

SETUP OF AN X2 LINK USING VIRTUAL TERMINALS

The present invention relates to a base station for a radiocommunications
5 network comprising a set of base stations and of first user terminals, said base station comprising:

- a radio interface module adapted for emitting and receiving radiofrequency data;
and

- a control block adapted for establishing a communication link and
10 communicating over said link with at least one first user terminal according to a radio protocol comprising a radio protocol section specific to the base stations and a radio protocol section specific to the user terminals, by using said radio interface module.

The cell networks of the 4th generation, in particular the LTE and the LTE-A having a certain number of advantages among which the high throughput
15 communications possibility, low latency, multiple band widths, a high tolerance to relative movements of the transmitters, a variety of available terminals and a relatively low cost by means of the investments of the civil sector.

The conventional architecture of these networks is illustrated in Fig. 1. It is based on a planned set of base stations generally fixed, called eNodeBs or eNBs ("evolved
20 Node B"), which provide a wireless radio service via their radio interface LTE to mobile users, called UEs ("User Pieces of Equipment").

The eNBs and UEs make up the E-UTRAN (Evolved Universal Terrestrial Radio Access Network).

These eNBs are connected through logical links to the MMEs ("Mobility
25 Management Entities") and to P/S-GWs (Packet/Serving Gateways) of the network core, called EPC ("Evolved Packet Core"). The logical links (S1-MME, S1-U, S6a, S7, S5-8, S11) between these elements are often achieved via wired physical links (for example Fibre, Cable, ADSL) or point-to-point wireless connections, or even point-to-multipoint links (proprietary technologies on ISM bands (Industrial, Scientific and Medical) or
30 licensed, Wi-Fi...).

The EPC centralizes the communications. The exchanges between the eNBs or between the UEs are based on EPC and the eNBs cannot directly communicate between them through their radio interface LTE, although a logical link (X2) allows communication between two eNBs, the latter only authorizes the transmission of certain specific control
35 messages.

If the eNBs loose or cannot ensure their connection with the EPC (or with different EPCs connected with each other), for example during a catastrophe or in a mobility scenario of the eNBs, there then can no longer be any exchanges between them or between their UEs (whether these are handled by a single eNB or borne by several
 5 different eNBs), and this even when said eNBs are within radio range (LTE) with each other.

For finding a remedy to this problem, physical links between an eNB and the network core EPC, called « backhaul links » may be positioned, but they require the installation of specific radio links.

10 Moreover there exist in the LTE architecture of the relay nodes ("relay nodes"), capable of communicating both with UEs and with an eNB, called a "Donor eNB" or DeNB. These relay nodes give the possibility of extending the coverage of an eNB and of improving the capacity thereof. But these relay nodes are not capable of handling alone UEs, they depend on their DeNB which provides them access to the EPC and they can
 15 only connect to a single eNB.

To this end, according to a first aspect, the invention proposes a base station of the aforementioned type and characterized in that it further comprises a management unit adapted for generating a plurality of second user terminals, said generated second terminal users being virtual user terminals adapted for communicating according to said
 20 radio protocol with base stations neighboring said base station, by using the radio interface module.

Such a base station gives the possibility of generating a meshed network of base stations and of directly transmitting between base stations data according to for example the LTE protocol.

25 In embodiments, the base station according to the invention further includes one or several of the following features:

- the management unit is adapted for selectively distributing the use of the radio interface module between the control block, for communication between said control block and said at least one first user terminal, and the second virtual terminals for their
 30 communication with neighboring base stations;
- the management unit assigns to each second virtual terminal a respective identifier;
- said communication protocol is compliant with the LTE standard;
- a second virtual user terminal is adapted for regularly carrying out a radio scan
 35 and for detecting neighboring base stations and for indicating to the management unit said detected neighboring stations, said management unit being adapted for, when one

of the detected neighboring base stations is not part of the neighboring base stations having an established link with the second virtual terminals, generating a new virtual second terminal for applying communications between said novel second virtual terminal and said detected neighboring base station;

- 5 - the base station includes a management block of the mobility and a base of information for authentication relatively to the first and second user terminals, said management block for mobility being adapted for, when the control block receives, from a first user terminal, a request for applying a communication link with said base station according to said communication protocol, proceeding with the authentication of said first
10 user terminal depending on other authentication elements indicated in the request and authentication information in the base, relative to said first user terminal; and wherein the management unit is adapted, when it generates a second virtual user terminal, for providing to said second virtual user terminal, if authentication elements specific to said second virtual terminal, each virtual second terminal being adapted so, when it emits a
15 request for applying a communication link intended for a neighboring base station according to said communication protocol, inserting, in said request, said authentication elements provided by the management unit;
 - the management unit is adapted for storing a list of neighboring base stations connected to said base station, and
20 - each virtual second terminal is adapted for indicating to the management unit the neighboring base station with which it has established a current communication link, and the management unit is adapted for updating the list of neighboring base stations connected to said base station, by inserting into the list, said indicated neighboring base station, matching in the list with said second virtual terminal;
25 - the control block is adapted for indicating to the management unit said first terminals with which it has established a current communication link, and when one of said first terminals is a virtual terminal of a neighboring base station of said base station, the management unit is adapted for updating the list by inserting therein said neighboring matched base station, in the list, with said first virtual terminal;
30 - the base station comprises a router and wherein the management unit is adapted for updating the routing rules according to said updated list of the neighboring base stations connected to said base station, said router being adapted for routing, according to updated routing rules by the management unit, data selectively towards the control block for emission towards the first user terminals or towards the second virtual
35 terminals for emission towards neighboring base stations.

According to a second aspect, the present invention proposes a method for treatment in a base station for a radiocommunications network comprising a set of base stations and first user terminals, said base station comprising a radio interface module and a control block, comprising the following steps:

- 5 - emission and reception of radiofrequency data by the adapted radio interface module; and
- establishing a communication link through the control block and communication by the control block on said link with at least one first user terminal according to a radio protocol comprising a radio protocol section specific to the base
- 10 stations and a radio protocol section specific to the user terminals, by using said radio interface module, said method being characterized in that it comprises a step for generating, through a management unit of said base station, a plurality of second virtual user terminals adapted for communicating according to said radio protocol with neighboring base stations of said base station, by using said radio interface module.

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These features and advantages of the invention will become apparent upon reading the description which follows, only given as an example, and made with reference to the appended drawings, wherein:

- Fig. 1 represents a view of a telecommunication LTE system in the prior art;
- 20 - Fig. 2 illustrates a functional view of a base station in an embodiment of the invention;
- Fig. 3 is a view of a network of base stations in an embodiment of the invention.

25 Fig. 2 illustrates a functional view of a base station adapted for communicating with radio user terminals, UEs, according to a communication protocol, in an embodiment of the invention.

In the relevant particular case, this base station is adapted for communicating with the UEs according to the radio protocol LTE (« Long Term Evolution ») defined by the 3GPP consortium.

30 In a known way, the LTE protocol defines communication rules specific to the user terminals and communication rules specific to the base stations.

The base station according to the invention is called an e2NB station (« enhanced eNB »).

35 The e2NB comprises a block eNB 1, a set 2 of vUE(s), a management unit 3, an MME block 4, an HSS (for « Home Subscriber Server ») block 5 and a router 6.

A vUE is a virtual user terminal.

In an embodiment, a vUE is adapted for applying the same protocols and functionalities as the real user terminals.

In the relevant embodiment, the block eNB 1 and the set 2 of vUE(s) of the e2NB
5 are shared with a radio treatment chain adapted for applying the radio protocol LTE and comprising:

- a radio transceiver antenna defining a radio coverage area of the e2NB (which is the same as the radio coverage area of the vUEs of the set 2) and

- a radio transceiver module notably adapted for modulating/demodulating the
10 signals: it thereby receives a radiofrequency signal provided by the antenna, amplifies it, filters it and lowers the useful signal of the radiofrequency carrier into a base band signal, and then digitizes it; it further receives a useful signal in digital form to be emitted, de-digitizes it, the module with a radiofrequency carrier and delivers it to the antenna.

In other embodiments of the invention, the block eNB 1 and the set 2 of vUE(s) of
15 the e2NB share several radio treatment chains adapted for applying the radio protocol LTE (for example three radio chains, each with a radio transceiver module and an antenna covering a distinct portion of the space of 120 degrees in the horizontal plane, thereby allowing coverage of the whole space).

The e2NB according to the invention further includes a microprocessor and a
20 memory (not shown) storing software instructions. The e2NB is for example adapted for carrying out at least certain of the operations described below, following the execution of the software instructions, on the microprocessor.

25 **eNB block**

The eNB block 1 carries out the functions of an eNB LTE of the prior art relatively to the user terminals (other than those of its set 2 of vUE(s)) located in its radio coverage area: these user terminals comprise actual user terminals and the vUE(s) being part of other e2NBs located in its radio coverage area.

30 Thus the block eNB 1 is adapted for regularly emitting, via the radio treatment chain, beacon signals giving the possibility to each of these user terminals, either real and virtual, of detecting it and of being synchronized with it and obtaining from the block eNB 1 the allocation of resources for exchanging signaling data and if necessary applying an operation for attachment to the eNB1 block of the e2NB.

A UE, either virtual or real, wishing to transmit useful data (i.e. data other than signaling data) to an addressee, has to be attached to the block eNB 1 of an e2NB according to the invention, for communicating these data via this e2NB.

During an operation for attachment to the block eNB 1 of the e2NB, a real or
 5 virtual user terminal transmits to the eNB 1 identification and authentication data of the SIM type of this user terminal. In the case of a real UE, these data are based on elements stored in the SIM card of the UE. In the case of a virtual UE, they are based on elements transmitted by the management unit of the e2NB within which the UE was generated.

10 The eNB 1 receives this information, and then provides it to the MME block 4, which applies the steps indicated in the standard LTE standard with view to proceeding with the identification, with the confirmation that the identified user terminal is actually authorized to communicate with the e2NB and to the authentication of the user terminal.

eNB 1 then receives the MME block 4, the confirmation of the proper occurrence
 15 of the identification, of the authentication and of the attachment or the notification of its failure.

By "UE attached to e2NB", is meant a UE, either real or virtual, having achieved successfully an operation for attachment to the eNB 1 of this e2NB.

20 Once the UE is authenticated, when a communication is applied with the UE, the eNB 1, which is used as a termination of the IP flow transmitted by the UE, provides this flow IP to the router 6 so that the latter directs it adequately according to the addressee of the flow.

When an attached UE is a real or virtual UE, the block eNB 1 indicates to the
 25 management unit 3 the links established with this thereby identified UE, as well as an identifier of the UE, such that the IMSI ("International Mobile Subscriber Identity") of the UE transmitted through the UE during the identification procedure and which is unique and related to the SIM card ("Subscriber Identity Module") or else its IMEI ("International Mobile Equipment Identity"), optionally associated with the IP address of the UE provided
 30 by the MME.

When the attached UE is a vUE of a neighboring e2NB, the management unit 3 determines the identifier of this neighboring e2NB by means of an example of a correspondence table comprising a list of IMSIs of vUEs and indicating for each of the IMSIs, the identifier of the E-CGI cell ("EUTRAN Cell Global Identifier") (or the Global
 35 eNB ID) corresponding, which gives it the possibility of determining to which e2NB belongs a vUE.

It will be noted that an identifier of an e2NB is also an identifier of the block eNB which it includes and vice versa, insofar that there is only one eNB block in an e2NB.

Set of vUE(s)

5 The set 2 of vUE(s) includes one or several virtual UEs.

Each of these virtual UEs within the e2NB is generated (i.e. instantiated) by the management unit 3.

With each vUE are thereby associated a single identifier IMEI and an SIM service (IMSI and associated key) as described in the following.

10 At the LTE level, the vUE has all the functionalities of a conventional UE, notably it is adapted for decoding the messages which are transmitted to it, coding those which it transmits, achieving an attachment procedure, and this independently of the other vUEs (at the implementation level, this amounts to launching a new instance ("thread") of the program applying the attachment operations, by passing to it as a parameter the IMEI,
15 which will generate gradually during the time-dependent change in the connection of the vUE, the elements required for its operation, such as the different buffer memories ("buffers") for different protocol layers of the ISO model etc.).

It should also inform during the establishment of the RRC connection ("Radio Resource Control") with the eNB, on its material capacities at the radio chain. The latter
20 depend on the actual radio chain of the e2NB, information should therefore be provided relating to the latter to the vUE.

Upon starting the e2NB, a single vUE is instantiated; it is adapted for carrying out the regular radio scanning operations according to the LTE protocol section relative to the user terminals for detecting the neighboring e2NBs, i.e. the e2NBs other than the
25 e2NB within which the vUE was generated and which are found within radio range of the vUE, and for indicating them to the management unit 3.

The radio coverage of the vUE is that of the e2NB within which it was generated (since they use the same radio chain). It is co-localized with the e2NB.

In this example, a vUE can only be attached to a single e2NB of the radio vicinity
30 (in other embodiments, a vUE may be attached simultaneously to several e2NBs of the radio vicinity) and like in the case of an actual UE, the useful communication data, emitted or received by the vUE, borrow the radio links between the vUE and the attachment e2NB which were reserved for the vUE by the attachment e2NB.

The attachment e2NB is selected by a vUE according to a black list of e2NBs
35 and/or a white list of e2NBs provided by the management unit 3. The black list comprises

the e2NBs on which attachment is not authorized and the white list comprises the e2NBs on which attachment is authorized.

A virtual UE is adapted for carrying out, with a selected e2NB, the attachment operations according to the protocol LTE section relative to the user terminals.

- 5 The identification and authentication data of the SIM type specific to each vUE (more generally the service of the SIM type) and which are required for the attachment operation are provided to each vUE of the assembly 2 of vUE(s) by the management unit 3.

- 10 When a vUE of the assembly 2 of vUE(s) is attached to an e2NB, the vUE notifies to the management unit 3 the identifier of this e2NB to which it is attached or the identifier of the eNB block 1 of this e2NB (for example E-CGI or Global eNB ID of the eNB 1).

- 15 A virtual UE, once attached to a neighboring e2NB, is adapted for emitting and receiving data, via this attachment e2NB, with a network according to the invention comprising base stations, of the eNBs type or e2NBs type, connected together via vUEs and comprising the user terminals, either real and virtual, attached to these base stations.

- 20 The radiofrequency emission and the radiofrequency reception of packets by a vUE of the assembly 2 are applied by using the radio treatment chain of the e2NB, on the radio links assigned to the vUE through its attachment e2NB.

Management unit

The management unit 3 is adapted for controlling the generation, the suppression and the operation of each vUE of the assembly 2 of vUE(s).

- 25 It is adapted for determining, subsequently to the reception of the indication of neighboring detected e2NBs transmitted by a vUE of the assembly 2, that a novel connection with one of these detected e2NBs is to be applied (for example when this detected e2NB is not part of the list of the neighboring e2NBs held by the e2NB as described below).

- 30 When such a new connection with a neighboring e2NB is to be applied, the management unit provides for example a white list indicating this neighboring e2NB to a vUE generated earlier and not presently attached if it exists, in order that it proceeds with the attachment operation. And if all the vUE(s) of the assembly 2 are presently attached, the management unit 3 generates an additional vUE which may thus be attached to the
35 detected neighboring e2NB.

It will be noted that in an embodiment, the management unit does not authorize an attachment between a vUE of the assembly 2 and a neighboring e2NB in the case when a virtual terminal of this neighboring e2NB is already attached to the e2NB.

In this case, the neighboring eNB appears for example in the black list of each
5 new vUE.

The management unit 3 is adapted for controlling and steering the topology of the meshed network of e2NBs for the determination of the white and black lists of e2NBs respectively provided to the vUEs.

The management unit 3 is further adapted for distributing between the block
10 eNB1 and each of the vUEs of the assembly 2 the period (and/or the frequency) of the use of the radio treatment chain of the e2NB.

The rules of this distribution for example depend on the respective needs as communicated by the block eNB 1 and each of the vUEs.

The management unit 3 is adapted for providing an SIM service to the vUEs of
15 the assembly 2 notably comprising the provision of identification and authentication elements of the SIM type to each vUE, so that the latter may accomplished successfully the attachment operations by then providing to the e2NB to which its determined identification and authentication data is intended to be attached according to the elements provided by the management unit. To do this, the management unit 3
20 comprises real and/or virtual SIM cards.

The management unit 3 is adapted for storing in memory and updating, the list of the real and virtual UEs, to which the block eNB1 is attached, depending on corresponding pieces of information which are provided to it by the block eNB1 indicating the attachment operations of UEs and of attachment failures.

25 The management unit 3 is adapted for storing in memory, and updating the list of the neighboring e2NBs.

This list of neighboring e2NBs details:

- the identifiers of the neighboring e2NBs (each matching of the identifier of the block eNB 1 of this e2NB) attached to the vUE(s) of the assembly 2, each of these
30 neighboring e2NBs being matched, in the list with the identifier of the vUE of the assembly 2 which is attached to it and the indication of the allocated radio links (or even further the performances of these links, for example the signal level, indicated by this vUE to the management unit 3); and/or

- the identifier on any neighboring e2NB including vUE(s) attached to the eNB
35 block 1, each of these neighboring e2NBs being matched, in the list with the identifier of the vUE attached to the block eNB 1 and the indication of the allocated radio links (or

even further the performances of these links, for example the signal level, indicated by the block eNB1 to the management unit 3).

In an embodiment, the management unit 3 is adapted for communicating with the management units 3 of other e2NBs (for example via respective vUEs) for sharing this
5 information of their list of neighboring e2NBs defining the current meshing of the network.

The management unit 3 is for example adapted for utilizing the information of its list of neighboring e2NBs, or even also information from the lists of the communicated neighboring e2NBs, so as to define/modify the meshing of the network with view to its improvement, by suppressing, adding vUEs (and therefore the corresponding links), or
10 by changing the attachment e2NB of the vUEs.

The management unit 3 is adapted for defining the routing rules notably according to this current topology.

The management unit 3 is further adapted for defining the addressing rules IP.

It will be noted that a vUE of the assembly 2 may be generated by the
15 management unit 3 when there already exists a link between the e2NB and a neighboring e2NB (via a user terminal generated in the e2NB or the neighboring e2NB), but the needs in terms of communication flow rate between them requires additional communication capacities.

20 **MME block**

The MME block achieves the functions of an MME LTE of the prior art except that it is only capable of receiving the parameters and lists of IP addresses which it may give to the UEs which are connected via the management unit 3 (instead, the MME in the LTE network of the prior art recovers this via the S/P-GW).

25 The MME block 4 upon receiving each request for attachment of a UE, either virtual or real, indicating the identification and authentication elements and relayed by the block eNB 1, is adapted for requesting in turn at the HSS block 5 the information for confirming that the UE is well authorized to communicate on the network and is correctly authenticated.

30 Further, once the UE, either real or virtual, authenticated with success, the MME block provides an IP address to the UE (or vUE) at the origin of the procedure (it should be noted that in an embodiment, the UE may otherwise obtain an IP address at the router 6, which plays here the role of the S/P-GW of a conventional LTE network).

35 **HSS block**

The HSS block achieves the functions of an HSS LTE of the prior art.

The HSS block 5 includes a list defining the authorized UEs, real and virtual. This list of the authorized UEs includes in reality, in the relevant case, the cryptographic keys associated with the SIM cards.

5 This list includes the whole of the keys of the real UEs of the network authorized for communicating, and the whole of the keys of the virtual UEs authorized to communicate and which may be instantiated by the e2NBs of the network which would be found within the radio coverage of the relevant e2NB.

10 The authentication procedure specified in the LTE protocol (« Authentication and Key Agreement » Section, so called AKA section) allows the block MME 4, acting as an MME with the help of the HSS block 5 acting as an HSS, to proceed with the authentication.

Router

15 The router 6 is adapted for receiving data packets received by an element of the e2NB (a vUE of the assembly 2 or the block eNB1), for detecting, according to the routing rules which have been provided to it by the management unit 3, to which element of the e2NB (from among which the vUEs of the assembly 2 and of the block eNB1) or to which interface of the e2NB (for example an external connection of the Ethernet type) a received packet has to be relayed or delivered as the final addressee, depending on the
20 element of the e2NB or on the interface of the e2NB (for example an external connection of the Ethernet type) which has passed it on to the router 6 and/or of the final addressee of the packet.

25 In the LTE architecture of the prior art, the gateway P-GW ("Packet Gateway") is used as an end for the user flows as well as for the router flows in order to direct the latter towards other networks or on the network of the operator. But the connection between eNB and P-GW adds a protocol layer (and the associated burden) in order to cross transparently the network elements between the eNB and the P-GW, or the e2NB
30 is an "all-in-one" entity with co-localized elements and does not require such a mechanism. Thus, the S-GW and P-GW are not implemented in the e2NB in the particular embodiment described above in order to simplify the operation but may then be simplified in the case of a specific need.

The exchanges applied by the elements referenced from 1 to 6 of the e2NB within the scope of their operation according to the invention as described above notably include the exchanges described below with reference to fig. 2.

5 A vUE of the assembly 2 of vUE(s) applies exchanges 100 via a radiofrequency route with the neighboring e2NBs, among which the attachment procedures to a neighboring e2NB, the radiofrequency reception of data packets send by the neighboring e2NB to which the vUE is attached and the radiofrequency emission by the vUE of data packets which it emits, via the physical resources (time/frequency) which are allocated to it through its attachment e2NB.

10 The eNB block 1 applies exchanges 101 via a radiofrequency route with the neighboring real and virtual UEs, among which the attachment procedures to a neighboring e2NB, the radiofrequency reception of data packets emitted by an UE which is attached to it on the ascending link which is assigned to it, the radiofrequency emission by the block eNB 1 of data packets which it emits towards a UE which is
15 attached to it, on the descending route allocated to this UE.

The assembly 2 of vUEs applies exchanges 103 with the management unit 3, comprising:

- Indication by each vUE to the management unit 3, of the detected neighboring eNBs, attached, of the needs for resources in emission, in
20 reception;
- The exchanges required for instantiating by the management unit 3 a new vUE;
- the provision of a white list and of a black list to each vUE by the management unit 3;
- 25 - assignment to a vUE by the management unit 3 of frequency and time resources for using the radio treatment chain (giving rise if necessary, in LTE, to a frequency and time multiplexing);
- the provision by the management unit 3 to each vUE of a service of the SIM type.

30 The block eNB 1 applies the exchanges 104 with the block MME 4 and the block MME 4 applies exchanges 105 with the block HSS 5 according to the procedure AKA for an attachment operation.

The eNB block 1 applies exchanges 106 with the router 6 comprising:

- providing IP packets by the block eNB 1 to the router 6 and providing IP packets
35 by the router 6 to the eNB block 1;

The router 6 applies with the management unit 3 exchanges 107 comprising:

- providing by the management unit 3 to the router 6 of routing rules;
- the provision of IP packets to the router 6 by the management unit 3 and the provision of IP packets by the router 6 to the management unit 3 (for example intended for the other management units of other e2NBs for the exchange of information).

5 The router 6 applies with the assembly 2 of vUE(s) of the exchanges 109 comprising the provision of IP packets to the router 6 by the vUE(s) and the provision of IP packets by the router 6 to the vUEs.

The management unit 3 applies exchanges 108 with the block eNB 1 comprising:

- 10 - assigning to the eNB 1 by the management unit 3 of frequency and time resources for using the radio treatment chain (or radio treatment chains in the embodiments wherein the e2NB includes several radio treatment chains);
- the indication by the block eNB 1 to the management unit 3 of the real and virtual UEs which are presently attached to the e2NB;
- 15 - indicating, by the block eNB 1 to the management unit, of its present needs for resources in emission, in reception.

 The router 6 applies with external interface(s) of the e2NB such as an interface with an Ethernet network, exchanges 110 comprising the provision and reception of IP
20 packets.

The MME block 4 applies with the management unit 3 exchanges 111 relative to the parameters and lists of IP addresses which the block MME 4 gives to the UEs which connect onto the base of IP addressing rules which the management unit 3 provides beforehand to the block MME 4.

25 The means for communication between ships of a fleet are strategic for maintaining the control and the sharing of information in real time between the different forces and allows making a rapid decision facing the encountered events.

 The capacity for establishing a robust, reliable and low latency communication channel between different actors such as surface ships, surface or air drones, is a key
30 point of the success of an operation.

 The invention proposes a novel concept of base stations (e2NodeB), allowing the high throughput communication according to the LTE protocol conventionally with UE terminals, modified in order to allow communications directly between each other also according to the LTE radio protocol, by using the same material resources (notably radio
35 treatment chain) as those which they have for exchanging with real UEs.

The ships each equipped with e2NB according to the invention may thereby provide a communication service to their movable users while allowing the ships to connect to each other and established a meshed network of e2NBs.

Fig. 3 is a view of a meshed network including e2NBs according to the invention
5 connected between them via virtual UEs.

This meshed network at the relevant moment includes 7 e2NBs similar to the one shown in fig. 2: e2NB1, e2NB2, e2NB3, e2NB4, e2NB5, e2NB6 and e2NB7.

The e2NBs are for example installed on ships such as respective ships. The real terminals are for example possessed by movable users which may move from ship to
10 ship, or leave the ships by boats or other means.

Each e2NB is schematically illustrated by a rectangle in dotted lines including a block eNB and virtual terminal(s).

Thus, the e2NB1 includes a virtual terminal, the e2NB2 includes two virtual terminals. The radiofrequency links stemming from the attachment of an e2NB to a
15 neighboring virtual terminal are illustrated in solid lines, while the links stemming from the attachment between a real UE and an e2NB are illustrated in dotted lines.

The e2NBs thus dynamically connect to each other via their vUEs thereby generating a meshed wired network allowing communications between e2NBs, between UEs attached to these eNBs, and between eNBs and UEs.

20 When two e2NBs are within radio range of each other, links were generated between them: it is necessary that two e2NBs are found localized relatively to each other so that each is found in the radio coverage of the other so that these two e2NBs connect to each other via a vUE.

Sometimes the links between e2NBs are doubled: for example a virtual terminal
25 of e2NB4 is attached to the e2NB6 and symmetrically a virtual terminal of e2NB6 is attached to the e2NB4.

In a meshed network, a communication is applied comprising the transport of data packets along the path marked by the symbols "+", between the real UE attached to the e2NB3 and the real UE attached to the e2NB5, via the following elements:

- 30 - from the real UE attached to the block eNB of the e2NB3, and then
- from the block eNB of e2NB3 via the router of e2NB3 to the virtual terminal of the e2NB4 attached to the e2NB3,
- from the virtual terminal of the e2NB4 attached to the e2NB3 to the block eNB of the e2NB4 via the router of the e2NB4,
- 35 - from the block eNB of the e2NB4 to the virtual terminal of the e2NB5 attached to the e2NB4,

- from the virtual terminal of the e2NB5 attached to the e2NB4 to the block eNB of the e2NB5 via the router of the e2NB5,
- from the block eNB of the e2NB5 to the real UE attached to the e2NB5, via the router of e2NB5.

5 Of course, the router in each e2NB includes routing tables. In an embodiment, a routing table within an e2NB includes a list of addresses, corresponding to the destination addresses within the network; this routing table indicates for each address of the list, towards each element of the e2NB (management unit, vUE, bloc eNB, interface Ethernet...) the router has to route a data packet for which the destination address
10 corresponds to this address. The destination addresses may be addresses of real UEs, virtual UEs, of a management unit, of blocks eNB, of Ethernet interfaces etc. The table for example further indicates an identifier of a mask (when the element of e2NB towards which the router is the management unit, a vUE, the block eNB) or further an identifier of a gateway (when the element of the e2NB towards which router is an external interface).

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Another communication is for example applied, comprising the transport of data packets along the path marked by the succession of symbols "+" and "-", from an external network interfaced to e2NB1 intended for an external network interfaced at e2NB7 via the following elements:

- 20 - from the external network interfaced with e2NB1, via the router of e2NB1, to the block eNB of the e2NB1,
- from the block eNB of the e2NB1 to the vUE in e2NB2 which is attached to e2NB1,
- from the vUE in e2NB2 which is attached to the e2NB1, via the router, to the
25 vUE in the e2NB2 which is attached to the e2NB4,
- from the vUE in e2NB2 which is attached to the e2NB4 at the block eNB of the e2NB4,
- from the bloc eNB of the e2NB4, via the router of the e2NB4, to the vUE of e2NB4 which is attached to the e2NB6,
- 30 - from the vUE of e2NB4 which is attached to the e2NB6, to the block eNB of the e2NB6,
- from the bloc eNB of the e2NB6, via the router of the e2NB6, to the block eNB of the e2NB6,
- from the block eNB of the e2NB6 to the vUE of e2NB7 attached to the
35 e2NB6,

- from the vUE of the e2NB7 attached to the e2NB6 to the router of e2NB7, and then from the router of e2NB7 to the external interface of e2NB7.

The concept is of course not limited to a naval use and its use on land is just as
5 advantageous.

The invention has been described above more particularly relatively to a LTE radio protocol, but of course applied relatively to other radio protocols.

In the particular embodiment described above, the e2NB comprises a block eNB 1, an assembly 2 of vUE(s), a management unit 3, a MME block 4, an HSS block 5 and a
10 router 6. In another embodiment of the invention of the e2NBs, communications/connections (notably physical and of the first LTE layers) between base stations e2NB are established without using any block MME and/or any block HSS and/or of the router, but only with the block eNB, the vUEs and the management unit (the routing is for example in such a case directly applied at the block eNB, in lower layers
15 than the IP layer).

CLAIMS

1.- A base station (e2NB) for a radiocommunications network comprising an
5 assembly of base stations and of first user terminals,
said base station comprising:

- a radio interface module adapted for emitting and receiving radiofrequency data; and
- a control block (eNB 1) adapted for establishing a communication link and
10 communicating over said link with at least one first user terminal according to a radio protocol comprising a radio protocol section specific to the base stations and a radio protocol section specific to the user terminals, by using said radio interface module,

said base station being characterized in that it further comprises a management unit (3) adapted for generating a plurality of second user terminals (vUEs), said second
15 user terminals generated being virtual user terminals adapted for communicating according to said radio protocol with neighboring base stations of said base station, by using said radio interface module.

2.- The base station (e2NB) according to claim 1, wherein the management unit
20 (3) is adapted for selectively distributing the use of the radio interface module between the control block (eNB 1), for the communication between said control block (eNB 1) and said at least one first user terminal, and the second virtual terminals for their communication with neighboring base stations.

25 3.- The base station (e2NB) according to claim 1 or 2, wherein the management unit (3) assigns to each second virtual terminal a respective identifier.

4.- The base station (e2NB) according to any of the preceding claims, wherein
said communication protocol is compliant with the LTE standard.

30

5.- The base station (e2NB) according to any of the preceding claims, wherein a second user virtual terminal is adapted for regularly carrying out a radio scan and for detecting the neighboring base stations and for indicating to the management unit said detected neighboring stations,

35 said management unit being adapted for, when one of the detected neighboring base stations is not part of the neighboring base stations having a link established with

the second virtual terminals, generating a new second virtual terminal for applying communications between said new second virtual terminal and said detected neighboring base station.

5 6.- The base station (e2NB) according to any of the preceding claims, including a mobility management block (MME 4) and a base (HSS 5) of authentication information relative to the first and second user terminals, said mobility management block (MME 4) being adapted for, when the control block (eNB 1) receives, from a first user terminal, a request for applying a communication link with said base station according to said
10 communication protocol, for proceeding with the authentication of said first user terminal according to authentication elements indicated in the request and authentication information in the base relative to said first user terminal;

 and wherein the management unit (3) is adapted, when it generates a second virtual user terminal, for providing to said second virtual user terminal, authentication
15 elements specific to said second virtual terminal,

 each second virtual terminal being adapted for, when it emits a request for applying a communication link intended for a neighboring base station according to said communication protocol, inserting, in said request, said authentication elements provided by the management unit.

20

 7.- The base station (e2NB) according to any of the preceding claims, wherein the management unit (3) is adapted for storing a list of the neighboring base stations connected to said base station, and

 - each second virtual terminal is adapted for indicating to the management unit
25 the neighboring base station with which it has an established current communication link, and the management unit is adapted for updating the list of neighboring base stations connected to said base station, by inserting into the list, said neighboring base station indicated, matched, in the list, with said second virtual terminal;

 - the control block (eNB 1) is adapted for indicating to the management unit said
30 first terminals with which it has established a current communication link, and when one of said first terminals is a virtual terminal of a neighboring base station of said base station, the management unit is adapted for updating the list by inserting therein said neighboring base station matched in the list, with said first virtual terminal.

35 8.- The base station (e2NB) according to claim 7, comprising a router (6) and wherein the management unit (3) is adapted for updating routing rules according to said

updated list of the neighboring base stations connected to said base station, said router being adapted for routing, according to routing rules updated by the management unit, selectively data towards the control block for emission towards the first user terminals or towards the second virtual terminals for emission towards neighboring base stations.

5

9.- A treatment method in a base station (e2NB) for a radiocommunications network comprising an assembly of base stations and of first user terminals, said base station comprising a radio interface module and a control block (eNB 1), comprising the following steps:

10 - emission and reception of radiofrequency data by the adapted radio interface module; and

 - establishment of a communication link by the control block (eNB 1) and communication by the control block (eNB 1) over said link with at least one first user terminal according to a radio protocol comprising a radio protocol section specific to the
15 base stations and a radio protocol section specific to the user terminals, by using said radio interface module,

 said method being characterized in that it comprises a step for generating, by a management unit (3) of said base station, a plurality of virtual second user terminals (vUEs) adapted for communicating according to said radio protocol with neighboring
20 base stations of said base station, by using said radio interface module.

10.- The treatment method in a base station (e2NB), according to claim 9, comprising a selective distribution step, by the management unit (3), of the use of the radio interface module between the control block (eNB 1), for the communication
25 between said control block (eNB 1) and said at least one first user terminal, and the second virtual terminals for their communication with neighboring base stations.

11.- The treatment method in a base station (e2NB) according to claim 9 or 10, according to which the management unit (3) assigns to each second virtual terminal a
30 respective identifier.

12.- The treatment method in a base station (e2NB) according to any of claims 9 to 11, according to which said communication protocol is compliant with the LTE standard.

35

13.- The treatment method in a base station (e2NB) according to any of claims 9 to 12, according to which a second virtual user terminal regularly carries out a radio scan, detects neighboring base stations and indicates to the management unit said detected neighboring stations,

5 and according to which when one of the detected neighboring base stations is not part of the neighboring base stations having a link established with the second virtual terminals, said management unit generates a new second virtual terminal for applying communications between said new second virtual terminal and said detected neighboring base station.

10

14.- The treatment method in a base station (e2NB) according to any of claims 9 to 13, according to which, when the control block (eNB 1) receives, from a first user terminal, a request for applying a communication link with said base station according to said communication protocol, a mobility management block (MME 4) of the base station
15 proceeds with the authentication of said first user terminal according to authentication elements indicated in the request and of authentication information relative to said first user terminal and stored in a base (HSS 5) of the base station comprising authentication information relative to the first and second user terminals;

 according to which the management unit (3), when it generates a second virtual
20 user terminal, provides said second virtual user terminal, authentication elements specific to said second virtual terminal,

 each second virtual terminal, when it emits a request for applying a communication link intended for a neighboring base station according to said communication protocol, inserts, in said request, said authentication elements provided
25 by the management unit.

15.- The treatment method in a base station (e2NB) according to any of claims 9 to 14, according to which the management unit (3) stores a list of the neighboring base stations connected to said base station, and

30 - each second virtual terminal indicates to the management unit the neighboring base station with which it has established a current communication link, and the management unit updates the list of the neighboring base stations connected to said base station, by inserting into the list, said indicated neighboring base station, matched, in the list, with said second virtual terminal;

35 - the control block (eNB 1) indicates to the management unit said first terminals with which it has established a current communication link, and when one of said first

terminals is a virtual terminal of a neighboring base station of said base station, the management unit updates the list by inserting therein said neighboring base station, matched, in the list, with said first virtual terminal.

- 5 16.- The treatment method in a base station (e2NB) according to claim 15, according to which the management unit (3) updates routing rules according to said list updated with the neighboring base stations connected to said base station, and a router of the base station routes, according to routing rules updated by the management unit, selectively data towards the control block for emission towards the first user terminals or
10 towards second virtual terminals for emission towards neighboring base stations.