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(54) SPREAD SPECTRUM WIRELESS COMMUNICATION SYSTEM

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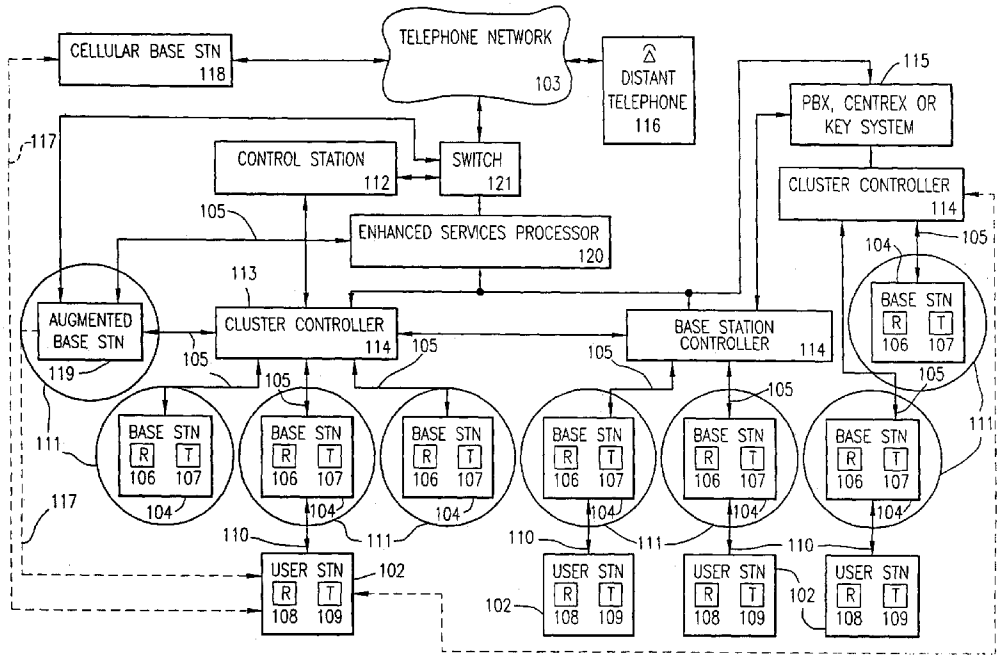
(57) **ABSTRACT**

A system for accessing a telephone system, in which a set of user stations are matched with a set of base stations for connection to a telephone network. Each base station may be coupled directly or indirectly to the telephone network and may be capable of initiating or receiving calls on the telephone network. Each user station may comprise a spread-spectrum transmitter or receiver and may be capable of dynamic connection to selected base stations. A plurality of base stations may be coupled to a private exchange telephone system for coupling user stations in calls outside the telephone network. User stations may use CDMA, FDMA, TDMA or other multiple-access techniques to obtain one or more clear communication paths to base stations. Base stations may be placed at convenient locations or may themselves be mobile. User stations may make and break connections with base stations as the user station moves between service regions, or is otherwise more advantageously serviced by, base stations. User stations may direct requests to and receive information from an enhanced telephone services processor, so as to obtain enhanced telephone services within the telephone network. Base stations may be coupled to each other by means of a private exchange telephone system or other small business telephone system (such as a PBX, Centrex, or key-type system) so as to couple user stations in calls outside the telephone network. User stations may also be coupled directly or indirectly to the telephone network on their own or by another access path, such as narrowband or spread-spectrum cellular telephone circuits.



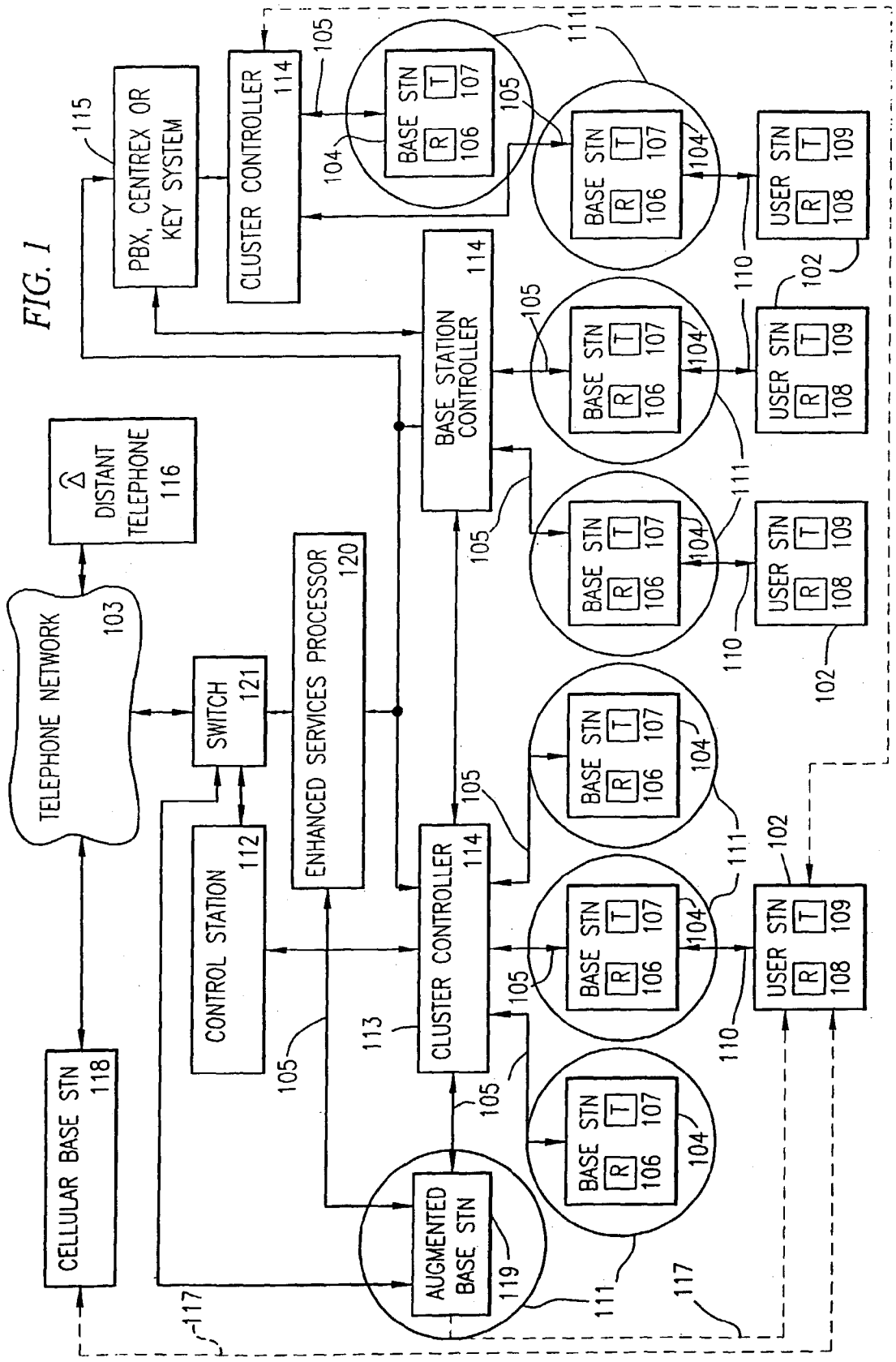

PBX, CENTREX OR KEY SYSTEM
115
CLUSTER CONTROLLER
114
105
BASE STN
R
T
106
107
104
111
USER STN
108
109
110
102
BASE STATION CONTROLLER
DISTANT TELEPHONE
116
TELEPHONE NETWORK
103
SWITCH
121
ENHANCED SERVICES PROCESSOR
120
CONTROL STATION
112
CLUSTER CONTROLLER
113
CELLULAR BASE STN
118
AUGMENTED BASE STN
119
117

FIG. 1

SPREAD SPECTRUM WIRELESS COMMUNICATION SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation-in-part of copending application Ser. No. _____ (Lyon & Lyon Docket No. 194/135), filed Jun. 3, 1991 in the name of the same inventor with the same title, hereby incorporated by reference as if fully set forth herein.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] This invention relates to a spread spectrum wireless telephone system.

[0004] 2. Description of Related Art

[0005] Access to telephone networks may commonly occur via one of two general mechanisms, termed "private access" and "public access". As used herein, "private access" means access by means of dedicated circuits (and includes business telephones through PBX, centrex, and key-type systems, and home telephones), while "public access" means access by means of common communication channels (and includes cellular telephones and payphones). Interconnection to a public switched telephone network (PSTN) for both private access and public access may make use of cable, fiber optic, wire, or radio frequency links, or other methods of communication known in the art. Many telephone network have a large number of telephones which are hardwired into the network and which have private access to the network from fixed locations.

[0006] One problem which has arisen in the art is the desire of mobile persons to have convenient and inexpensive access to telephone networks. These persons generally have a choice between locating a private-access business or home telephone, or a public-access payphone, which can be inconvenient, and using cellular telephone service, which can be expensive. Accordingly, it would be advantageous to provide a relatively convenient and inexpensive system which allows public access to telephone networks.

[0007] Moreover, public access to telephone networks is subject to a number of problems, due in part to the public nature of the communication channel. Such communication may be subject to eavesdropping and other security risks, and may also be subject to unpredictable loss, noise, interference, and even active jamming. Many of these problems are ameliorated by spread-spectrum radio communication, in which transmitted signals are spread across a bandwidth which is wider than the bandwidth of the signal. Spread-spectrum communication may also be used in conjunction with CDMA, FDMA, TDMA, and other multiplexing techniques, and thus may offer advantages in a switching network.

[0008] One method of public access to telephone networks is shown in U.S. Pat. No. 4,878,238. while the system shown therein may achieve the goal of public access to a telephone network, it is subject to the drawback that it is not able to achieve the advantages of spread-spectrum communication. Moreover, the system shown therein has little or no ability to handoff user stations from one base station to another when conditions warrant. It would be advantageous to allow public access to the telephone network with relatively inexpensive user stations and which achieve this and other advantages of spread-spectrum communication.

[0009] Some aspects of the art of spread spectrum wireless communication are shown in U.S. Pat. No. 5,016,255 (issued May 14, 1991) and 5,022,047 (issued Jun. 4, 1991), and in the following copending applications: Ser. No. 07/682,050, filed Apr. 8, 1991, in the name of inventor Robert C. Dixon, titled "THREE-CELL WIRELESS COMMUNICATION SYSTEM", and Ser. No. 07/600,772, filed Oct. 23, 1990, in the name of inventors Robert C. Dixon and Jeffrey S. Vanderpool, titled "METHOD AND APPARATUS FOR ESTABLISHING SPREAD SPECTRUM COMMUNICATIONS". Each of these patents and applications is hereby incorporated by reference as if fully set forth herein.

[0010] Another aspect of the problem of access to telephone networks is the desire for mobile persons to be able to contact each other, for example, when these persons are closely located. Access by each such person to a telephone network would allow for them to contact each other, but it might place excess burden on the telephone network and might result in unwarranted delays in making such contacts. Accordingly, it would be advantageous to provide a relatively convenient and inexpensive system which allows contact between multiple user stations which have access (either private or public) to telephone networks.

[0011] One method of wireless contact between a plurality of user stations is shown in U.S. Pat. No. 4,672,658. While the system shown therein may achieve the goal of operating a wireless PBX, it is subject to the drawback that it may require complex and relatively expensive user stations, and may not be smoothly integrated into a system for access to telephone networks. Accordingly, it would be advantageous to provide private exchange telephone systems (including PBX, Centrex, or key-type systems) which can be smoothly integrated in a system for providing access (either private or public) to telephone networks with relatively inexpensive user stations.

[0012] Another development in the art of telephone networks is the "intelligent network", used herein to mean a telephone network in which enhanced telephone network services are performed by an independent processor, rather than by a local switch or a local switching processor. In an intelligent network, a telephone caller can communicate directly with the independent processor, for controlling enhanced telephone network features. Examples of these enhanced features are call routing and call screening.

[0013] Some of these enhanced features are useful for rerouting messages from one telephone to another, while others are useful for caching messages while a person is not available at a particular telephone. Both of these purposes are quite suited to mobile persons who frequently access telephone networks. Moreover, enhanced features add to the value of having a telephone and thus encourage mobile persons to use mobile telephones. Accordingly, it would be advantageous if enhanced features were available to mobile telephones.

SUMMARY OF THE INVENTION

[0014] The invention provides a system for accessing a telephone system, in which a set of user stations are matched

with a set of base stations for connection to a telephone network. Base stations may be coupled directly or indirectly to the telephone network and may be capable of initiating or receiving calls on the telephone network. User stations may be mobile, may comprise a spread-spectrum transmitter or receiver and may be capable of dynamic connection to selected base stations. A plurality of base stations may be coupled to a private exchange telephone system for coupling user stations in calls outside the telephone network.

[0015] In embodiments of the invention, user stations may use CDMA, FDMA, TDMA or other multiple-access techniques to obtain one or more clear communication paths to base stations. Base stations may be placed at convenient locations or may themselves be mobile. User stations may make and break connections with base stations as the user station moves between service regions, or is otherwise more advantageously serviced by, base stations. User stations may direct requests to and receive information from an enhanced telephone services processor, so as to obtain enhanced telephone services within the telephone network. Base stations may be coupled to each other by means of a private exchange telephone system or other small business telephone system. (such as a PBX, Centrex, or key-type system) so as to couple user stations in calls outside the telephone network. User stations may also be coupled directly or indirectly to the telephone network on their own or by another access path, such as narrowband or spread-spectrum cellular telephone circuits.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The FIGURE shows a wireless communication system coupled to a telephone network.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0017] The FIGURE shows a wireless communication system coupled to a telephone network.

[0018] A wireless communication system **101** for communication between a user station **102** and a telephone network **103** includes a base station **104**, which is coupled to the telephone network **103** by means of a telephone link **105**. The base stations **104** each generally comprise a base station receiver **106** and a base station transmitter **107**, and the user stations **102** each generally comprise a user station receiver **108** and a user station transmitter **109** (although some base stations **104** or some user stations **102** may be receive-only or transmit-only, e.g. for emergency signals or locationing information), and may be coupled by a spread-spectrum communication link **110**.

[0019] In a preferred embodiment, the telephone link **105** may comprise a private access link, such as cable, fiber optics, or wire, or a laser or microwave link. However, the telephone link **105** may alternatively comprise a public access link, such as a radio channel, a cellular telephone link, or other means. Moreover, the telephone link **105** may alternatively comprise an indirect communication link, such as by means of a switching processor or a different telephone network. It would be clear to one of ordinary skill in the art, after perusal of the specification, drawings and claims herein, that all of these alternative techniques, as well as other and further techniques, would be workable, and are within the scope and spirit of the invention.

[0020] The communication link **110** between base stations **104** and user stations **102** may make use of known spread-spectrum techniques, such as those disclosed in patents and applications incorporated by reference herein. These generally provide for distinguishing the base stations **104** and the user stations, **102** with logical identifiers such as frequency bands, spread-spectrum codes, timeslots, or station identifiers. The base stations **104** and the user stations **102** may operate on a plurality of spread-spectrum codes, thus performing CDMA, on a plurality of (possibly overlapping) frequency bands, thus performing FDMA, on a plurality of timeslots, thus performing TDMA, with a plurality of station identifiers to be included in-messages, or with other multiplexing techniques.

[0021] Locations near base stations **104** may generally define a set of cells **111**, as in a cellular system. However, there is no particular requirement that the cells **111** will form a convenient repeating pattern or that they will be of uniform size or traffic density. In fact, base stations **104** may be placed at convenient locations, or may themselves be mobile.

[0022] If the cells **111** local to base stations **104** overlap, such as when base stations **104** are closely located or when base stations **104** are mobile, techniques for allocating logical identifiers (such as frequency bands, spread-spectrum codes, timeslots, or station identifiers), between base stations **104** and user stations **102**, within and among cells **111**, may use methods such as those disclosed in patents and applications incorporated by reference herein. In a preferred embodiment, base stations **104** may have logical identifiers allocated by a control station **112** coupled to the telephone network **103** or to a base station **104**.

[0023] Spread-spectrum communication between base stations **104** and user stations **102** may comprise handoff of user stations **102** from an old base station **104** to a new base station **104**. A user station **102** may be handed-off from one base station **104** to another for one of several reasons. For example, the user station **102** may have moved, or may have better radio contact with the new base station **104**, such as if the radio environment changes. For example, a large object may move between the user station **102** and the old base station **104**). Alternatively, if base stations **104** are located in different parts of the telephone network **103** or controlled by different oversight hardware, such as different area code or telephone exchange, it may be advantageous to handoff a user station **102** from one base station **104** to another for the purpose of using a new area code or telephone exchange.

[0024] If handoff occurs while a call on the telephone network **103** is in progress, the old base station **104** or the new base station **104** will direct the telephone network **103** to reroute the call to use the new base-station **104**, by a message to a rerouting processor **113**. The rerouting processor **113** could be a cluster controller **114** for directly controlling a set of base stations **104**, a private exchange telephone system **115** such as a PBX, Centrex, or key-type system (or the cluster controller **114** and the private exchange telephone system **115** operating in conjunction), a local switch, a local switching processor, or the control station **112**.

[0025] Spread-spectrum communication between base stations **104** and user stations **102** may comprise protocol for

initiating communication between base stations **104** and user stations **102** like that disclosed in patents and applications incorporated by reference herein. After a base station **104** and a user station **102** Initiate communication, the user station **102** may communicate with a distant telephone **116** (which is not necessarily physically distant) on the telephone network **103** by initiating or receiving calls.

[**0026**] In a preferred embodiment, a user station **102** may initiate a call by initiating communication with a base station **104** and directing that base station **104** to initiate a call in the telephone network **103**. The base station **104** may direct the telephone network **103** to initiate the call and to make a connection to the distant telephone **116**. Communication between the user station **102** and the distant telephone **116** nay be coupled from the user station **102** to the base station **104** to the telephone network **103** to the distant telephone **116**, and on the reverse path.

[**0027**] Similarly, a user station **102** may receive a call by the base station **104** initiating communication with the user station **102** and directing the user station **102** to receive the call. The base station **104** may receive the call and make the connection from the distant telephone **116**. Communication between the distant telephone **116** and the user station **102** may be coupled from the distant telephone **116** to the telephone network **103** to the base station **104** to the user station **102**, and on the reverse path.

[**0028**] Spread-spectrum communication between base stations **104** and user stations **102** may comprise CDMA, FDMA, TDMA, and other multiplexing techniques for communication between base stations **104** and user stations **102** without interference, and may also comprise allocation of frequencies, spread-spectrum codes and other communication resources in a region by the control station **112** such as those techniques disclosed in patents and applications incorporated by reference herein.

[**0029**] User stations **102** may also be coupled to the telephone network **103** by an independent access path **117**, such as by cellular wireless telephone communication using a cellular base station **118**. In a preferred embodiment, user stations **102** may have multiple communication channels (e.g., multiple codes, frequencies, or timeslots), and thus be capable of coupling to a plurality of different base stations **104**. An augmented base station **119** may additionally perform the function of the cellular base station **118** in a cellular wireless telephone network, so that a user station **102** which can make an independent access path to the augmented base station **119** may have direct access to the telephone network **103** like a cellular telephone.

[**0030**] An enhanced-services processor **120** coupled to the telephone network **103** may provide enhanced telephone services within the telephone network **103**, as is well known in the art. After a base station **104** and a user station **102** initiate communication, the user station **102** may communicate with the enhanced-services processor **120** by initiating or receiving messages between the user station **102** and the enhanced-services processor **120**, so as to obtain enhanced telephone services within the telephone network **103** just as if the user station **102** was an ordinary telephone on the telephone network **103**.

[**0031**] Other and further details on the nature and operation of enhanced-services processors (also known as "intelligent network" processors or adjunct network processors) may be-found in "ADVANCED INTELLIGENT NETWORK RELEASE 1 PROPOSAL" (Issue 1, November 1989), Document No. SR-NPL-001509; "ADVANCED INTELLIGENT NETWORK RELEASE 1 BASELINE ARCHITECTURE" (Issue 1, March 1990), Document No. SR-NPL-001555; "AMERITECH PUBLIC TELEPHONE MESSAGE DELIVERY SERVICE INTERFACE SPECIFICATIONS" (Issue 1, November 1989), Document No. AM-TR-MKT-000046; "INTELLIVIEW NETWORK MANAGEMENT SERVICE TERMINAL INTERFACE SPECIFICATION, BELL ATLANTIC", Document No. TR72511, all published by Bellcore. All of these documents are hereby incorporated by reference as if fully set forth herein.

[**0032**] A plurality of cluster controllers **114** and private exchange telephone systems **115** may be coupled to the enhanced-services processor **120**. A plurality of enhanced-services processors **120** may also be coupled to one or more local switches **121** for coupling to the telephone network **103**. Moreover, control stations **112** or augmented base stations **119** may be coupled to local switches **121**, enhanced-services processors **120**, cluster controllers **114** or base stations **104**. The cluster controllers **114** may be coupled to each other for direct routing of calls outside the telephone network **103**, e.g. by means of known routing methods. The cluster controllers **114** may also be coupled to the private exchange telephone system **115**, which may perform routing among them.

[**0033**] In a preferred embodiment, user stations **102** may be coupled to each other in calls outside the telephone network **103**. A first user station **102** may initiate a call by initiating communication with a first base station **104** and directing that first base station **104** to initiate a call with a second user station **102**. The first base station **104** may route the call to a second base station **104**, either directly by couplings between base stations **104** or by means of the private exchange telephone system **115**. The second base station **104** may direct the second user station **102** (coupled to the second base station **104**) to receive the call. Communication between the first user station **102** and the second user station **102** may be coupled from the first user station **102** to the first base station **104** to the private exchange telephone system **115** to the second base station **104** to the second user station **102**, and on the reverse path.

[**0034**] In a preferred embodiment, if handoff of user stations **102** from an old base station **104** to a new base station **104** occurs while a call outside the telephone network **103** is in progress, the old base station **104** or the new base station **104** may direct the private exchange telephone system **115** to reroute the call to use the new base station **104**.

[**0035**] Alternative Embodiments

[**0036**] While preferred embodiments are disclosed herein, many variations are possible which remain within the concept and scope of the invention, and these variations would become clear to one of ordinary skill in the art after perusal of the specification, drawings and claims herein.

I claim:

1. A wireless communication system, comprising

a base station coupled to a telephone network and having means for initiating a call on said telephone network and means for receiving a call on said telephone network; and

a user station having means for completing a communication path with said base station, said communication path, employing a spread-spectrum communication technique;

wherein said communication path is completed between said base station and said user station when said user station initiates or receives a call on said telephone network.

2. A system as in claim 1, wherein said base station is coupled to said telephone network by a private access link.

3. A system as in claim 1, wherein said base station is coupled to said telephone network by a public access link.

4. A system as in claim 1, wherein said base stations are mobile.

5. A system as in claim 1, wherein said base stations are stationary.

6. A system as in claim 1, comprising

a second base station coupled to a telephone network and having means for initiating a call on said telephone network and means for receiving a call on said telephone network; and

means for breaking said communication path between said one base station and said user station and for completing a second communication path between said second base station and said user station.

7. A system as in claim 6, wherein said means for breaking and for completing comprises means for handing-off said user station from said one base station to said second base station during a call on said telephone network.

8. A system as in claim 6, wherein said means for breaking and for completing comprises means for handing-off said user station from said one base station to said second base station when said user station moves from a first region to a second region.

9. A system as in claim 6, comprising a plurality of cluster controllers for controlling a set of base stations, wherein said means for breaking and for completing comprises means for handing-off said user station from said one base station to said second base station when said user station terminates a call relating to a first cluster controller and initiates a call relating to a second cluster controller.

10. A system as in claim 1, wherein said user station comprises means for directing requests to an enhanced telephone services processor on said telephone network.

11. A system as in claim 1, wherein said user station comprises means for receiving information from an enhanced telephone services processor on said telephone network.

12. A system as in claim 1, wherein said user station comprises means for initiating a call on said telephone network and means for receiving a call on said telephone network independently of said base station.

13. A system as in claim 12, wherein said means for initiating and receiving independently comprises a cellular telephone circuit.

14. A system as in claim 12, comprising a second base station coupled-to said telephone network and having means for coupling a cellular telephone circuit to said telephone network.

15. A system as in claim 12, comprising a spread-spectrum cellular telephone system having said user station as a cellular telephone handset and at least one base station as a cellular telephone base station.

16. A system as in claim 1, comprising

a second communication path between said base station and said user station; and

means for multiplexing signals between said base station and said user station over said one communication path and said second communication path.

17. A system as in claim 16, comprising means for distinguishing a plurality of channels on said one communication path and said second communication path.

18. A system as in claim 16, wherein said one communication path and said second communication path comprise a plurality of logical identifiers, said logical identifiers being frequency bands, spread-spectrum codes, station identifiers, or timeslots.

19. A wireless communication system, comprising

a first base station coupled to a telephone network and having means for initiating a call on said telephone network and means for receiving a call on said telephone network;

a first user station having means for completing a communication path with said first base station, said communication path employing a spread-spectrum communication technique; and

a private exchange telephone system coupled to said first base station and to a second base station, capable of routing a call between said first user station and a second user station coupled to said second base station;

wherein said communication path is completed between said first base station and said first user station when said first user station initiates or receives a call on said telephone network and when said first user station initiates or receives a call with said second user station outside said telephone network.

20. A system as in claim 19, wherein said private exchange telephone system comprises a PBX.

21. A system as in claim 19, wherein said private exchange telephone system comprises a Centrex system.

22. A system as in claim 19, wherein said private exchange telephone system comprises a key-type system.

23. A system as in claim 19, comprising

a third base station coupled to said telephone network; and

means for breaking said communication path between said first base station and said first user station and for completing a second communication path between said third base station and said first user station.

24. A system as in claim 23, wherein said means for breaking and for completing comprises means for handing-off said first user station from said first base station to said third base station during a call outside said telephone network.

25. A wireless communication system, comprising

a plurality of base stations coupled to a telephone network and having means for initiating a call on said telephone network and means for receiving a call on said telephone network;

a plurality of user stations having means for completing communication paths with said base stations, at least one of said communication paths employing a spread-spectrum communication technique; and

means for routing a call from a first one of said base stations to a second one of said base stations whereby one of said user stations is capable of initiating or receiving a call on said telephone network by means of one of said communication paths and is capable of initiating or receiving a call outside said telephone network by means of said means for routing.

26. A system as in claim 25, wherein said means for routing comprises a PBX, Centrex or key-type system.

27. A system as in claim 25, comprising at least one of said user stations coupled to said means for routing by means of a communication path not including any of said base stations.

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