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(54) Method and system for wireless cellular indoor communications

Verfahren und System für drahtlose zellulare Innenkommunikationen

Procédé et système de communications d'intérieur cellulaires sans fil

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(73) Proprietor: **Alcatel Lucent**
75007 Paris (FR)

(72) Inventors:
• **Heinz-Dieter Hettstedt**
30916 Isernhagen (DE)

• **Dr. Ekkehard Schomburg**
30938 Burgwedel (DE)
• **Dr. Roland Muenzner**
73266 Bissingen an der Teck (DE)

(74) Representative: **Wetzel, Emmanuelle et al**
Alcatel Lucent
Intellectual Property & Standards
70430 Stuttgart (DE)

(56) References cited:
EP-A- 1 085 773 EP-A- 1 617 598
WO-A-03/013065 WO-A-03/079645
WO-A-2004/025887 US-B1- 6 477 154

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Description

[0001] The present invention relates to indoor communications systems, and particularly to wireless cellular communications systems in buildings and tunnels.

[0002] Wireless communications systems are becoming an increasingly widespread phenomenon of modern communications. Since many users place an increasing number of cellular calls or data transmissions within buildings or other confined structures, there is a need to achieve high quality indoor coverage at appropriate capacity.

[0003] Document WO 03/079645 A2 discloses a communication system including a housing unit that is adapted to communicate wireless telephony signals with a telephony network and adapted to communicate wireless data with at least one data network. The communication link carries both the wireless telephony signals and the wireless data.

[0004] Document WO 2004/025887 A2 discloses a system and method for providing access to a communication network that includes providing a radio node comprising a first set of access point components including a radio component, and providing a physically separated controller node in communication with the radio node. The access point controller comprises a second set of access point components listing from the first set of access point components, creating a distributed access point.

[0005] Document EP 1 085 773 A1 discloses a mobile telecommunications local area network with a concentrator connected to a plurality of radio heads via a local area network., the concentrator providing digital signal processing as a shared resource for the radio heads.

[0006] A conventional configuration to extend a wireless communications service e.g. GSM or UMTS, from an outdoor environment to an indoor area is shown in Figure 1 and is characterized by the utilization of a repeater R that is typically located within a building B to retransmit within the building a wireless signal Ws received at an external antenna A1 or retransmit outside the building the wireless signals Ws of mobile stations Ms, e.g. mobile phones, handheld computers and the like, located inside the building B. In the downlink, that is when the wireless signals Ws from the external environment are transmitted to the mobile stations Ms inside the building B, said outdoor wireless signals are passed along a first connection Co1 to the repeater R which forwards the signal along a second connection Co2 to a plurality of inter-connected amplifiers Am, the amplifiers amplify the signals which are then transmitted over the in-building antennas A2 to A4. In the uplink direction, that is, when the wireless signals Ws from the mobile stations Ms are transmitted to a wireless infrastructure outside the building B, the repeater R receives said signals along connection Co2 and transmits them along connection Co1 to the external antenna A1.

[0007] It is also possible that the repeater R of the in-

door communications structure is replaced by a base station connected to a communications core network along connection Co1. Typically, the information is distributed via analogue signals inside the buildings and confined areas.

[0008] Another known indoor communications system providing wireless cellular service is shown in figure 2. A core network CN is connected to a base station Bs. The radio frequency (RF) signals from the base station or an off-air repeater OAR are digitized into base band signals in a base station interface BSI (and vice versa in uplink transmission) and distributed in the form of data packets using data cables, e.g. category 5 (CAT5) or optical fiber, to at least one Ethernet switch ES. The Ethernet switch ES then distributes the information to the corresponding remote radio heads RH1 to RH4 serving a particular cell area C1 and C2. An example of such system is disclosed in Patent Application US 2005/0157675 A1. An advantage of such systems is that they provide a cost-effective solution due to the use or re-use of low cost distribution cabling which is usually already present, totally or partly, in buildings and used for other types of digital communications e.g. local area network LAN structures using Ethernet protocol.

[0009] Using standard Ethernet switches, cell configurations can be achieved due to the sectorization of data flow. Normally, an Ethernet hub is needed in each Ethernet sector for data distribution in downlink and data packaging in uplink. The hub function is placed in at least one of the associated remote radio heads. In complex systems, series of Ethernet switches are necessary and bottlenecks of data flow are evident due to the 1 to n distribution characteristic of the Ethernet switch resulting in limiting the capacity of the network.

[0010] The object of the present invention is to provide a method and a system for wireless cellular indoor communications with improved cell and load balancing management.

[0011] The object is achieved by a wireless cellular indoor communications system according to claim 1 and a method for wireless cellular indoor communications according to claim 5, and a cell management unit according to claim 6.

[0012] The system for wireless cellular indoor communications of the invention uses a cell management unit with complex matrix function, instead of distributed standard Ethernet switches, for flexible cell management of multi-service and multi-operator functions.

[0013] The cell management unit is the interface between a number of base stations and the Ethernet connection. It provides multi-functions for a broad scope of complex scenarios of operation, with multi-carrier, multi-service and multi-operator functions, and efficient data management. In this way, the remote radio heads can be used in parallel for different services and at different functions, such as for frequency division duplex (FDD) and time division duplex (TDD). The remote radio heads are serviced by RF-Hubs similar to the original Ethernet

hub functionality. Due to a compact arrangement of the cell management unit, data concentrations can be avoided and high data transfer can be achieved in complex networks.

[0014] The cell management unit provides data management in terms of packaging and addressing to the radio heads in downlink and un-packaging and addressing to the base stations in uplink. Since the cell management unit performs the frequency allocation of the remote radio heads, cell management for different services and operators can be achieved. Cell management can be performed manually, by software control or even automatically adaptive to current cell scenarios.

[0015] Due to a traffic activity control, un-used carriers in remote radio heads can be deactivated at locations of low traffic and can be shifted and activated in remote radio heads at locations of high traffic. The load-balancing in base stations can be performed independently of the cell management function. In this way, capacity can follow moving users in complex buildings, such as airports, stations, etc., with dynamic distribution of hot-spots.

[0016] Cost optimization can be achieved when cell architectures must no longer be designed for peak traffic with moving users all over the whole building. Further cost optimization is achieved using base stations with digital interface and remote radio heads at dedicated locations, where capacity and coverage is needed. Additionally, since information is distributed in digital base-band, cost-effective transport can be used or eventually re-used, such as CAT5 cabling and optical fiber. Due to the LAN characteristic of the digital distribution infrastructure, the remote radio heads can advantageously be easily relocated.

[0017] Radio heads can be designed using low-cost technology of mobile stations avoiding high RF transmission levels.

[0018] An embodiment example of the invention is now explained with the aid of Figures 1 to 6.

Figure 1 shows a first typical indoor communications system structure, for analogue systems, according to the prior art.

Figure 2 shows a wireless cellular indoor communications system, with digital distribution of signals over Ethernet, according to the prior art.

Figure 3 shows a first example of a wireless cellular indoor communications system, with separated cell configuration, according to the invention.

Figure 4 shows a second example of a wireless cellular indoor communications system, with overlapping cell configuration, according to the invention.

Figure 5 shows an example of carrier distribution according to the wireless cellular indoor communica-

tions method of the invention.

Figure 6 shows an example block schematic of a wireless cellular indoor communications system according to the invention.

[0019] A first example of a wireless cellular indoor communications system structure according to the invention is shown in Figure 3, comprising a core network CN, a base station Bs, a cell management unit CMU, an off-air repeater (OAR), digital interfaces i1 to i3, RF hubs RFH1 and RFH2, and remote radio heads RH1 to RH5.

[0020] In the downlink direction, communications core network signals intended for the mobile station inside the indoor environment, e.g. a building or a tunnel, are received by the base station Bs. Said signals are then passed in digital form through a first connection interface i1, e.g. an electrical or optical connection using Ethernet protocol or of other standards (e.g. OBSAI or CPRI), to the cell management unit CMU. The cell management unit CMU performs data packaging in downlink and forwards said digital packets through a second digital connection interface i2, e.g. an electrical or optical connection using Ethernet protocol, to the RF Hubs RFH1 and RFH2, which in turn pass the packets through a third connection interface i3, e.g. an electrical or optical connection using Ethernet protocol, to the remote radio heads RH1 to RH5.

[0021] Similarly, in the uplink direction, radio signals Ws transmitted by the mobile stations located in the indoor environment are received by the remote radio heads RH1 to RH5 and sent to the core network CN with data packaging in the RF Hubs.

[0022] The base station is a conventional base station without radio equipment. The cell management unit CMU provides transparent operation of the radio heads RH1 to RH5 from the base station and comprises standard digital interfaces to the base station Bs and to the off-air repeater OAR, at least one Ethernet interface to connect the RF Hubs RFH1 and RFH2, an intelligent switching unit for data distribution and cell organization configurable in size and functionality according to system dimensions, a complex matrix function to combine different base stations with a number of RF hubs, multi-service and multi-operator functionality for full transparency, flexible cell management for static cell configurations, automatic cell management for adaptive cell configurations.

[0023] The CMU preferably comprises the following functionality (in a form independent of the used air interface standard):

- means for supporting efficient load balancing at and between base stations through adaptive cell reconfiguration, especially through the shifting of un-used carriers from radio heads inside areas of low traffic load to radio heads inside areas of high traffic load, e.g. means for individual load identification for each carrier on each of the radio heads by air interface

activity detection and interference sensing. Air interface activity detection thereby is realized on the basis of the individually supported air interface protocols; means for de-activation of un-used carriers per radio head on an individual basis; means for shifting carriers from radio heads, where these carriers are not used for radio heads with high load on their active carriers, means for activation of the shifted carriers at locations (radio heads) of high loading. The cell management unit mechanism of adaptive cell re-configuration thereby will neither require any changes to the load balancing mechanisms at or between the access nodes (e.g. BTS, Node-B, WiMAX base station) nor any dedicated messaging between access nodes and CMU for supporting load balancing.

- mapping means from carriers or time, frequency or time-frequency allocations to individual radio heads, as identified e.g. through their MAC addresses or the connectors of the respective digital lines to which the radio heads are connected,
- delay management means for alignment of the individual delays accumulated on the digital connections between the cell management unit and each of the radio heads,
- means for synchronization of the signals between the cell management unit and the individual radio heads,
- failure detection means for the individual digital links between the cell management unit and the radio heads.

[0024] The RF hubs provide data distribution to the remote radio heads in downlink and data packaging in uplink

[0025] The remote radio heads RH1 to RH5 are RF air interfaces to users providing a digital interface to the network. They are part of the BTS according to standards, such as OBSAI or CPRI. The remote radio heads are equipped to transmit four carriers over the full RF bandwidth of each service but channel-selective at least in uplink. In this way, a remote radio head can operate individually for dedicated operators only. Since frequency allocation of each carrier can be tuned remotely by the cell management unit CMU, the remote radio heads RH1 to RH5 can represent an individual cell and/or can be part of a greater cell. Thus, in both cases, extension of capacity and/or coverage, can be achieved. Different types of remote radio heads can be planned either for FDD or for TDD operation.

[0026] In Figure 3, the wireless cellular indoor communications system, according to the invention, is illustrated with separated cell configuration, that is, a first RF Hub RFH1 is connected to two remote radio heads RH1 and RH2 which provide service in a first cell area C1 inside

a certain first indoor location area A1, and a second RF Hub RFH2 is connected to three remote radio heads RH3 to RH5 which provide service in a second cell area C2 inside a certain second indoor location area A2, and the first and second indoor location areas A1 and A2 being isolated or separated. On the other hand, Figure 4 illustrates a wireless cellular indoor communications system, according to the invention, which presents overlapping cell configuration, that is, now the first RF Hub RFH1 is connected to two remote radio heads RH1 and RH2, RH1 providing service in cell C1, and RH2 providing service in cell C2, and cells C1 and C2 overlapping in the same indoor location area A1, and the second RF Hub RFH2 is connected to three remote radio heads RH3, RH4 and RH5 which also provide service in different overlapping cells C1, C2 at the same indoor location area A2.

[0027] For the sake of generalization, other cell configurations, as the ones illustrated in the examples of Figures 3 and 4, are possible according to the invention. Each remote radio head can service a different cell area, or two, or more, remote radio heads can belong the same cell area, said cell areas overlapping inside a certain indoor location area or being in different location areas. The RF hubs can be connected to remote radio heads which serve the same cell or serve different cells.

[0028] Figure 5 shows an example of carrier distribution according to the wireless cellular indoor communications method of the invention considering four carriers per remote radio head RH-1 to RH-N. The base station Bs provides the M carriers Ca1 to CaM to the cell management unit CMU which in turn distributes it between the at least one RF Hub RFH 1 to X of the next stage. The one or more RF Hubs distribute carriers 1 to 4 to a first remote radio head RH-1 according to medium access control (MAC) addresses MA1 to MA4 in the Ethernet packets, carriers 5 to 8 to a second remote radio head RH-2 according to MAC addresses 5 to 8, and carriers M-3 to M to an N remote radio head RH-N according to MAC addresses M-3 to M, where $M = N \times 4$.

[0029] Figure 6 shows an example block schematic of a wireless cellular indoor communications system according to the invention. In the example of the figure the cell management unit CMU operates on eight base stations BS1 to BS8 and on eight RF Hubs RFH1 to RFH8 (but, of course, more or less base stations Bs and RF Hubs could also be connected to the CMU). Each base station can provide four carriers at individual services. The eight BS can cover different services of different operators. The network between interfaces I1 and I3 is fully transparent, while the remote radio heads RH1 to RH32 are dedicated for individual services.

Claims

1. A wireless cellular indoor communications system comprising at least one base station (Bs) connected to a cell management unit (CMU) through a first dig-

ital connection interface (i1), the cell management unit connected to at least one RF hub (RFH1,RFH2) through a second digital connection interface (i2), and the at least one RF hub connected to at least one remote radio head (RH1 to RH5) through a third digital connection interface (i3), the at least one remote radio head providing service in a certain cell area (C1, C2) inside a confined environment, the cell management unit (CMU) comprising

- means for providing efficient load balancing at and between base stations through adaptive cell reconfiguration and through data management in terms of packaging and addressing to the radio heads in downlink and un-packaging and addressing to the base stations in uplink,
- means for shifting un-used carriers from remote radio heads inside areas of low traffic load to remote radio heads inside areas of high traffic load,
- means for mapping carriers, time, frequency or time-frequency allocations to individual radio heads,
- means for alignment of individual delays accumulated on the digital connections between the cell management unit and each of the radio heads,
- means for synchronization of the signals between the cell management unit and the individual remote radio heads,
- means for failure detection of the individual digital links between the cell management unit and the remote radio heads,

whereby the cell management unit is operatively coupled to the at least one base station and configured to operate on the at least one base station by applying at least one of the means.

2. The wireless cellular indoor communications system of claim 1 wherein the means for shifting un-used carriers from remote radio heads inside areas of low traffic load to remote radio heads inside areas of high traffic load comprise

- means for individual load identification for each carrier on each of the radio heads by air interface activity detection and interference sensing,
- means for de-activation of un-used carriers per remote radio head on an individual basis;
- means for shifting carriers from radio heads, where these carriers are not used for radio heads with high load on their active carriers,
- means for activation of the shifted carriers at locations where the remote radio heads are loaded over a predetermined value.

3. The wireless cellular indoor communications system

of claim 1, wherein the carriers, time, frequency or time-frequency allocations are identified through their MAC addresses or the connectors of the respective digital lines to which the radio heads are connected.

4. The wireless cellular indoor communications system of claim 1, wherein the first, second and third digital interface is an electrical or optical connection using Ethernet protocol.

5. A method for wireless cellular indoor communications, the method comprising the at least one base station (Bs) transmitting or receiving call or data information to/from a cell management unit (CMU) through a first digital connection interface (i1), the cell management unit transmitting or receiving call or data information to/from at least one RF hub (RFH1,RFH2) through a second digital connection interface (i2), and the at least one RF hub transmitting or receiving call or data information to/from at least one remote radio head (RH1 to RH5) through a third digital connection interface (i3), the at least one remote radio head providing service in a certain cell area (C1, C2) inside a confined environment, and the cell management unit (CMU)

- providing efficient load balancing at and between base stations through adaptive cell reconfiguration and through managing data in terms of packaging and addressing to the radio heads in downlink and un-packaging and addressing to the base stations in uplink,
- shifting un-used carriers from remote radio heads inside areas of low traffic load to remote radio heads inside areas of high traffic load,
- mapping carriers, time, frequency or time-frequency allocations to individual radio heads,
- aligning individual delays accumulated on the digital connections between the cell management unit and each of the radio heads,
- synchronizing signals between the cell management unit and the individual remote radio heads,
- detecting failure of the individual digital links between the cell management unit and the remote radio heads,

whereby the cell management unit is operatively coupled to the at least one base station and operates on the at least one base station by applying at least one of the means.

6. A cell management unit (CMU) comprising:

- means for providing efficient load balancing at

and between base stations, the base stations connected to the cell management unit,

- means for adaptive cell reconfiguration,
- means for data management in terms of pack-aging and addressing to the radio heads in downlink and un-packaging and addressing to the base stations in uplink,
- means for shifting un-used carriers from re-mote radio heads inside areas of low traffic load to remote radio heads inside areas of high traffic load, the remote radio heads connected to at least one RF Hub, the RF Hub connected to the cell management unit,
- means for mapping carriers, time, frequency or time-frequency allocations to individual radio heads,
- means for alignment of individual delays accumulated on the digital connections between the cell management unit and each of the radio heads,
- means for synchronization of the signals between the cell management unit and the individual remote radio heads,
- means for failure detection of the individual digital links between the cell management unit and the remote radio heads,
- means for operatively coupling the cell management unit to the base stations,

means for operating on the base stations.

7. The management unit (CMU) according to claim 6, wherein the means for shifting un-used carriers from remote radio heads inside areas of low traffic load to remote radio heads inside areas of high traffic load comprise

- means for individual load identification for each carrier on each of the radio heads by air interface activity detection and interference sensing,
- means for de-activation of un-used carriers per remote radio head on an individual basis;
- means for shifting carriers from radio heads, where these carriers are not used for radio heads with high load on their active carriers,
- means for activation of the shifted carriers at locations where the remote radio heads are loaded over a predetermined value.

Patentansprüche

1. Drahtloses zellulares Innenkommunikationssystem mit mindestens einer über eine erste digitale Verbindungsschnittstelle (i1) an eine Zellenverwaltungseinheit (CMU) angeschlossenen Basisstation (Bs), wobei die Zellenverwaltungseinheit über eine zweite digitale Verbindungsschnittstelle (i2) an mindestens

einen RF-Hub (RFH1, RFH2) gekoppelt ist und der mindestens eine RF-Hub über eine dritte digitale Verbindungsschnittstelle (i3) an mindestens einen entfernt angeordneten Funkkopf (RH1 bis RH5) gekoppelt ist, wobei der mindestens eine entfernt angeordnete Funkkopf in einem bestimmten Zellenbereich (C1, C2) innerhalb einer begrenzten Umgebung Dienste bereitstellt,

wobei die Zellenverwaltungseinheit (CMU) umfasst:

- Mittel zum Gewährleisten einer effizienten Lastverteilung an und zwischen Basisstationen durch adaptive Zellenrekonfiguration und durch die Verwaltung der Daten in Bezug auf das Verpacken und das Adressieren an die Funkköpfe in Abwärtsrichtung und das Auspacken und Adressieren an die Basisstationen in Aufwärtsrichtung,
- Mittel zum Verlagern von unbenutzten Trägern von entfernt angeordneten Funkköpfen in Bereichen mit niedriger Verkehrslast an entfernt angeordnete Funkköpfe in Bereichen mit hoher Verkehrslast,
- Mittel zum Abbilden von Trägern, Zeit, Frequenz oder Zeit-Frequenz-Zuweisungen auf einzelne Funkköpfe,
- Mittel zum Abgleichen von auf den digitalen Verbindungen zwischen der Zellenverwaltungseinheit und einem jeden der Funkköpfe aufgelaufenen einzelnen Verzögerungen,
- Mittel zum Synchronisieren der Signale zwischen der Zellenverwaltungseinheit und den einzelnen entfernt angeordneten Funkköpfen,
- Mittel zur Fehlererfassung der einzelnen digitalen Links zwischen der Zellenverwaltungseinheit und den entfernt angeordneten Funkköpfen,

wobei die Zellenverwaltungseinheit operativ an die mindestens eine Basisstation gekoppelt und für den Betrieb auf der mindestens einen Basisstation durch Anwenden mindestens eines der Mittel konfiguriert ist.

2. Drahtloses zellulares Innenkommunikationssystem nach Anspruch 1, wobei die Mittel zum Verlagern von unbenutzten Trägern von entfernten Funkköpfen in Bereichen mit niedriger Verkehrslast an entfernte Funkköpfe in Bereichen mit hoher Verkehrslast umfassen:

- Mittel zur individuellen Lastidentifikation für jeden Träger auf einem jeden der Funkköpfe durch Erfassen der Aktivität der Luftschnittstelle und Abtasten der Interferenzen;
- Mittel zum Deaktivieren von unbenutzten Trägern pro entfernt angeordneten Funkkopf auf einer individuellen Basis;

- Mittel zum Verlagern von Trägern von Funkköpfen, wenn diese Träger nicht für Funkköpfe mit hoher Last auf deren aktiven Trägern benutzt werden;
- Mittel zum Aktivieren der verlagerten Träger an Orten, an welchen die Last der entfernt angeordneten Funkköpfe einen vorbestimmten Wert überschreitet.

3. Drahtloses zellulARES Innenkommunikationssystem nach Anspruch 1, wobei Träger, Zeit, Frequenz oder Zeit-Frequenz-Zuweisungen über deren MAC-Adressen oder die Anschlussvorrichtungen der jeweiligen digitalen Leitungen, an welche die Funkköpfe angeschlossen sind, identifiziert werden.

4. Drahtloses zellulARES Innenkommunikationssystem nach Anspruch 1, wobei die erste, die zweite und die dritte digitale Schnittstelle eine elektrische oder optische Verbindung ist, welche das Ethernet-Protokoll anwendet.

5. Verfahren für drahtlose zellulare Innenkommunikation, wobei das Verfahren umfasst:

Übertragen durch die oder Empfangen an der mindestens eine(n) Basisstation (Bs) von Ruf- oder Dateninformationen an eine/von einer Zellenverwaltungseinheit (CMU) über eine erste digitale Verbindungsschnittstelle (i1),
 Übertragen durch die oder Empfangen an der Zellenverwaltungseinheit von Ruf- oder Dateninformationen an mindestens einen/von mindestens einem RF-Hub (RFH1, RFH2) über eine zweite digitale Verbindungsschnittstelle (i2),
 und
 Übertragen durch den oder Empfangen an dem mindestens einen RF-Hub von Ruf- oder Dateninformationen an mindestens einen/von mindestens einem entfernt angeordneten Funkkopf (RH1 bis RH5) über eine dritte digitale Verbindungsschnittstelle (i3), wobei der mindestens eine entfernt angeordnete Funkkopf in einem bestimmten Zellenbereich (C1, C2) innerhalb einer begrenzten Umgebung Dienste bereitstellt, und wobei die Zellenverwaltungseinheit (CMU) die folgenden Schritte durchführt:

- Gewährleisten einer effizienten Lastverteilung an und zwischen Basisstationen durch adaptive Zellenrekongfiguration und durch Verwalten von Daten in Bezug auf das Verpacken und das Adressieren an die Funkköpfe in Abwärtsrichtung und das Auspacken und Adressieren an die Basisstationen in Aufwärtsrichtung,
- Verlagern von unbenutzten Trägern von entfernt angeordneten Funkköpfen in Be-

reichen mit niedriger Verkehrslast an entfernt angeordnete Funkköpfe in Bereichen mit hoher Verkehrslast,

- Abbilden von Trägern, Zeit, Frequenz oder Zeit-Frequenz-Zuweisungen auf einzelne Funkköpfe,
- Abgleichen von auf den digitalen Verbindungen zwischen der Zellenverwaltungseinheit und einem jeden der Funkköpfe aufgelaufenen einzelnen Verzögerungen,
- Synchronisieren der Signale zwischen der Zellenverwaltungseinheit und den einzelnen entfernt angeordneten Funkköpfen,
- Erfassen der Fehler der einzelnen digitalen Links zwischen der Zellenverwaltungseinheit und den entfernt angeordneten Funkköpfen,

wobei die Zellenverwaltungseinheit operativ an die mindestens eine Basisstation gekoppelt ist und auf der mindestens einen Basisstation durch Anwenden mindestens eines der Mittel betrieben wird.

6. Zellenverwaltungseinheit (CMU), umfassend:

- Mittel zum Gewährleisten einer effizienten Lastverteilung an und zwischen Basisstationen, wobei die Basisstationen an die Zellenverwaltungseinheit angeschlossen sind,
- Mittel zur adaptiven Zellenrekongfiguration
- Mittel zur Verwaltung der Daten in Bezug auf das Verpacken und das Adressieren an die Funkköpfe in Abwärtsrichtung und das Auspacken und Adressieren an die Basisstationen in Aufwärtsrichtung,
- Mittel zum Verlagern von unbenutzten Trägern von entfernt angeordneten Funkköpfen in Bereichen mit niedriger Verkehrslast an entfernt angeordnete Funkköpfe in Bereichen mit hoher Verkehrslast, wobei die entfernt angeordneten Funkköpfe an mindestens einen RF-Hub angeschlossen sind, wobei der RF-Hub an die Zellenverwaltungseinheit angeschlossen ist,
- Mittel zum Abbilden von Trägern, Zeit, Frequenz oder Zeit-Frequenz-Zuweisungen auf einzelne Funkköpfe,
- Mittel zum Abgleichen von auf den digitalen Verbindungen zwischen der Zellenverwaltungseinheit und einem jeden der Funkköpfe aufgelaufenen einzelnen Verzögerungen,
- Mittel zum Synchronisieren der Signale zwischen der Zellenverwaltungseinheit und den einzelnen entfernt angeordneten Funkköpfen,
- Mittel zur Fehlererfassung der einzelnen digitalen Links zwischen der Zellenverwaltungseinheit und den entfernt angeordneten Funkköpfen,

- Mittel zum operativen Koppeln der Zellenverwaltungseinheit an die Basisstationen,
- Mittel für den Betrieb auf den Basisstationen.

7. Zellenverwaltungseinheit (CMU) nach Anspruch 6, wobei die Mittel zum Verlagern von unbenutzten Trägern von entfernt angeordneten Funkköpfen in Bereichen mit niedriger Verkehrslast an entfernt angeordnete Funkköpfe in Bereichen mit hoher Verkehrslast umfassen:
- Mittel zur individuellen Lastidentifikation für jeden Träger auf einem jeden der Funkköpfe durch Erfassen der Aktivität der Luftschnittstelle und Abtasten der Interferenzen;
 - Mittel zum Deaktivieren von unbenutzten Trägern pro entfernt angeordneten Funkkopf auf einer individuellen Basis;
 - Mittel zum Verlagern von Trägern von Funkköpfen, wenn diese Träger nicht für Funkköpfe mit hoher Last auf deren aktiven Trägern benutzt werden;
 - Mittel zum Aktivieren der verlagerten Träger an Orten, an welchen die Last der entfernt angeordneten Funkköpfe einen vorbestimmten Wert überschreitet.

Revendications

1. Système de communications intérieures cellulaires sans fil comprenant au moins une station de base (Bs) connectée à une unité de gestion de cellules (CMU) par l'intermédiaire d'une première interface de connexion numérique (i1), l'unité de gestion de cellules étant connectée à au moins un concentrateur RF (RFH1, RFH2) par l'intermédiaire d'une deuxième interface de connexion numérique (i2), et l'au moins un concentrateur RF étant connecté à au moins une tête radio distante (RH1 à RH5) par l'intermédiaire d'une troisième interface de connexion numérique (i3), l'au moins une tête radio distante fournissant un service dans une certaine zone de cellule (C1, C2) dans un environnement confiné, l'unité de gestion de cellules (CMU) comprenant :
- moyens pour fournir un équilibrage de charge efficace à des stations de base et entre celles-ci par l'intermédiaire d'une reconfiguration cellulaire adaptative et par l'intermédiaire d'une gestion de données en termes d'encapsulation et d'adressage aux têtes radio en liaison descendante et de désencapsulation et d'adressage aux stations de base en liaison montante,
 - moyens pour décaler des porteuses non-utilisées à partir de têtes radio distantes dans des zones à faible charge de trafic vers des têtes radio distantes dans des zones à forte charge

- de trafic,
- moyens pour mettre en correspondance des attributions de porteuses, de temps, de fréquence ou de temps-fréquence avec des têtes radio individuelles,
- moyens pour aligner des retards individuels accumulés sur les connexions numériques entre l'unité de gestion de cellules et chacune des têtes radio,
- moyens pour synchroniser les signaux entre l'unité de gestion de cellules et les têtes radio distantes individuelles,
- moyens pour la détection de défaillance des liaisons numériques individuelles entre l'unité de gestion de cellules et les têtes radio distantes,

l'unité de gestion de cellules étant couplée de manière opérationnelle à l'au moins une station de base et configurée pour fonctionner sur l'au moins une station de base en appliquant au moins un des moyens.

2. Système de communications intérieures cellulaires sans fil selon la revendication 1 dans lequel les moyens pour décaler des porteuses non-utilisées à partir de têtes radio distantes dans des zones à faible charge de trafic vers des têtes radio distantes dans des zones à forte charge de trafic comprennent :
- moyens d'identification de charge individuelle pour chaque porteuse sur chacune des têtes radio par détection d'activité d'interface radio et détection de brouillage,
 - moyens de désactivation de porteuses non-utilisées par tête radio distante sur une base individuelle ;
 - moyens pour décaler des porteuses à partir de têtes radio, dans lesquels ces porteuses ne sont pas utilisées pour des têtes radio à forte charge sur leurs porteuses actives,
 - moyens d'activation des porteuses décalées à des emplacements où les têtes radio distantes sont chargées sur une valeur prédéterminée.
3. Système de communications intérieures cellulaires sans fil selon la revendication 1, dans lequel les attributions de porteuses, de temps, de fréquence ou de temps-fréquence sont identifiées par leurs adresses MAC ou les connecteurs des lignes numériques respectives auxquelles les têtes radio sont connectées.
4. Système de communications intérieures cellulaires sans fil selon la revendication 1, dans lequel les première, deuxième et troisième interfaces numériques sont une connexion électrique ou optique utilisant

un protocole Ethernet.

5. Procédé pour des communications intérieures cellulaires sans le procédé comprenant :

l'au moins une station de base (Bs) transmettant des informations d'appel ou de données à une unité de gestion de cellules (CMU) ou recevant ces informations à partir de cette unité par l'intermédiaire d'une première interface de connexion numérique (i1),
l'unité de gestion de cellules transmettant des informations d'appel ou de données à au moins un concentrateur RF (RFH1, RFH2) ou recevant ces informations à partir de cet au moins un concentrateur RF par l'intermédiaire d'une deuxième interface de connexion numérique (i2), et
l'au moins un concentrateur RF transmettant des informations d'appel ou de données à au moins une tête radio distante (RH1 à RH5) ou recevant ces informations à partir de cette tête radio distante par l'intermédiaire d'une troisième interface de connexion numérique (i3), l'au moins une tête radio distante fournissant un service dans une certaine zone de cellule (C1, C2) à l'intérieur d'un environnement confiné, et l'unité de gestion de cellules (CMU)

- fournit un équilibrage de charge efficace à des stations de base et entre celles-ci par l'intermédiaire d'une reconfiguration cellulaire adaptative et par l'intermédiaire d'une gestion de données en termes d'encapsulation et d'adressage aux têtes radio en liaison descendante et de désencapsulation et d'adressage aux stations de base en liaison montante,
- décale des porteuses non-utilisées à partir de têtes radio distantes dans des zones à faible charge de trafic vers des têtes radio distantes dans des zones à forte charge de trafic,
- met en correspondance des attributions de porteuses, de temps, de fréquence ou de temps-fréquence avec des têtes radio individuelles,
- aligne des retards individuels accumulés sur les connexions numériques entre l'unité de gestion de cellules et chacune des têtes radio,
- synchronise les signaux entre l'unité de gestion de cellules et les têtes radio distantes individuelles,
- détecte une défaillance des liaisons numériques individuelles entre l'unité de gestion de cellules et les têtes radio distantes,

l'unité de gestion de cellules étant couplée de ma-

nière opérationnelle à l'au moins une station de base et fonctionnant sur l'au moins une station de base en appliquant au moins un des moyens.

6. Unité de gestion de cellules (CMU) comprenant :

- moyens pour fournir un équilibrage de charge efficace à des stations de base et entre celles-ci, les stations de base étant connectées à l'unité de gestion de cellules,
- moyens pour la reconfiguration cellulaire adaptative,
- moyens pour la gestion de données en termes d'encapsulation et d'adressage aux têtes radio en liaison descendante et de désencapsulation et d'adressage aux stations de base en liaison montante,
- moyens pour décaler des porteuses non-utilisées à partir de têtes radio distantes dans des zones à faible charge de trafic vers des têtes radio distantes dans des zones à forte charge de trafic, les têtes radio distantes étant connectées à au moins un concentrateur RF, le concentrateur RF étant connecté à l'unité de gestion de cellules,
- moyens pour mettre en correspondance des attributions de porteuses, de temps, de fréquence ou de temps-fréquence avec des têtes radio individuelles,
- moyens pour aligner des retards individuels accumulés sur les connexions numériques entre l'unité de gestion de cellules et chacune des têtes radio,
- moyens pour synchroniser les signaux entre l'unité de gestion de cellules et les têtes radio distantes individuelles,
- moyens pour la détection de défaillance des liaisons numériques individuelles entre l'unité de gestion de cellules et les têtes radio distantes,
- moyens pour coupler de manière opérationnelle l'unité de gestion de cellules aux stations de base,

moyens pour fonctionner sur les stations de base.

7. Unité de gestion (CMU) selon la revendication 6, dans laquelle les moyens pour décaler des porteuses non-utilisées à partir de têtes radio distantes dans des zones à faible charge de trafic vers des têtes radio distantes dans des zones à forte charge de trafic comprennent :

- moyens d'identification de charge individuelle pour chaque porteuse sur chacune des têtes radio par détection d'activité d'interface radio et détection de brouillage,
- moyens de désactivation de porteuses non-

utilisées par tête radio distante sur une base individuelle ;

- moyens pour décaler des porteuses à partir de têtes radio, dans lesquels ces porteuses ne sont pas utilisées pour des têtes radio à forte charge sur leurs porteuses actives, 5

- moyens d'activation des porteuses décalées à des emplacements où les têtes radio distantes sont chargées sur une valeur prédéterminée. 10

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Figure 1

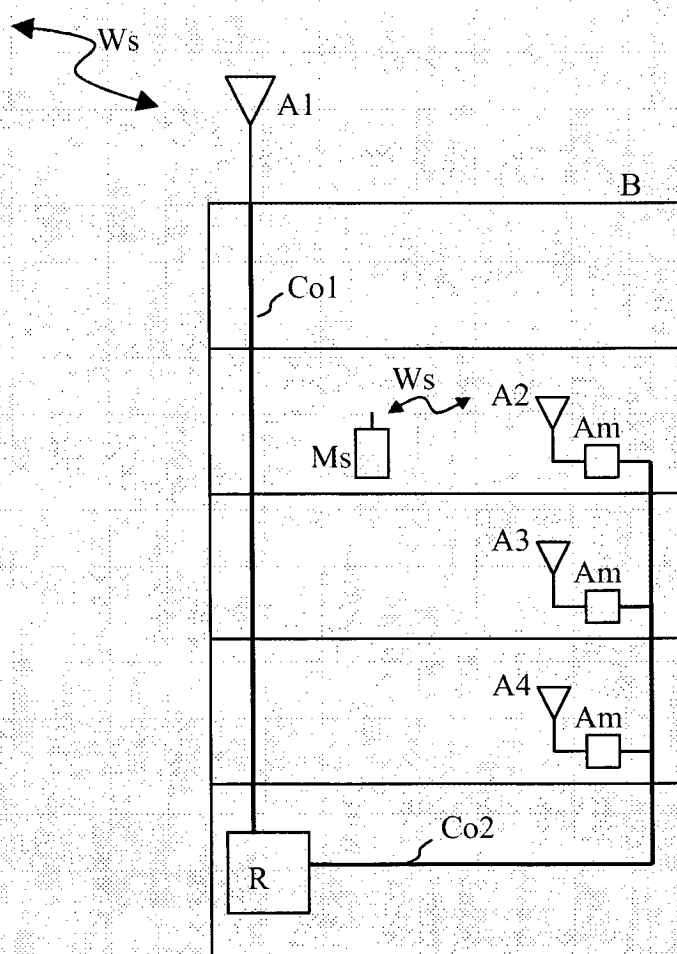


Figure 2

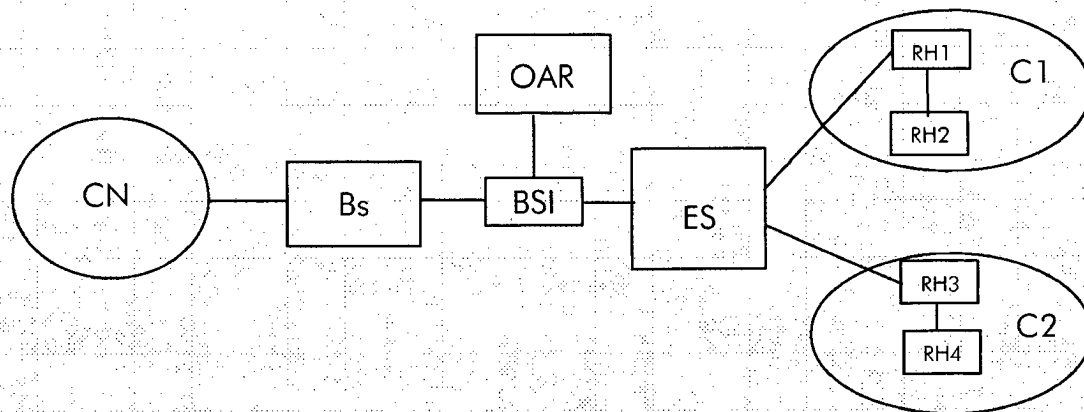


Figure 3

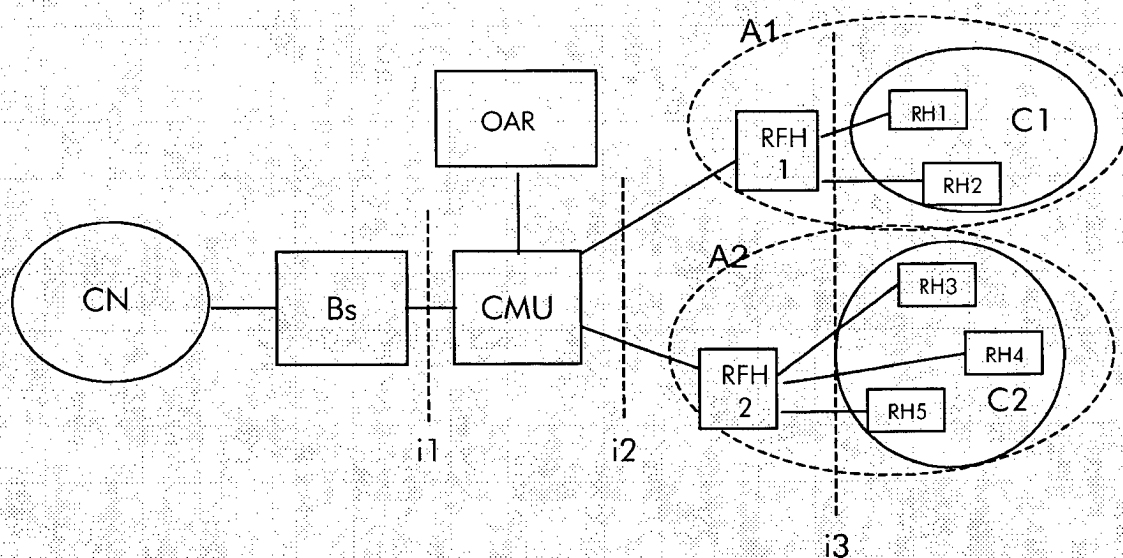


Figure 4

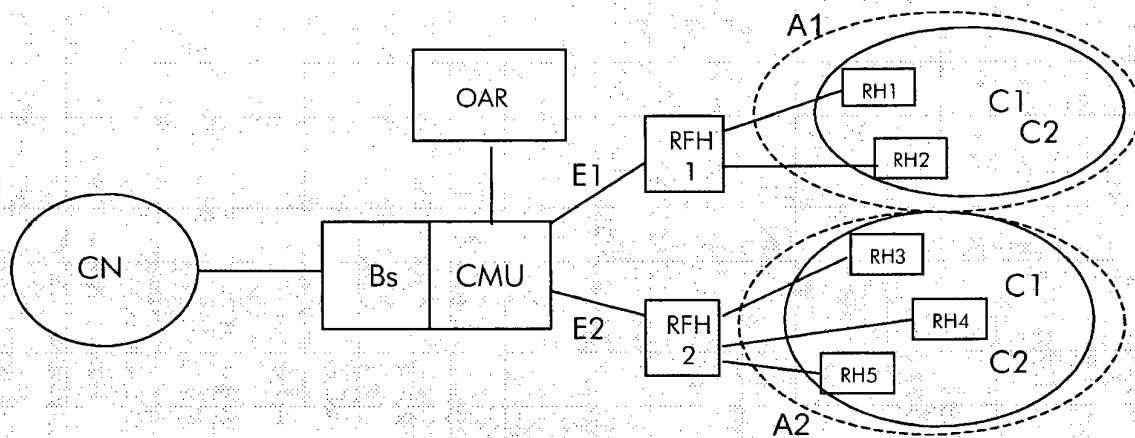


Figure 5

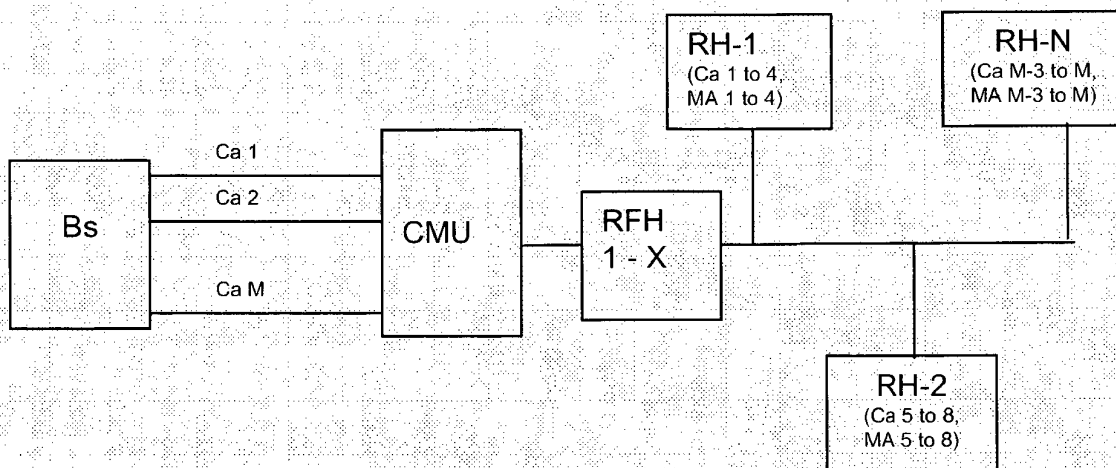
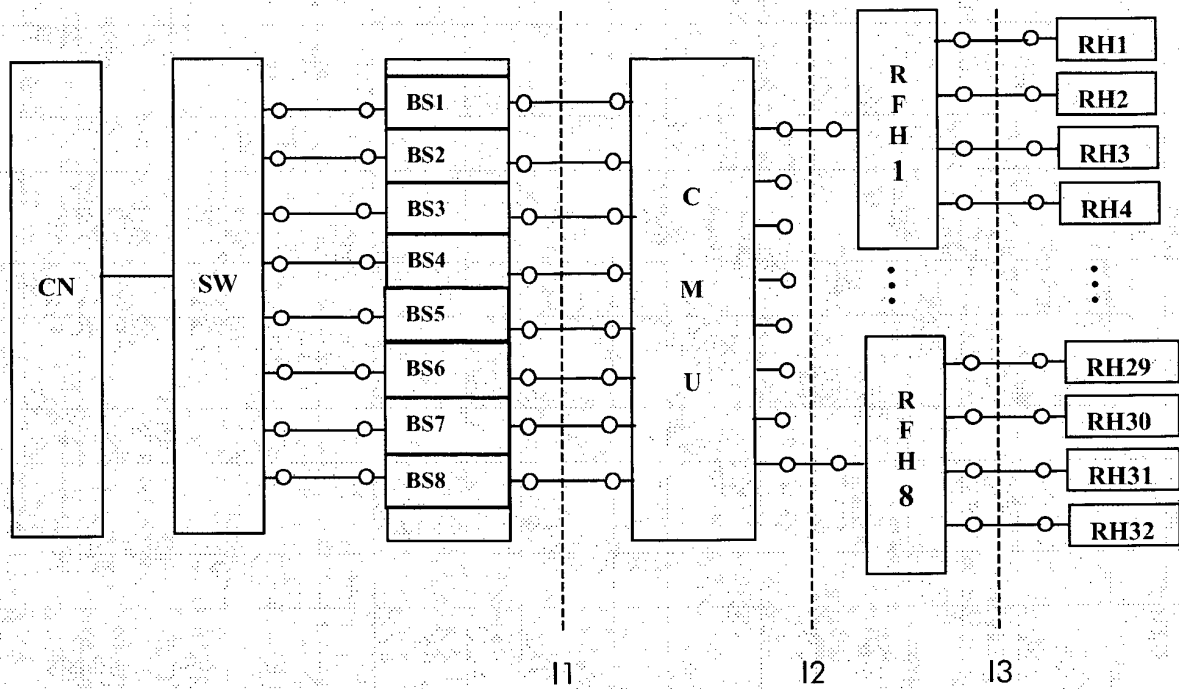


Figure 6



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 03079645 A2 [0003]
- WO 2004025887 A2 [0004]
- EP 1085773 A1 [0005]
- US 20050157675 A1 [0008]