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Communications Systems and Transceiver devices for the
Communications Systems

Field of the Invention

The present invention relates to a cellular data communications system of the
5 sort having a plurality of user-operated mobile interface devices, such as
mobile telephones.

Background of the Invention

In this document the term "mobile interface devices" will be used to include
mobile telephones, personal digital assistants (PDAs), notebook PCs, and
10 audio-visual (AV) devices, although it is not exclusively limited to such
devices.

It is known to provide data communication to mobile interface devices by
providing a fixed network of radio base stations, each defining a cell. Each
mobile interface device is located in one of the cells, and is provided with
15 antenna(s) for two-way communication with the base station of that cell.

Typically, the mobile interface device may be a handset having a single
antenna and a single transceiving channel. The ability of this type of mobile
handset is disadvantageously limited however, since it is difficult to satisfy the
required data rates of future video and internet services either in macro-cells
20 (that is cells having a radius of 1-10km) or in micro-cells (that is cells having a
radius of 0.1-1km).

Many advanced technologies have been proposed to alleviate this problem,
such as providing the mobile interface unit with adaptive antenna arrays,
sophisticated interference suppression systems and space-time coding. To
25 use an adaptive antenna array for a mobile handset, there is a basic
requirement that the distance between antenna elements is about one half of



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the wavelength. The distances for the current wireless communications (using a 1GHz to 2GHz carrier frequency) range from 15cm to 7.5cm. Thus, even a four-element antenna array will require a distance of 45cm to 22.5cm. This is definitely too large for current mobile handsets.

5 Moreover, since many different cellular communication protocols such as GSM, IS-95, PDC, WCDMA and cdma2000 exist, a mobile handset should preferably be able to operate according to all of these protocols to as to enable global roaming. A mobile interface device can fulfil this requirement by using so-called "software radio" technology, so as to adapt to different
10 wireless networks. However, software radio and sophisticated signal processing methods require correspondingly sophisticated transceiver structures and greater power supplies. Within the confines of present technology, these requirements can only be met by increasing the size of the handset, but users will not accept larger handsets.

15 Summary of the Invention

In general terms the present invention proposes a mobile transceiver device which is adapted to communicate with one or more base stations of one or more cellular communication networks over long distances (e.g. up to at least 0.1 km), and also with one or more mobile (e.g. handheld) interface devices
20 located within a short distance of the mobile transceiver device (e.g. within 100 metres of the mobile transceiver device). The transceiver may be provided with one of more of: a multiple-element antenna array, signal processing capability such as interference suppression capability, and a larger power supply than the mobile interface units.

25 Specifically, the invention provides in a first aspect a mobile transceiver device having:

a first communication apparatus for wireless communication with at least one cellular base station of a communications network according to a first communication protocol,

5 a second wireless communication apparatus for communication according to a second communication protocol with at least one mobile interface unit which is operable to input and to output data, and

conversion means for converting data between the protocols,

wherein the conversion means is arranged to provide interference suppression.

10 Preferably, there are a plurality of the mobile interface units. Preferably at least one of the mobile interface units is for two-way data communication with the transceiver and with a user, and the transceiver is for two way data communication with the base station.

15 Optionally, at least two of the mobile interface units are arranged for direct wireless communication, so that communication on a local scale is not limited by the local data communication capacity of the transceiver device. By "local" is means communication on the distance scale of the maximum separation between the transceiver device and the furthest of the mobile interface units, which is preferably no more than 100 metres.

20 The first communication apparatus may comprise a multi-element antenna array. The multi-element antenna may be of any configuration, such as a linear array, or a two-dimensional array such as a triangular or circular array.

By means of the multi-element antenna and interference suppression, the system can markedly improve the downlink performance of mobile
25 communication systems, for example providing a higher data rate and/or a

lower bit error rate (BER), by using the adaptive antenna array and more sophisticated signal processing techniques.

Preferably, the transceiver device is re-configurable to change the first communication protocol, e.g. by incorporating software radio technology so
5 that the transceiver can communicate with the base station by whichever of a predetermined set of protocols is used by that base station and/or at that time.

The transceiver device preferably includes a relatively greater power supply compared with that of the mobile phones. The larger the total energy which the battery of the transceiver stores, the longer the battery lifetime. The power
10 supply powers the long distance (e.g. at least 100m, but with no lower limit) communication with the base station through the first communication apparatus, and the short distance (e.g. up to 100m) communication with the one or more mobile interface units through the second communication apparatus, and the greater battery size makes it possible to provide a long
15 battery life

The present invention is suitable in applications including mobile telephone systems, the Internet, and multimedia. The wireless communication between the transceiver and the base stations is generally by radio. The wireless communication between the transceiver and the mobile interface units is also
20 preferably by radio but is not limited in this respect and may for example in principle be by infra-red communication.

Brief description of the Figures

A non-limiting embodiment of the invention will now be described for the sake of example only with reference to the following figures, in which:

25 Fig. 1 is a schematic view of a mobile terminal architecture according to the present invention;

Fig. 2 is a block diagram of the transceiver of the embodiment of Fig. 1;

Fig. 3 is composed of Fig. 3(a) illustrating a linear antenna array, Fig. 3(b) illustrating a triangular antenna array, and Fig. 3(c) illustrating a circular antenna array; and

5 Fig. 4 is a block diagram of an interface device of the embodiment of Fig. 1.

Detailed Description of Embodiments

In the embodiment of the invention illustrated in Fig. 1, a base station 1 of a communication network is shown in two-way long-distance (e.g. 0.1km to
10 10km) communication with a mobile transceiver device 3. The base station 1 defines a cell e.g. a macro-cell or micro-cell, within which the transceiver device 3 is located.

The transceiver may also be within the respective cells of one or more other base stations (not shown) of the same communications network or separate
15 communications network(s). In this case, the transceiver device may select which of the base stations to communicate with, e.g. by a selection of its long-distance operating frequency, or in principle even communicate with more than one of the base stations simultaneously.

The transceiver device 3 is provided with a multi-element antenna array 5 for
20 communication with the base station 1, and with the base stations (not shown) of any other cell(s) within which the transceiver device 3 is located.

The transceiver device 3 is further provided with a separate antenna 7 for short-range (e.g. up to 100m) two-way communication with a mobile telephone 9, and any number of other user-operated mobile interface devices
25 11, 13 (for simplicity only two are shown, but the invention is not limited in this

respect). This two-way communication is operated using antennas 15, 17 of the mobile interface devices 11, 13.

Optionally, the mobile interface devices 11,13 may be arranged for (e.g. two-way) direct communication, e.g. other than via the transceiver device 3. The two-way communication channels between the transceiver device 3, mobile telephone 9 and other interface devices 11, 13 (and optionally also between any two or more of the interface devices 9,11,13) constitute a local area wireless communication network.

The telephone 9 (and optionally any other of the mobile interface devices 11, 13) are optionally enabled to communicate directly with the base station 1, for example in the case that communication with the transceiver 3 is interrupted (e.g. because the telephone 9 is too far from the transceiver 3, or because some obstacle is provided between the telephone 9 and the transceiver device 3). The telephone 9 may be provided with means to establish whether short-distance communication with the transceiver device 3 is possible, and if not to communicate with the base station 1 directly.

The wireless communication within the local area network, i.e. between the transceiver unit 3, telephone 9 and other interface units 11, 13, may be by any protocol, particularly protocols well-adapted for short-distance communication such as Bluetooth, IEEE 802.11, or HomeRF. This protocol may be fixed, or alternatively it may be possible to reselect the protocol, for example in the case that a new mobile interface device is added which is not capable of communicating in the existing protocol.

Turning to Fig. 2, the transceiver device 3 is shown in detail. The multi-element antenna array 5 is represented for simplicity by only two antenna elements 19, but the number of antenna elements may in fact be any number greater than two. Note that there is in principle no direct link between the number of antenna elements 19 and mobile interface units 9, 11, 13. Each

antenna element 19 is in two-way electrical communication with a respective TX duplexer 21 which passes signals received by the antenna elements 19 to respective Low Noise Amplifiers followed by Analogue-to-Digital Converters (LNA/ADC) 23. From the converters 23 the signal is passed to digital LOs (local oscillators) 25, and the results are passed to a digital receiver unit 27 comprising a digital signal processor (DSP) and field-programmable gate array (FPGA). These components (the construction and control of which is known from existing mobile communications technology), provide quadrature down-conversion, space-time adaptive processing and FEC (forward error correction) decoding, etc.. The results are then passed to a unit 29 which transmits the processed signals via the antenna 7 to the devices 9, 11, 13 with the local area wireless network.

When signals are received by the antenna 7 from the devices 9, 11, 13 across the local area wireless network, they are passed by the unit 29 to a digital transmitter unit which prepares them to be transmitted using the array 5 to the base station 1. Specifically, the unit 31 comprises a DSP and FPGA and is arranged (by techniques known in this field) for data modulation/pulse shaping, sampling-rate conversion and symbol timing/FEC encoding, etc..

The outputs of the unit 31, which are directed to different ones of the antenna elements 19, are passed to respective digital-to-analogue converters (DAC) 33, from there to respective power-amplifiers 35, and from there to the TX duplexers 21 which pass them to the antenna elements 19.

In particular, the digital receiver path (which includes the converters 23, the oscillators 25 and the digital receiver unit 27) and the digital transmitter path (which includes the digital transmitter unit 31, the converters 33 and the power amplifiers 35) are each software re-configurable. Specifically, they are arranged to receive/transmit signals to/from the base station 1 according to a selected one of a plurality of communication protocols. The selection is

preferably a selection from a plurality of predetermined communication protocols, preferably including at least one or more of GSM, IS-95, PDC, HDR, EDGE, WCDMA and cdma2000 but not limited to these protocols. The selection may be made automatically (e.g. by a detection of the standard used
5 by the base station 1), and/or selected by an input made to a user-operated re-configuration control unit 37.

All elements of the transceiver device 3 are powered by a power supply 39, which provides a greater wattage and which stores a greater amount of power in total than that which is conventionally provided within a mobile interface
10 unit.

Within the scope of the invention antenna array 5 may be one of several possible configurations. For example, it may be a linear equally-spaced antenna array as shown in Fig. 3(a), a triangular antenna array as shown in Fig. 3(b), or a circular antenna array as shown in Fig. 3(c).

15 Turning to Fig. 4, the construction of any one of the interface units is illustrated (for concreteness, interface unit 11). The interface unit 11 includes one or more input devices 41 (two input devices 41 are shown, but there may be more than two) such as any one or more of a microphone, a keyboard for typing input, a touch-panel input, or a video camera for video input. By the
20 input devices 41 the user may input data, which is processed by an input processing unit 43, and transmitted to a unit 45 which transforms it into a format suitable for transmission via the antenna 15 to the transceiver device 3 (or optionally to another of the interface devices, e.g. device 13). Signals received from the transceiver device 3 (and optionally also from another of the
25 interface devices 13), are transmitted to the unit 45, which passes them to the output processing unit 49, which processes them into a format suitable for one of one of more data output devices 47 (two output devices 47 are shown, but there may be more than two), such as speakers for audio output or displays

for image/video output. Note that optionally, a single device (e.g. a touch-sensitive screen) may play the role of both an input device 41 and an output device 47.

5 Although the invention has been described above in relation to a single embodiment, the invention is not limited in this respect and various modifications are possible within the scope of the invention as will be clear to a skilled reader.

CLAIMS

1. A mobile transceiver device having:

a first communication apparatus for wireless communication with at least one cellular base station of a communications network according to a first communication protocol,

a second wireless communication apparatus for communication according to a second communication protocol with at least one mobile interface unit which is operable to input and to output data, and

conversion means for converting data between the protocols,

wherein the conversion means is arranged to provide interference suppression.

2. A mobile transceiver device according to claim 1 wherein

the first communication apparatus comprises a multi-element antenna array.

3. A transceiver device according to claim 2 wherein the multi-element antenna array is an adaptive antenna array.

4. A transceiver device according to claim 2 or 3 in which the configuration of the elements of the antenna array is substantially linear, triangular or circular.