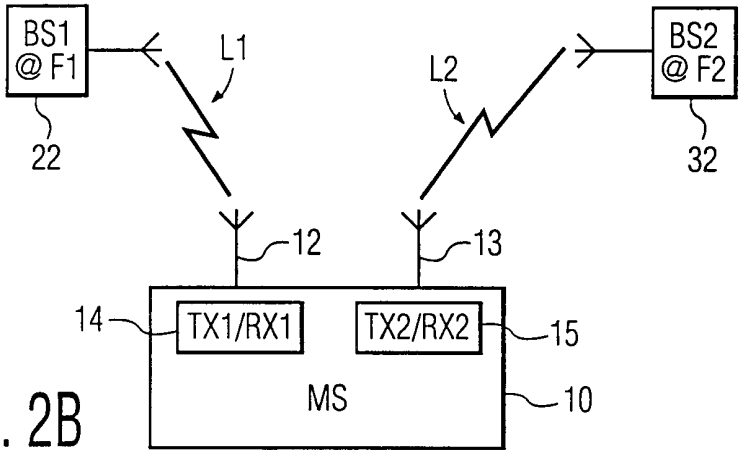


FIG. 2B

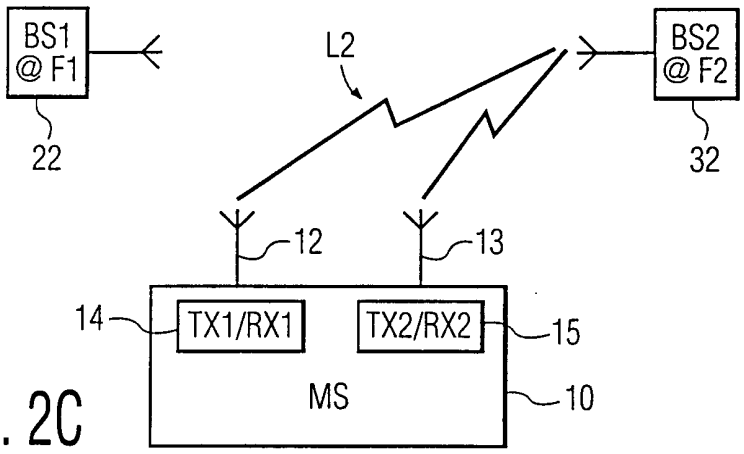


FIG. 2C

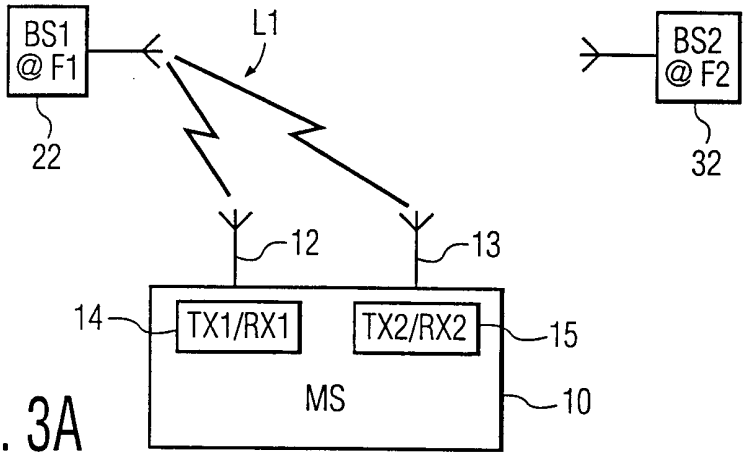


FIG. 3A

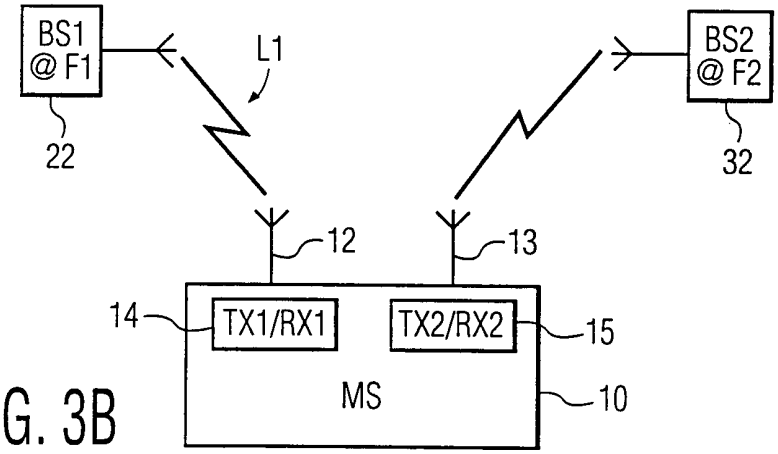


FIG. 3B

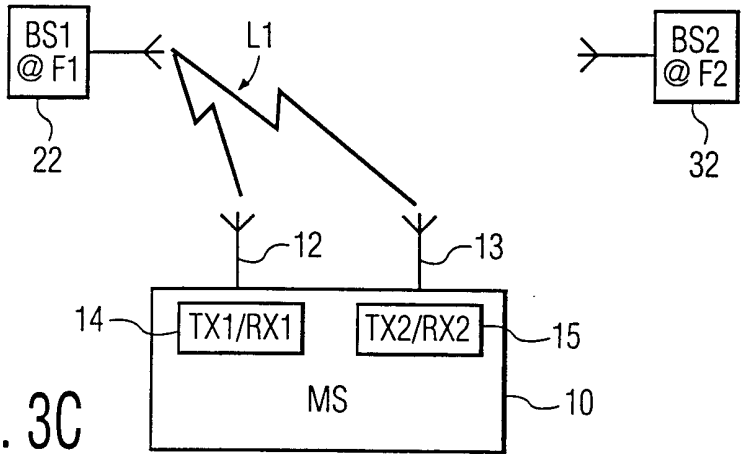


FIG. 3C

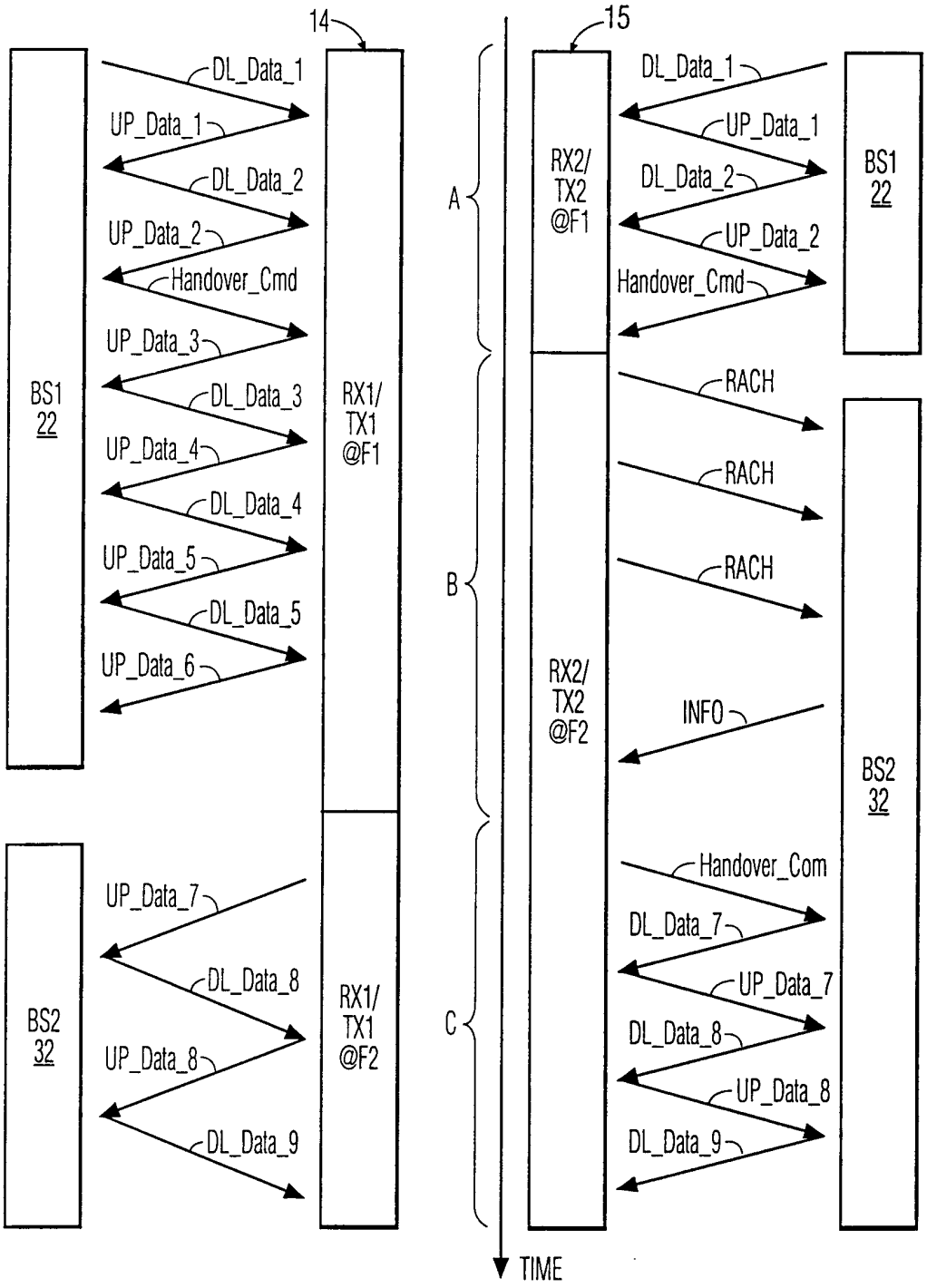

14
15
BS1
22
RX1/
TX1
@F1
RX2/
TX2
@F1
BS1
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DL_Data_2
UP_Data_2
Handover_Cmd
UP_Data_3
DL_Data_3
UP_Data_4
DL_Data_4
UP_Data_5
DL_Data_5
UP_Data_6
A
B
C
RACH
RACH
RACH
RX2/
TX2
@F2
INFO
BS2
32
BS2
32
RX1/
TX1
@F2
UP_Data_7
DL_Data_8
UP_Data_8
DL_Data_9
Handover_Com
DL_Data_7
UP_Data_7
DL_Data_8
UP_Data_8
DL_Data_9
TIME

FIG. 4

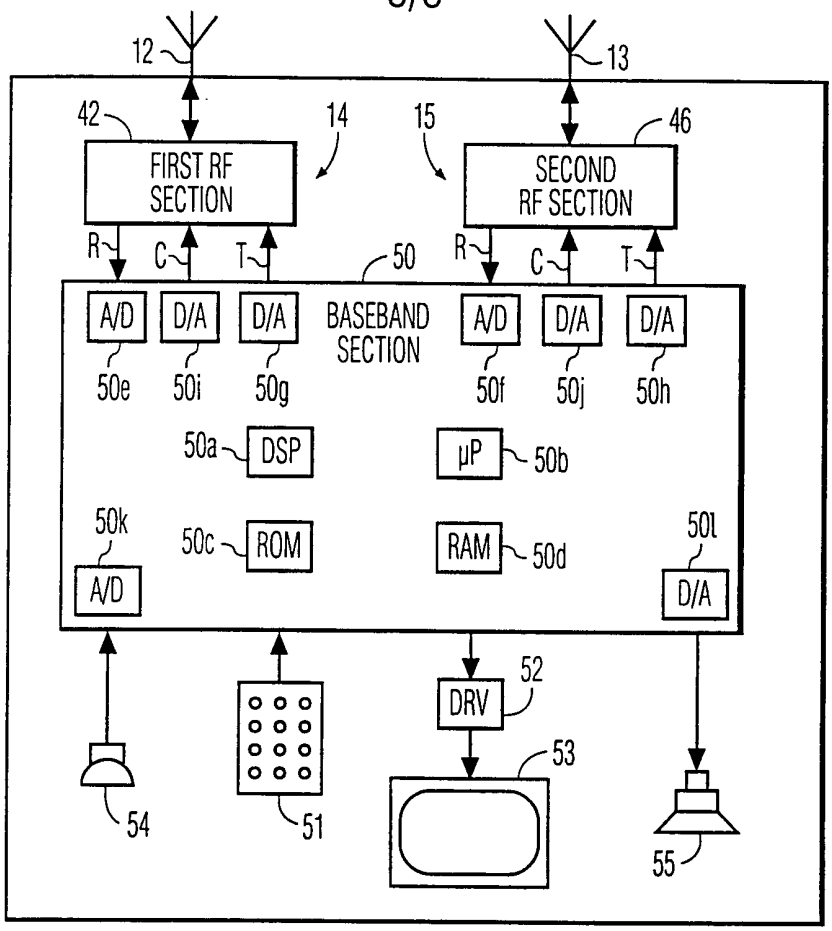

12
13
42
14
15
46
FIRST RF SECTION
SECOND RF SECTION
R
C
T
50
BASEBAND SECTION
A/D
D/A
D/A
A/D
D/A
D/A
50e
50i
50g
50f
50j
50h
50a
DSP
µP
50b
50k
50c
ROM
RAM
50d
50l
A/D
D/A
52
DRV
53
54
51
55

FIG. 5

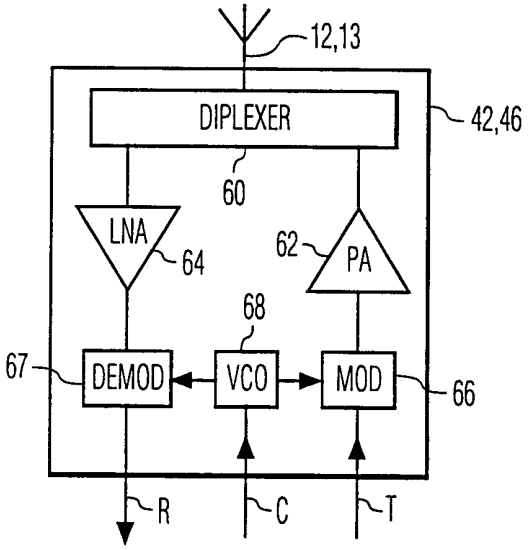

12,13
DIPLEXER
42,46
60
LNA
64
62
PA
68
67
DEMOD
VCO
MOD
66
R
C
T

FIG. 6