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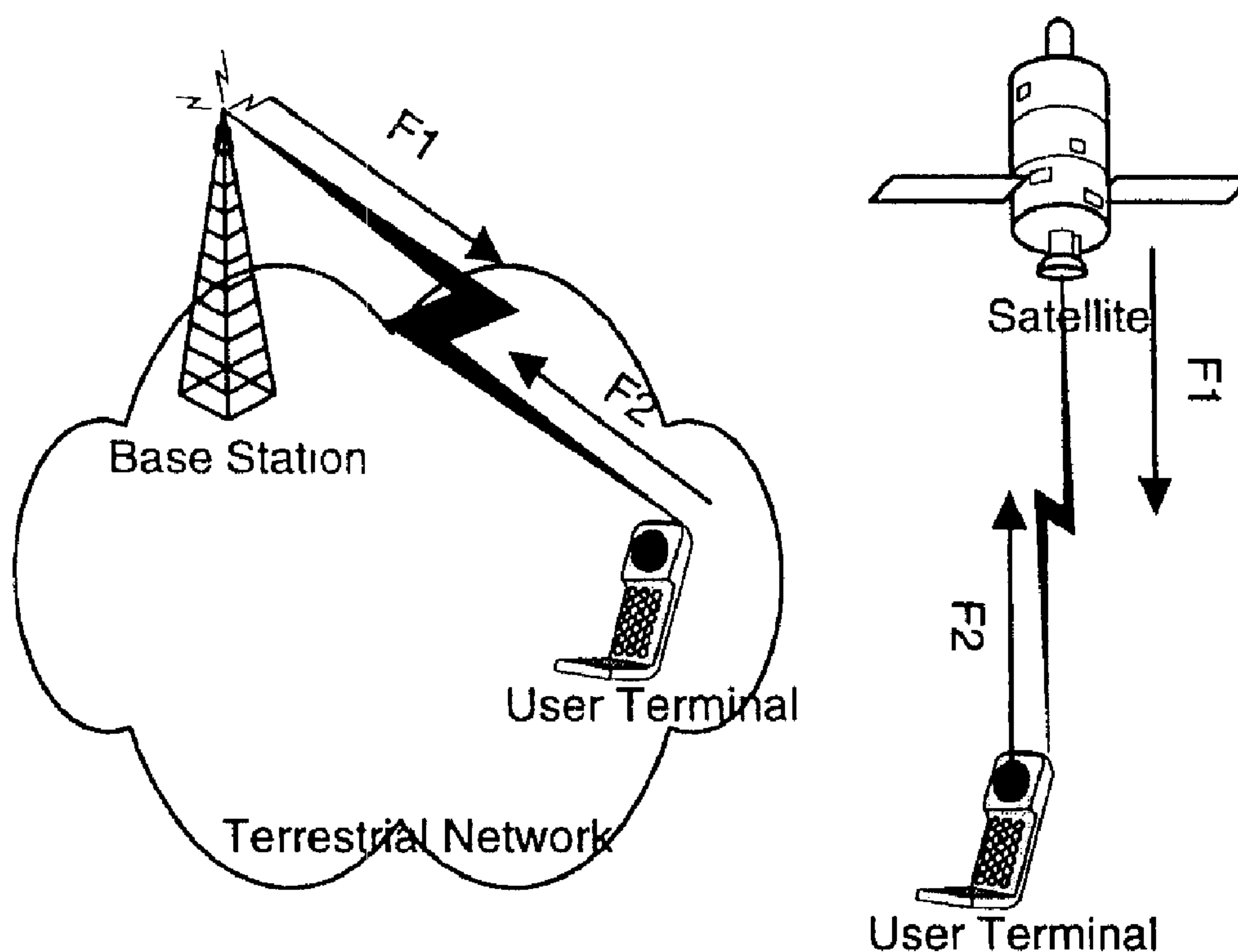
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(54) Titre : REUTILISATION COORDONNEE DE FREQUENCES ENTRE DES SATELLITES ET LA TERRE

(54) Title: COORDINATED SATELLITE-TERRESTRIAL FREQUENCY REUSE



Normal Mode operation

(57) Abrégé/Abstract:

A system and method of operation for efficiently reusing and/or sharing at least a portion of the frequency spectrum between a first satellite spot beam and a second satellite spot beam, and/or an underlay terrestrial network associated with a second satellite spot

(57) **Abrégé(suite)/Abstract(continued):**

beam. The spectrum is efficiently reused and/or shared between respective spot beams and/or associated underlay terrestrial systems in a manner minimizes interference between the respective satellite and terrestrial systems.

ABSTRACT OF THE DISCLOSURE

A system and method of operation for efficiently reusing and/or sharing at least a portion of the frequency spectrum between a first satellite spot beam and a second satellite spot beam, and/or an underlay terrestrial network associated with a second satellite spot beam. The spectrum is efficiently reused and/or shared between respective spot beams and/or associated underlay terrestrial systems in a manner minimizes interference between the respective satellite and terrestrial systems.

COORDINATED SATELLITE-TERRESTRIAL FREQUENCY REUSE

DESCRIPTION

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BACKGROUND OF THE INVENTION

Field of the Invention

10 The present invention generally relates to frequency reuse and/or sharing among satellite-terrestrial communications systems and, more particularly, to a satellite-terrestrial communications system and method of operation thereof that provides frequency reuse and/or sharing between the respective portions of the satellite system and terrestrial underlay systems associated therewith, while substantially reducing interference therebetween.

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Background Description

20 In present satellite-terrestrial systems, there is a need to separately allocate at least a portion of the frequency spectrum for the satellite, while allocating a separate portion for the terrestrial network. The present invention provides a system and method for efficiently reusing and/or sharing the spectrum between satellite and terrestrial base stations in a manner that facilitates efficient and optionally complete spectrum usage by both the satellite and terrestrial networks, while minimizing interference between the respective satellite and terrestrial systems.

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SUMMARY OF THE INVENTION

5 It is a feature and advantage of the present invention to provide a satellite-terrestrial communications system and method of operation thereof that facilitates efficient spectrum usage and/or reuse.

It is another feature and advantage of the present invention provide a satellite-terrestrial communications system and method of operation thereof that minimizes interference between the satellite and terrestrial systems.

10 It is still another feature and advantage of the present invention to provide a satellite-terrestrial communications system and method of operation thereof that enables at least a portion of the frequency spectrum of, for example, a portion of the frequencies associated with a first satellite spot beam to be utilized by a terrestrial system having overlapping coverage with a second satellite spot beam.

15 The satellite-terrestrial communications system and method according to the present invention enhances spectrum usage by allocating at least a portion of the spectrum of, for example, at least a first satellite spot beam to an underlay terrestrial system preferably associated with or having overlapping coverage with, for example, at least a second satellite spot beam. The satellite-terrestrial communications system of the present invention also minimizes interference between each of the respective satellite and terrestrial systems that reuse or share a portion of the spectrum. The system and method according to the present invention will hereinafter be called the satellite-terrestrial frequency reuse system (STFRS). It should be understood that the STFRS can be deployed with all
20 satellite (e.g., low-Earth orbit (LEO), mid-Earth orbit (MEO), geosynchronous orbit (GEO), etc.) and cellular or other terrestrial technologies as long as the frequency planning is maintained dynamically or substantially dynamically (e.g., time division multiple access (TDMA), code division multiple access (CDMA),
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Global System for Mobile Communication (GSM), Time Division Duplex (TDD), Frequency Hopping (FHMA), etc.).

5 Within any given satellite spot beam of the STFRS, the frequencies (e.g., Radio frequency channels) used in a first spot beam are preferably not used in the underlay terrestrial system associated with the first spot beam. For example, an area of coverage by a satellite system may comprise seven spot beams, with each spot beam having nine channels. Thus, the system would have sixty three channels that can be allocated between the satellite and the respective underlay terrestrial systems. The satellite may use, for example, nine (9) of the channels, and the remaining fifty four (54) may therefore be allocated to the respective underlay terrestrial systems associated with each respective spot beam. In such a system, the nine channels associated with, for example, a first spot beam are preferably not utilized by the underlay terrestrial system associated with the first spot beam. The general concept is to efficiently allocate (e.g., based on demand) the total frequency band (e.g., sixty three channels) between the terrestrial and satellite systems within each of the spot beams and each of the respective terrestrial underlay systems associated therewith, while minimizing interference therebetween.

20 To accomplish this objective, the present invention provides both a terrestrial frequency reuse plan and a satellite frequency reuse plan. FIG. 2 shows one example of a satellite frequency reuse plan. As shown, there are seven regions/cells, each of which represents a spot beam designated by $f_1, f_2, f_3, f_4, f_5, f_6$ and f_7 , respectively. Note that FIG. 2 does not show the terrestrial system underlaying each of the respective spot beams which will include a plurality of terrestrial cell therein. The reuse scheme employed by the satellite is generally dependent on the satellite technology being used. The technology can, for example, be GSM/TDMA based, spread spectrum CDMA, and the like, where there may be a single antenna that is making multiple spot beams, multiple antennas, and the like.

In any given spot beam, the channels allocated to the satellite within that spot beam are used for satellite transmissions, whereas the terrestrial transmissions within that spot beam may use all channels except those allocated to the satellite. For example, with regard to FIG. 3a, a superscript T represents a terrestrial system, and the frequencies without a superscript T represent satellite systems. The terrestrial frequency sets (designated by $(f_3, f_4, f_5, f_1, f_6)^T$, etc.) associated with the f_7 spot beam use, in various combinations, f_1, f_2, f_3, f_4, f_5 , and f_6 . However, the channels used by spot beam f_7 are preferably not used by the underlay terrestrial system associated with the f_7 satellite spot beam. In this manner, the different channels are preferably allocated among the various spot beams and associated underlay terrestrial systems such that any interfere between them is minimized. To accomplish this, the STFRS according to the present invention utilizes the inter-spot beam isolation (e.g., the isolation between the various spot beams). Thus, the terrestrial system associated with a particular spot beam preferably uses the channels that are not utilized by the spot beam since the spot beam provides an isolation that can be utilized in reducing interference. In other words, the present invention takes the co-channel, co-beam and “transfers” it to co-channel, adjacent beam interference.

Referring now to FIG. 3a, it is preferred that the distance between the terrestrial frequencies and the satellite frequencies be maximized. It is further preferred that the interference between adjacent satellites/spot beams and adjacent cells be minimized. However, even when these objectives are accomplished, the transmissions by the terrestrial network(s) will generally, to a certain extent and depending on the local attenuation, be “heard” by the associated satellite. As shown in FIG. 3a, frequency reuse planning must be carefully done along adjacent spot beam boundaries to ensure that interferences are minimized.

Consider FIG. 3a from a geographic perspective. As shown, New York city falls within spot beam f_1 , Philadelphia falls within spot beam f_7 , and Washington, D.C. falls within spot beam f_4 . In general, the channels associated

with one particular spot beam can be reassigned for satellite and/or terrestrial reuse in conjunction with any other spot beam. The channels within spot beam f_4 , for example, can also be used as a terrestrial frequency in, for example, spot beam f_7 . It is preferred that the f_4 channels are used in five of the six cell sites of f_7 . As shown in FIG. 3a, it is also preferred, however, that the channels of spot beam f_4 not be used in the cell site of spot beam f_7 that is contiguous with the f_4 spot beam.

Any energy that is being generated by the f_4 channels within the f_7 spot beam is attenuated by the antenna pattern of the f_7 spot beam satellite, so that the f_4 terrestrial frequencies used within spot beam f_7 are not interfering with the f_7 spot beam satellite frequencies. Nor, in a preferred embodiment, will the f_4 channels within the f_7 spot beam interfere with the f_4 spot beam since, as previously discussed, it is preferred that the channels of spot beam f_4 not be used in the cell site of spot beam f_7 that is contiguous with the f_4 spot beam. At some point the f_4 terrestrial frequencies within the f_7 spot beam will interfere with the f_4 spot beam satellite transmissions, but any potential interference can be minimized by managing the frequency reuse and the size of these networks.

The present invention thus provides a system and method for coordinating a reuse plan between a satellite network and a terrestrial network using the same frequencies on an interference managed basis. In general, if one spot beam (e.g., f_7) gets too congested, it can borrow frequency spectrum from other spot beams (e.g., f_1, f_2, f_3, f_4, f_5 and/or f_6) that have available capacity. The present invention thus provides different ways of using the same frequencies between the satellite, which employs frequency reuse, and using that fact to allow one or more satellite channel sets to be selected for within a terrestrial network on a non-interfering basis with the satellite.

FIG. 3a also illustrates how to maximize the frequency distance of the terrestrial system. As shown, f_7 represents 9 frequency channels. Therefore, in the embodiment shown in FIG. 3a, each spot beam cell will have 45 terrestrial frequencies available. For example, consider spot beam cell A within f_7 . Since

each of f_2, f_3, f_4, f_5 and f_6 has 9 frequencies, 45 terrestrial frequencies are thus available in cell A within the f_7 spot beam cell. Similarly, 45 frequencies are also available within spot beam cells B, C, D, E and F. It should be understood that this is a single embodiment, and that the present invention generally works
5 regardless of how many spot beams there are or how many channels there are per satellite spot beam.

Thus, in each of the seven satellite spot beams shown in FIG. 3a, the possible terrestrial frequencies that can be used are all satellite spot beam frequencies except the satellite spot beam associated with the spot beam under
10 consideration and those used by the spot beam closest to the particular cell of the spot beam under consideration. The system and method of the present invention therefore maximizes the frequency distance between the terrestrial and the satellite frequencies.

The frequencies being assigned are thus preferably location dependent upon where the spot beam hits. Thus, if spot beam f_1 has nine frequencies and
15 only three of the nine frequencies are needed for satellite transmission, the remaining six frequencies can dynamically be reassigned to either a terrestrial system or to increase capacity in, for example, an adjacent or non-adjacent satellite spot beam. The present invention thus provides a novel system and
20 method of using satellite channels within a given spot beam and allocating at least a portion of those channel(s) to one or more ground based terrestrial networks within one or more respective spot beams.

It should be understood that repeat patterns other than a seven cell repeat pattern can be used. For example, a fourteen cell repeat pattern could provide
25 additional separation between the terrestrial networks and the satellite networks. The allocation of frequencies between the terrestrial network and the satellite network should be managed efficiently. For example, a large reuse repeat pattern on the satellite and a small repeat pattern terrestrial network may give rise to inefficient use of spectrum on the satellite (unless there is sufficient excess

spectrum), which could render the satellite capacity limited rather than power limited.

5 In this regard, it will be realized that one technique that may be practiced with the present invention is increasing the reuse cluster size. This will generally minimize the interference between the satellite and terrestrial systems. For example, in a reuse pattern traditionally associated with GSM systems, a pattern of four cells with three sectors each is used. Thus the same frequency is reused in every fifth cell.. If instead, twenty-four channels, for example, are assigned across the cells, one site in eight has the same frequency, as opposed to one site in four having the same frequency as with the four cell three sector pattern. Thus, the number of instances where the same frequency exists has been halved, and the energy density of an individual channel has also been reduced by half. In this example, the interference between the satellite and terrestrial systems would be reduced by approximately 3dB vis-à-vis the traditional four cell three sector reuse pattern.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

20 Before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and to the arrangements of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced and carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein are for the purpose of description and should not be regarded as limiting.

25 As such, those skilled in the art will appreciate that the conception, upon which this disclosure is based, may readily be utilized as a basis for the designing of other structures, methods and systems for carrying out the several purposes of

the present invention. It is important, therefore, that the invention be regarded as including equivalent constructions to those described herein insofar as they do not depart from the spirit and scope of the present invention.

5 To better appreciate the novelty and advantages provided by the present invention, a brief discussion of satellite terrestrial frequency reuse management is presented. It should be understood, however, that the techniques presented are general, and are independent of any specific values of parameters used to illustrate the concepts.

10 The capacity of a satellite network utilizing spot beams is directly proportional to the number of times a cluster of spot beams is replicated. The cluster size, N , chosen for the satellite system is seven (7). Other sizes may optionally be used. It is assumed that each spot beam has a frequency set containing nine 200 kHz channels ($f_i = \{q_{i,1}, q_{i,2}, q_{i,3}, \dots, q_{i,9}\}$ for $i = 1 \dots 7$). Other sets of frequencies may optionally be used. It is also assumed that there is a spot beam to adjacent spot beam average isolation of 8 dB. It should also be understood that the satellite terrestrial frequency reuse can operate in normal mode or reversed mode, and that the techniques presented here are applicable to both normal mode operation and reverse mode operation. As such, further reference to specific mode of operation will not be made. In the normal mode, shown in FIG. 1a, the terrestrial forward ($F1$) and reverse ($F2$) bands are the same as the satellite network. However, in the reverse mode operation, shown in FIG. 1b, the satellite forward band is the same as the terrestrial reverse band, and the satellite reverse band is the same as the terrestrial forward band.

25 *Co-Channel / Adjacent Beam Technique*

Within each spot beam, the use of satellite frequency set by the terrestrial network results in the worst case interference, called co-channel/co-beam interference. To utilize the isolation rendered by the availability of the spot beams, satellite terrestrial frequency reuse should preferably be implemented on

adjacent spot beams. The resulting co-channel/adjacent beam interference will generally be approximately reduced by the spot beam to adjacent spot beam isolation factor. It should be noted, however, that in a cluster of, for example, seven spot beams, as shown in FIGs. 2 and 3, each spot beam has six adjacent spot beams that can contribute to the interference received. The advantage of co-channel/adjacent beam technique over co-channel/co-beam technique lay with the fact that not all spot beams have equal service demand. Consequently, the distribution of interference between adjacent spot beams can reduce the average interference in a high service demand beam.

The STFR plan for the adjacent beam interference case is shown in FIG. 2. In this configuration, each spot beam is assigned a set of frequencies that will be used exclusively by the satellite network (f_i) and likewise the terrestrial network in each spot beam uses a set of frequency exclusive to the terrestrial network ($\bar{f}_i$).

The satellite frequencies used in the center spot beam is f_7 , and the terrestrial frequencies in this spot beam can include all other frequency sets $\{f_1, f_2, f_3, \dots, f_6\} = (\bar{f}_7)^T$. Note that in this configuration the entire spectral allocation is shared or substantially shared between the satellite network and the terrestrial network in each of the seven spot beams.

Terrestrial Cluster Size Technique

Cross network interference occurs when an RF channel is utilized both in the terrestrial network and in the satellite network, either in the co-beam configuration or in the adjacent-beam configuration. The severity of such interference depends on the power received by the competing network. In particular, the terrestrial networks reuse an RF channel or channels many times in an area covered by a given satellite spot beam or beams. Each occurrence of this RF channel gives rise to increased co-channel interference for the satellite network.

In the case of the co-beam configuration, the co-channel interference can

be approximated by MI , where M is the number of times an RF channel is reused and I is the interference power of one source. For the adjacent-beam configuration the co-channel interference from one adjacent beam can be approximated by αMI , where α accounts for the fraction of power leaked from the adjacent beam. Thus, in both co-beam and adjacent beam configuration, the co-channel interference is directly proportional to the number of times a particular frequency is reused terrestrially.

Increasing Cluster Size

By increasing the cluster size for the terrestrial network the reuse of a particular frequency is reduced. To illustrate the point, consider a terrestrial network in the center spot beam in FIG. 4a. As shown, the terrestrial network has 12 available RF channels for reuse with a cluster size of four and three sectors per cell site. In each terrestrial cluster, the skyward energy from one sector will interfere with all satellite co-channels in the adjacent spot beams (in the same spot beam for co-beam configuration). FIG. 4b shows a terrestrial network with 16 cell sites (48 sectors), each RF channel is repeated four times in this network. In this same 16 site network, if twenty-four RF channels are used, for example, in a cluster of 8, then the number of co-channel sectors is reduced from 4 to 2. In general, this type of tradeoff between bandwidth and interference can be employed to reduce co-channel interference.

Terrestrial Frequency Plan Technique

In addition to increasing terrestrial cluster size within a satellite spot beam to decrease co-channel interference, careful frequency planning can help to reduce interference through maximizing satellite-terrestrial frequency reuse distance. To demonstrate this concept, again consider a terrestrial network in the center spot beam in FIG. 2. Suppose that the terrestrial network has 45 available RF channels for reuse with a cluster size of 15. As shown in FIG. 2, any satellite frequency sets

that do not include f_7 can be used in the terrestrial network to provide adjacent beam isolation.

A random selection from the pool of 54 frequencies available for terrestrial use may result in areas where the distance between the terrestrial frequencies and satellite frequencies used in the adjacent spot beams is minimum. However, selective assignment of terrestrial frequencies to the immediate area adjacent to each spot beam in accordance with the present invention can result in increased satellite-terrestrial frequency reuse distance. FIG. 3a shows a terrestrial frequency allocation that result in maximum terrestrial-satellite frequency distance. As shown, the terrestrial network underlay in the center spot beam has been partitioned into six separate sections. In each section, the terrestrial frequency sets have been selected in order to maximize the frequency reuse distance from the satellite frequency sets in neighboring spot beams. For example, in section A of the center spot beam, the spot beam with the largest distance from this section has the assigned frequency set f_4 . The spot beams with next largest distance have the assigned satellite frequency sets f_3 and f_5 , and finally the last set of the spot beams have the assigned frequency sets f_2 and f_6 . In general, the terrestrial network within each spot beam must also be sectioned in the same way that has been done for the center spot beam as shown in FIG. 3a.

Satellite spot beams at the edge of the service area do not have the full complement of six neighbors. As such, the terrestrial network within the areas covered by this type of spot beams will have slightly different configuration. FIG. 3b shows the terrestrial network frequency plan for such a spot beam. The spot beam with assigned satellite frequency of f_7 has only three adjacent spot beam (f_1, f_5, f_6). The spot beams with frequency assignment f_2, f_3 , and f_4 are missing from the f_7 cluster. As a result, the f_2, f_3 , and f_4 frequency sets can be assigned to all terrestrial underlay partitions in f_7 spot beam. The remaining terrestrial frequency assignments for this spot beam follow the procedure described above with the exception of section B. In section B, there are two

choices for one frequency set assignment, f_5 and f_1 , either of these frequency sets can be assigned to this section. This is because both f_1 and f_5 are equidistant from section B.

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Frequency Borrowing Technique

In highly populated areas where terrestrial coverage can present great spectral efficiency over the satellite coverage, the terrestrial cell site density will be high. Accordingly, the interference generated in these cell sites will also be high. In such circumstances, it is advantageous to trade part of the satellite frequency spectrum of the spot beam (and even part of adjacent spot beams) to the terrestrial network. Such a trade off results in lower co-channel interference levels. As an example of a frequency borrowing technique, consider the example discussed in the previous section where each of the terrestrial networks have been configured with 45 RF channels and the satellite network in the corresponding spot beam has been configured with nine (9) RF channels. To reduce the interference by increasing the cluster size, three (3) RF channels from the satellite network can be reassigned to the terrestrial network resulting in 48 RF channels for reuse terrestrially and six (6) RF channels for the corresponding satellite spot beam.

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Use Of And Prediction Of Terrain Clutter To Protect The Satellite From Terrestrial Energy

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Terrestrial units are always going to be working in some sort of clutter. For example, handsets, say, six feet above the ground generally must work through buildings, trees, etc. The base stations themselves can be installed in such a manner as to provide as much isolation from the satellite as possible by, for example, putting antennas on sides of buildings (e.g., away from direct line of

sight from the satellite).

5 This present invention provides a system and method that ensures that potential attenuators are used to provide maximum separation between a terrestrial base station and a satellite. The present invention considers the morphological and/or topological characteristics to increase the separation between the satellite and the terrestrial system. This enables, for example, the capacity and density of terrestrial networks in urban areas to be increased without giving rise to objectionable interference on the satellite or satellites.

10 The present invention utilizes shadow analysis (e.g., modeling tools) that, as shown in FIG. 5, have information about not only the terrain in an area but the buildings, trees, etc. As shown in FIG. 6, a three dimensional picture of the morphology in the area is thus provided. This information is used to do a shadow analysis between the satellite and any potential base station in the area so that base stations can be optimally located in areas that do not, for example, have a line of sight to the satellite. Base stations can thus be optimally located such that they preferably have no view or minimal view of the sky, and thus, no view or a minimal view of the satellite. Energy is thus optimally directed to covering ground users within an area covered by the base station.

20 In accordance with the present invention, a standard system is provided that enables standard measurements to be taken pertaining to how much satellite energy and/or how much satellite visibility there is in any particular location. This data can in turn be used in deciding upon base station location(s). Generally, base stations should be located where there is more shadowing, and where there is minimal signal strength directed towards the satellite and therefore interference. 25 The system and method quantifies the shadowing, where the more shadowing, the better possible location for a terrestrial base station.

For example, going from the south side of a building to the north side of a building (or vice-versa) can add a significant attenuation towards the satellite because these may be additional signal blockage. The present invention thus

enhances spectral efficiency and interference protection, particularly within a combined satellite-terrestrial network.

The many features and advantages of the invention are apparent from the detailed specification, and thus, it is intended by the appended claims to cover all such features and advantages of the invention which fall within the true spirit and scope of the invention. Further, since numerous modifications and variations will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation illustrated and described, and accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention. While the foregoing invention has been described in detail by way of illustration and example of preferred embodiments, numerous modifications, substitutions, and alterations are possible without departing from the scope of the invention.

CLAIMS

1. A method of at least one of assigning and reusing frequencies between one or more communication systems, comprising the steps of:
 - configuring a first satellite spot beam having a first set of frequencies associated therewith and comprising a first substantially central portion and a first plurality of subareas, each of the first plurality of subareas extending substantially from a periphery of the first substantially central portion to substantially near a circumference of the first satellite spot beam;
 - configuring a second satellite spot beam having a second set of frequencies associated therewith and comprising a second substantially central portion and a second plurality of subareas, each of the second plurality of subareas extending substantially from a periphery of the second central portion to substantially near a circumference of the second satellite spot beam;
 - configuring at least one terrestrial cell that at least partially overlaps the first satellite spot beam having a third set of frequencies associated therewith; and
 - at least one of assigning, reusing and borrowing, by the terrestrial system, at least one of a portion of the second set of frequencies and a portion of the first set of frequencies used in the first central portion, responsive to predetermined criteria associated with the third set of frequencies, including at least one of assigning, reusing and borrowing at least one of the second set of frequencies when the second set of frequencies are at least substantially geographically distant from the first satellite spot beam.
2. The method of claim 1 wherein the first plurality of subareas are substantially equal sized cells having a first size and the second plurality of subareas are substantially equal sized cells having a second size.
3. The method of claim 2 wherein the first size and the second size are approximately equal.
4. The method of claim 1 wherein the second set of frequencies are substantially distant from the first satellite spot beam when they are at least one of assigned, reused and borrowed for use in those first plurality of subareas not sharing a common boundary with the second satellite spot beam.

5. The method of claim 1 wherein the first set of frequencies used in the first central portion comprise at least one of those frequency sets respectively associated with satellite spot beams directly adjacent to the first satellite spot beam.

6. The method of claim 1 wherein said step of assigning, reusing and borrowing is based on prioritization rules.

7. The method of claim 6 wherein the prioritization rules include dynamic load and capacity constraints of cells that frequencies are taken from.

8. The method of claim 1 wherein a subscriber terminal positioned within the first central portion can be assigned, reuse and/or borrow use any of the respective set of frequencies associated with the at least one second satellite spot beam.

9. The method of claim 1 wherein a subscriber terminal positioned within the first central portion can be assigned, reuse and/or borrow use any of the respective set of frequencies associated with any spot beams adjacent the first satellite spot beam.

10. The method of claim 1 wherein a subscriber terminal positioned within a subarea of the first spot beam not sharing at least a portion of a common boundary with the second satellite spot beam can be assigned, reuse and/or borrow any of the second set of frequencies associated with the second satellite spot beam.

11. The method of claim 1 wherein the predetermined criteria is at least one of load balancing and received signal strength interference.

12. The method of claim 1 further comprising the steps of:

configuring a second terrestrial cell that at least partially overlaps the second satellite spot beam having a fourth set of frequencies associated therewith; and

at least one of assigning, reusing and borrowing, by the second terrestrial cell, at least one of the first set of frequencies and the frequencies used in the second central portion, responsive to predetermined criteria associated with the fourth set of frequencies, including at least one of assigning, reusing and borrowing at least one of the first set of

frequencies when the first set of frequencies are at least substantially geographically distant from the second satellite spot beam.

13. The method of claim 1 wherein the first central portion and the second central portion comprise approximately twenty five percent of the area covered by the first satellite spot beam and the second satellite spot beam, respectively.

14. The method of claim 1 wherein the first set of frequencies and the second set of frequencies comprise a plurality of paired uplink and downlink frequencies.

15. The method of claim 14 wherein a downlink frequency of a frequency set is used in a first subarea of the first spot beam, and wherein a corresponding one of the uplink frequencies is reused in a second subarea of the first spot beam.

16. The method of claim 1 wherein the area of coverage of a spot beam comprises an area having a radius substantially equal to a distance from a center of the spot beam having a substantially maximum signal strength to a distance from the center of the spot beam where the signal strength of the spot beam is attenuated by approximately 3 dB.

17. The method of claim 1 wherein an area of coverage of at least one of a spot beam and a terrestrial cell comprises an area corresponding to a bit error rate in the range of at least one of 10^{-2} to 10^{-3} for voice and 10^{-5} to 10^{-6} for data.

18. The method of claim 1 wherein the number of subareas is equal to a number of spot beams comprising a cluster minus one.

19. A method of at least one of assigning and reusing frequencies, comprising the steps of:
configuring a first communications area having a first set of frequencies associated therewith and comprising a first substantially central portion and a first plurality of subareas, each of the first plurality of subareas extending substantially from a periphery of the first substantially central portion to substantially near a circumference of the first communications area;
configuring a second communications area having a second set of frequencies associated therewith and comprising a second substantially central portion and a second plurality of

subareas, each of the second plurality of subareas extending substantially from a periphery of the central portion to substantially near a circumference of the second communications area;

configuring at least one third communications area that at least partially overlaps the first communications area, having a third set of frequencies associated therewith; and
at least one of assigning, reusing and borrowing, by the third communications area, at least one of a portion of the second set of frequencies and a portion of the first set of frequencies used in the first central portion, responsive to predetermined criteria associated with the third set of frequencies, including at least one of assigning, reusing and borrowing at least one of the second set of frequencies when the second set of frequencies are at least substantially geographically distant from the first satellite spot beam.

20. The method of claim 19 wherein the first plurality of subareas are substantially equal sized cells having a first size and the second plurality of subareas are substantially equal sized cells having a second size.

21. The method of claim 20 wherein the first size and the second size are approximately equal.

22. The method of claim 19 wherein the second set of frequencies are substantially distant from the second communications area when they are at least one of assigned, reused and borrowed for use in those first plurality of subareas not sharing a common boundary with the second communications area.

23. The method of claim 19 wherein the first set of frequencies used in the first central portion comprise at least one of those frequency sets respectively associated with communication areas external to and directly adjacent to the first communications area.

24. The method of claim 19 wherein said step of assigning, reusing and borrowing is based on prioritization rules.

25. The method of claim 24 wherein the prioritization rules include dynamic load and capacity constraints of candidate cells that frequencies are being taken from.

26. The method of claim 19 wherein a user positioned within the first central portion can be assigned, reuse and/or borrow use any of the respective set of frequencies associated with the at least one second satellite spot beam.

27. The method of claim 19 wherein a user positioned within the first central portion can be assigned, reuse and/or borrow use any of the respective set of frequencies associated with any communication areas adjacent the first satellite spot beam.

28. The method of claim 19 wherein a user positioned within a subarea not sharing at least a portion of a common boundary with the second communications area can be assigned, reuse and/or borrow any of the second set of frequencies associated with the second communications area.

29. The method of claim 19 wherein the predetermined criteria is at least one of load balancing and received signal strength interference.

30. The method of claim 19 further comprising the steps of:
configuring a fourth communications area within the second communications area having a fourth set of frequencies associated therewith; and
at least one of assigning, reusing and borrowing, by the fourth communications area, at least one of the first set of frequencies and the frequencies used in the second central portion, responsive to predetermined criteria associated with the fourth set of frequencies, including at least one of assigning, reusing and borrowing at least one of the first set of frequencies when the first set of frequencies are at least substantially geographically distant from the second communications area.

31. The method of claim 19 wherein the first central portion and the second central portion comprise approximately twenty five percent of the area covered by the first communications area and the second communications area, respectively.

32. The method of claim 19 wherein the first and second set of frequencies comprise a plurality of paired uplink and downlink frequencies, wherein a downlink frequency of a frequency set is used in a first subarea of the first communications area, and wherein a corresponding one of the uplink frequencies is reused in a second subarea of the first communications area.

33. The method of claim 19 wherein the area of coverage of a communications area comprises an area having a radius substantially equal to a distance from a center of the communications area having a substantially maximum signal strength to a distance from the center of the communications area where the signal strength of the communications area is attenuated by approximately 3 dB.

34. The method of claim 19 wherein an area of coverage of at least one of a spot beam and a terrestrial cell comprises an area corresponding to a bit error rate in the range of at least one of 10^{-2} to 10^{-3} for voice and 10^{-5} to 10^{-6} for data.

35. A method of at least one of assigning and reusing frequencies between one or more communication systems, comprising the steps of:

configuring a first satellite spot beam having a first set of frequencies associated therewith and comprising a first substantially central portion and a first plurality of subareas, each of the first plurality of subareas extending substantially from a periphery of the first substantially central portion to substantially near a circumference of the first satellite spot beam;

configuring a second satellite spot beam having a second set of frequencies associated therewith and comprising a second substantially central portion and a second plurality of subareas, each of the second plurality of subareas extending substantially from a periphery of the central portion to substantially near a circumference of the second satellite spot beam;

configuring at least one terrestrial cell that at least partially overlaps the first satellite spot beam having a third set of frequencies associated therewith; and

at least one of assigning, reusing and borrowing, by the second satellite spot beam, at least one of a portion of the third set of frequencies responsive to predetermined criteria, including at least one of assigning, reusing and borrowing at least one of the third set of frequencies associated with the at least one terrestrial cell when the terrestrial cell is at least substantially geographically distant from the second set of frequencies.

36. A method of at least one of assigning and reusing frequencies between one or more communication systems, comprising the steps of:

configuring a first satellite spot beam having a first set of frequencies associated therewith and comprising a first substantially central portion and a first plurality of subareas, each of the first plurality of subareas extending substantially from a periphery of the first

substantially central portion to substantially near a circumference of the first satellite spot beam;

configuring a second satellite spot beam having a second set of frequencies associated therewith;

configuring at least one terrestrial cell that at least partially overlaps the first satellite spot beam having a third set of frequencies associated therewith; and

at least one of assigning, reusing and borrowing, by the terrestrial cell, at least one of a portion of the second set of frequencies and a portion of the first set of frequencies used in the first central portion, responsive to predetermined criteria associated with the third set of frequencies, including at least one of assigning, reusing and borrowing at least one of the second set of frequencies when the second set of frequencies are at least substantially geographically distant from the terrestrial cell.

37. The method of claim 36 wherein the first plurality of subareas are substantially equal sized.

38. The method of claim 36 wherein the second set of frequencies are substantially distant from the first satellite spot beam when they are at least one of assigned, reused and borrowed for use in those first plurality of subareas not sharing a common boundary with the second satellite spot beam.

39. The method of claim 36 wherein the first set of frequencies used in the first central portion comprise at least one of those frequency sets respectively associated with one or more satellite spot beams directly adjacent to the first satellite spot beam.

40. The method of claim 36 wherein said step of assigning, reusing and borrowing is based on prioritization rules.

41. The method of claim 40 wherein the prioritization rules include dynamic load and capacity constraints of candidate cells that frequencies are being taken from.

42. The method of claim 36 wherein a user positioned within the first central portion can be assigned, reuse and/or borrow use any of the respective set of frequencies associated with the second satellite spot beam.

43. The method of claim 36 wherein a subscriber terminal positioned within the first central portion can be assigned, reuse and/or borrow use any of the respective set of frequencies associated with any spot beams adjacent the first satellite spot beam.

44. The method of claim 36 wherein a subscriber terminal positioned within a subarea of the first spot beam not sharing at least a portion of a common boundary with the second satellite spot beam can be assigned, reuse and/or borrow any of the second set of frequencies associated with the second satellite spot beam.

45. The method of claim 36 wherein the predetermined criteria is at least one of load balancing and received signal strength interference.

46. The method of claim 36 further comprising the steps of:
configuring a second terrestrial cell that at least partially overlaps the second satellite spot beam
having a fourth set of frequencies associated therewith; and
at least one of assigning, reusing and borrowing, by the second terrestrial cell, at least one of the first set of frequencies and the frequencies used in the second central portion, responsive to predetermined criteria associated with the fourth set of frequencies, including at least one of assigning, reusing and borrowing at least one of the first set of frequencies when the first set of frequencies are at least substantially geographically distant from the second terrestrial cell.

47. The method of claim 36 wherein the first central portion comprises approximately twenty five percent of the area covered by the first satellite spot beam.

48. The method of claim 36 wherein the first and second set of frequencies comprise a plurality of paired uplink and downlink frequencies, wherein a downlink frequency of a frequency set is used in a first subarea of the first spot beam, and wherein a corresponding one of the uplink frequencies is reused in a second subarea of the first spot beam.

49. The method of claim 36 wherein the area of coverage of a spot beam comprises an area having a radius substantially equal to a distance from a center of the spot beam having a substantially maximum signal strength to a distance from the center of the spot beam where the signal strength of the spot beam is attenuated by approximately 3 dB.

50. The method of claim 36 wherein an area of coverage of at least one of a spot beam and a terrestrial cell comprises an area corresponding to a bit error rate in the range of at least one of 10^{-2} to 10^{-3} for voice and 10^{-5} to 10^{-6} for data.

51. A method of at least one of assigning and reusing frequencies between one or more communication systems, comprising the steps of:

configuring a first satellite spot beam having a first set of frequencies associated therewith and comprising a first plurality of subareas, each of the first plurality of subareas extending from a substantially center area of the first satellite spot beam to substantially near a circumference of the first satellite spot beam in a fan-like manner thereby forming the first plurality of subareas;

configuring a second satellite spot beam having a second set of frequencies associated therewith;

configuring at least one terrestrial cell that at least partially overlaps the first satellite spot beam having a third set of frequencies associated therewith; and

at least one of assigning, reusing and borrowing, by the at least one terrestrial cell, at least one of a portion of the second set of frequencies and a portion of the first set of frequencies used in the first central portion, responsive to predetermined criteria associated with the third set of frequencies for communication therewith, including at least one of assigning, reusing and borrowing at least one of the second set of frequencies when the second set of frequencies are at least substantially geographically distant from the first spot beam.

52. The method of claim 51 wherein the first plurality of subareas are substantially equal sized.

53. The method of claim 51 wherein the second set of frequencies are substantially distant from the second satellite spot beam when they are at least one of assigned, reused and borrowed for use in those first plurality of subareas not sharing a common boundary with the second satellite spot beam.

54. The method of claim 51 wherein the first set of frequencies used in the first central portion comprise those frequency sets respectively associated with at least one of the satellite spot beams directly adjacent to the first satellite spot beam.

55. The method of claim 51 wherein said step of assigning, reusing and borrowing is based on prioritization rules.

56. The method of claim 55 wherein the prioritization rules include dynamic load and capacity constraints of candidate cells that frequencies are being taken from.

57. The method of claim 55 wherein the prioritization rules further include signal strength.

58. The method of claim 51 wherein a user positioned within the first central portion can be assigned, reuse and/or borrow use any of the respective set of frequencies associated with the second satellite spot beam.

59. The method of claim 51 wherein a user positioned within the first central portion can be assigned, reuse and/or borrow use any of the respective set of frequencies associated with any spot beams adjacent the first satellite spot beam.

60. The method of claim 51 wherein a user positioned within a subarea not sharing at least a portion of a common boundary with the second satellite spot beam can be assigned, reuse and/or borrow any of the second set of frequencies associated with the second satellite spot beam.

61. The method of claim 51 wherein the predetermined criteria comprise at least one of load balancing and received signal strength interference.

62. The method of claim 51 further comprising the steps of:

configuring a terrestrial cell that at least partially overlaps the second satellite spot beam having a fourth set of frequencies associated therewith; and

at least one of assigning, reusing and borrowing, by the terrestrial cell, at least one of the first set of frequencies and the frequencies used in the second central portion, responsive to predetermined criteria associated with the fourth set of frequencies, including at least one of assigning, reusing and borrowing at least one of the first set of frequencies when the first set of frequencies are at least substantially geographically distant from the terrestrial cell.

63. The method of claim 51 wherein the first and second set of frequencies comprise a plurality of paired uplink and downlink frequencies.

64. The method of claim 63 wherein a downlink frequency of a frequency set is used in a first subarea of the first spot beam, and wherein a corresponding one of the uplink frequencies is used in a second subarea of the first spot beam.

65. The method of claim 51 wherein the area of coverage of a spot beam comprises an area having a radius substantially equal to a distance from a center of the spot beam having a substantially maximum signal strength to a distance from the center of the spot beam where the signal strength of the spot beam is attenuated by approximately 3 dB.

66. The method of claim 51 wherein an area of coverage of at least one of a spot beam and a terrestrial cell comprises an area corresponding to a bit error rate in the range of 10^{-2} to 10^{-3} for voice and 10^{-5} to 10^{-6} for data.

67. A system for at least one of assigning and reusing frequencies between one or more communication systems, comprising:

at least one satellite capable of configuring: a) a first spot beam having a first set of frequencies associated therewith, the first spot beam comprising a first substantially central portion and a first plurality of subareas, each of the first plurality of subareas extending substantially from a periphery of the first substantially central portion to substantially near a circumference of the first satellite spot beam, and b) a second satellite spot beam having a second set of frequencies associated therewith, the second spot beam comprising a second substantially central portion and a second plurality of subareas, each of the second plurality of subareas extending substantially from a periphery of the second central portion to substantially near a circumference of the second satellite spot beam;

a terrestrial base station positioned within the first satellite spot beam for configuring a terrestrial cell having at least partially overlapping coverage with the first spot beam, the terrestrial cell having a third set of frequencies associated therewith and an area coverage at least partially overlapping with an area of coverage associated with the first spot beam;

a first subscriber terminal positioned within the terrestrial base station area of coverage; and

means for at least one of assigning, reusing and borrowing, by the terrestrial base station and for use by said first subscriber terminal in communicating with at least one of a second subscriber terminal and other communications device, at least one of a portion of the

second set of frequencies and a portion of the first set of frequencies used in the first central portion, responsive to predetermined criteria associated with the third set of frequencies, including at least one of assigning, reusing and borrowing at least one of the second set of frequencies when the second set of frequencies are at least substantially geographically distant from the second satellite spot beam.

68. The system of claim 67 wherein the first plurality of subareas are substantially equal sized and having a first size, and the second plurality of subareas are substantially and having a second size.

69. The system of claim 68 wherein the first size and the second size are approximately equal.

70. The system of claim 67 wherein the second set of frequencies are substantially distant from the second satellite spot beam when they are at least one of assigned, reused and borrowed for use by subscriber terminals positioned in those first plurality of subareas not sharing a common boundary with the second satellite spot beam.

71. The system of claim 67 wherein the first set of frequencies used by subscriber terminals positioned in the first central portion comprise at least one of those frequency sets respectively associated with one or more satellite spot beams directly adjacent to the first satellite spot beam.

72. The system of claim 67 wherein at least one of assigning, reusing and borrowing is based on prioritization rules.

73. The system of claim 72 wherein the prioritization rules include dynamic load and capacity constraints of cells that frequencies are taken from.

74. The system of claim 67 wherein a subscriber terminal positioned within the first central portion can be assigned, reuse and/or borrow any of the respective set of frequencies associated with the at least one second satellite spot beam.

75. The system of claim 67 wherein a subscriber terminal positioned within the first central portion can be assigned, reuse and/or borrow use any of the respective set of frequencies associated with any spot beam directly adjacent the first satellite spot beam.

76. The system of claim 67 wherein a subscriber terminal positioned within a subarea of the first spot beam not sharing at least a portion of a common boundary with the second satellite spot beam can be assigned, reuse and/or borrow any of the second set of frequencies associated with the second satellite spot beam.

77. The system of claim 67 wherein the predetermined criteria is at least one of load balancing and received signal strength interference.

78. The system of claim 67 further comprising:

a second terrestrial base station positioned within the second satellite spot beam and having at least partially overlapping coverage with the first spot beam, for configuring at least one terrestrial cell therein, wherein the terrestrial cell has a fourth set of frequencies associated therewith; and

at least one of assigning, reusing and borrowing, by said second terrestrial base station, at least one of the first set of frequencies and the frequencies used in the second central portion, responsive to predetermined criteria associated with the fourth set of frequencies for establishing communication between the second subscriber unit positioned within an area of coverage of said second base station and at least one of the first subscriber terminal and other communications device, including at least one of assigning, reusing and borrowing at least one of the first set of frequencies when the first set of frequencies are at least substantially geographically distant from the second satellite spot beam.

79. The system of claim 67 wherein the first central portion and the second central portion comprise approximately twenty five percent of the area covered by the first satellite spot beam and the second satellite spot beam, respectively.

80. The system of claim 67 wherein the first and second set of frequencies comprise a plurality of paired uplink and downlink frequencies.

81. The system of claim 80 wherein a downlink frequency of a frequency set is used in a first subarea of the first spot beam, and wherein a corresponding one of the uplink frequencies is reused in a second subarea of the first spot beam.

82. The system of claim 67 wherein the area of coverage of a spot beam comprises an area having a radius substantially equal to a distance from a center of the spot beam having a substantially maximum signal strength to a distance from the center of the spot beam where the signal strength of the spot beam is attenuated by approximately 3 dB.

83. The system of claim 67 wherein an area of coverage of at least one of a spot beam and a terrestrial cell comprises an area corresponding to a bit error rate in the range of 10^{-2} to 10^{-3} for voice and 10^{-5} to 10^{-6} for data.

84. The system of claim 67 wherein the number of subareas is equal to a number of spot beams comprising a cluster minus one.

85. A system for making a telephone call using a satellite-terrestrial communications system that at least one of assigns and reuses frequencies between a first satellite spot beam and a second satellite spot beam, comprising:

- a subscriber terminal for dialing a telephone number to communicate with at least a second communications device;
- a first terrestrial cell having said subscriber terminal positioned therein;
- at least one satellite for configuring: a) a first satellite spot beam associated with said first terrestrial cell and having a first set of frequencies associated therewith, the first satellite spot beam comprising a first substantially central portion and a first plurality of subareas, each of the first plurality of subareas extending substantially from a periphery of the first substantially central portion to substantially near a circumference of the first satellite spot beam, and b) a second satellite spot beam having the second communications device positioned therein and a second set of frequencies associated therewith; and
- means for establishing a connection between the subscriber terminal and at least the second communications device, by at least one of assigning, reusing and borrowing, by the first spot beam, at least one of the second set of frequencies, responsive to predetermined criteria including at least one of assigning, reusing and borrowing at least one of the second set of frequencies when the subscriber terminal is substantially geographically distant from the second satellite spot beam.

86. A system for use in at least one of assigning and reusing frequencies, comprising:

- at least a first satellite for: a) configuring a first communications area having a first set of frequencies associated therewith, the communications area comprising a first

substantially central portion and a first plurality of subareas, each of the first plurality of subareas extending substantially from a periphery of the first substantially central portion to substantially near a circumference of the first communications area, and for b) configuring a second communications area having a second set of frequencies associated therewith and comprising a second substantially central portion and a second plurality of subareas, each of the second plurality of subareas extending substantially from a periphery of the central portion to substantially near a circumference of the second communications area;

a terrestrial base station positioned within the first communications area and having at least partially overlapping coverage with the first communications area, that configures at least a third communications area within the first communications area, the third communications area having a third set of frequencies associated therewith; and

means for at least one of assigning, reusing and borrowing, by said terrestrial base station, at least one of a portion of the second set of frequencies and a portion of the first set of frequencies used in the first central portion for facilitating communications between a subscriber terminal positioned within the first communications area and a second communications device, and responsive to predetermined criteria associated with the third set of frequencies, including at least one of assigning, reusing and borrowing at least one of the second set of frequencies when the second set of frequencies are at least substantially geographically distant from the first satellite spot beam.

87. The system of claim 86 wherein the first plurality of subareas are substantially equal sized and having a first size and the second plurality of subareas are substantially equal sized and having a second size.

88. The system of claim 87 wherein the first size and the second size are approximately equal.

89. The system of claim 86 wherein the second set of frequencies are substantially distant from the second communications area when they are at least one of assigned, reused and borrowed for use in those first plurality of subareas not sharing a common boundary with the second communications area.

90. The system of claim 86 wherein the first set of frequencies used in the first central portion comprise those frequency sets respectively associated with communication areas external to and directly adjacent to the first communications area.

91. The system of claim 86 wherein the assigning, reusing and borrowing is based on prioritization rules.

92. The system of claim 91 wherein the prioritization rules comprise dynamic load and capacity constraints of candidate cells that frequencies are being taken from.

93. The system of claim 86 wherein a user positioned within the first central portion can be assigned, reuse and/or borrow use any of the respective set of frequencies associated with the second communications area.

94. The system of claim 86 wherein when the subscriber terminal is positioned within the first central portion it can be assigned, reuse and/or borrow any of the respective set of frequencies associated with any communication areas adjacent the first communications area.

95. The system of claim 86 wherein when the subscriber terminal is positioned within a subarea of the first communications area not sharing at least a portion of a common boundary with the second communications area it can be assigned, reuse and/or borrow any of the second set of frequencies associated with the second communications area.

96. The system of claim 86 wherein the predetermined criteria is at least one of load balancing and received signal strength interference.

97. The system of claim 86, further comprising:

a second terrestrial base station positioned within the second communications area and having at least partially overlapping coverage with the second communications area, wherein the second communications area comprises at least one terrestrial cell within the second communications area, and wherein said second terrestrial base station has a fourth set of frequencies associated therewith; and

at least one of assigning, reusing and borrowing, by said second terrestrial base station, at least one of the first set of frequencies and the frequencies used in the second central portion, responsive to predetermined criteria associated with the fourth set of frequencies, for establishing communication between a second subscriber unit positioned within an area covered by said second terrestrial base station and at least one of the first subscriber unit

and the second communication device, including at least one of assigning, reusing and borrowing at least one of the first set of frequencies when the first set of frequencies are at least substantially geographically distant from the second terrestrial base station.

98. The system of claim 86 wherein the first central portion and the second central portion comprise approximately twenty five percent of the area covered by the first communications area and the second communications area, respectively.

99. The system of claim 86 wherein the first and second set of frequencies comprise a plurality of paired uplink and downlink frequencies, wherein a downlink frequency of a frequency set is used in a first subarea of the first communications area, and wherein a corresponding one of the uplink frequencies is reused in a second subarea of the first communications area.

100. The system of claim 86 wherein the area of coverage of a communications area comprises an area having a radius substantially equal to a distance from a center of the communications area having a substantially maximum signal strength to a distance from the center of the communications area where the signal strength of the communications area is attenuated by approximately 3 dB.

101. The system of claim 86 wherein an area of coverage of at least one of a spot beam and a terrestrial cell comprises an area corresponding to a bit error rate in the range of 10^{-2} to 10^{-3} for voice and 10^{-5} to 10^{-6} for data.

102. A system for at least one of assigning and reusing frequencies between a plurality of communication systems, comprising:

- at least one satellite capable of: a) configuring a first satellite spot beam having a first set of frequencies associated therewith and comprising a first substantially central portion and a first plurality of subareas, each of the first plurality of subareas extending substantially from a periphery of the first substantially central portion to substantially near a circumference of the first satellite spot beam, and b) configuring a second satellite spot beam having a second set of frequencies associated therewith and comprising a second substantially central portion and a second plurality of subareas, each of the second plurality of subareas extending substantially from a periphery of the central portion to substantially near a circumference of the second satellite spot beam;
- a terrestrial base station positioned within the first satellite spot beam and having at least partially overlapping coverage with the first spot beam, for configuring at least one

terrestrial cell within the first satellite spot beam having a third set of frequencies associated therewith and having an area of coverage at least partially overlapping with the first satellite spot beam; and

means for at least one of assigning, reusing and borrowing, by the second satellite spot beam, at least one of a portion of the third set of frequencies responsive to predetermined criteria, including at least one of assigning, reusing and borrowing at least one of the third set of frequencies associated with the at least one terrestrial cell when the portion is at least substantially geographically distant from the second set of frequencies.

103. A system of at least one of assigning and reusing frequencies between a plurality of communication systems, comprising:

a first satellite capable of: a) configuring a first satellite spot beam having a first set of frequencies associated therewith and comprising a first substantially central portion and a first plurality of subareas, each of the first plurality of subareas extending substantially from a periphery of the first substantially central portion to substantially near a circumference of the first satellite spot beam, and b) configuring a second satellite spot beam having a second set of frequencies associated therewith;

a terrestrial base station positioned within the first satellite spot beam and having at least partially overlapping coverage with the first spot beam, for configuring at least one terrestrial cell within the first satellite spot beam, the terrestrial cell having a third set of frequencies associated therewith and having an area of coverage at least partially overlapping with an area of coverage of the first satellite spot beam; and

means for at least one of assigning, reusing and borrowing, by the terrestrial base station for use in establishing communications between a first subscriber terminal positioned within an area of coverage of said terrestrial base station and at least one of a second subscriber terminal and communications device, at least one of a portion of the second set of frequencies and a portion of the first set of frequencies used in the first central portion, responsive to predetermined criteria associated with the third set of frequencies, including at least one of assigning, reusing and borrowing at least one of the second set of frequencies when the second set of frequencies are at least substantially geographically distant from the first satellite spot beam.

104. The system of claim 103 wherein the first plurality of subareas are substantially equal sized.

105. The system of claim 103 wherein the second set of frequencies are substantially distant from the second satellite spot beam when they are at least one of assigned, reused and borrowed for use in those first plurality of subareas not sharing a common boundary with the second satellite spot beam.

106. The system of claim 103 wherein the first set of frequencies used in the first central portion comprise those frequency sets respectively associated with satellite spot beams directly adjacent to the first satellite spot beam.

107. The system of claim 103 wherein said step of assigning, reusing and borrowing is based on prioritization rules.

108. The system of claim 107 wherein the prioritization rules include dynamic load and capacity constraints of candidate cells that frequencies are being taken from.

109. The system of claim 103 wherein a subscriber terminal positioned within the first central portion can be assigned, reuse and/or borrow any of the respective set of frequencies associated with the second satellite spot beam.

110 . The system of claim 103 wherein a subscriber terminal positioned within the first central portion can be assigned, reuse and/or borrow any of the respective set of frequencies associated with any spot beams adjacent the first satellite spot beam.

111. The system of claim 103 wherein a subscriber terminal positioned within a subarea not sharing at least a portion of a common boundary with the second satellite spot beam can be assigned, reuse and/or borrow any of the second set of frequencies associated with the second satellite spot beam.

112. The system of claim 103 wherein the predetermined criteria is at least one of load balancing and received signal strength interference.

113. The system of claim 103 further comprising:

a second terrestrial base station positioned within the second satellite spot beam and having at least partially overlapping coverage with the second spot beam, wherein the second

satellite spot beam further comprises at least one terrestrial cell having a fourth set of frequencies associated therewith,

wherein said means facilitates at least one of assigning, reusing and borrowing, by said second terrestrial base station for use with a second subscriber terminal positioned within an area covered by said second terrestrial base station, at least one of the first set of frequencies and the frequencies used in the second central portion, responsive to predetermined criteria associated with the fourth set of frequencies for establishing communication between the second subscriber terminal and at least one of the first subscriber terminal and communications device, including at least one of assigning, reusing and borrowing at least one of the first set of frequencies when the first set of frequencies are at least substantially geographically distant from the second satellite spot beam.

114. The system of claim 103 wherein the first central portion comprises approximately twenty five percent of the area covered by the first satellite spot beam.

115. The system of claim 103 wherein the first and second set of frequencies comprise a plurality of paired uplink and downlink frequencies, wherein a downlink frequency of a frequency set is used in a first subarea of the first spot beam, and wherein a corresponding one of the uplink frequencies is reused in a second subarea of the first spot beam.

116. The system of claim 103 wherein an area of coverage of at least one of a spot beam and a terrestrial cell comprises an area corresponding to a bit error rate in the range of 10^{-2} to 10^{-3} for voice and 10^{-5} to 10^{-6} for data.

117. The system of claim 103 wherein the area of coverage of a spot beam comprises an area having a radius substantially equal to a distance from a center of the spot beam having a substantially maximum signal strength to a distance from the center of the spot beam where the signal strength of the spot beam is attenuated by approximately 3 dB.

118. A system of at least one of assigning and reusing frequencies between a plurality of communication systems, comprising:

a first satellite capable of: a) configuring a first satellite spot beam having a first set of frequencies associated therewith and comprising a first plurality of subareas, each of the first plurality of subareas extending from a substantially center area of the first satellite spot beam to substantially near a circumference of the first satellite spot beam in a fan-

like manner thereby forming the first plurality of subareas, and b) configuring a second satellite spot beam having a second set of frequencies associated therewith;

a terrestrial base station positioned within the first satellite spot beam and having at least partially overlapping coverage with the first spot beam, for configuring a terrestrial cell, the terrestrial cell having a third set of frequencies associated therewith and having an area of coverage at least partially overlapping with an area of coverage associated with the first spot beam; and

means for at least one of assigning, reusing and borrowing, by said terrestrial base station and for use by a first subscriber terminal in communicating with at least one of a second subscriber terminal or communications device, at least one of a portion of the second set of frequencies and a portion of the first set of frequencies used in the first central portion, responsive to predetermined criteria associated with the third set of frequencies, including at least one of assigning, reusing and borrowing at least one of the second set of frequencies when the second set of frequencies are at least substantially geographically distant from the first satellite spot beam.

119. The system of claim 118 wherein the first plurality of subareas are substantially equal sized.

120. The system of claim 118 wherein the second set of frequencies are substantially distant from the second satellite spot beam when they are at least one of assigned, reused and borrowed for use in those first plurality of subareas not sharing a common boundary with the second satellite spot beam.

121. The system of claim 118 wherein the assigning, reusing and borrowing is based on prioritization rules.

121. The system of claim 121 wherein the prioritization rules include dynamic load and capacity constraints of candidate cells that frequencies are being taken from.

123. The system of claim 118 wherein a subscriber terminal positioned within a subarea not sharing at least a portion of a common boundary with the second satellite spot beam can be assigned, reuse and/or borrow any of the second set of frequencies associated with the second satellite spot beam.

124. The system of claim 118 wherein the predetermined criteria is at least one of load balancing and received signal strength interference.

125. The system of claim 118 further comprising:

a second terrestrial base station positioned within the second satellite spot beam and having at least partially overlapping coverage with the second spot beam, and associated with a terrestrial cell having a fourth set of frequencies associated therewith; and

at least one of assigning, reusing and borrowing, by said second terrestrial base station, at least one of the first set of frequencies and the frequencies used in spot beams adjacent to the second spot beam, responsive to predetermined criteria associated with the fourth set of frequencies, for establishing communication between a second subscriber terminal positioned within the area of coverage of said second terrestrial base station and at least one of a subscriber terminal and communications device, including at least one of assigning, reusing and borrowing at least one of the first set of frequencies when the first set of frequencies are at least substantially geographically distant from the second satellite spot beam.

126. The system of claim 118 wherein the first and second frequencies comprise a plurality of paired uplink and downlink frequencies, wherein one of the frequency sets is used in a first subarea of the first spot beam, and wherein a corresponding one of the uplink frequencies is reused in a second subarea of the first spot beam.

127. The system of claim 118 wherein an area of coverage of at least one of a spot beam and a terrestrial cell comprises an area corresponding to a bit error rate in the range of 10^{-2} to 10^{-3} for voice and 10^{-5} to 10^{-6} for data.

128. The system of claim 118 wherein the area of coverage of a spot beam comprises an area having a radius substantially equal to a distance from a center of the spot beam having a substantially maximum signal strength to a distance from the center of the spot beam where the signal strength of the spot beam is attenuated by approximately 3 dB.

129. A system for at least one of assigning and reusing frequencies between one or more communication systems, comprising:

means for configuring: a) a first spot beam having a first set of frequencies associated therewith, the first spot beam comprising a first substantially central portion and a first

plurality of subareas, each of the first plurality of subareas extending substantially from a periphery of the first substantially central portion to substantially near a circumference of the first satellite spot beam, and b) a second satellite spot beam having a second set of frequencies associated therewith, the second spot beam comprising a second substantially central portion and a second plurality of subareas, each of the second plurality of subareas extending substantially from a periphery of the second central portion to substantially near a circumference of the second satellite spot beam;

means positioned within the first satellite spot beam for configuring a terrestrial cell having at least partially overlapping coverage with the first spot beam, the terrestrial cell having a third set of frequencies associated therewith and an area coverage at least partially overlapping with an area of coverage associated with the first spot beam;

a first subscriber terminal positioned within the terrestrial base station area of coverage; and

means for at least one of assigning, reusing and borrowing, by the terrestrial base station and for use by said first subscriber terminal in communicating with at least one of a second subscriber terminal and other communications device, at least one of a portion of the second set of frequencies and a portion of the first set of frequencies used in the first central portion, responsive to predetermined criteria associated with the third set of frequencies, including at least one of assigning, reusing and borrowing at least one of the second set of frequencies when the second set of frequencies are at least substantially geographically distant from the second satellite spot beam.

130. A system for making a telephone call using a satellite-terrestrial communications system that at least one of assigns and reuses frequencies between a first satellite spot beam and a second satellite spot beam, comprising:

a subscriber terminal for dialing a telephone number to communicate with at least a second communications device;

a first terrestrial cell having said subscriber terminal positioned therein;

means for configuring: a) a first satellite spot beam associated with said first terrestrial cell, having a first set of frequencies associated therewith, and having at least partially overlapping coverage with the first terrestrial cell, the first satellite spot beam comprising a first substantially central portion and a first plurality of subareas, each of the first plurality of subareas extending substantially from a periphery of the first substantially central portion to substantially near a circumference of said first satellite spot beam, and b) a second satellite spot beam having the second communications device positioned therein and a second set of frequencies associated therewith; and

means for establishing a connection between said subscriber terminal and at least the second communications device, by at least one of assigning, reusing and borrowing, by the first spot beam, at least one of the second set of frequencies, responsive to predetermined criteria including at least one of assigning, reusing and borrowing at least one of the second set of frequencies when the subscriber terminal is substantially geographically distant from the second satellite spot beam.

131. A system for use in at least one of assigning and reusing frequencies, comprising:

means for configuring: a) a first communications area having a first set of frequencies associated therewith, the communications area comprising a first substantially central portion and a first plurality of subareas, each of the first plurality of subareas extending substantially from a periphery of the first substantially central portion to substantially near a circumference of the first communications area, and b) a second communications area having a second set of frequencies associated therewith and comprising a second substantially central portion and a second plurality of subareas, each of the second plurality of subareas extending substantially from a periphery of the central portion to substantially near a circumference of the second communications area;

means positioned within the first satellite spot beam for configuring at least a third communications area within the first communications area, the third communications area having a third set of frequencies associated therewith and having at least partially overlapping coverage with the first spot beam; and

means for at least one of assigning, reusing and borrowing, by said terrestrial base station, at least one of a portion of the second set of frequencies and a portion of the first set of frequencies used in the first central portion for facilitating communications between a subscriber terminal positioned within the first spot beam and a second communications device, and responsive to predetermined criteria associated with the third set of frequencies, including at least one of assigning, reusing and borrowing at least one of the second set of frequencies when the second set of frequencies are at least substantially geographically distant from the first satellite spot beam.

132. A system for at least one of assigning and reusing frequencies between a plurality of communication systems, comprising:

means for: a) configuring a first satellite spot beam having a first set of frequencies associated therewith and comprising a first substantially central portion and a first plurality of subareas, each of the first plurality of subareas extending substantially from a periphery

of the first substantially central portion to substantially near a circumference of the first satellite spot beam, and b) configuring a second satellite spot beam having a second set of frequencies associated therewith and comprising a second substantially central portion and a second plurality of subareas, each of the second plurality of subareas extending substantially from a periphery of the central portion to substantially near a circumference of the second satellite spot beam;

means positioned within the first satellite spot beam for configuring at least one terrestrial cell within the first satellite spot beam having a third set of frequencies associated therewith and having an area of coverage at least partially overlapping with the first satellite spot beam; and

means for at least one of assigning, reusing and borrowing, by the second satellite spot beam, at least one of a portion of the third set of frequencies responsive to predetermined criteria, including at least one of assigning, reusing and borrowing at least one of the third set of frequencies associated with the at least one terrestrial cell when the portion is at least substantially geographically distant from the second set of frequencies.

133. A system of at least one of assigning and reusing frequencies between a plurality of communication systems, comprising:

means for: a) configuring a first satellite spot beam having a first set of frequencies associated therewith and comprising a first substantially central portion and a first plurality of subareas, each of the first plurality of subareas extending substantially from a periphery of the first substantially central portion to substantially near a circumference of the first satellite spot beam, and b) configuring a second satellite spot beam having a second set of frequencies associated therewith;

means positioned within the first satellite spot beam for configuring at least one terrestrial cell within the first satellite spot beam, the terrestrial cell having a third set of frequencies associated therewith and having an area of coverage at least partially overlapping with an area of coverage of the first satellite spot beam; and

means for at least one of assigning, reusing and borrowing, by the terrestrial base station for use in establishing communications between a first subscriber terminal positioned within an area of coverage of said terrestrial base station and at least one of a second subscriber terminal and communications device, at least one of a portion of the second set of frequencies and a portion of the first set of frequencies used in the first central portion, responsive to predetermined criteria associated with the third set of frequencies, including at least one of assigning, reusing and borrowing at least one of the second set

of frequencies when the second set of frequencies are at least substantially geographically distant from the first satellite spot beam.

134. A system of at least one of assigning and reusing frequencies between a plurality of communication systems, comprising:

means for: a) configuring a first satellite spot beam having a first set of frequencies associated therewith and comprising a first plurality of subareas, each of the first plurality of subareas extending from a substantially center area of the first satellite spot beam to substantially near a circumference of the first satellite spot beam in a fan-like manner thereby forming the first plurality of subareas, and b) configuring a second satellite spot beam having a second set of frequencies associated therewith;

means positioned within the first satellite spot beam for configuring a terrestrial cell, the terrestrial cell having a third set of frequencies associated therewith and having an area of coverage at least partially overlapping with an area of coverage associated with the first spot beam; and

means for at least one of assigning, reusing and borrowing, by said terrestrial base station and for use by a first subscriber terminal in communicating with at least one of a second subscriber terminal or communications device, at least one of a portion of the second set of frequencies and a portion of the first set of frequencies used in the first central portion, responsive to predetermined criteria associated with the third set of frequencies, including at least one of assigning, reusing and borrowing at least one of the second set of frequencies when the second set of frequencies are at least substantially geographically distant from the first satellite spot beam.

135. A method of at least one of assigning and reusing frequencies between one or more communication systems, comprising the steps of:

configuring a first satellite spot beam having a first set of frequencies associated therewith and comprising a first substantially central portion;

configuring a second satellite spot beam having a second set of frequencies associated therewith and comprising a second substantially central portion

configuring at least one terrestrial cell within the first satellite spot beam having a third set of frequencies associated therewith and having at least partially overlapping coverage with the first spot beam; and

at least one of assigning, reusing and borrowing, by the terrestrial system, at least one of a portion of the second set of frequencies and a portion of the first set of frequencies used

in the first central portion, responsive to predetermined criteria associated with the third set of frequencies, including at least one of assigning, reusing and borrowing at least one of the second set of frequencies when the second set of frequencies are at least substantially geographically distant from the first satellite spot beam.

136. The method of claim 135 wherein the second set of frequencies are substantially distant from the first satellite spot beam when they are used in subareas of the second spot beam that do not share a common boundary with the first satellite spot beam.

137. The method of claim 135 wherein the first set of frequencies used in the first central portion comprise at least one of those frequency sets respectively associated with satellite spot beams directly adjacent to the first satellite spot beam.

138. The method of claim 135 wherein said step of assigning, reusing and borrowing is based on prioritization rules.

139. The method of claim 138 wherein the prioritization rules include dynamic load and capacity constraints of cells that frequencies are taken from.

140. The method of claim 135 wherein a subscriber terminal positioned within the first central portion can be assigned, reuse and/or borrow use any of the respective set of frequencies associated with the at least one second satellite spot beam.

141. The method of claim 135 wherein a subscriber terminal positioned within the first central portion can be assigned, reuse and/or borrow use any of the respective set of frequencies associated with any spot beams adjacent the first satellite spot beam.

142. The method of claim 135 wherein the predetermined criteria is at least one of load balancing and received signal strength interference.

143. The method of claim 135 further comprising the steps of:

configuring a second terrestrial cell within the second satellite spot beam having a fourth set of frequencies associated therewith and having at least partially overlapping coverage with the second spot beam; and

at least one of assigning, reusing and borrowing, by the second terrestrial cell, at least one of the first set of frequencies and the frequencies used in the second central portion, responsive to predetermined criteria associated with the fourth set of frequencies, including at least one of assigning, reusing and borrowing at least one of the first set of frequencies when the first set of frequencies are at least substantially geographically distant from the second satellite spot beam.

144. The method of claim 135 wherein the first central portion and the second central portion comprise approximately twenty five percent of the area covered by the first satellite spot beam and the second satellite spot beam, respectively.

145. The method of claim 135 wherein the first set of frequencies and the second set of frequencies comprise a plurality of paired uplink and downlink frequencies, wherein a downlink frequency of a frequency set is used in the first spot beam, and wherein a corresponding one of the uplink frequencies is reused in the second spot beam.

146. The system of claim 136 wherein an area of coverage of at least one of a spot beam and a terrestrial cell comprises an area corresponding to a bit error rate in the range of 10^{-2} to 10^{-3} for voice and 10^{-5} to 10^{-6} for data.

147. The method of claim 135 wherein the area of coverage of a spot beam comprises an area having a radius substantially equal to a distance from a center of the spot beam having a substantially maximum signal strength to a distance from the center of the spot beam where the signal strength of the spot beam is attenuated by approximately 3dB.

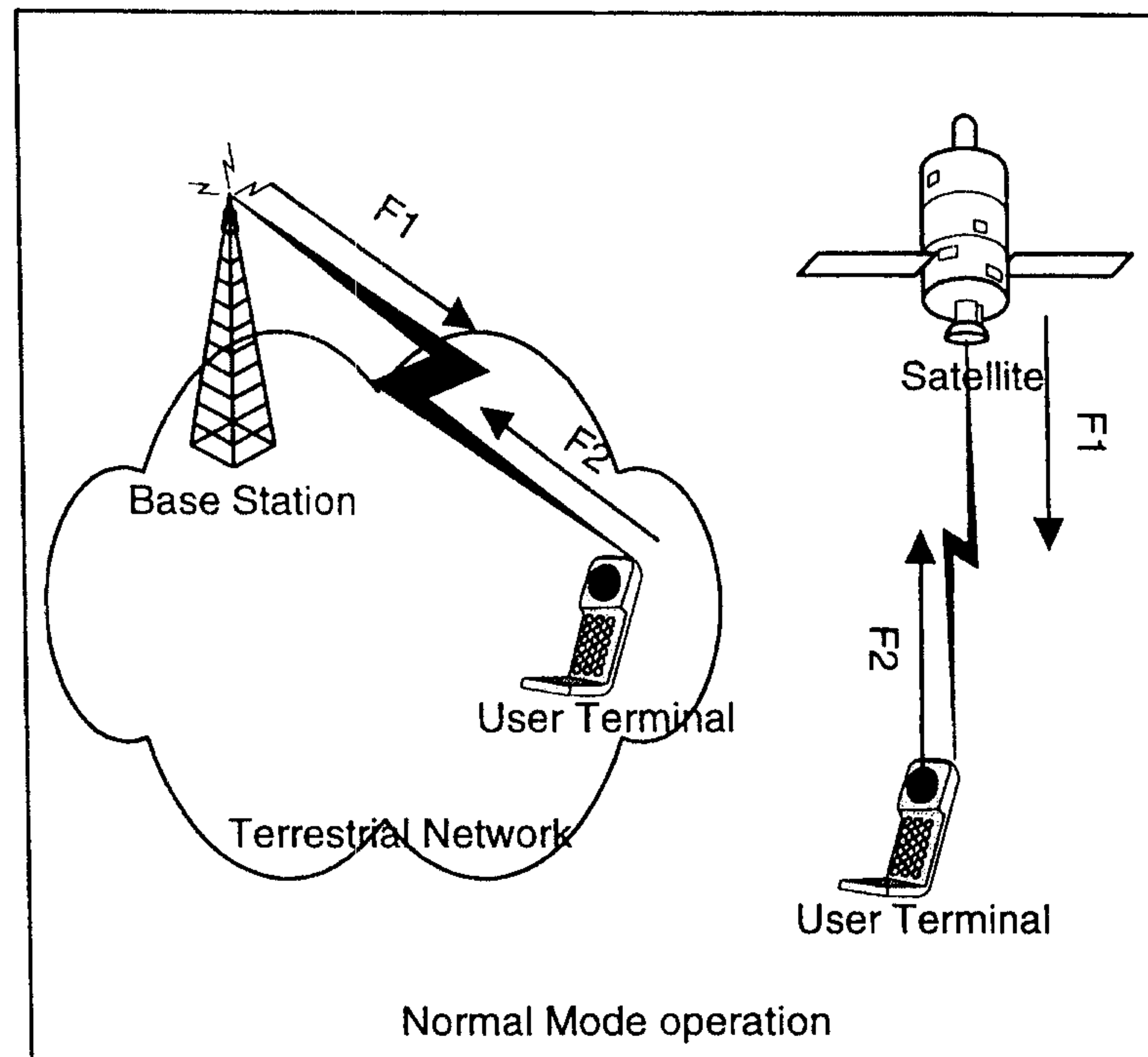


FIGURE 1a

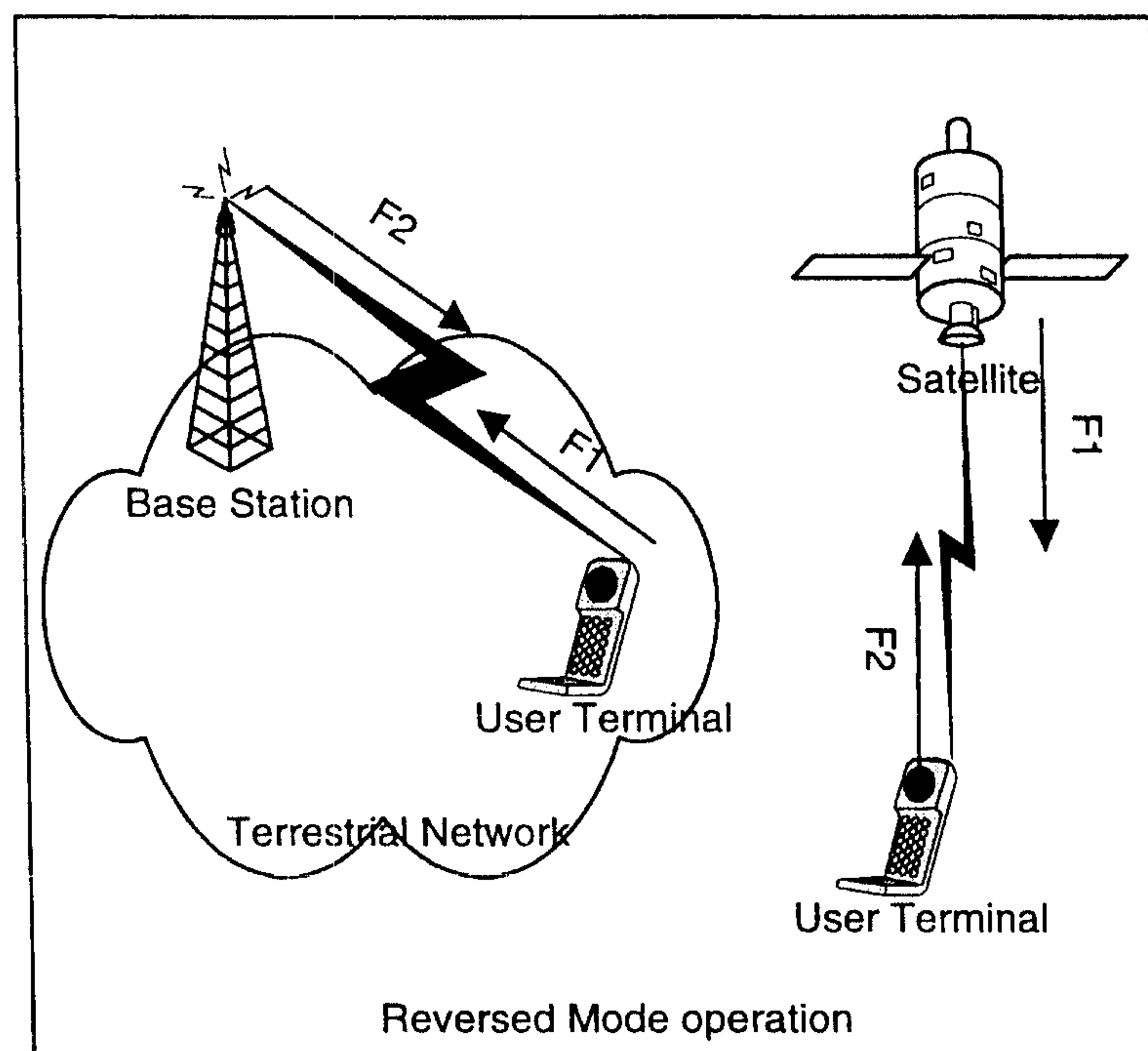
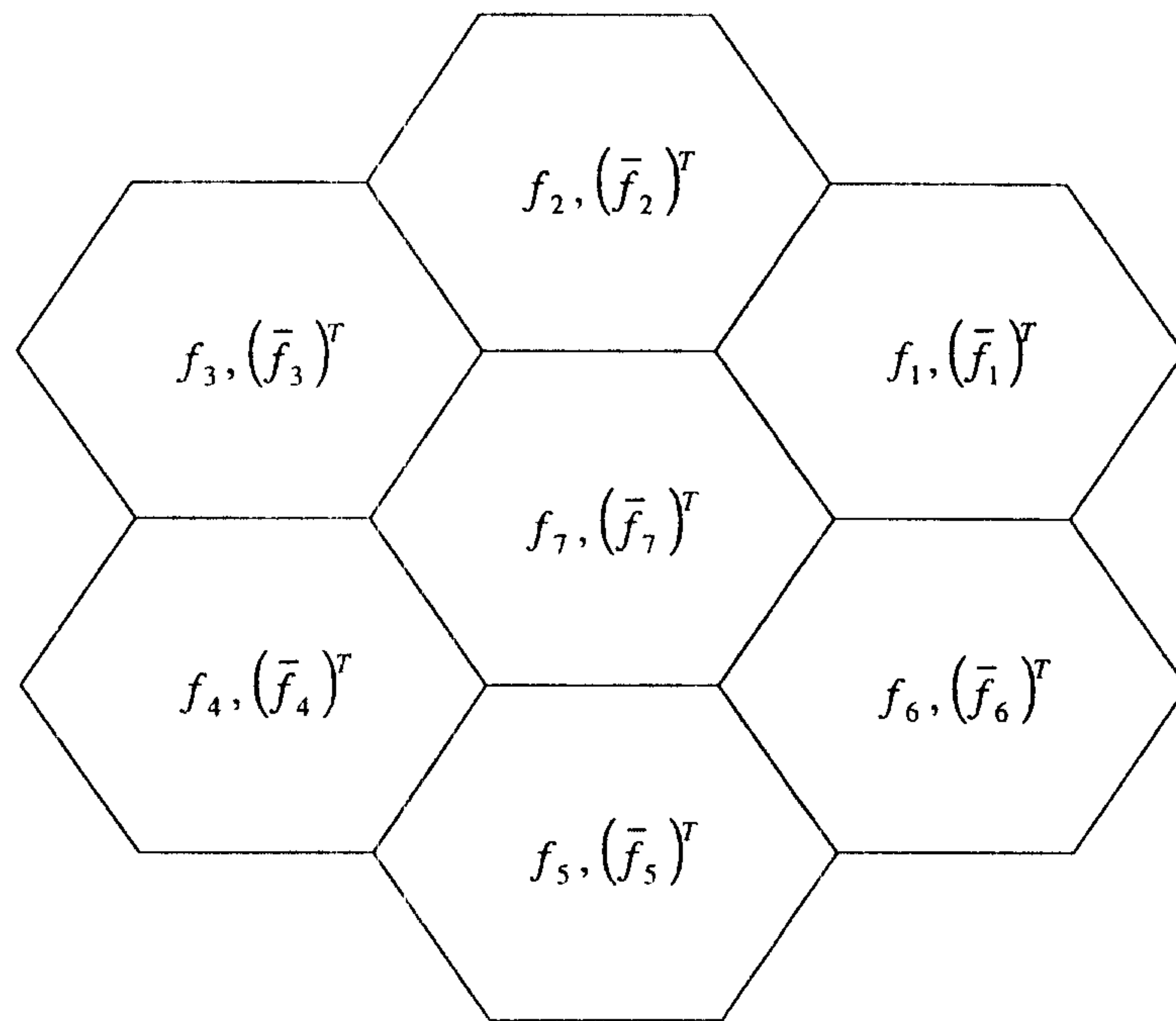


FIGURE 1b

**FIGURE 2**

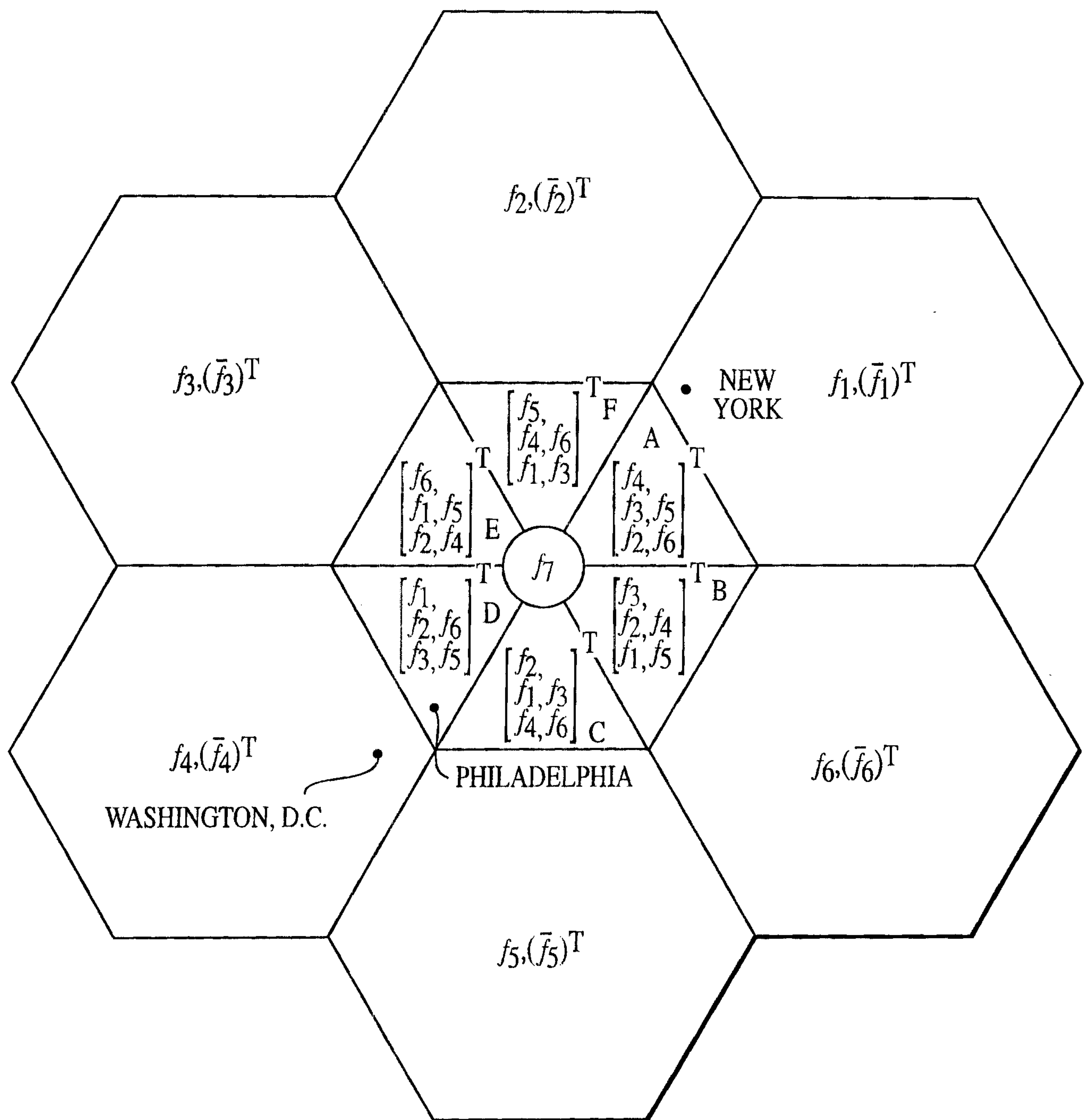


FIG. 3a

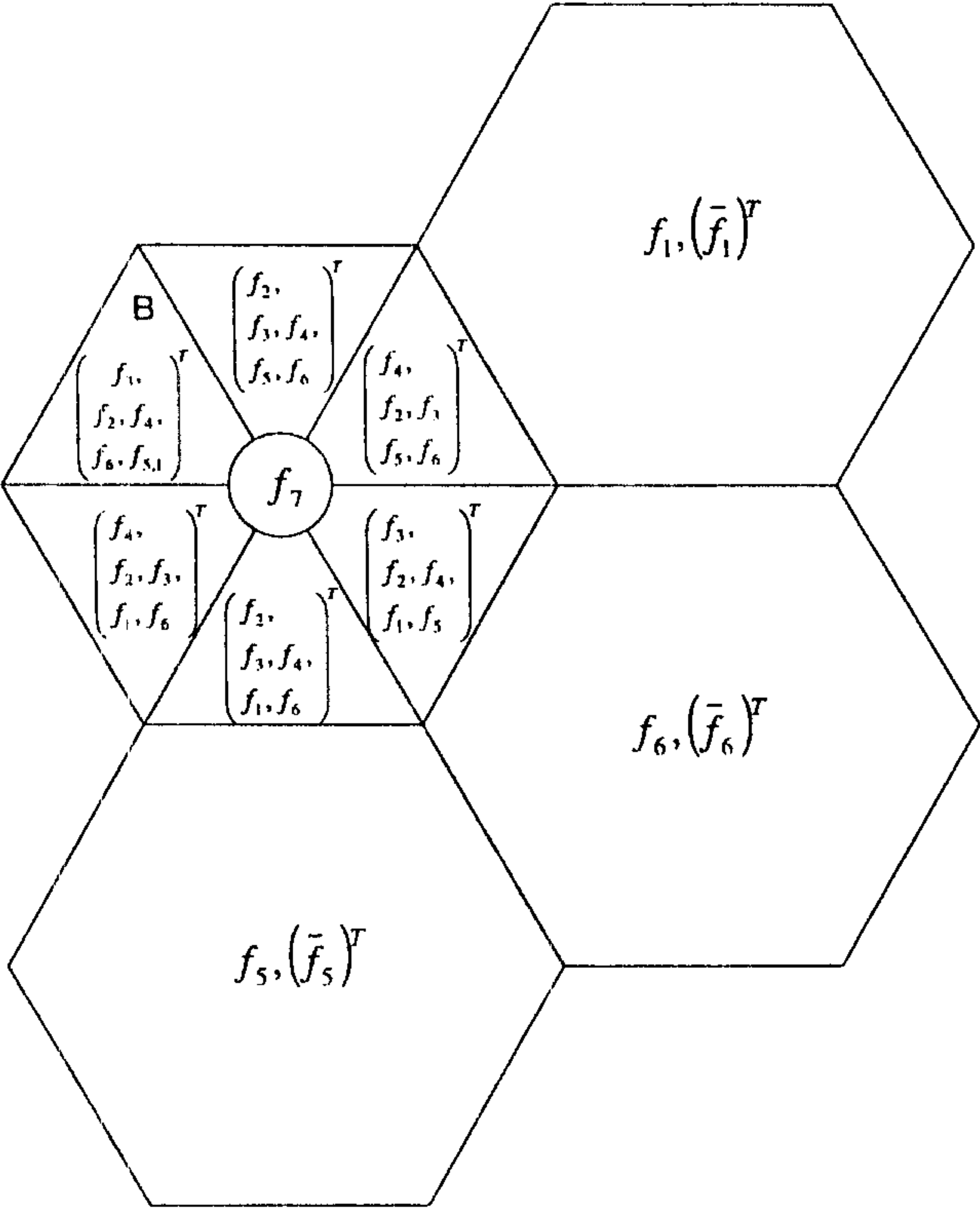


FIGURE 3b

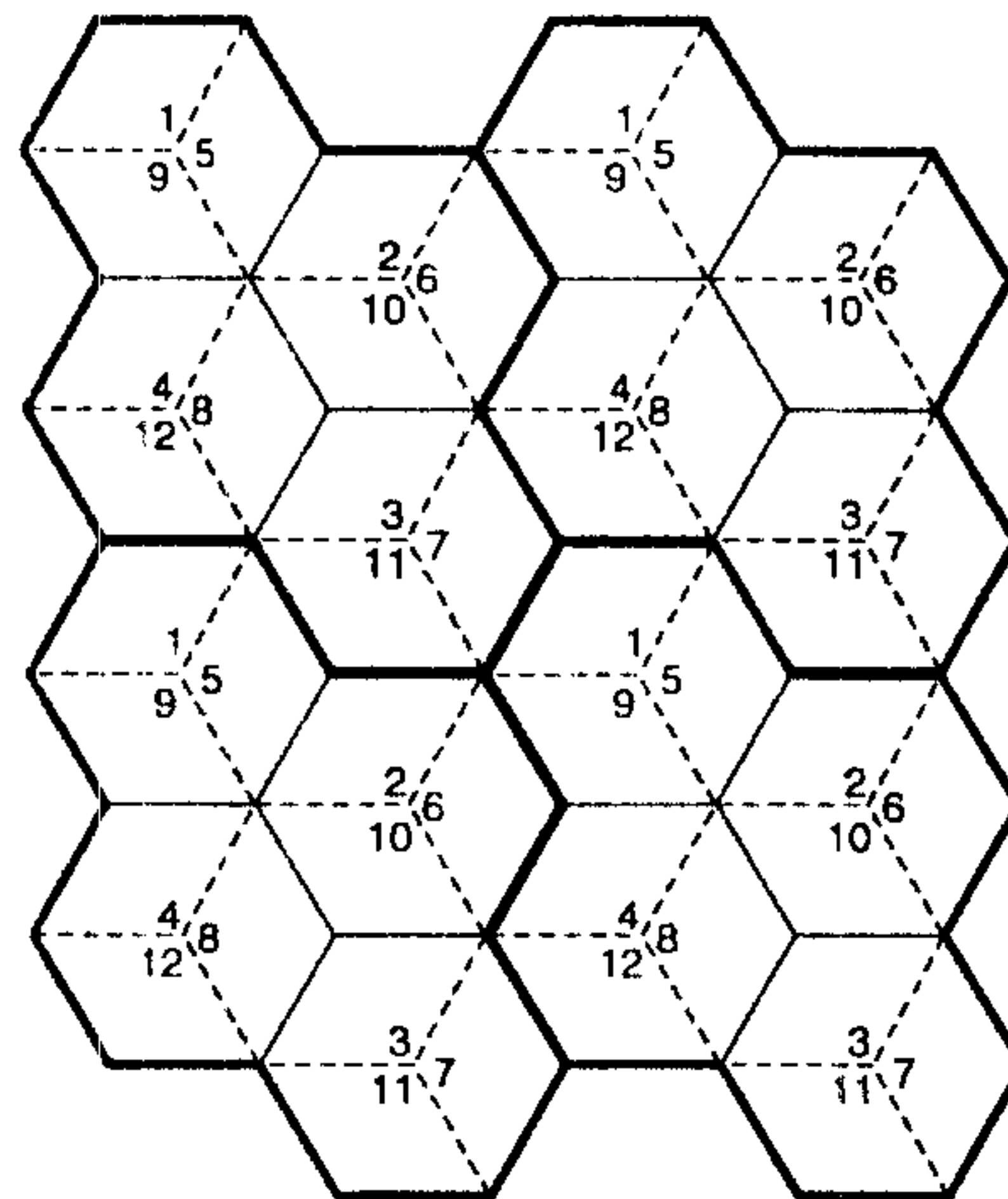


FIGURE 4a
Cluster Size of 4 with 12 RF Channels

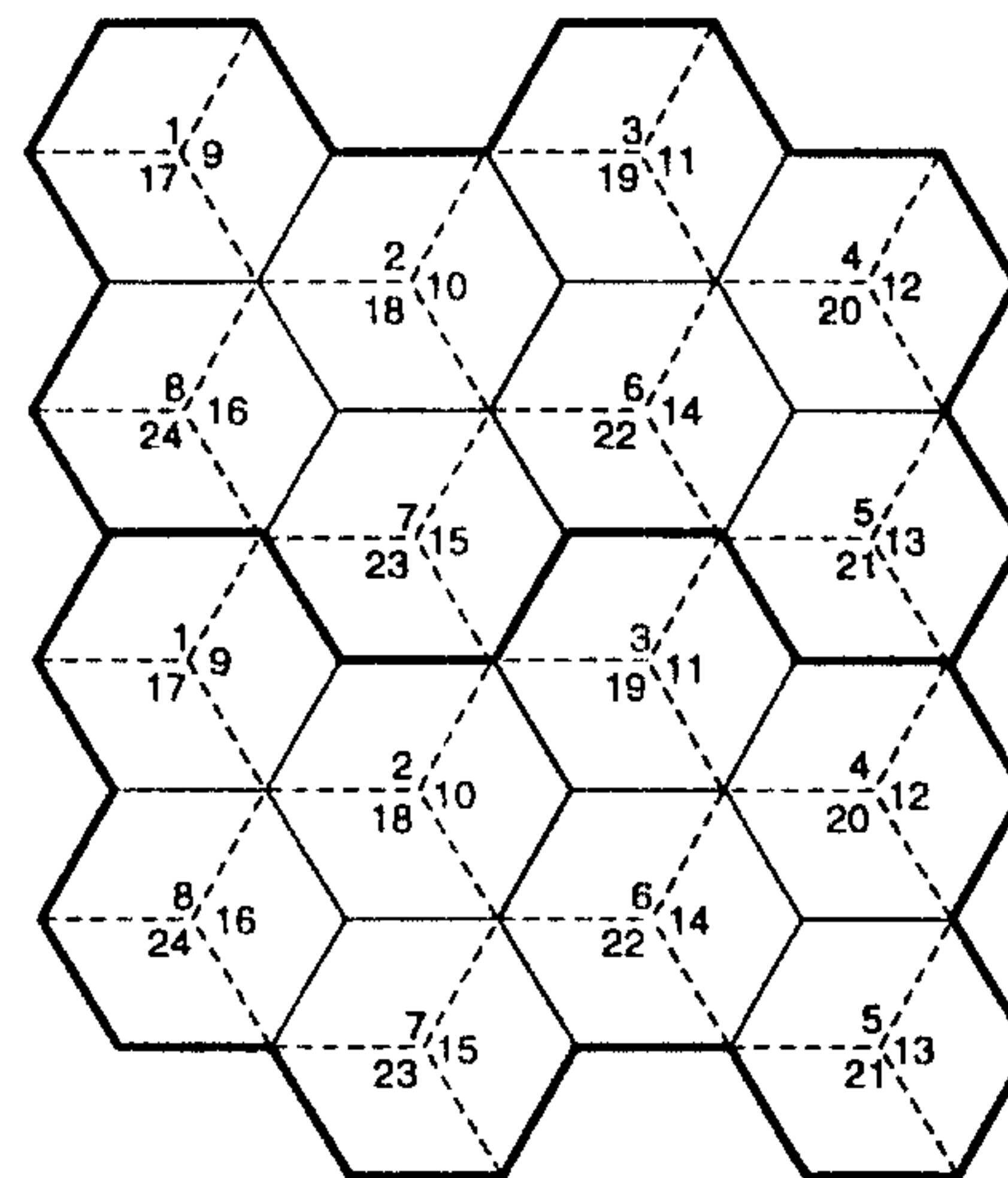


FIGURE 4b
Cluster Size of 8 with 24 RF Channels

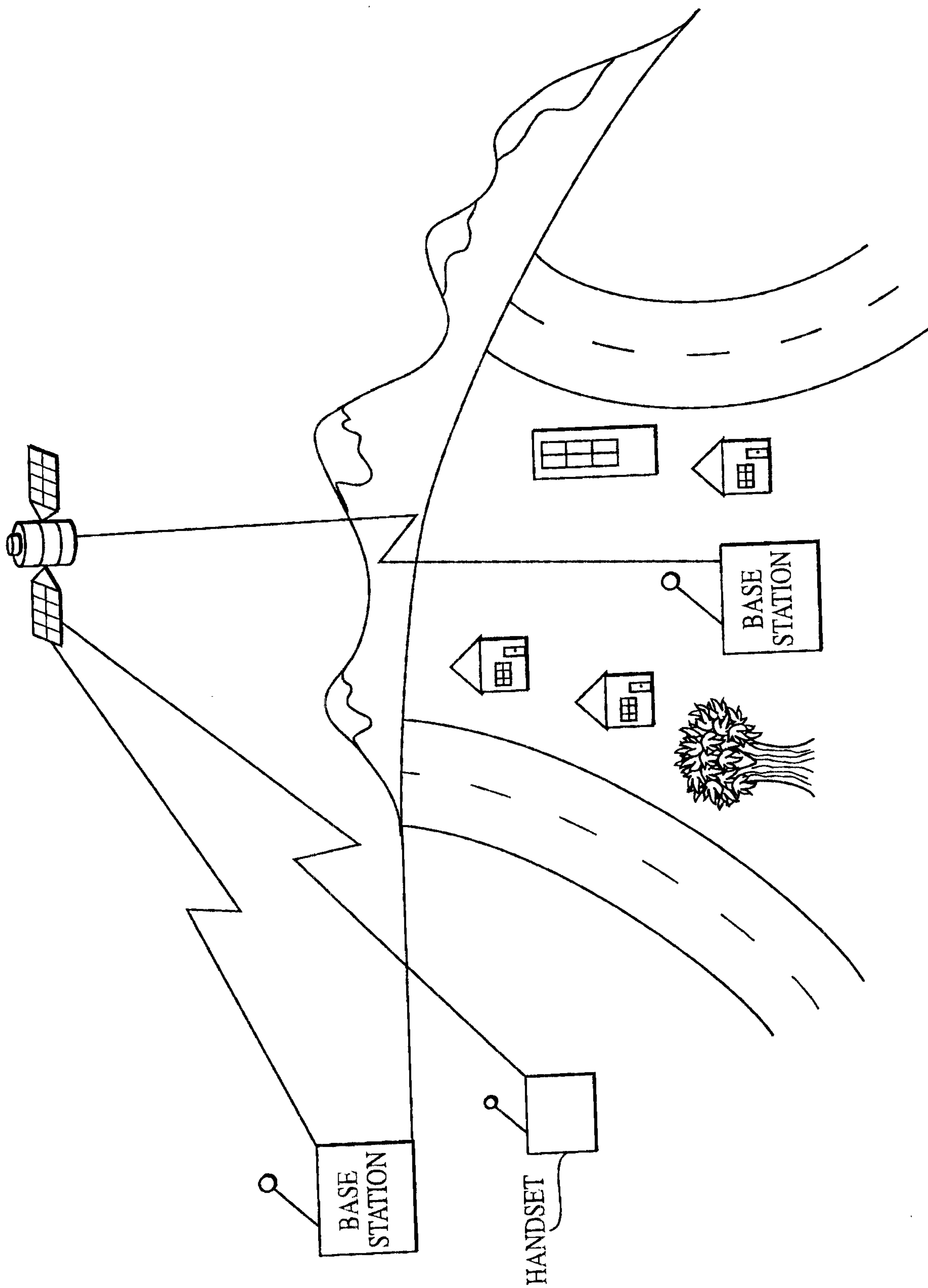


FIG. 5

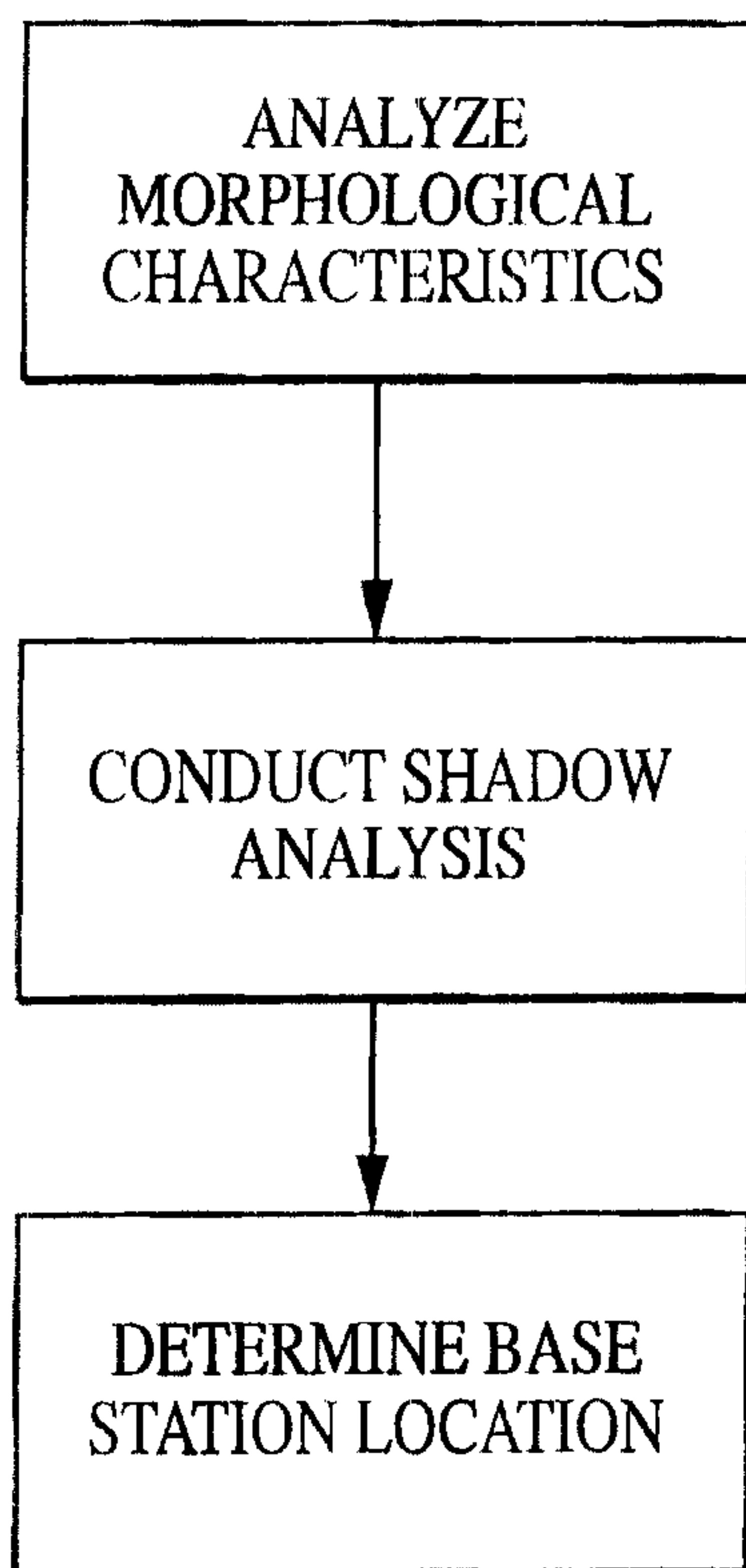
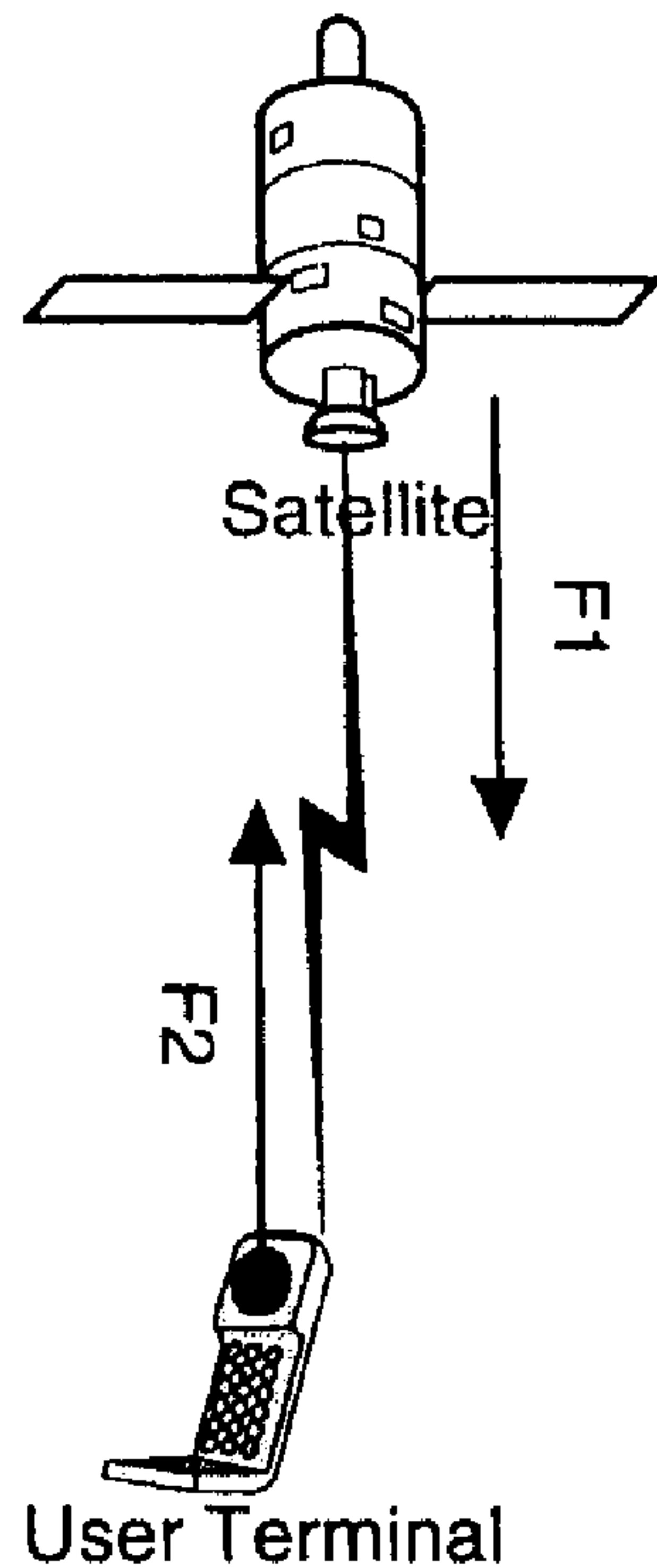
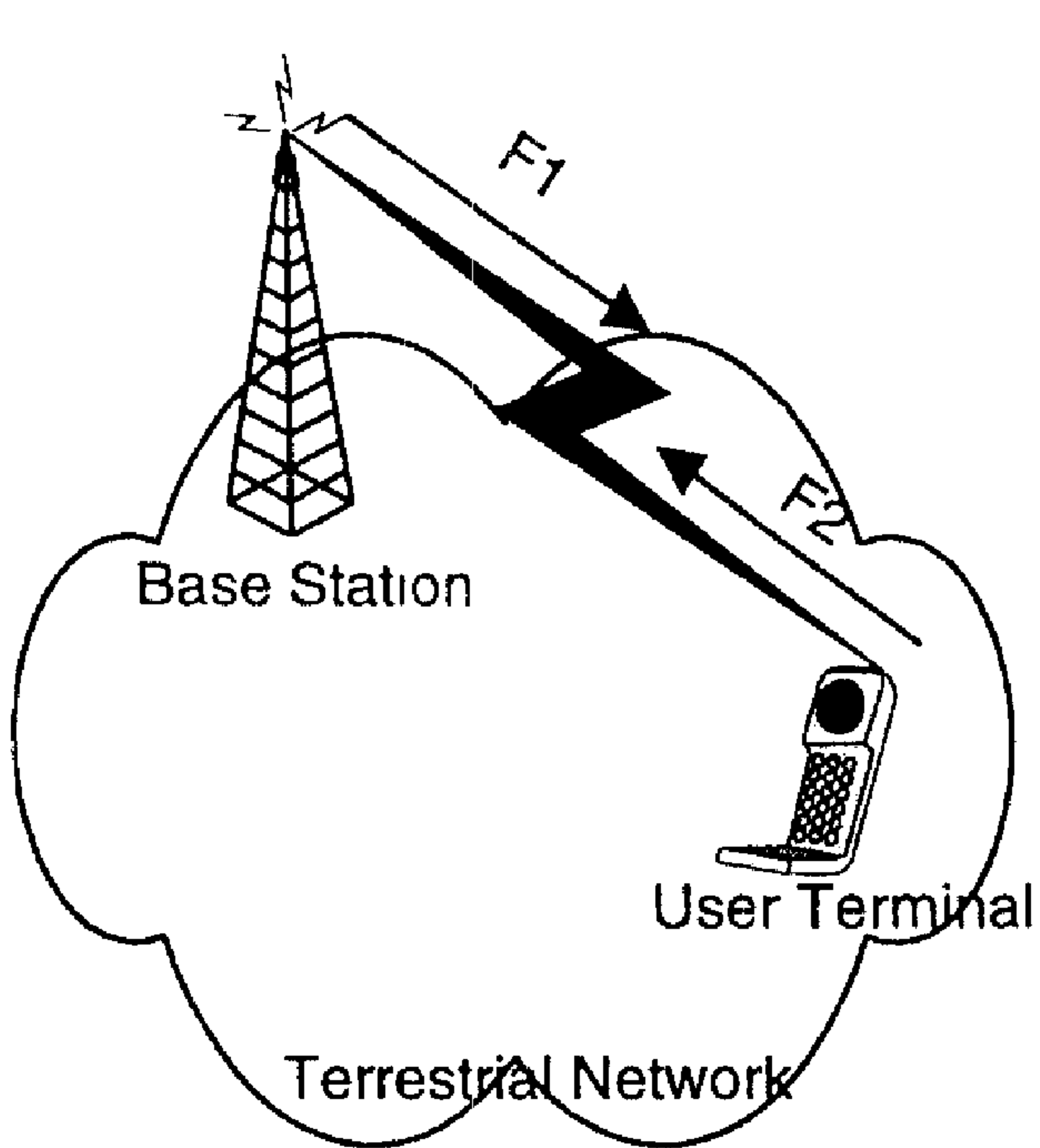


FIG. 6



Normal Mode operation