

(21) Application No: 1213787.3

(22) Date of Filing: 02.08.2012

(71) Applicant(s):
Renesas Mobile Corporation
(Incorporated in Japan)
6-2, Otemachi 2-Chome, Chiyoda-Ku 100-0004,
Tokyo, Japan

(72) Inventor(s):
Brian Alexander Martin
Keiichi Kubota
Tero Henttonen
Jari Isokangas
Samuli Turtinen
Wei Bai

(74) Agent and/or Address for Service:
EIP
Fairfax House, 15 Fulwood Place, LONDON,
WC1V 6HU, United Kingdom

(51) INT CL:
H04W 48/18 (2009.01) H04W 36/16 (2009.01)
H04W 52/02 (2009.01)

(56) Documents Cited:
GB 2403870 A1 WO 2011/147439 A1
WO 2002/003733 A1 US 20100273486 A1
US 20090068969 A1

(58) Field of Search:
INT CL H04W
Other: EPODOC, WPI, XP3GPP, TXTUS1, TXTUS2,
TXTUS3, TXTUS4, TXTEP1, TXTGB1, TXTWO1

(54) Title of the Invention: **Wireless devices, methods and apparatus and computer programs therefor**
Abstract Title: **Selecting a different radio access technology in order to achieve power savings**

(57) A wireless device operates under network control. The wireless device operates using a first radio access technology under control of a network control apparatus 204. The wireless device determines that using a different radio access technology would consume less power 210. The wireless device signals to the network control apparatus that it would like to use the different radio access technology in order to achieve power savings 220 (e.g. by sending a SIGNALLING CONNECTION RELEASE INDICATION (SCRI) message). When the network receives a request to use a different radio access technology in order to achieve power savings at the wireless device, the network transmits a signal that at least one of: (i) redirects the wireless device to the different radio access technology in response to receipt by the network control apparatus of the signalling from the wireless device; (ii) changes cell reselection priorities of the wireless device such that the different radio access technology has a higher priority; and (iii) hands over the wireless device to a cell that uses the different radio access technology. The wireless device may monitor power consumption over time for different applications running on the device or for different activity states of the device.

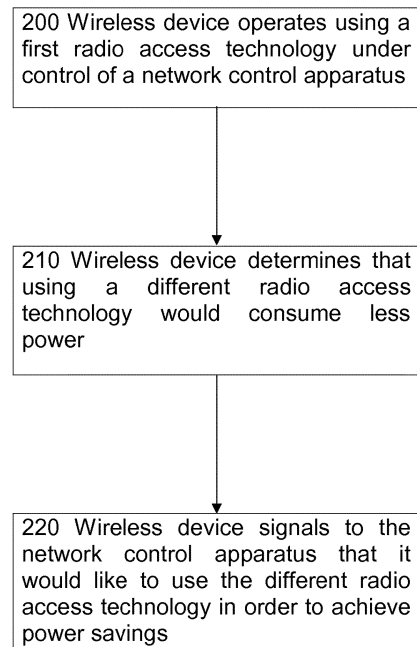


Fig. 2

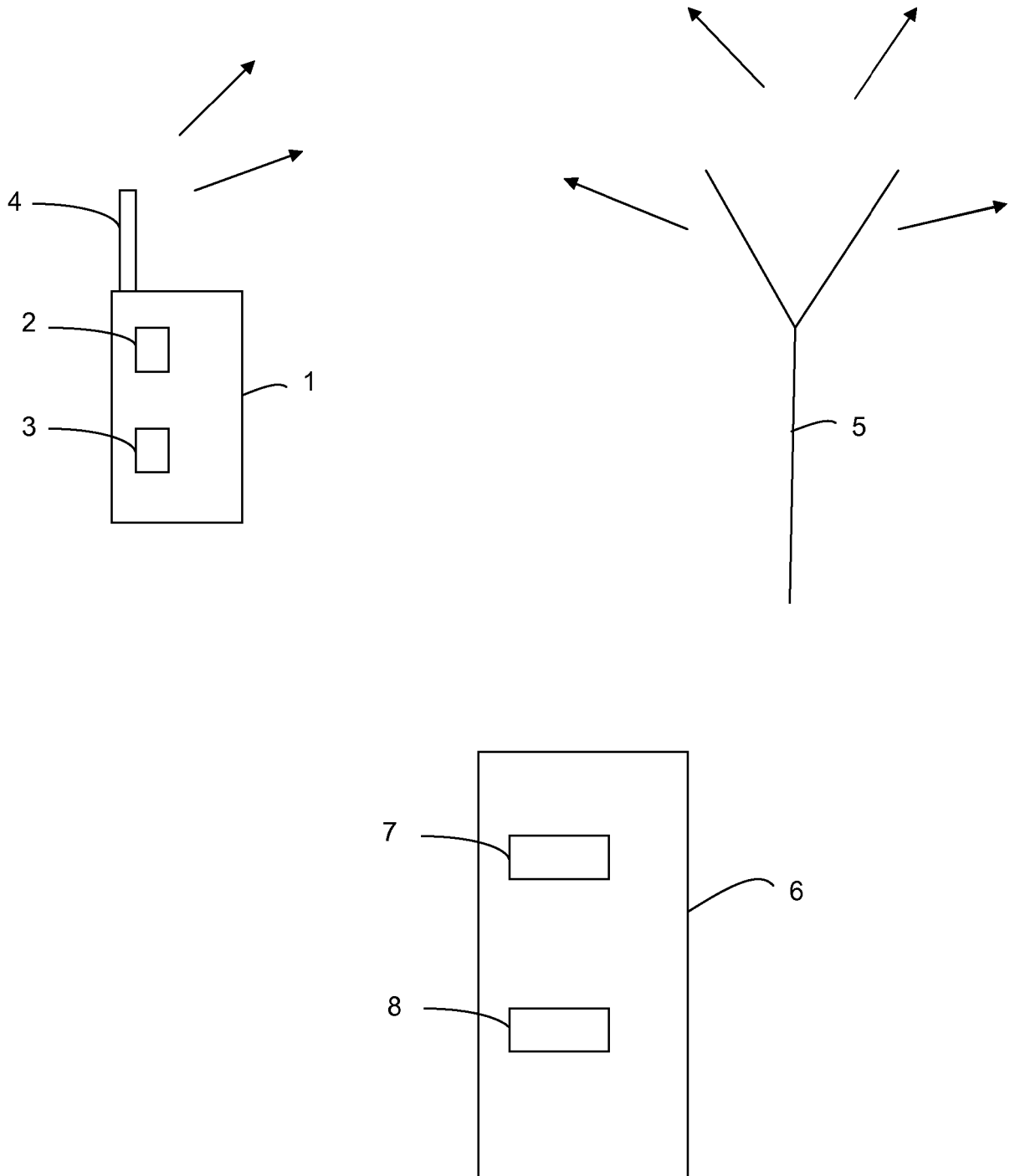


Fig. 1

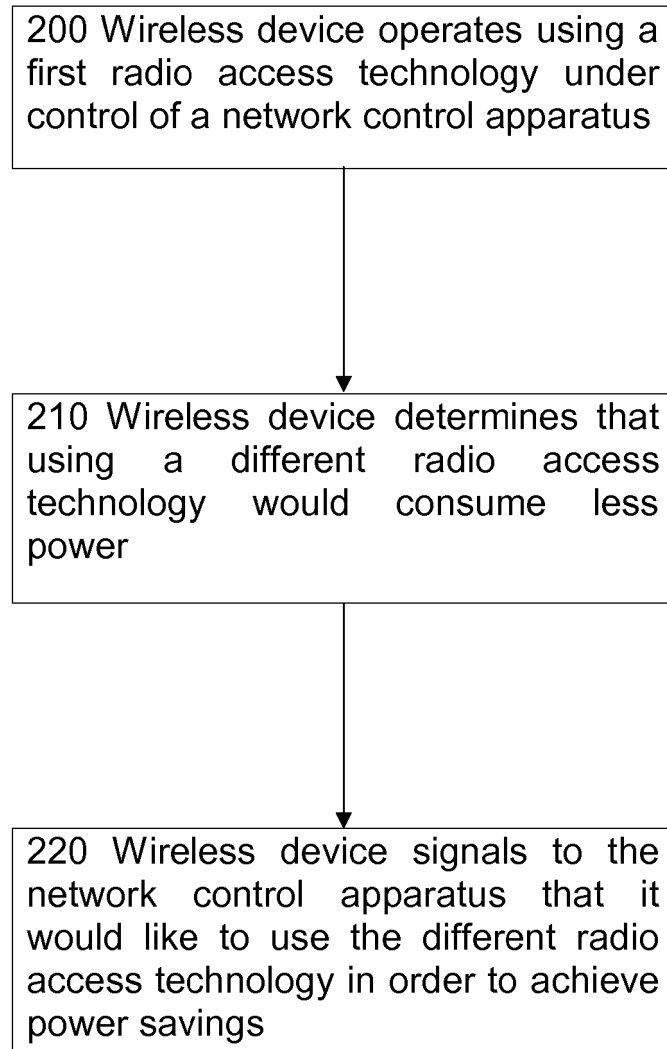


Fig. 2

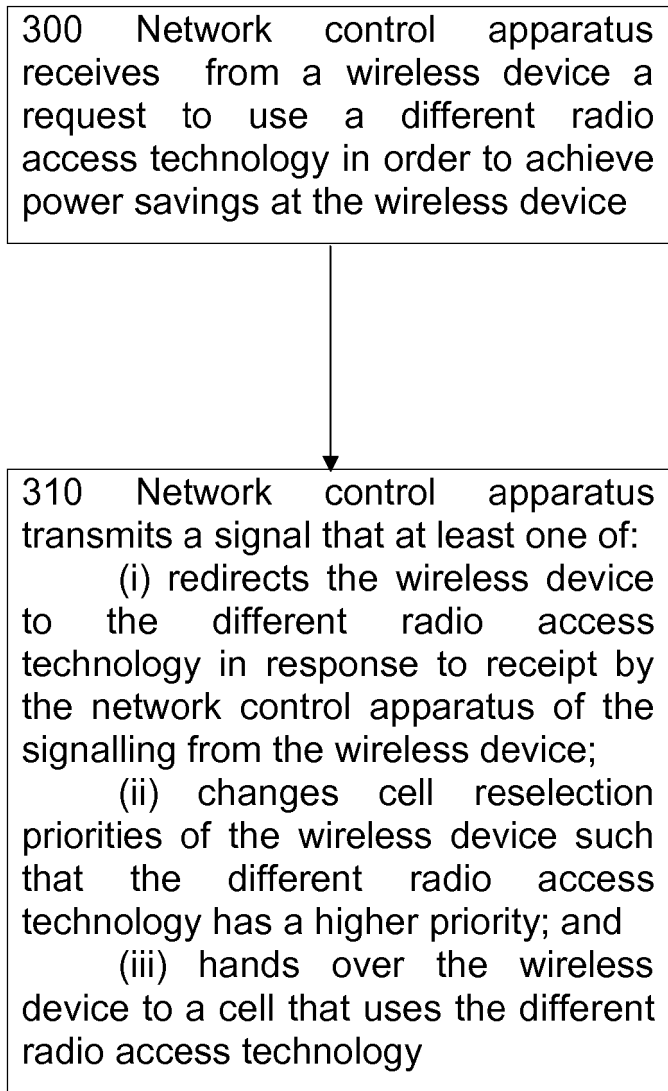
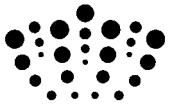


Fig. 3



The following terms are registered trademarks and should be read as such wherever they occur in this document:

Skype
YouTube

WIRELESS DEVICES, METHODS AND
APPARATUS AND COMPUTER PROGRAMS THEREFOR

Technical Field

5 The present invention relates to a method of operating a wireless device, apparatus for a wireless device, a method of operating a network control apparatus, apparatus for a network control apparatus, and computer programs therefor.

Background

10 The following abbreviations are used in the present specification:

	3GPP	Third Generation Partnership Project
	CPC	Continuous Packet Connectivity
	DRX	discontinuous reception
	eNB	evolved Node B
15	EUTRAN	Evolved UTRAN
	FD	Fast Dormancy
	GERAN	GSM-Enhanced Data Rates for Global Evolution (EDGE) RAN
	GPS	Global Positioning System
	GSM	Global System for Mobile Communications
20	IDC	in-device coexistence
	LTE	Long Term Evolution
	PS	packet switched
	RAN	radio access network
	RAT	radio access technology
25	RF	radio frequency
	RRC	radio resource control
	SCRI	signalling connection release indication
	UE	user equipment
	UMTS	Universal Mobile Telecommunications System
30	URA	user registration area
	UTRAN	Universal Terrestrial Radio Access Network

WLAN wireless local area network

Wireless networks have in recent years experienced a considerable increase in the amount of data being transmitted to and from wirelessly connected devices or “user equipment” (UE). The traffic characteristics of this data traffic are very different from that of traditional mobile phones, and can be characterised by its use of a lot of background signalling and bursty traffic consisting of relatively small data packets. The introduction of machine-type communications to the networks can also be expected to follow this trend. As a result, wireless networks need to implement new mechanisms to cope with this new traffic and make efficient use of the available resources while providing high capacity and throughputs and minimum delays. Of particular concern in improving the support of this low volume, bursty data is minimising the signalling load on the network and improving the power consumption of the user equipment.

15

In general, in many types of wireless systems, the user equipment is typically in one of a number of predefined activity states. These may be for example an idle state, a paging state in which the user equipment checks a paging channel for incoming paging messages at predefined time intervals and has an RRC (Radio Resource Control) connection, and one or more data connection states in which the user equipment can actively transmit and receive data. In general, these states use increasingly more power at the user equipment and also more network signalling. In order to minimise power consumption, particularly to maximise battery life before recharging is required, the user equipment is often caused to operate in a state having a low or the lowest power consumption possible, depending on for example the operational demands of the user equipment and/or network requirements. A particular concern from the perspective of the wireless network operator is to keep down the amount of control signals that have to be passed to and from the user equipment in order to cause the user equipment to transition between states, and/or to allow the user equipment to send or receive data, and/or to locate the user equipment.

30

As a particular example, Fast Dormancy (FD) is a 3GPP (Third Generation Partnership Project) feature specified from Release 8 for UMTS (Universal Mobile Telecommunications System) which allows the UE to request that the network reconfigure the UE into a more power efficient state by the UE indicating that packet data transfer has ended. This feature allows the UE to optimise the power consumption particularly during bursty packet data transfer, which is a typical characteristic of the data activity of smart phones. To initiate Fast Dormancy, the UE sends a SIGNALLING CONNECTION RELEASE INDICATION (SCRI) message to the network. This message triggers the network to send a signal to the UE to cause the UE to move into a more power efficient state, which effectively provides the network with control over this procedure. The focus of this approach to date has been on the UE being moved to a state that has a longer DRX (discontinuous reception) period or to provide a configuration for the UE that has longer DRX and/or faster inactivity timers. In DRX, in simple terms, during inactive periods the UE enters a low power state (which may be for example an IDLE state) in which inter alia its receiver is turned off to save power, with the UE periodically “waking” and moving to some connected state in which it can receive signals from the network. Likewise, in LTE (Long Term Evolution), the UE is again able to indicate to the network that it would like to be moved to a state or configuration that uses less power.

20

By way of further background, in LTE Release 11 there is provision for “in-device coexistence” or IDC. A UE may be equipped with for example LTE, WiFi, and Bluetooth transceivers. Due to the extreme proximity of multiple radio transceivers within the same UE, the transmit power of one transmitter may be much higher than the received power level of another receiver. It can happen that different radio technologies within the same UE operating on adjacent or similar frequencies can cause severe interference to each other. There are a number of proposals for dealing with this, including changing the frequency used by at least one of the radio technologies if interference occurs, changing the timing of transmissions, and changing the DRX periods.

30

Summary

According to a first aspect of the present invention, there is provided a method of operating a wireless device under network control, the method comprising:

5 the wireless device operating using a first radio access technology under control of a network control apparatus;

the wireless device determining that using a different radio access technology would consume less power; and

the wireless device signalling to the network control apparatus that it would like to use the different radio access technology in order to achieve power savings.

10

This allows a wireless device to indicate to a network control apparatus (often simply referred to as “the network” by convention in this field) its preference to move to using another radio access technology in order to operate in a more power efficient way. In examples, various criteria may be used by the wireless device to make the determination that using a different radio access technology would consume less power.

15

In an embodiment, the wireless device signals to the network control apparatus plural different radio access technologies that it would like to use in order of preference in order to achieve power savings.

20

In an embodiment, the wireless device monitors power consumption over time when using the first radio access technology and when using a different radio access technology so as to be able to determine that using the different radio access technology would consume less power. In an embodiment, the wireless device monitors power consumption over time for different applications running on the wireless device. These embodiments enable the wireless device to effectively “learn” which radio access technology provides or is most likely to provide the most power-efficient operation. This thus allows for the fact that for example different applications running on the wireless device may consume different amounts of power,

25
30

and will do differently according to the particular usage by the user of the wireless device.

5 In an embodiment, the wireless device monitors power consumption over time for different activity states of the wireless device.

In an embodiment, the wireless device estimates power consumption based on network configuration, or the wireless device configuration, or the network configuration and the wireless device configuration.

10

In an embodiment, the first radio access technology is Universal Mobile Telecommunications System (UMTS), the wireless device signalling to the network control apparatus that it would like to use the different radio access technology in order to achieve power savings by sending a SIGNALLING CONNECTION
15 RELEASE INDICATION message to the network control apparatus, the SIGNALLING CONNECTION RELEASE INDICATION message including an indication that the wireless device wants to use a different radio access technology and a cause indicative of power saving. The different radio access technology may be at least one of Long Term Evolution Evolved Universal Terrestrial Radio Access
20 Network (LTE EUTRAN), Global System for Mobile Communications Enhanced Data Rates for Global Evolution Radio Access Network (GERAN), and Universal Terrestrial Radio Access Network (UTRAN). Other RATs may also be selected.

In an embodiment, the first radio access technology is Long Term Evolution
25 Evolved Universal Terrestrial Radio Access Network (LTE EUTRAN) and the different radio access technology is at least one of Universal Mobile Telecommunications System (UMTS), Global System for Mobile Communications Enhanced Data Rates for Global Evolution Radio Access Network (GERAN), and Universal Terrestrial Radio Access Network (UTRAN).

30

In an embodiment, the wireless device receives from the network control apparatus a signal redirecting the wireless device to use the different radio access technology in response to receipt by the network control apparatus of the signalling from the wireless device.

5

In an embodiment, the wireless device receives from the network control apparatus a signal that changes cell reselection priorities of the wireless device such that the different radio access technology has a higher priority.

10 In an embodiment, the wireless device is handed over by the network control apparatus to a cell that uses the different radio access technology.

According to a second aspect of the present invention, there is provided apparatus comprising a processing system for a wireless device, the processing system
15 being constructed and arranged to:

cause the wireless device to operate using a first radio access technology under control of a network control apparatus;

determine if using a different radio access technology would consume less power; and

20 cause the wireless device to signal to said network control apparatus that it would like to use the different radio access technology in order to achieve power savings.

According to a third aspect of the present invention, there is provided a
25 computer program for a wireless device, the computer program comprising instructions such that when the computer program is executed on a processing system of the wireless device, the wireless device is arranged to:

operate using a first radio access technology under control of a network control apparatus;

30 determine if using a different radio access technology would consume less power; and

signal to said network control apparatus that it would like to use the different radio access technology in order to achieve power savings.

According to a fourth aspect of the present invention, there is provided a method of operating a network control apparatus, the method comprising:

receiving, from a wireless device operating using a first radio access technology, a request to use a different radio access technology in order to achieve power savings at the wireless device; and in response thereto:

transmitting a signal that at least one of:

redirects the wireless device to the different radio access technology in response to receipt by the network control apparatus of the signalling from the wireless device;

changes cell reselection priorities of the wireless device such that the different radio access technology has a higher priority; and

hands over the wireless device to a cell that uses the different radio access technology.

According to a fifth aspect of the present invention, there is provided apparatus comprising a processing system for a network control apparatus, the processing system being constructed and arranged to:

upon receipt from a wireless device of a request to use a different radio access technology in order to achieve power savings at said wireless device, cause the network control apparatus to transmit a signal that at least one of:

redirects said wireless device to use the different radio access technology;

changes cell reselection priorities of said wireless device such that the different radio access technology has a higher priority; and

hands over the wireless device to a cell that uses the different radio access technology.

According to a sixth aspect of the present invention, there is provided a computer program for a network control apparatus, the computer program comprising

instructions such that when the computer program is executed on a processing system of the network control apparatus, the network control apparatus is arranged to:

upon receipt from a wireless device of a request to use a different radio access technology in order to achieve power savings at said wireless device, transmit a signal that at least one of:

redirects said wireless device to use the different radio access technology;

changes cell reselection priorities of said wireless device such that the different radio access technology has a higher priority; and

hands over the wireless device to a cell that uses the different radio access technology.

There may be provided a non-transitory computer-readable storage medium comprising a set of computer-readable instructions stored thereon, which, when executed by a processing system, cause the processing system to carry out a method as described above.

The processing systems described above may comprise at least one processor and at least one memory including computer program instructions, the at least one memory and the computer program instructions being configured to, with the at least one processor, cause the apparatus at least to perform as described above.

Further features and advantages of the invention will become apparent from the following description of preferred embodiments of the invention, given by way of example only, which is made with reference to the accompanying drawings.

Brief Description of the Drawings

Figure 1 shows schematically a wireless device operating in a cellular network serviced by a base station;

Figure 2 shows a schematic flow diagram for an example of one embodiment of the present invention; and

Figure 3 shows a schematic flow diagram for an example of another embodiment of the present invention.

5 Detailed Description

“Wireless devices” include in general any device capable of connecting wirelessly to a network, and includes in particular mobile devices including mobile or cell phones (including so-called “smart phones”), personal digital assistants, pagers, tablet and laptop computers, content-consumption or generation devices (for music and/or video for example), data cards, USB dongles, etc., as well as fixed or more static devices, such as personal computers, game consoles and other generally static entertainment devices, various other domestic and non-domestic machines and devices, etc. The term “user equipment” or UE is often used to refer to wireless devices in general, and particularly mobile wireless devices.

15

Figure 1 shows schematically a user equipment or wireless device, in this case in the form of a mobile phone/smartphone 1. The user equipment 1 contains the necessary radio module 2, processor(s) and memory/memories 3, antenna 4, etc. to enable wireless communication with the network. The user equipment 1 in use is in communication with a radio mast 5. As a particular example in the context of UMTS (Universal Mobile Telecommunications System), there may be a network control apparatus 6 (which may be constituted by for example a so-called Radio Network Controller) operating in conjunction with one or more Node Bs (which, in many respects, can be regarded as “base stations”). As another example, LTE (Long Term Evolution) makes use of a so-called evolved Node B (eNB) where the RF transceiver and resource management/control functions are combined into a single entity. The term “base station” is used in this specification to include a “traditional” base station, a Node B, an evolved Node B (eNB), or any other access point to a network, unless the context requires otherwise. The network control apparatus 6 (of whatever type) may have its own processor(s) 7 and memory/memories 8, etc. Moreover for

30

convenience and by convention, the terms “network”, “network control apparatus” and “base station” will often be used interchangeably, depending on the context.

In general terms, wireless devices or UEs are in communication with each other, and/or with the Internet, via a network. The particular wireless technology that is used for the connection between the network and the wireless devices is commonly referred to as the radio access technology or “RAT”. Different RATs apply or conform to different wireless Standards, or in some cases different “releases” of a Standard. Examples of different RATs or implementations that use different RATs include GSM (Global System for Mobile Communications), GSM/EDGE (GSM-Enhanced Data Rates for Global Evolution), UMTS (Universal Mobile Telecommunications System or “3G”), and LTE (Long Term Evolution or “4G”), etc., amongst many others. Different RATs typically use one or more of different transmission frequencies and/or frequency bands, different modulation schemes, different protocols, etc. Depending on a number of factors, including for example the particular RATs concerned and/or the capabilities of the particular wireless device, a particular wireless device may be capable of using different RATs, with some wireless devices being able to use more than one RAT simultaneously. The term “RAT” or “radio access technology” as used in this manner is common and well understood by those working in this field.

The following specific examples of embodiments of the present invention are given particularly in the context of 3GPP (Third Generation Partnership Project) UMTS (Universal Mobile Telecommunications System) and LTE EUTRAN (Long Term Evolution Evolved Universal Terrestrial Radio Access Network) systems. However, the principles of the present invention are applicable to other wireless systems and RATs, operating according to different standards (including in at least some cases different releases within a standard) and protocols.

The system currently in use in 3GPP provides for a number of defined activity states for the user equipment, including an Idle state, a CELL_PCH/URA_PCH

(paging channel) state, a CELL_FACH (forward access channel) state, and a CELL_DCH (dedicated channel) state. In the Idle state, the user equipment does not have an RRC (Radio Resource Control) connection and this is the state having the lowest power consumption. In the CELL_PCH/URA_PCH state, the user equipment is again in a low power consumption state as it only periodically looks for incoming paging messages, and in this state does have a RRC connection. However, the user equipment needs to be in the CELL_FACH or CELL_DCH state in order to be able to perform both transmission and reception of data (including in particular “user” data, as opposed to data relating to control or management of the device and its network connection, etc. for example). In the CELL_DCH state, a dedicated physical channel is allocated to the user equipment. In the CELL_FACH state, the user equipment shares the physical channel with other user equipment, though nevertheless may have a dedicated logical channel. As is well understood, a logical channel in this context is an information stream dedicated to the transfer of a specific type of information over the radio interface and corresponds to an individual signal which can be separated or isolated from an aggregate of signals which occupy the same physical bandwidth or channel. CELL_FACH can be regarded as a transition state between the CELL_PCH/URA_PCH and CELL_DCH states. Keeping the user equipment in CELL_FACH state improves power consumption for the user equipment compared to the CELL_DCH state (because the transmitter and/or receiver may be switched off for longer periods of time while no uplink data is available and during discontinuous reception or “DRX”) and also reduces the network signalling load (by avoiding radio resource control or “RRC” signalling to perform a state transition from the PCH or Idle states to the CELL_FACH state when both data transmission and reception are required). Nevertheless, the CELL_FACH state still has a higher power consumption for the user equipment than the PCH or Idle states.

For UMTS, the 3GPP standards (see 3GPP TS 25.331) allow the UE to trigger so-called Fast Dormancy by sending a SIGNALLING CONNECTION RELEASE INDICATION (SCRI) in all connected states, including CELL_PCH, URA_PCH, CELL_FACH and CELL_DCH. In particular, if there is no more packet switched

data that needs to be sent by the UE, the UE in one of the connected states can send the SCRI message with an information element (IE) “Signaling Connection Release Indication Cause” (SCRI with Cause) to the network/base station. As an alternative, this transition request may be sent in a “Cell Update” or a “URA Update” message.

5 In any event, after the transition request message is received, the network may initiate a state transition, i.e. exchange control signals with the UE, to move the UE to Idle Mode, CELL_PCH, URA_PCH or CELL_FACH state to achieve lower power usage at the UE and reduced network signalling. For UMTS, the UE may trigger Fast Dormancy when in one of the paging channel states, i.e. the CELL_PCH state or the

10 URA_PCH state, as it wants the network to move it to the Idle Mode state to achieve maximum power savings and therefore typically longer battery life in the case of a mobile device. In the case that the DRX cycle length in CELL_PCH or URA_PCH as the case may be is equal to or longer than the DRX cycle length in Idle Mode, then the UE is limited to sending the SCRI only once. However if the DRX cycle in

15 CELL_PCH or URA_PCH as the case may be is shorter than the DRX cycle length in Idle Mode, then the UE can send the SCRI as many times as it wants. The same issue may apply for other transition requests sent by the UE, including for example if the transition request is sent in a “Cell Update” or a “URA Update” message.

20 Similarly, for LTE, the 3GPP standards (see 3GPP TR 36.822) provide for the UE to send assistance information to the eNB, to assist the eNB in configuring connected mode parameters and connection release handling for the UE. The UE can send to the eNB a 1-bit indication that it has a preference for a power-optimised configuration, which in the 3GPP specification is taken to indicate that for example a

25 long DRX cycle or RRC connection release is desired.

Significantly, in each of these “Fast Dormancy” examples for UMTS and LTE, the UE remains attached to the network and, in particular, uses the same RAT before and after any change that was prompted by the network as a result of the

30 network receiving the indication from the UE that the UE wants to be moved to a state or configuration that consumes less power. Looking at this another way, the current

Fast Dormancy procedures of UMTS and LTE consider only the RAT in which the indication is sent. No account is taken of the different power consumptions of states and/or usage behaviour that are available in different RATs.

5 In broad terms, examples of embodiments of the present invention enable a UE to indicate to the network that it has a preference to move to a different RAT in order to achieve power savings. The UE may indicate a preference for being moved to a particular RAT specified by the UE, and/or may indicate plural RATs to which it would like to be moved in order of preference.

10

 As one example, LTE Idle mode may consume less power than a UMTS PCH state. As another example, a UMTS CELL_FACH state may consume less power than LTE Connected mode. There are many other examples of possible different rates of power consumption between RATs for different UE states. Different rates of
15 power consumption may result from different network configurations, including for example the length of the idle DRX period, the bandwidth, etc. Such configuration settings are typically provided as System Information by the network.

 Also, the relative rates of power consumption between RATs may differ
20 according to the particular application that is running on the UE and consuming power, and/or the particular usage of the application by the user of the UE at a particular time. For example, a UE sending small amounts of data frequently may benefit from lower power consumption by being in one RAT, whereas another UE of the same type but with a different user (who has different usage behaviour) and/or
25 applications in use may benefit from a lower power consumption by being in the other RAT because of the different usage of the UE by the user and/or applications running on that UE.

 As a particular example, it may be advantageous in terms of minimising power
30 consumption for the UE to be moved to LTE for large data transfers, but remain in UMTS at all other times to conserve power. As yet another particular example, it may

be advantageous in terms of minimising power consumption for the UE to remain in LTE and move to UMTS only for CS (circuit switched) calls or when the service may be degraded due to IDC (in-device coexistence) or other interference-avoidance measures that might be taken. Many other examples of different rates of power consumption exist. The details of the actual power consumption depend on UE implementations and network configurations, as well as the UE type, the particular applications running on the UE and being used by the user, and user behaviour or usage of those applications or the UE in general.

10 In UMTS, one way for the UE to indicate to the network that it would like to be moved to a different RAT to achieve powers savings is as follows. The UE sends a SIGNALLING CONNECTION RELEASE INDICATION (SCRI) message to the network in which the message includes an indication that the UE wants to be moved to a different RAT and the message has a cause “power”, or at least some indication that the “cause” or reason it wants to be moved is to obtain a power saving. The message from the UE to the network may specify a particular RAT to which the UE wants to be moved. Alternatively or additionally, the message from the UE to the network may specify a number of RATs to any of which the UE wants to be moved, with the plural RATs being indicated in order of preference.

20

To illustrate this, as one particular example an indication may be added to “SIGNALLING CONNECTION RELEASE INDICATION” including one or both of the following:

- single bit (where for example a ‘0’ or a ‘1’ indicates a preference for EUTRAN)
- enumeration (using for example plural bits, for example to indicate a preference in order for EUTRAN, GERAN, UTRAN)

and:

- Cause (power)

30

It will be understood however that the indication sent by the UE may be sent in some other way, such as in a different, separate indication or message altogether, typically in some uplink RRC signalling message. The preferred RAT indicated by the UE may also be different from the specific example(s) given above.

5

For EUTRAN (LTE), the indication could be incorporated into an assistance information message, or may be sent in some other message, and may include similar information and options as detailed above for the UMTS example.

10

In any event, the network will typically respond to receipt of such an indication or message by reconfiguring the UE appropriately. For example, the network may redirect the UE to another RAT, preferably the RAT or one of the RATs requested by the UE. Alternatively or additionally, the network may change the cell reselection priorities to be used by the UE such that the other RAT has a higher priority than before the message or indication was sent, increasing the likelihood that the UE will be moved to the desired RAT. Alternatively or additionally, the network may hand over the UE to a cell that uses another RAT, preferably the RAT or one of the RATs requested by the UE. Once the UE has been reconfigured by the network in this way, the UE will typically move to the other RAT and/or cell, reconfiguring itself as necessary to use the appropriate transceiver, transmission frequency and protocol, etc. for the other RAT and/or cell.

15

20

A number of different criteria or mechanisms may be used by the UE to determine that it would like to be moved to a different RAT to achieve power savings. The UE may monitor actual power consumption over time for different network configurations, particular applications running on the UE, different usage patterns by the user of the UE, etc. Alternatively or additionally, the UE may make an estimate of likely power usage. The estimate may be based at least in part on for example network configuration, including for example which features are enabled according to System Information provided by the network, such as length of the idle DRX period, the bandwidth, previous connected mode configurations in that RAT such as

25

30

connected mode DRX lengths (for UMTS/LTE in an example), whether or not the network enables DRX in CELL_FACH (for UMTS only in an example), whether CPC (Continuous Packet Connectivity) is enabled (for UMTS in an example, this being another DRX feature for CELL_DCH), whether carrier aggregation has been
5 used (for UMTS/LTE in an example; this can determine whether one or two receivers need to be used by the UE for example), etc., etc. Alternatively or additionally, the estimate may be based at least in part on for example the configuration of the UE itself, such as which radios it may have enabled (bearing in mind that a UE might have separate radios for one or more of GPS, WLAN, 2G/3G/4G, etc., etc.). Other
10 factors for the configuration of the network and/or UE may be taken into account.

The UE may “learn” based on previous activity which configurations a particular network is likely to use in different RATs, so the UE may find one RAT more efficient than another for power saving. Also, the UE may take into account
15 which application or applications are running on the UE (at a particular time) and hence which RAT has the best chance of conserving power when those applications are running. For example, a UE might prefer a network with the best data rate potential when using a streaming video service (e.g. YouTube or the like), but when
20 changing to a messaging-like application (e.g. Skype or the like) typically requiring a lower data rate, the UE might prefer another RAT with a lower bit rate potential but a higher power saving potential. The UE might monitor average power consumption over time to learn how well the current network enables power saving and how each kind of network offers power saving opportunities on average. The UE may record
25 which applications are running at the relevant times so that it can make an informed decision as to which RAT is likely to be the most efficient in terms of power consumption at any particular time given the applications that are running on the UE at that time. The UE may record the different activity states at the relevant time so that it can make a better informed decision as to which RAT has the best chance of conserving power given the activity state of the UE. For example, an LTE network
30 might offer worse power consumption for speech calls when first deployed compared to a UMTS network. The UE may take into account that the network may command

use of different transmission powers in different circumstances, for example to minimise interference (in-device interference IDC or interference with neighbouring UEs or other equipment), and that that may affect the rate of power consumption by the UE. For example, the UE might be using an LTE carrier which it knows to be problematic for a Bluetooth headset currently in use, which might affect the LTE power consumption, so the UE might indicate to prefer a UMTS carrier which has no issue with the IDC interference.

Rules may be imposed on the UE to specify when the UE is allowed and not allowed to send the indication that it would like to be moved to a different RAT. The UE might need to be indicated via dedicated or broadcast signalling whether it is allowed to send such an indication. The rules for conditions in which such indication is allowed could also be predetermined according to radio conditions or other conditions perceived by the UE. The UE might also be always allowed to send an initial indication but be prohibited from sending the indications afterwards until it receives a response or a predefined condition occurs, for example a timer expires. The UE might also be prevented from sending indications after having transferred from one RAT to another RAT via the preference indication, optionally for a predetermined period of time following the transfer. There may be different rules in different RATs concerning when the indication can be signalled.

Referring to Figure 2, there is shown a schematic flow diagram for an example of one embodiment of the present invention relating to the wireless device or UE. At 200, the wireless device operates using a first radio access technology under control of a network control apparatus. At 210, the wireless device determines that using a different radio access technology would consume less power. As a result, at 220, the wireless device signals to the network control apparatus that it would like to use the different radio access technology in order to achieve power savings.

Referring to Figure 3, there is shown a schematic flow diagram for an example of one embodiment of the present invention relating to the network or network control

apparatus or the like. At 300, the network receives from a wireless device a request to use a different radio access technology in order to achieve power savings at the wireless device. At 310, the network transmits a signal that at least one of: (i) redirects the wireless device to the different radio access technology in response to receipt by the network control apparatus of the signalling from the wireless device;
5 (ii) changes cell reselection priorities of the wireless device such that the different radio access technology has a higher priority; and (iii) hands over the wireless device to a cell that uses the different radio access technology.

10 Although at least some aspects of the embodiments described herein with reference to the drawings comprise computer processes performed in processing systems or processors, the invention also extends to computer programs, particularly computer programs on or in a carrier, adapted for putting the invention into practice. The program may be in the form of non-transitory source code, object code, a code
15 intermediate source and object code such as in partially compiled form, or in any other non-transitory form suitable for use in the implementation of processes according to the invention. The carrier may be any entity or device capable of carrying the program. For example, the carrier may comprise a storage medium, such as a solid-state drive (SSD) or other semiconductor-based RAM; a ROM, for example
20 a CD ROM or a semiconductor ROM; a magnetic recording medium, for example a floppy disk or hard disk; optical memory devices in general; etc.

It will be understood that the processor or processing system or circuitry referred to herein may in practice be provided by a single chip or integrated circuit or
25 plural chips or integrated circuits, optionally provided as a chipset, an application-specific integrated circuit (ASIC), field-programmable gate array (FPGA), digital signal processor (DSP), etc. The chip or chips may comprise circuitry (as well as possibly firmware) for embodying at least one or more of a data processor or processors, a digital signal processor or processors, baseband circuitry and radio
30 frequency circuitry, which are configurable so as to operate in accordance with the exemplary embodiments. In this regard, the exemplary embodiments may be

implemented at least in part by computer software stored in (non-transitory) memory and executable by the processor, or by hardware, or by a combination of tangibly stored software and hardware (and tangibly stored firmware).

5 The above embodiments are to be understood as illustrative examples of the invention. Further embodiments of the invention are envisaged. For example, the various indications that may be sent by the wireless device or UE mentioned above may be sent in other forms. It is to be understood that any feature described in relation to any one embodiment may be used alone, or in combination with other
10 features described, and may also be used in combination with one or more features of any other of the embodiments, or any combination of any other of the embodiments. Furthermore, equivalents and modifications not described above may also be employed without departing from the scope of the invention, which is defined in the accompanying claims.

15

CLAIMS

1. A method of operating a wireless device under network control, the method comprising:
 - 5 the wireless device operating using a first radio access technology under control of a network control apparatus;
 - the wireless device determining that using a different radio access technology would consume less power; and
 - the wireless device signalling to the network control apparatus that it would
10 like to use the different radio access technology in order to achieve power savings.
2. A method according to claim 1, the wireless device signalling to the network control apparatus plural different radio access technologies that it would like to use in order of preference in order to achieve power savings.
15
3. A method according to claim 1 or claim 2, the wireless device monitoring power consumption over time when using the first radio access technology and when using a different radio access technology so as to be able to determine that using the different radio access technology would consume less power.
20
4. A method according to claim 3, the wireless device monitoring power consumption over time for different applications running on the wireless device.
5. A method according to claim 3 or claim 4, the wireless device monitoring
25 power consumption over time for different activity states of the wireless device.
6. A method according to any of claims 1 to 5, the wireless device estimating power consumption based on network configuration, or the wireless device configuration, or the network configuration and the wireless device configuration.
30

7. A method according to any of claims 1 to 6, wherein the first radio access technology is Universal Mobile Telecommunications System, the wireless device signalling to the network control apparatus that it would like to use the different radio access technology in order to achieve power savings by sending a SIGNALLING CONNECTION RELEASE INDICATION message to the network control apparatus, the SIGNALLING CONNECTION RELEASE INDICATION message including an indication that the wireless device wants to use a different radio access technology and a cause indicative of power saving.
8. A method according to claim 7, wherein the different radio access technology is at least one of Long Term Evolution Evolved Universal Terrestrial Radio Access Network, Global System for Mobile Communications Enhanced Data Rates for Global Evolution Radio Access Network, and Universal Terrestrial Radio Access Network.
9. A method according to any of claims 1 to 6, wherein the first radio access technology is Long Term Evolution Evolved Universal Terrestrial Radio Access Network and the different radio access technology is at least one of Universal Mobile Telecommunications System, Global System for Mobile Communications Enhanced Data Rates for Global Evolution Radio Access Network, and Universal Terrestrial Radio Access Network.
10. A method according to any of claims 1 to 9, the wireless device receiving from the network control apparatus a signal redirecting the wireless device to use the different radio access technology in response to receipt by the network control apparatus of the signalling from the wireless device.
11. A method according to any of claims 1 to 10, the wireless device receiving from the network control apparatus a signal that changes cell reselection priorities of the wireless device such that the different radio access technology has a higher priority.

12. A method according to any of claims 1 to 11, the wireless device being handed over by the network control apparatus to a cell that uses the different radio access technology.

5

13. Apparatus comprising a processing system for a wireless device, the processing system being constructed and arranged to:

cause the wireless device to operate using a first radio access technology under control of a network control apparatus;

10 determine if using a different radio access technology would consume less power; and

cause the wireless device to signal to said network control apparatus that it would like to use the different radio access technology in order to achieve power savings.

15

14. Apparatus according to claim 13, arranged to cause the wireless device to signal to said network control apparatus plural different radio access technologies that it would like to use in order of preference in order to achieve power savings.

20

15. Apparatus according to claim 13 or claim 14, arranged to monitor power consumption by the wireless device over time when using the first radio access technology and when using a different radio access technology so as to be able to determine that using the different radio access technology would consume less power.

25

16. Apparatus according to claim 15, arranged to monitor power consumption by the wireless device over time for different applications running on the wireless device.

30

17. Apparatus according to claim 15 or claim 16, arranged to monitor power consumption by the wireless device over time for different activity states of the wireless device.

18. Apparatus according to any of claims 13 to 17, arranged to estimate power consumption by the wireless device based on network configuration, or the wireless device configuration, or the network configuration and the wireless device configuration.

5

19. Apparatus according to any of claims 13 to 18, wherein the first radio access technology is Universal Mobile Telecommunications System, the processing system being arranged to cause the wireless device to signal to said network control apparatus that it would like to use the different radio access technology in order to achieve power savings by sending a SIGNALLING CONNECTION RELEASE INDICATION message to said network control apparatus, the SIGNALLING CONNECTION RELEASE INDICATION message including an indication that the wireless device wants to use a different radio access technology and a cause indicative of power saving.

15

20. Apparatus according to claim 19, wherein the different radio access technology is at least one of Long Term Evolution Evolved Universal Terrestrial Radio Access Network, Global System for Mobile Communications Enhanced Data Rates for Global Evolution Radio Access Network, and Universal Terrestrial Radio Access Network.

20

21. Apparatus according to any of claims 13 to 18, wherein the first radio access technology is Long Term Evolution Evolved Universal Terrestrial Radio Access Network and the different radio access technology is at least one of Universal Mobile Telecommunications System, Global System for Mobile Communications Enhanced Data Rates for Global Evolution Radio Access Network, and Universal Terrestrial Radio Access Network.

25

22. A computer program for a wireless device, the computer program comprising instructions such that when the computer program is executed on a processing system of the wireless device, the wireless device is arranged to:

30

operate using a first radio access technology under control of a network control apparatus;

determine if using a different radio access technology would consume less power; and

5 signal to said network control apparatus that it would like to use the different radio access technology in order to achieve power savings.

23. A computer program according to claim 22, comprising instructions such that the wireless device signals to said network control apparatus plural different radio
10 access technologies that it would like to use in order of preference in order to achieve power savings.

24. A computer program according to claim 22 or claim 23, comprising instructions such that the wireless device monitors power consumption over time
15 when using the first radio access technology and when using a different radio access technology so as to be able to determine that using the different radio access technology would consume less power.

25. A computer program according to claim 24, comprising instructions such that
20 the wireless device monitors power consumption over time for different applications running on the wireless device.

26. A computer program according to claim 24 or claim 25, comprising instructions such that the wireless device monitors power consumption over time for
25 different activity states of the wireless device.

27. A computer program according to any of claims 22 to 26, comprising instructions such that the wireless device estimates power consumption based on network configuration, or the wireless device configuration, or the network
30 configuration and the wireless device configuration.

28. A computer program according to any of claims 22 to 27, wherein the first radio access technology is Universal Mobile Telecommunications System, the computer program comprising instructions such that the wireless device signals to said network control apparatus that it would like to use the different radio access technology in order to achieve power savings by sending a SIGNALLING CONNECTION RELEASE INDICATION message to said network control apparatus, the SIGNALLING CONNECTION RELEASE INDICATION message including an indication that the wireless device wants to use a different radio access technology and a cause indicative of power saving.

10

29. A computer program according to claim 28, wherein the different radio access technology is at least one of Long Term Evolution Evolved Universal Terrestrial Radio Access Network, Global System for Mobile Communications Enhanced Data Rates for Global Evolution Radio Access Network, and Universal Terrestrial Radio Access Network.

15

30. A computer program according to any of claims 22 to 27, wherein the first radio access technology is Long Term Evolution Evolved Universal Terrestrial Radio Access Network and the different radio access technology is at least one of Universal Mobile Telecommunications System, Global System for Mobile Communications Enhanced Data Rates for Global Evolution Radio Access Network, and Universal Terrestrial Radio Access Network.

20

31. A method of operating a network control apparatus, the method comprising:
receiving, from a wireless device operating using a first radio access technology, a request to use a different radio access technology in order to achieve power savings at the wireless device; and in response thereto:

25

transmitting a signal that at least one of:

redirects the wireless device to the different radio access technology in response to receipt by the network control apparatus of the signalling from the wireless device;

30

changes cell reselection priorities of the wireless device such that the different radio access technology has a higher priority; and

hands over the wireless device to a cell that uses the different radio access technology.

5

32. A method according to claim 31, wherein the first radio access technology is Universal Mobile Telecommunications System and the different radio access technology is at least one of Long Term Evolution Evolved Universal Terrestrial Radio Access Network, Global System for Mobile Communications Enhanced Data Rates for Global Evolution Radio Access Network, and Universal Terrestrial Radio Access Network.

33. A method according to claim 31, wherein the first radio access technology is Long Term Evolution Evolved Universal Terrestrial Radio Access Network and the different radio access technology is at least one of Universal Mobile Telecommunications System, Global System for Mobile Communications Enhanced Data Rates for Global Evolution Radio Access Network, and Universal Terrestrial Radio Access Network.

34. Apparatus comprising a processing system for a network control apparatus, the processing system being constructed and arranged to:

upon receipt from a wireless device of a request to use a different radio access technology in order to achieve power savings at said wireless device, cause the network control apparatus to transmit a signal that at least one of:

25 redirects said wireless device to use the different radio access technology;

changes cell reselection priorities of said wireless device such that the different radio access technology has a higher priority; and

hands over the wireless device to a cell that uses the different radio access technology.

30

35. A computer program for a network control apparatus, the computer program comprising instructions such that when the computer program is executed on a processing system of the network control apparatus, the network control apparatus is arranged to:

5 upon receipt from a wireless device of a request to use a different radio access technology in order to achieve power savings at said wireless device, transmit a signal that at least one of:

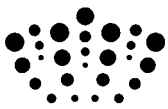
redirects said wireless device to use the different radio access technology;

10 changes cell reselection priorities of said wireless device such that the different radio access technology has a higher priority; and

hands over the wireless device to a cell that uses the different radio access technology.

36. A method of operating a wireless device under network control, substantially
15 in accordance with any of the examples as described herein with reference to and illustrated by the accompanying drawings.

37. Apparatus for operating a wireless device, substantially in accordance with
20 any of the examples as described herein with reference to and illustrated by the accompanying drawings.



Application No: GB1213787.3

Examiner: Dr Andrew Courtenay

Claims searched: 1 to 35

Date of search: 8 November 2012

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1 to 6, 9, 10, 12 to 18, 21 to 27 and 30 to 35	US 2009/068969 A1 (LINDOFF et al) Whole document relevant, especially figures 2 to 4, and paragraphs 25 to 32, 40, 47 & 50 to 52.
X	1 to 6, 9, 10, 12 to 18, 21 to 27 and 30 to 35	WO 2011/147439 A1 (NOKIA SIEMENS) Whole document relevant, especially page 8, line 1 to page 9, line 26.
A	-	WO 02/03733 A1 (ERICSSON TELEFON) See abstract.
A	-	US 2010/273486 A1 (KHARIA et al) See figure 7 especially.
A	-	GB 2403870 A1 (NEC TECHNOLOGIES) See abstract.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

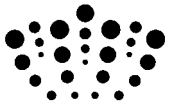
Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

Worldwide search of patent documents classified in the following areas of the IPC

H04W

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI, XP3GPP, TXTUS1, TXTUS2, TXTUS3, TXTUS4, TXTEP1, TXTGB1, TXTWO1



International Classification:

Subclass	Subgroup	Valid From
H04W	0048/18	01/01/2009
H04W	0036/16	01/01/2009
H04W	0052/02	01/01/2009