processes based on the attached RAN (i.e. location of the device) and the MDT capability of the UE (i.e. the device needs to be MDT capable).

[0030]

International patent application WO2010/145531 discloses a method and apparatus for measuring a log by minimizing drive test (MDT). The method includes the steps of: creating MDT log measurement configuration information; according to a predefined rule, sending said MDT logging measurement configuration information to the connected user equipment (UE) and/or the idle UE.

[0031]

International patent application WO2011/050846 discloses measures for enhancing network performance monitoring. Such measures may for example comprise receiving a report on measurements of terminal-related network performance parameters from a terminal, acquiring information of access network-related network performance parameters, and combining the received terminal-related network performance parameters and the acquired access network-related network performance parameters into a combined network performance report.

[0032]

It will be appreciated that, when performing MDT processes, if MTCs are considered in addition to non-MTC UE devices (as is the current situation), the amount of data collected can be very large. The network does not distinguish between MTCs and non-MTCs when selecting devices for MTD processes. Data collected from MTC devices during MDT processes is generally less useful than that collected from non-MTC devices. Therefore, a large amount of data collected is not useful (generally, the portion corresponding to that collected from the MTC devices). Consequently, a large amount of signalling overhead is potentially wasted for communication with MTC devices.

[0033]

Embodiments of the present invention seek to provide a MDT process offering advantages over known processes and, in particular, to a mobile radio communications network device, and a mobile radio communications device, arranged to implement such a MDT process in a manner exhibiting advantages over known devices, and to related operational methods.

Solution to Problem

[0033a]

According to a first aspect of the present invention, there is provided a mobile radio communication network device operative to select at least one mobile radio communication device to perform Minimization of Drive Testing (MDT) measurements based on a Type of Allocation Code (TAC) information field of the mobile radio communication device, and to collect MDT measurement results from the mobile radio communication device.

[0033b]

According to á second aspect of the present invention, there is provided a mobile radio communication device operative to perform Minimization of Drive Testing (MDT) measurements and to provide MDT measurement results to a mobile radio communication network device operative to select, based on a Type of Allocation Code (TAC) information field, at least one mobile radio communication device for MDT measurements, if the mobile radio communication device is selected as the mobile radio communication device for MDT measurements, wherein information identifying whether the mobile radio communication device should perform MDT measurements or not is configured in the TAC information field of device identity information of the mobile radio communication device.

[0033c]

According to a third aspect of the present invention, there is provided a method of collecting measurement results, comprising: selecting at least one mobile radio communication device to perform Minimization of Drive Testing (MDT) measurements based on a Type of Allocation Code (TAC) information field of the mobile radio communication device; and collecting MDT measurement results from the mobile radio communication device.

[0033d]

According to a fourth aspect of the present invention, there is provided a non-transitory computer readable medium that stores a computer program, the program comprising instructions for enabling a mobile radio communication network device to: select at least one mobile radio communication device to perform Minimization of Drive Testing (MDT) measurements based on a Type of Allocation Code (TAC) information field of the mobile radio communication device; and collect MDT measurement results from the mobile radio communication device.

[0033e]

According to a fifth aspect of the present invention, there is provided a mobile radio communications system comprising: a mobile radio communication device operative to perform Minimization of Drive Testing (MDT) measurements; and a mobile radio communication network device operative to select, a Type of Allocation Code (TAC) information field, at least one mobile radio communication device for MDT measurements, and to collect MDT measurement results from the mobile radio communication device.

[0034]

Disclosed herein is a mobile radio communications network device operative to collect network performance measurements and to

select at least one mobile radio communications device from which network performance measurements are to be collected if at least one parameter of the at least one mobile radio communication device corresponds to at least one specified selection parameter, wherein the at least one specified selection parameter comprises data identifying at least one mobile radio communication device characteristic.

[0035]

Embodiments of the present invention may be applicable to MDT processes (which may be known as management of UE based network performance measurements) in the LTE radio technology, and to terminal equipment (handset) or User Equipment (UE) access to the Evolved Packet System (EPS) through an E-UTRAN (Evolved Universal Technology Radio Access Network) radio network. Embodiments of the present invention may also be applicable in UMTS radio technology and to terminal equipment access to the CN through a UTRAN radio network. More specifically, the present invention may be applicable to device selection in the context of collection of UE radio measurements by a network operator and in particular to control the type of device relevant for that data collection.

[0036]

Embodiments of the present invention may serve to reduce signalling overheads in relation to MDT processes (i.e. MDT configuration and MDT data collection). Since the number of Machine-Type communications can be up to at least two orders of magnitude higher than for human-to-human communications, the signalling overhead reduction would be in this order if the network is operative not to configure such MTC devices for MDT processes.

[0037]

Embodiments of the present invention may also serve to allow a network operator/provider to consider only certain types of devices depending on what it wants to achieve with MDT measurements. For example, small data transmissions devices may not be relevant for MDT data collection targeting the network throughput (and so the network operator may wish to exclude these types of device from the devices from which measurements are collected in an MDT process). On the other hand, trouble-shooting of MTC devices might become a relevant business case in the future, and so the network operator may wish to include these types of device in the devices from which measurements are collected in an MDT process.

[0038]

Embodiments of the present invention may also serve to allow consideration of only those devices which are human-controlled (i.e. non-MTC devices), for example, in instances where the network operator wishes to perform network coverage optimization to improve user experience. Hence

those (e.g. MTC) devices not fulfilling certain requirements (e.g. restricted time, low mobility, low traffic, low energy characteristics) would not be considered during MDT measurement collection. Such MTC devices are not relevant for UE (User Equipment) based network performance measurements in this instance because the network operator wishes to improve the network coverage and capacity primarily for human communications devices. Specifically, it may be less relevant to improve the network coverage/capacity for machine type communications devices at the radio cell edge. Furthermore, the consideration of user consent or roaming is not needed when it comes to MTC device selection for the purpose of UE based network performance measurements.

[0039]

Embodiments of the present invention may also serve to allow measurements to be taken from those devices which are known to provide reliable location information (e.g. by virtue of them being low mobility).

[0040]

Embodiments of the present invention may also serve to allow a network operator to check and improve radio network throughput. In this instance, small data transmissions devices are not relevant for UE based network performance measurements and so the invention can allow the network operator to exclude such devices from consideration during the acquisition of UE based network performance measurements.

[0041]

Extra low power consumption UE devices may not be relevant for UE based network performance measurements because such measurements can drain the remaining battery of the device which renders the device unable to transmit critical data to the network when needed (e.g. periodic location information for a prisoner being tracked). Embodiments of the invention may be operative to allow a network operator to exclude such devices from consideration during the acquisition of UE based network performance measurements. If such devices were required for acquisition of measurements therefrom, the present invention may operate to allow a RAN to instruct the UE device to switch to the most efficient power saving state (i.e. by release of the radio connection) instead of configuring the device for long discontinuous reception/transmission periods.

[0042]

Low-memory UE devices may not be relevant for UE based network performance measurements. Currently, the mandated memory size is set to 64 kbytes for the UE device to gather a consistent minimal set of radio measurements. However, it is deemed that some machine type communications devices do not have such memory size. Therefore, embodiments of the present

invention may be operative to exclude such devices from consideration during the acquisition of UE based network performance measurements.

[0043]

Low-mobility UE devices whose location area matches the targeted area scope of UE based network performance measurements may be more relevant than high-mobility UE devices which do not remain in the area for a sufficient length of time to allow collection of network performance measurements therefrom. Therefore, embodiments of the present invention may be operative to exclude such devices from consideration during the acquisition of UE based network performance measurements. Embodiments of the present invention may also be operative to cause a RAN not to configure radio measurements reports from those UE devices.

[0044]

Optionally, some categories of UE devices (e.g. MTC) may not be selected. For example: (a) those time controlled devices which send data at some specific point in time and are not supposed to send data outside of the scheduled point in time; (b)small data transmissions devices (which are not relevant for MDT data collection targeting the network throughput).
Further examples are extra low power consumption devices. These may not be selected or may be preferred for selection over other (e.g. MTC) devices (e.g. low mobility devices whose location area matches the targeted area scope of MDT for most of the time). In addition, MTC devices operative to perform non-human communications may be selected regardless of user consent and roaming characteristics.

[0045]

Currently, there are no mechanisms to consider the type of UE device selected for MDT measurements configuration. Also, there are no mechanisms such as intelligent knowledge in the network to enhance the selection of UE devices from the collected traces because those cannot be linked to specific UE devices since the data is "anonymized" due to the presence of user location information therein.

[0046]

Optionally, the at least one mobile radio communication device characteristic may comprise an operational characteristic of the mobile radio communication device. Further optionally, the mobile radio communication device operational characteristic may be configured towards the mobile radio communication device. Yet further optionally, the configuration may be implemented by way of Open Mobile Alliance Device Management (OMA DM) signalling.

[0047]

Optionally, the at least one mobile radio communication device characteristic may

Optionally, the operational characteristic of the mobile radio communication device may relate to at least one of: mobility of the mobile radio communication device; call and/or data traffic of the mobile radio communication device; memory capacity of the mobile radio communication device; and battery life of the mobile radio communication device. Further optionally, the mobile radio communication device selection does not take into account either user consent or a roaming characteristic of the device.

[0052]

Optionally, the network device may be arranged such that the network performance measurements are undertaken in a Minimization of Drive Testing (MDT) process.

[0053]

Disclosed herein is a mobile radio communication device operative for configuration by the network device described above.

[0054]

Optionally, the mobile radio communication device may be operative to deactivate a capability to partake in network performance measurements and, further optionally, may be operative to provide, to the mobile radio communication network device, information indicative of at least one of: an access stratum (AS) capability of said mobile radio communication device; the at least one mobile radio communication device operational characteristic; and the mobile radio communication device type. Yet further optionally, the mobile radio communication device may be operative to set the at least one device operational characteristic as information in a radio capability information module thereof.

[0055]

Disclosed herein is a mobile radio communication device selection signal for network performance measurements, the signal comprising data identifying at least one mobile radio communication device characteristic.

[0056]

Optionally, the at least one mobile radio communication device characteristic may comprise an operational characteristic of the mobile radio communication device. Further optionally, the at least one mobile radio communication device characteristic may comprise data identifying a mobile radio communication device type. Yet further optionally, the mobile radio communication device type may be included in a Type of Allocation Code (TAC) information field of mobile equipment identity information (for example, so-called International Mobile Equipment Identity (IMEI)).

[0057]

Optionally, the signal may comprise an OMA DM signal.

[0058]

Disclosed herein is a method of collecting network performance measurements, comprising: selecting at least one mobile radio communications device from which network performance measurements are to be collected if at least one parameter of the at least one mobile radio communication device corresponds to at least one specified selection parameter, wherein the at least one specified selection parameter comprises data identifying at least one mobile radio communication device characteristic.

[0059]

Optionally, the at least one mobile radio communication device characteristic may comprise an operational characteristic of said mobile radio communication device. Further optionally, the mobile radio communication device operational characteristic may be configured towards the mobile radio communication device and, yet further optionally, the configuration may be implemented by way of OMA DM signalling.

[0060]

Optionally, the at least one mobile radio communication device characteristic may comprise data identifying a mobile radio communication device type. Further optionally, the mobile radio communication device type may be included in a Type of Allocation Code (TAC) information field of mobile equipment identity information (for example, so-called International Mobile Equipment Identity (IMEI)). Yet further optionally, mobile radio communication device selection does not take into account either user consent or a roaming characteristic of the device.

[0061]

Optionally, the data identifying a mobile radio communication device type may comprise data specifying that Machine-Type Communications (MTC) mobile radio communications devices are not to be included in acquisition of network performance measurements by the network device.

[0062]

Optionally, the method may further comprise selecting a mobile radio communication device from which the network device should acquire network performance measurements if each of a plurality of parameters of that mobile radio communication device has a corresponding specified selection parameter from a plurality of specified selection parameters.

[0063]

Optionally, the method may further comprise the step of retrieving, from the at least one

mobile radio communications device, information indicative of at least one of: an access stratum (AS) capability of the mobile radio communication device; the at least one mobile radio communication device operational characteristic; and the mobile radio communication device type. Further optionally, the retrieving step may be implemented upon initial registration of the mobile radio communication device with the network device. Yet further optionally, the method may comprise the step of storing obtained indicative information, wherein the information is selectable to form at least a part of the selection parameters.

[0064]

Optionally, the method may further comprise the step of transferring the stored obtained indicative information to a further network entity.

[0065]

Optionally, the method may further comprise the steps of forwarding, from a first operational element to a second operational element, an instruction comprising the selection parameters and, responsive to receipt of the instruction, collecting network performance measurements from one or more mobile radio communication devices having parameters matching said selection parameters. Further optionally, the instruction comprising said selection parameters may comprise a trace session activation command and, yet further optionally, information relating to each selection parameter may comprise at least one flag in the trace session activation command.

[0066]

Optionally, the at least one mobile radio communication device operational characteristic may relate to at least one of: mobility of the mobile radio communication device; call and/or data traffic of the mobile radio communication device; memory capacity of the mobile radio communication device; and battery life of the mobile radio communication device.

[0067]

Optionally, the network performance measurements may be undertaken in a Minimization of Drive Testing (MDT) process.

[0068]

Disclosed herein is a method of configuring a mobile radio communication device using a network device operating using the method described above.

[0069]

Optionally, the method may further comprise the mobile radio communication device operating to deactivate a capability to partake in network performance measurements and, further

optionally, may comprise providing, from the mobile radio communication device to the mobile radio communication network device, information indicative of at least one of: an access stratum (AS) capability of the mobile radio communication device; the at least one mobile radio communication device operational characteristic; and the mobile radio communication device type.

[0070]

Optionally, the method may further comprise setting the at least one device operational characteristic as information in a radio capability information module of the mobile radio communication device.

[0071]

Disclosed herein is a computer program, computer program product or computer readable medium, comprising instructions for enabling a mobile radio communication network device to carry out at least one of the methods described above.

[0072]

Disclosed herein is a mobile radio communication network device and/or a mobile radio communication device including a computer program, computer program product or computer readable medium as described above.

[0073]

Disclosed herein is a mobile radio communications system comprising: a mobile radio communications network device operative to collect network performance measurements and to select at least one mobile radio communications device from which network performance measurements are to be collected if at least one parameter of the at least one mobile radio communication device corresponds to at least one specified selection parameter, wherein the at least one specified selection parameter comprises data identifying at least one mobile radio communication device characteristic; and a mobile radio communication device operative for configuration by said network device.

[0074]

Optionally, the at least one mobile radio communication device characteristic comprises an operational characteristic of the mobile radio communication device. Further optionally, the mobile radio communication device operational characteristic may be configured towards the said mobile radio communication device. Yet further optionally, the device characteristic may comprise data identifying a mobile radio communication device type.

[0075]

one device operational characteristic as information in a radio capability information module thereof

Advantageous Effects of Invention

[0090]

According to embodiments of the present invention, it is possible to provide a MDT process offering advantages over known processes and, in particular, to a mobile radio communications network device, and a mobile radio communications device, arranged to implement such a MDT process in a manner exhibiting advantages over known devices, and to related operational methods.

Brief Description of Drawings

[0091]

[Fig. 1]

Fig. 1 is a sequence diagram illustrating a schematic process signalling flow for a current MDT process in an LTE network.

[Fig- 2]

Fig. 2 is a sequence diagram illustrating a schematic process signalling flow for a current MDT process in a UMTS network.

[Fig- 3]

Fig. 3 is a sequence diagram illustrating a schematic process signalling flow for a current process for selection of UE devices for participation in an MDT process.

[Fig. 4A]

Fig. 4A is a sequence diagram illustrating a part of a schematic process signalling flow for a process in accordance with a first one or more embodiments of the present invention for selection of UE devices for participation in an MDT process.

[Fig. 4B]

Fig. 4B is a sequence diagram illustrating the remaining part of a schematic process signalling flow for a process in accordance with a first one or more embodiments of the present invention for selection of UE devices for participation in an MDT process.

[Fig. 5]

Fig. 5 is a sequence diagram illustrating a schematic process signalling flow for a process in accordance with a second one or more embodiments of the present invention for selection of UE devices for participation in an MDT process.

[Fig. 6]