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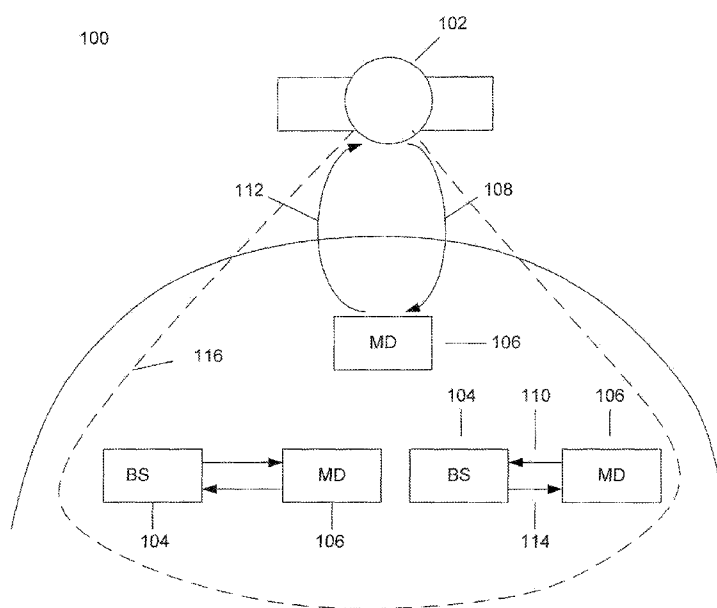


FIG. 1

(57) Abstract: An apparatus for communicating between a mobile device, and a plurality of transceivers. The apparatus includes a first transceiver which transmits to the mobile device on any one of a plurality of channels. The apparatus further includes a second transceiver which transmits to the mobile device on any one of the plurality of channels.

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METHOD AND SYSTEM FOR IMPROVING THE SPECTRAL EFFICIENCY OF A DATA COMMUNICATION LINK

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based on and derives benefit of the filing date of the U.S. Provisional Patent Application No. 60/908,289, filed on March 27, 2007, the contents of which are incorporated herein by reference.

FIELD OF THE INVENTION

[0002] Methods and apparatuses consistent with the present invention relate to communications by a mobile device with a plurality of transceivers, and more particularly, to reusing channels to improve spectral efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] Detail embodiments of the present invention will be described with reference to the attached drawings, in which:

[0004] **FIG. 1** illustrates a mobile satellite communication system according to an embodiment of the present invention;

[0005] **FIG. 2A** illustrates an allocation of channels in a spot beam;

[0006] **FIG. 2B** illustrates an allocation of channels in a spot beam with the addition of a plurality of out of band channels, according to an embodiment of the present invention;

[0007] **FIG. 2C** illustrates an allocation of channels in a spot beam with the addition of out of band spectrum in an MSS/ATC system, according to another embodiment of the present invention;

[0008] **FIG. 3** illustrates hand-off boundaries between Mobile Satellite System (MSS) mode, Terrestrial Mode ATC (TMA) mode and Terrestrial Mode Enhanced (TME) mode according to an embodiment of the present invention; and

[0009] **FIG. 4** illustrates a flow chart describing a method for communicating between a mobile device with plural transceivers according to an embodiment of the present invention.

DETAILED DESCRIPTION OF SEVERAL EMBODIMENTS

[0010] Embodiments of the present invention will be described in detail with reference to the accompanying drawings.

[0011] Throughout the description, several acronyms and shorthand notations are used to aid the understanding of certain concepts pertaining to the associated system and services. These acronyms and shorthand notations are solely intended for the purpose of providing an easy methodology of communicating the ideas expressed herein and are in no way meant to limit the scope of the present invention.

[0012] The present invention may be embodied in many different forms and should not be construed as being limited to the embodiments set forth herein, and are defined by the appended claims. Like reference numerals refer to like elements throughout the specification.

[0013] **FIG. 1** illustrates a mobile satellite communication system **100** with multiple communication devices interacting with each other according to an embodiment of the present invention.

[0014] As shown in **FIG. 1**, a satellite transceiver **102** can communicate bi-directionally with multiple mobile devices **106**. Likewise, a terrestrial base station **104** can communicate bi-directionally with multiple mobile devices **106**. In this embodiment, a mobile device **106** may include a cellular mobile phone, a personal digital assistant (PDA), or any mobile device that is capable of communicating data to other objects.

[0015] The satellite transceiver **102** may include any object that is capable of orbiting another object and capable of communicating data bi-directionally with other objects.

[0016] A base station **104** may include any station with a radio transceiver that maintains communications with a mobile radio device within a given range.

[0017] According to an embodiment of the present invention, there are four different communication links to be discussed.

[0018] In the satellite-to-earth communication link **108**, a satellite transceiver **102** may transmit data to a mobile device **106**. Here, the satellite-to-earth communication may be a part of the Mobile Satellite System (MSS) communication standard. In one embodiment, the satellite transceiver **102** may transmit and receive data to and from an area illuminated by a spot beam **116** that encompasses a mobile device **106**. In an earth-to-satellite communication link **112**, a mobile device **106** may transmit data to a satellite transceiver **102**. In a base station-to-mobile device communication link **114**, a base station **104** may transmit data to a mobile device **106**. In a mobile device-to-base station communication link **110**, a mobile device **106** may transmit data to a base station **104**.

[0019] The satellite transceiver **102** may transmit data over multiple channels. Each channel can have an assigned frequency. According to an embodiment of the present invention, a satellite transceiver **102** can transmit over any of the four channels labeled A_1 , B_1 , C_1 , D_1 , respectively, as shown in **FIG. 2A**. Of course, any number of channels can be provided. Mobile device **106** can transmit to satellite transceiver **102** over multiple channels. Each channel can have an assigned frequency. According to an embodiment of present invention, the mobile device **106** can transmit over any of four channels labeled A, B, C, D, respectively, corresponding to channels A_1 , B_1 , C_1 , D_1 , respectively.

[0020] In one embodiment, the communication from the satellite transceiver **102** will be over one of those channels, for example, channel A_1 . The mobile device **106** will transmit

over corresponding channel A. Within the spot beam 116 of satellite transceiver 102, base stations 104 will also be communicating with mobile devices 106. Typically, the frequencies used to communicate between base stations 104 and mobile devices 106 are different from the frequencies used to communicate between satellite transceiver 102 and mobile devices 106. Alternatively, the conventional MSS/ATC standard provides that channels reserved for satellite communications, but unused by the satellite transceiver 102, can be used for base station to mobile device communications within the spot beam 116 of the satellite transceiver 102. Thus, the other channels, in this example, channels B₁, C₁ and D₁ can be used for base station to mobile device communications, for example as Auxiliary Terrestrial Component (ATC) channels. In accordance with MSS standard, FIG. 2A provides a plurality of channels used in these data transmissions. The satellite-to-earth communication link will be referred to as a MSS communication downlink and the earth-to-satellite communication link will be referred to as a MSS communication uplink.

[0021] In the uplink data transmission, in the embodiment illustrated, there are four possible channels labeled A, B, C and D, respectively, as depicted in FIG. 2A. Uplink channel A is associated to downlink channel A₁ mentioned above. That is, channels A and A₁ form a channel pair. In other words, downlink channel A₁ refers to the half of the channel used for sending data from a satellite to a terrestrial device on the earth. Uplink channel A, on the other hand, refers the other half of the channel for sending data from a terrestrial device to the satellite 102. Similarly, this is the case for the remaining channel pairs B/B₁, C/C₁, and D/D₁, where B, C and D correspond to the uplink channels and B₁, C₁ and D₁ correspond to the downlink channels.

[0022] In the example shown in FIG. 2A, the frequency spectrum from 2000 to 2020 MHz may be used for conventional MSS communication uplinks 202 and the frequency spectrum from 2180 to 2200 MHz may be used for MSS communication downlinks 204. In

this example, four 5 MHZ wide channels are used as the communication uplink and downlink channels.

[0023] **FIG. 2B** illustrates an allocation of channels in a spot beam with the addition of a plurality of out of band channels, according to an embodiment of the present invention. As shown in **FIG. 2B**, there are a plurality of dual downlink T/S channels **250** used for communication from satellite to mobile device (downlink S channels) and from base station to mobile device (downlink T channels). The notation T and S is used to generally indicate terrestrial (T) based communication, such as a communication between the base station and the mobile device and a satellite (S) based communication, such as a communication between the mobile device and satellite. For example, in one embodiment, the one or more terrestrial (T) channels can be ATC channels and one or more of the satellite (S) channels can be MSS channels, although this system can be used apart from a MSS/ATC system. The T/S dual downlink channels **250** allow both the satellite transceiver **102** and base stations **104** to communicate to mobile device **106** on each of the plurality of channels **250**. The satellite transmission will not interfere with the base station transmission on the same frequency because the base station signal is order of magnitude stronger than the satellite signal in the coverage area of the spot beam transmission from the satellite transceiver **102**. The downlink S channels in the T/S dual downlink channels **250** (i.e., satellite to mobile device downlink channels) are paired with the uplink S channels **252** (i.e., mobile device to satellite uplink channels).

[0024] The uplink channels (i.e., mobile device to base station channels) corresponding to the downlink T channels (i.e., base station to mobile device channels) in the T/S dual downlink channels **250** are handled differently. As shown in **FIG. 2B**, a plurality of terrestrial out-of-band uplink channels (T OOB) **254** are added to the uplink S channels (i.e., mobile device to satellite uplink channels). The T OOB channels **254** allow a mobile device

106 to communicate with a base station **104** without interfering with reception by the satellite transceiver **102**. Each terrestrial out-of-band channel (T OOB channel) in the plurality of uplink T OOB channels **254** together with each of the plurality of downlink T channels in the plurality of dual T/S downlink channels **250** form a terrestrial channel pair permitting communications between a base station and a mobile device. In the embodiment illustrated in **FIG. 2B**, the OOB spectrum portion is comprised of four OOB uplink channels and each of the four OOB uplink channels is paired with a respective channel in four downlink T channels. However, it must be appreciated that any number of channels can be implemented, as desired.

[0025] Each uplink T OOB channel in the T OOB channels **254** can be used along with a corresponding downlink T channel in the plurality of dual T/S downlink channels **250** for terrestrial transmission within a coverage area of a spot beam from a satellite transceiver. The uplink T OOB spectrum may include any spectrum with adequate propagation characteristics for mobile or portable use.

[0026] Interference is mitigated because the uplink T OOB channel is not seen by the satellite transceiver **102**. The uplink T OOB channels **254** are out of the satellite transceiver band pass.

[0027] By pairing T OOB uplink (mobile device to base station) spectrum with terrestrial T downlink spectrum in the dual T/S downlink spectrum (at the satellite downlink frequency) in the manner described above, there is substantially no uplink interference posed to any satellite transceiver operating in the normal satellite uplink band. The satellite transceiver “sees” only energy associated with desired uplink earth to space communications. Any energy associated with the uplink to terrestrial base stations is removed to another band of frequencies outside the satellite uplink spectrum that cause substantially no interference to the satellite transceiver.

[0028] In areas where the satellite is the only service provider, the uplink from the mobile device to satellite transceiver and downlink from the satellite transceiver to the mobile device operate in a designated satellite band. In areas where terrestrial base stations operate, either some or all of the satellite downlink spectrum is used by the terrestrial base stations to provide downlink (i.e., downlink from the base station to the mobile device). Since the terrestrial signals are order of magnitude stronger in the coverage area, the stronger terrestrial signals will “override” the satellite downlink signals. In the uplink direction, the OOB spectrum is used in the terrestrial uplink (i.e., uplink from the mobile device to the base station) with substantially no effect on satellite operation as the OOB uplink spectrum is outside the “normal” satellite uplink spectrum.

[0029] **FIG. 2C** illustrates an allocation of channels in a spot beam with the addition an out of band channel in an MSS/ATC system, according to another embodiment of the present invention. As shown in **FIG. 2B**, there are a plurality of data transmission uplink channels **208**. In accordance with the MSS/ATC standard, one or more channels may be used as either a satellite (e.g., MSS) channel or a terrestrial (e.g., ATC) channel. For example, in one embodiment, one uplink channel **210** can be used as a MSS uplink channel (i.e., mobile device to satellite communication channels). The remaining channels **212** can be used as uplink terrestrial channels (i.e., mobile device to base station communication channels), for example, in ATC channels.

[0030] Furthermore, **FIG. 2C** shows modified data transmission links **216** in accordance with the co-channel reuse and out of band techniques described herein. The modified data transmission downlinks **216** can comprise a MSS/ATC dual downlink channel **218** in addition to the normal downlink terrestrial channels **219** (i.e., base station to mobile device communication channels) which are paired with uplink terrestrial channels **212** (i.e., mobile device to base station communication channels). The MSS/ATC dual downlink channel **218**

allows both the satellite transceiver **102** and base stations **104** to communicate to mobile devices **106** on the same channel. Similar to the embodiment described above with respect to **FIG. 2B**, the satellite transmission will not interfere with the base station transmission on the same frequency because the base station signal is orders of magnitude stronger than the satellite signal.

[0031] The uplink channel corresponding to base station to mobile device downlink channel in dual downlink channel **218** is handled differently. As shown in **FIG. 2C**, a terrestrial out-of-band (OOB) uplink channel **214** is added to the data transmission uplink channels **208**. For example, an ATC OOB uplink channel **214** is added to the data transmission links **208**. This terrestrial out-of-band uplink channel (e.g., ATC OOB uplink channel) **214** allows a mobile device **106** to communicate with a base station **104** without interfering with reception by the satellite transceiver **102**. The terrestrial out-of-band uplink channel (e.g., ATC OOB uplink channel) **214** together with the terrestrial downlink channel (e.g., ATC downlink channel) **218** form a terrestrial channel pair (e.g., an ATC channel pair) permitting communications between base station and mobile device.

[0032] The OOB spectrum is a portion of spectrum which may be equal to the spectrum allocation of any channel transmitted in the data transmission link. The same OOB spectrum can be used for any spot beam from a satellite transceiver using any channel. Preferably, the OOB spectrum may include any spectrum with adequate propagation characteristics for mobile or portable use.

[0033] Interference is mitigated because the OOB channel is not seen by the satellite transceiver. That is, the OOB channel is out of the satellite transceiver band pass.

[0034] The schemes described above improve the spectral efficiency. For example, referring to the embodiment illustrated in **FIG. 2C**, with convention MSS/ATC communications a spot beam would normally allow three of the four channels, for example,

to be used for terrestrial data communications. Thus, one-fourth of the channels would not be available for terrestrial communications. The additional use of an MSS downlink channel for satellite to mobile device transmissions coupled with a mobile device to base station uplink in additional OOB spectrum outside the pre-assigned spectrum portion for satellite communications enables an increase in spectral efficiency. That is, another channel pair is now available for terrestrial data transmission.

[0035] For example, referring to the embodiment illustrated in **FIG. 2C**, if the MSS or ATC uplink and downlink channels each occupy 20 MHZ of bandwidth and the terrestrial OOB uplink (ATC OOB) channel occupies a 5 MHZ portion of terrestrial, unpaired spectrum, the efficiency of an MSS/ATC system may be increased by 12%. In other words, 45 MHZ of allocated spectrum gives rise to 50 MHZ of effective spectrum.

[0036] Similarly, referring to the embodiment illustrated in **FIG. 2B**, in the downlink direction, each of the four downlink channels is used for both communications from satellite to mobile device (downlink S channels) and from base station to mobile device (downlink T channels). In the uplink direction, each of the four uplink channels is used for communication between the mobile device and the satellite. The uplink communication between the mobile device and the base station is handled using the four OOB uplink channels to prevent interference with the satellite uplink channels. So, there is a total of 8 uplink channels. Normally, in the downlink direction there would be also 8 counterpart downlink channels, i.e., 4 downlink channels for communication between the satellite and the mobile device (S downlink channels) and 4 downlink channels for communication between the base station and the mobile device (T downlink channels) giving rise to a total of 16 satellite and terrestrial channels. However, because the signal from the base station is orders of magnitude stronger than the satellite signal, the terrestrial signal would override the satellite signal. Therefore, the 4 downlink channels for communication between the satellite

and the mobile device (S downlink channels) and 4 downlink channels for communication between the base station and the mobile device (T downlink channels) can be combined or merged such that each S downlink channel and a corresponding T downlink channel uses the same frequency band. As a result, in the downlink direction, only 4 downlink channels are used instead of the normal 8 channels, in this example.

[0037] Therefore, if each of the uplink and downlink channels and each of the OOB uplink channels occupies a same bandwidth, for example, 5 MHZ of bandwidth, the efficiency of a satellite-terrestrial system may be increased by 25% (i.e., 4 channels divided by a total of 16 channels).

[0038] The OOB spectrum application may be applied to a terrestrial implementation of overlay base station sites and underlay base station sites. Overlay base station sites may include any site used for broad coverage, for example, a site located at a higher elevation. Underlay base station sites may include any sites used to fill in coverage and capacity at least partially within the coverage of the overlay site, for example, sites located at a lower elevation relative to the overlay site. The OOB spectrum application may allow co-channel use of the same downlink channel for both the underlay base station-to-mobile device communications link and the overlay base station-to-mobile device communications link. Interference is avoided on the uplink side by using the OOB spectrum for the mobile device-to-underlay terrestrial base station communication uplink.

[0039] This implementation can avoid regulatory hurdles associated with ATC as the terrestrial implementation will have no negative effect on satellite operations. Furthermore, this implementation can also offer an alternative method of implementing a terrestrial component in a satellite based communication system.

[0040] **FIG. 3** illustrates hand off boundaries between Mobile Satellite System (MSS) mode, Terrestrial Mode ATC (TMA) mode and Terrestrial Mode Enhanced (TME) mode, according to an embodiment of the present invention.

[0041] As shown in **FIG. 3**, a spot beam **116** illuminates an area that encompasses a mobile device **106**. Within this area, there are three communication modes in which the satellite transceiver **102** may communicate bi-directionally with the mobile devices **106**. Similarly, in some of this area, the base stations **104** may communicate bi-directionally with the mobile devices **106**.

[0042] The MSS mode region **302** is the region where the mobile devices **106** may communicate bi-directionally with the satellite transceiver **102**. In MSS mode region **302**, the mobile devices **106** are out of range of base stations **104**. The TMA mode region **306** and the TME mode region **304** are regions where the mobile devices **106** can communicate with either base stations **104** or satellite transceivers **102**. Further, **FIG. 3** shows the various boundaries at which the mobile devices **106** are handed off between modes.

[0043] MSS mode refers to the mode where a mobile device **106** is communicating via a satellite transceiver **102** on a portion of the radio spectrum assigned for satellite transceiver **102** communications (i.e. MSS communication downlink and uplink) in accordance with the conventional MSS standard. MSS mode may be employed where terrestrial communications with a base station **104** is not possible. Channels employed for adjacent satellite spot beams **116** are governed by conventional rules to avoid adjacent spot beam interference.

[0044] TMA mode refers to the mode where a mobile device **106** is communicating via a terrestrial base station **104** within a spot beam **116** of a satellite transceiver **102**. The spectrum is assigned for both terrestrial base stations-to-mobile device communication links and mobile device-to-terrestrial base station communication links employing conventional

MSS/ATC standards. For example, a channel is assigned for satellite communications and remaining channels can be used for terrestrial communications, as depicted in **FIG. 2A**.

[0045] TME mode refers to the mode where a mobile device **106** is communicating via a terrestrial base station **104** using the spectrum assigned using the conventional MSS/ATC standards, the spectrum assigned for the MSS communication link for an additional terrestrial base station-to-mobile device communication link and the out of band spectrum that is not part of the portion of spectrum assigned to the MSS communication link for an additional mobile device-to-base station communication link.

[0046] TMA mode regions **306** between TME mode regions **304** and MSS mode regions **302** cause mobile devices **106** which may have been receiving communications from base station **104** using a channel shared with a downlink from the satellite transceiver in TME mode regions **304** to switch to a channel not used for satellite communications in accordance with the MSS/ATC standard before the mobile devices **106** enter the MSS mode regions **302**. Here, it is assumed that TMA mode coverage is greater than TME mode coverage. That is, TME mode allows the utilization of more channels. In this case, TMA covers any given geographical area which is covered by TME.

[0047] Mitigation of interference in the TME mode can be achieved by using different multiplexing schemes for the base station-to-mobile device link and the satellite-to-mobile device link that share the same channel. For example, a wide-band code division multiple access (CDMA) signal can be used in the terrestrial base stations-to-mobile device communication link. The satellite-to-mobile device communications link can employ orthogonal frequency division multiplexing (OFDM). Of course, many other variations are possible. If a channel is subdivided into multiple portions, the wide-band CDMA signal will appear as a narrow band signal with weak signal strength and will be rejected by the CDMA

system gain discriminator. As a result, any degradation on the communication link is minimal.

[0048] In general, in transitional areas between terrestrial operations and satellite operations, several methods may be used to achieve an interference free or minimize interference in a hand over between the terrestrial and satellite systems. For example, if the individual channel bandwidths on the satellite and ground systems are similar, a portion of the satellite downlink spectrum can be eliminated from use in outer coverage areas of the terrestrial system so as to offer a co-channel interference free channel for handoff between the satellite and terrestrial systems in those transitional areas where terrestrial service ends and satellite-only service begins.

[0049] However, the bandwidth of the individual channels used on the satellite can also be narrower than the bandwidth of a channel used on a terrestrial network. For example, this may be the case when the MSS system uses modified Global System for Mobile communications (GSM) channels and the terrestrial network uses Universal Mobile Telecommunications System (UMTS) or Worldwide Interoperability for Microwave Access (WiMax), or other 3G or 4G broadband transmission technologies. If the bandwidth of the individual channels used on the satellite are narrower than a bandwidth of channel in the terrestrial network, the difference in energy density per Hz between the wide terrestrial channels and the narrow satellite channels can be exploited as an interference protection between terrestrial operations and satellite operations. Indeed, at an edge of terrestrial coverage, terrestrial signals may have less energy than near the base station. In addition, the bandwidth of the terrestrial channels being broader than the bandwidth of the satellite system, the result is that the energy density per Hz for the terrestrial system is smaller than the energy density per Hz for the satellite system. Hence, at the transitional area, the mobile device would "see" the satellite transmission system and would drop the terrestrial transmission

system as the energy density of the terrestrial transmission system is smaller than the energy density in the satellite transmission system. This minimizes or substantially eliminates interference between the satellite and terrestrial transmission systems at the transitional areas.

[0050] FIG. 4 illustrates a flow chart 400 describing a method for communicating between a mobile device 106 with plural transceivers according to an embodiment of the present invention. A second transceiver may be positioned in an area covered by a first transceiver. Further, in this embodiment, a first signal is received by the mobile device from the first transceiver which has a lower energy than a second signal received by the mobile device from the second transceiver.

[0051] The first transceiver transmits to the mobile device on any one of a plurality of channels (S402). Next, a second transceiver transmits to the mobile device 106 on any one of the plurality of channels (S404). In turn, the mobile device 106 transmits to the first transceiver on the one channel on which the first transceiver is transmitting to the mobile device 106 (S406). Lastly, the mobile device 106 transmits to the second transceiver on any of the plurality of channels other than the one channel or on a channel separate from the plurality of channels (S408).

[0052] The first transceiver can be a satellite transceiver 102. Additionally, the second transceiver can be a base station 104. In one embodiment, any one of the plurality of channels other than the one channel may be an Auxiliary Terrestrial Component (ATC) channel having a spectrum equal to the spectrum allocation of any of the plurality of channels other than the one channel. In another embodiment, anyone of a plurality of channels used in a transmission from the first transceiver or from the second transceiver may be configured to be both a Mobile Satellite System (MSS) channel and an Auxiliary Terrestrial Component (ATC) channel.

[0053] It will be understood by those of ordinary skill in the art that various replacements, modifications and changes may be made in the form and details without departing from the spirit and scope of the present invention as defined by the following claims. Therefore, it is to be appreciated that the above described embodiments are for purpose of illustration only and are not to be construed as limitations of the invention.

What is claimed is:

1. A method for communicating between a mobile device, first and second transceivers wherein the second transceiver is positioned in an area covered by the first transceiver, wherein a first signal received by the mobile device from the first transceiver has lower energy than a second signal received by the mobile device from the second transceiver, the method comprising:

transmitting from the first transceiver to the mobile device on any one of a plurality of channels; and

transmitting from the second transceiver to the mobile device on any one of the plurality of channels, the plurality of channels including the one channel on which the first transceiver is transmitting.

2. The method of claim 1, further comprising:

transmitting from the mobile device to the first transceiver on the one channel on which the first transceiver is transmitting to the mobile device; and

transmitting from the mobile device to the second transceiver on any of the plurality of channels other than the one channel or on a channel separate from the plurality of channels.

3. The method of claim 1, wherein the first transceiver is a satellite transceiver.

4. The method of claim 1, wherein the second transceiver is a base station.

5. The method of claim 1, wherein any one of the plurality of channels other than the one channel is an Auxiliary Terrestrial Component (ATC) channel.

6. The method of claim 1, wherein the one channel used in a transmission from the first transceiver or from the second transceiver is configured to be both a Mobile Satellite System (MSS) channel and an Auxiliary Terrestrial Component (ATC) channel.

7. The method of claim 1, wherein each of the plurality of channels is configured to be both a satellite channel for communications from a satellite to the mobile device and a terrestrial channel for communication from a base station to the mobile device.

8. The method of claim 7, further comprising:

transmitting from the mobile device to the satellite on the satellite channel, and
transmitting from the mobile device to the base station on a channel separate from the plurality of channels.

9. The method of claim 8, wherein the channel separate from the plurality of channels is one channel in a plurality of terrestrial out-of-band (OOB) channels.

10. The method of claim 9, further comprising pairing each of the plurality of terrestrial out-of-band channels with a respective terrestrial channel in the plurality of channels.

11. A method for communicating between a mobile device and first and second transceivers, wherein the second transceiver is positioned in an area covered by the first transceiver, wherein a first signal received by the mobile device from the first transceiver has lower energy than a second signal received by the mobile device from the second transceiver, the method comprising:

transmitting from the mobile device to the first transceiver on any one of a plurality of channels; and

transmitting from the mobile device to a second transceiver on any of the plurality of channels other than the one channel or on a channel separate from the plurality of channels.

12. The method of claim 11, wherein the first transceiver is a satellite transceiver.
13. The method of claim 11, wherein the second transceiver is a base station.
14. The method of claim 11, wherein any one of the plurality of channels other than the one channel is an Auxiliary Terrestrial Component (ATC) channel.
15. The method of claim 11, wherein transmitting from the mobile device to the first transceiver on any one of a plurality of channels comprises transmitting from the mobile device to a satellite on a satellite channel in the plurality of channels.
16. The method of claim 11, wherein transmitting from the mobile device to the second transceiver comprises transmitting from the mobile device to a base station on a channel separate from the plurality of channels.
17. The method of claim 16, wherein the channel separate from the plurality of channels is one channel in a plurality of terrestrial out-of-band (OOB) channels.
18. The method of claim 17, wherein the terrestrial out-of-band channels are Auxiliary Terrestrial Component (ATC) channels.

19. The method of claim 17, further comprising pairing each of the plurality of terrestrial out-of-band (OOB) channels with a respective terrestrial channel in the plurality of channels.
20. An apparatus for communicating with a mobile device, the apparatus comprising:
a first transceiver which transmits to the mobile device on any one of a plurality of channels; and
a second transceiver which transmits to the mobile device on any one of the plurality of channels, the plurality of channels including the one channel on which the first transceiver is transmitting, wherein the second transceiver is positioned in an area covered by the first transceiver, and wherein a first signal received by the mobile device from the first transceiver has lower energy than a second signal received by the mobile device from the second transceiver.
21. The apparatus of claim 20, further comprising the mobile device, wherein the mobile device transmits to the first transceiver on the one channel on which the first transceiver is transmitting to the mobile device, and transmits to the second transceiver on any of the plurality of channels other than the one channel or on a channel separate from the plurality of channels.
22. The apparatus of claim 20, wherein the first transceiver is a satellite transceiver.
23. The apparatus of claim 20, wherein the second transceiver is a base station.

24. The apparatus of claim 20, wherein any one of the plurality of channels other than the one channel is an Auxiliary Terrestrial Component (ATC) channel.

25. The apparatus of claim 20, wherein the one channel used in a transmission from the first transceiver or from the second transceiver is configured to be both a Mobile Satellite System (MSS) channel and an Auxiliary Terrestrial Component (ATC) channel.

26. The apparatus of claim 20, wherein each of the plurality of channels is configured to be both a satellite channel for communications from a satellite to the mobile device and a terrestrial channel for communication from a base station to the mobile device.

27. The apparatus of claim 26, wherein the mobile device is configured to transmit to the satellite on the satellite channel, and to transmit to the base station on a channel separate from the plurality of channels.

28. The apparatus of claim 27, wherein the channel separate from the plurality of channels is one channel in a plurality of terrestrial out-of-band (OOB) channels.

29. The apparatus of claim 28, wherein each of the plurality of terrestrial out-of-band (OOB) channels is paired with a respective terrestrial channel in the plurality of channels.

30. An apparatus for communicating with a plurality of transceivers, the apparatus comprising:

a mobile device which transmits to a first transceiver on any one of a plurality of channels, and transmits to a second transceiver on any of the plurality of channels other than

the one channel or on a channel separate from the plurality of channels, wherein the second transceiver is positioned in an area covered by the first transceiver, wherein a first signal received by the mobile device from the first transceiver has lower energy than a second signal received by the mobile device from the second transceiver.

31. The apparatus of claim 30, wherein any one of the plurality of channels other than the one channel is an Auxiliary Terrestrial Component (ATC) channel.

32. The apparatus of claim 30, wherein the first transceiver is a satellite transceiver and the second transceiver is a base station, wherein the mobile device is configured to transmit to the satellite transceiver on any one of a plurality of satellite channels and configured to transmit to the base station on a channel in a plurality of terrestrial out-of-band channels separate from the satellite channels.

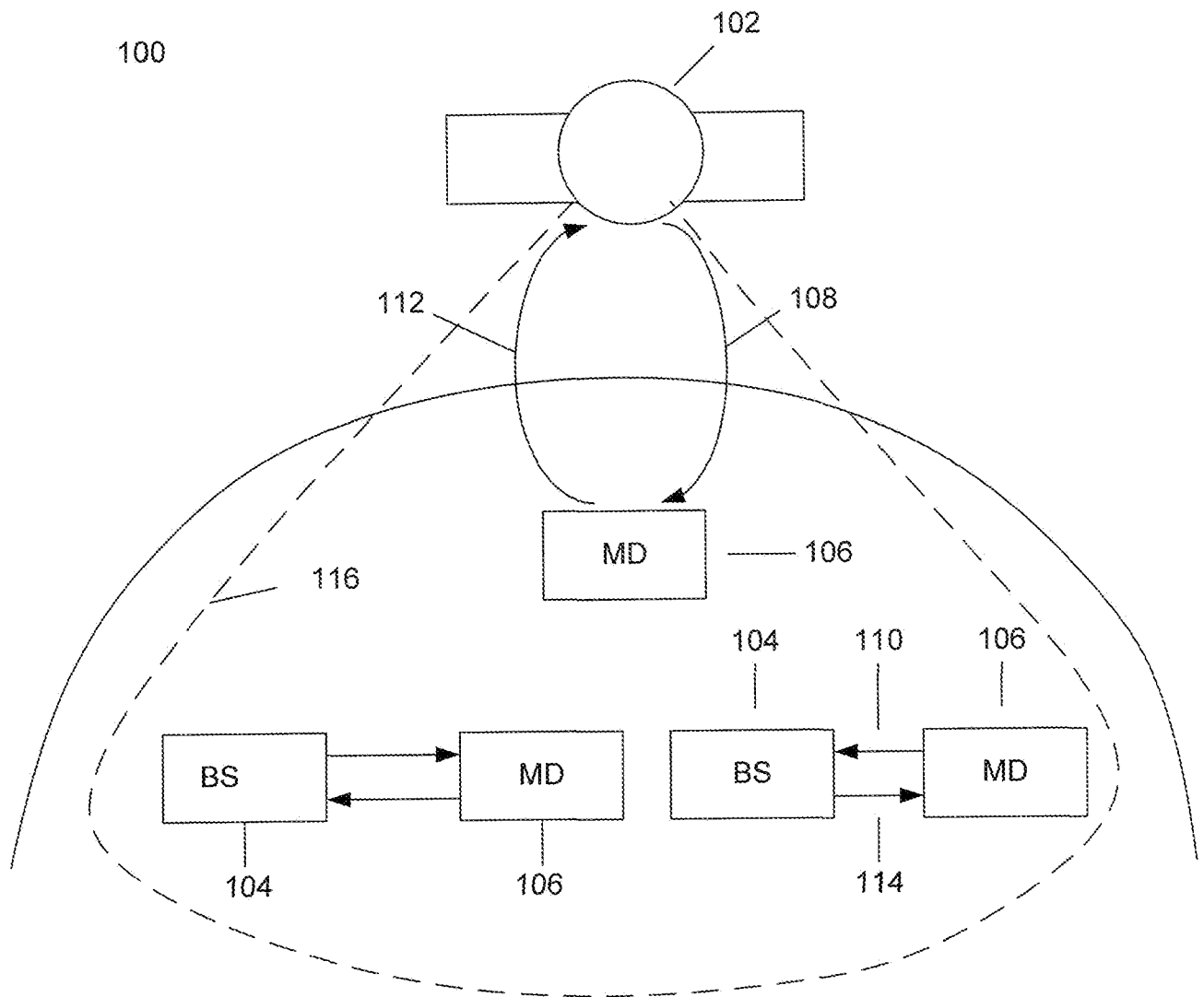


FIG. 1

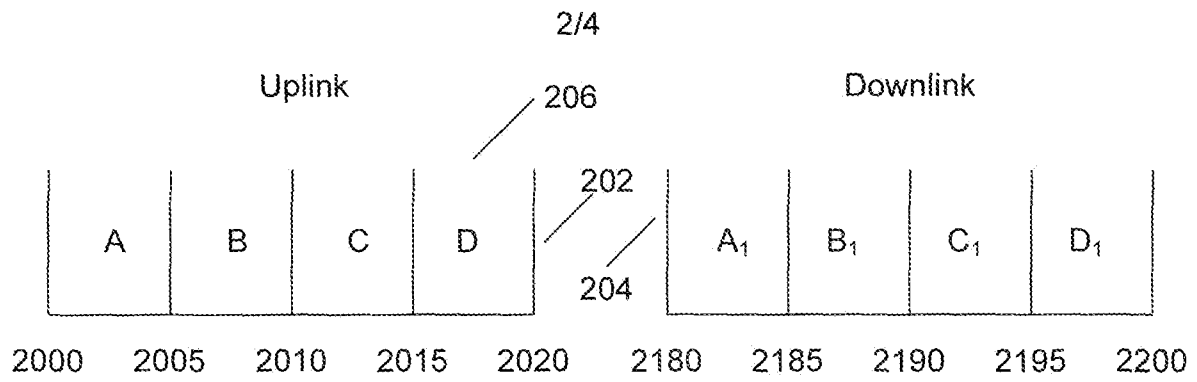


FIG. 2A

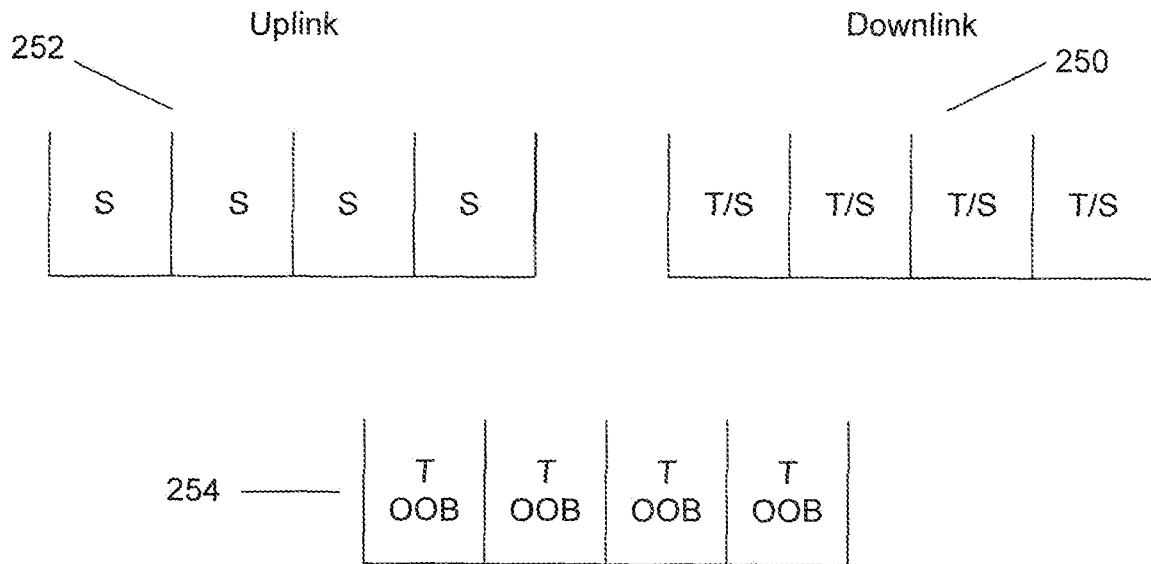


FIG. 2B

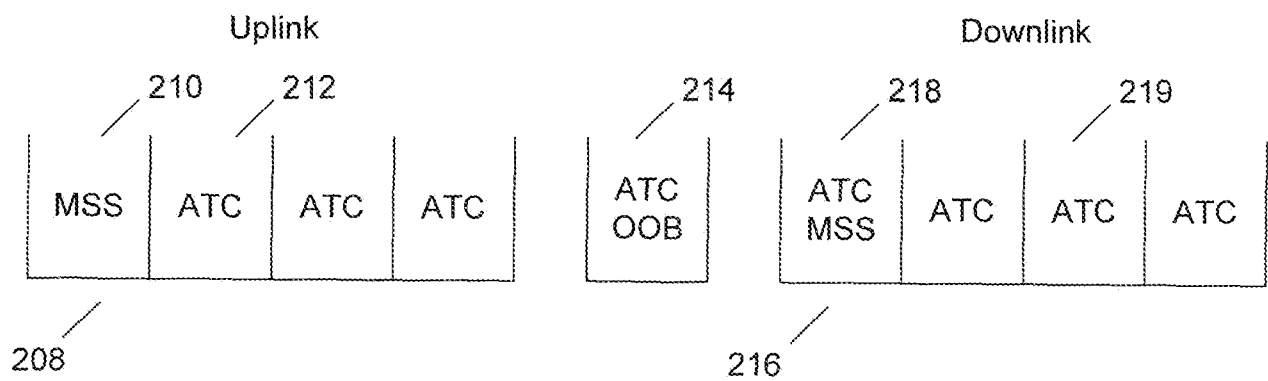


FIG. 2C

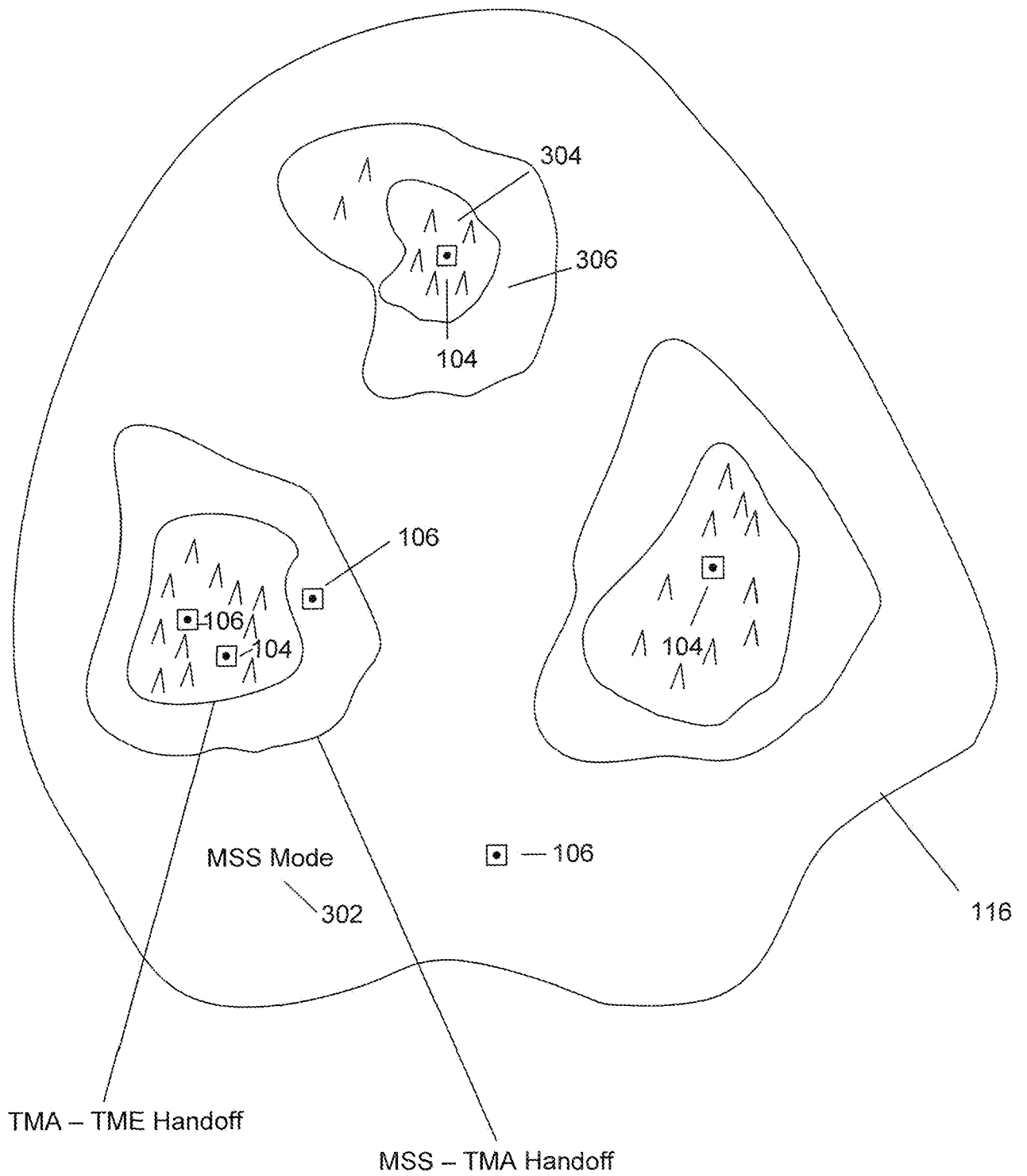


FIG. 3

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400

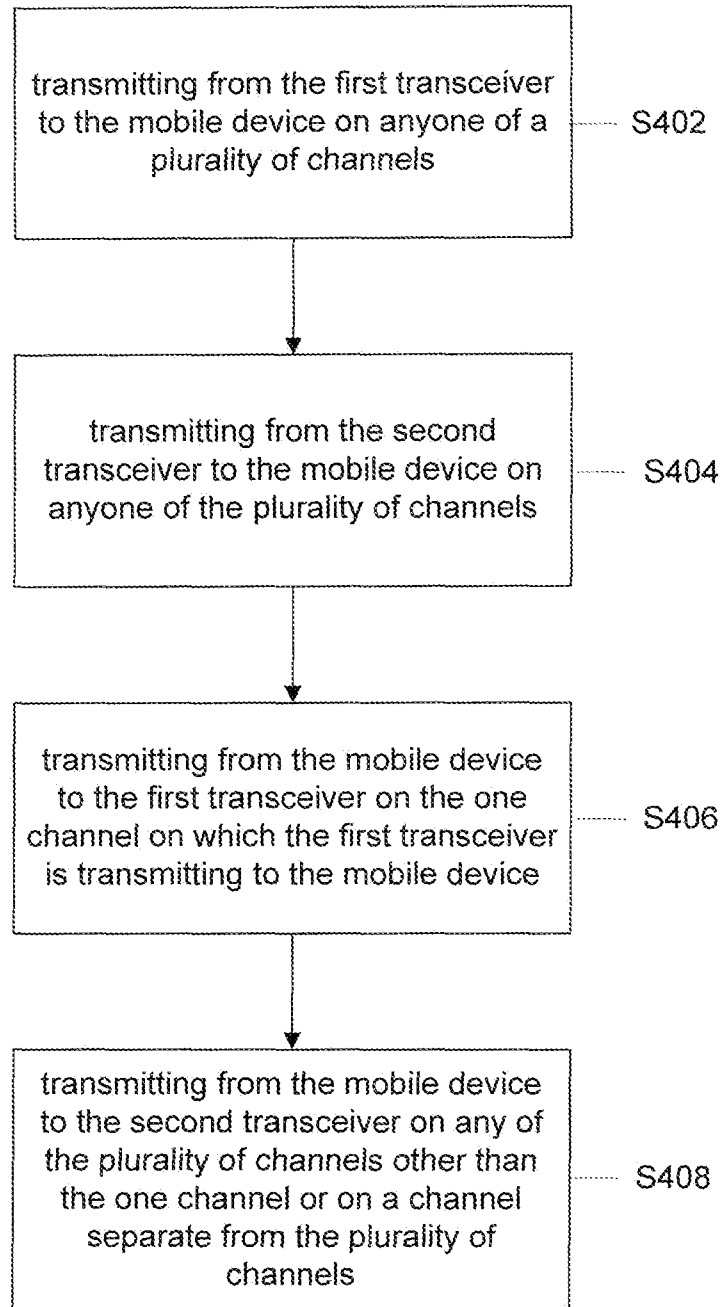


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 08/54985

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - H04B 7/00 (2008.04)

USPC - 455/500

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)
USPC: 455/500Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 340/825, 340/870.11 (search terms below)Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWest (USPB, USPT, USOC, EPAB, JPAB), DialogPro, GoogleScholar; method communicating mobile device first second transceivers area covered signal lower energy transmitting plurality channels separate satellite base station ATC Auxiliary Terrestrial Component Mobile Satellite System MSS terrestrial out-of-band OOB pairing

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|---|-----------------------|
| Y | US 2006/0135070 A1 (Karabinis), 22 June 2006 (22.06.2006), para [0015]-[0018]; [0020]-[0023]; [0033]; [0037]; [0047]-[0050]; [0062] | 1-32 |
| Y | US 2006/0111041 A1 (Karabinis), 25 May 2006 (25.05.2006), para [0038]-[0039]; [0062]; [0087]-[0088]; [0090]-[0091]; [0096]-[0100]; [0105]-[0110]; [0121]; [0130]; [0146]-[0148] | 1-32 |
| A | US 2006/0205367 A1 (Karabinis), 14 September 2006 (14.09.2006), entire document | 1-32 |
| A | US 2005/0176379 A1 (Grindahl et al.), 11 August 2005 (11.08.2005), entire document | 1-32 |
| A | US 2004/0072539 A1 (Monte et al.), 15 April 2004 (15.04.2004), entire document | 1-32 |

☐ Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

18 May 2008 (18.05.2008)

Date of mailing of the international search report

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