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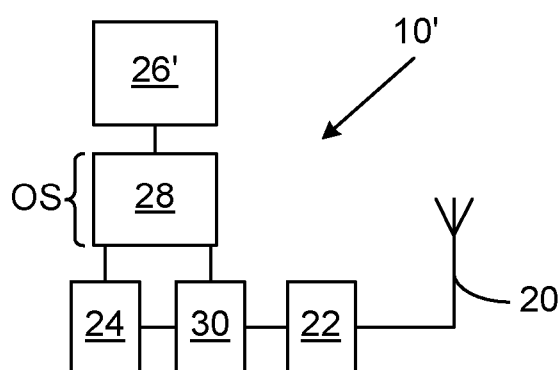


Fig. 3

(57) Abstract: A radio communication handling device handling communication for an application running in a mobile station (10) and communicating with an application server via a mobile communication network comprises a radio resource determination unit (24) that determines a state transition for the radio resources between the mobile station and the mobile communication network from a first current state to a second state, where the first state involves communication with a higher bandwidth than the second state, and informs, prior to the transition, at least one application communication control unit (28) about the transition in order to allow the application communication control unit to release unused application communication connections before the transition. The application communication control unit (26) receives the information about the following state transition and determines whether to release an application communication connection or not based on the information.

RADIO EFFICIENT TCP RELEASE

TECHNICAL FIELD

5 The invention concerns mobile communication. More particularly, the invention concerns a method and computer program product for enabling avoiding of unnecessary radio resource use by a mobile station, a radio communication handling device handling
10 communication for an application running in a mobile station as well as to a method, a connection releasing device and computer program product for controlling the release of application communication connections for an application in a mobile station.

15

BACKGROUND

Application/Service data as downloaded in a browser or application session is transported by means of an
20 Internet Protocol (IP) packet stream. This IP packet stream can be based on either Transmission Control Protocol (TCP) or User Datagram Protocol (UDP). TCP is a connection oriented protocol which has a setup and teardown procedure. Once a TCP connection is
25 established an application protocol, such as Hypertext Transfer Protocol (HTTP) may be used on top to transfer the data and when the application is finished with the data transfer the TCP connection can be released. A TCP connection is thus one type of application
30 communication connection and UDP another type of application communication connection.

TCP connections can either be persistent, an application keeping a constant connection to a server to fetch or send new data whenever need arises, or the TCP connection can be non-persistent in which case the
5 TCP connection is released whenever there is no data immediate to transfer, once the need arises again a new TCP connection is setup.

Processing and latency may be saved if the connection
10 is persistent; depending on application behavior e.g. intermittent data exchanged between one and the same server during a long time. The value of persistency is less if data is continuously exchanged with different servers.

15

It is well known that connection persistency is very valuable when a high number of data items should be collected from the same server; the persistency will here remove the phenomena of TCP slow start for all the
20 subsequent items, this given that the data items are fetched from the server back to back with no or very small interruptions in between.

Usually there is little cost for a client to maintain a
25 persistent connection, a certain amount of memory for state and buffers but no processing is associated with the persistency. On the server side of the connection the persistency can be more of an issue since many clients are connected to the same server and the memory
30 associated with the persistent connections need to be balanced with the processing cost of setting up and tearing down TCP connections with same client over and

over again. Different server setups will have different strategies.

Usually the decision to maintain or tear down a
5 connection can be taken very dynamically,
irrespectively of when a decision is taken the cost
associated with the release (exchange of data on an IP
network to negotiate the release) is the same; there is
no time dependency in the cost.

10

In particular each end of the connection can maintain
its own strategies and release the connection whenever
its own set of criteria is fulfilled.

15 The common strategy by both the client and the server
is to release the TCP a fixed set of seconds (timer)
after the last transmission on the connection. If
something is sent before the expiry of the timer, the
timer is restarted and the same fixed time is re-
20 applied. A server may also choose to maintain
connections for as long as it has the resources and
then release connections when resources are exhausted.

In a radio access network where there is a time
25 dependency in transport/power consumption/load cost it
is not obvious that the handling of the IP connection
can be totally independent of the state of the
underlying radio access network. Depending on state in
the radio access network the transmission of user data
30 will have different cost.

It is also usually so that the state of the radio access network is not known to both ends of the connection. In particular the server side of the connection is usually unaware of the current state of
5 the radio network.

In a Wideband Code Division Multiple Access (WCDMA) system the exact state behaviour of the radio access network will depend on a number of entities, timers and
10 strategies used by the cellular network operator and also timers and strategies used by the device vendor. In particular there are a number of timers in the cellular network: T1 inactivity to transition from Dedicated Channel (DCH) to Forward Access Channel
15 (FACH) and T2 inactivity to transition from FACH to URA (UTRAN Registration Area) Paging Channel/Cell Paging Channel/Idle (URA_PCH/CELL_PCH/Idle). There is also a device initiated state transition from DCH/FACH to URA_PCH/CELL_PCH/Idle called Fast Dormancy. Today these
20 transitions are executed without coordination with TCP releases.

Usually it is the behaviour of the user data flow that will control in which state the radio access network
25 will be in, but the exact transition times and strategies used will vary among the networks and can also have a time variance due to different traffic load etc.

30 In a situation as above it is for example costly to have the server side terminate an IP connection since the release of the connection can happen in a radio

network state where the device need to be paged, the device has no assigned physical channel and the system need to broadcast a request to re-establish the physical channel.

5

There is therefore a need for an improvement in the way application communication connections are released.

SUMMARY

10

The present invention is concerned with providing an improved method for enabling avoiding of unnecessary radio resource use by a mobile station having an application communicating with an application server
15 via a mobile communication network.

This object is according to a first aspect obtained through a method for enabling avoiding of unnecessary radio resource use by a mobile station having an
20 application communicating with an application server via a mobile communication network using an application communication protocol. The method is performed for radio communication involving the mobile station and comprises:

25 determining, in a radio resource determination unit, a state transition for the radio resources between the mobile station and the mobile communication network from a first current state to a second state, where the first state involves communication with a higher
30 bandwidth than the second state, and
informing, by the radio resource determination unit and prior to the transition, at least one application

communication control unit about the transition in order to allow the application communication control unit to release unused application communication connections before the transition.

5

Another object is to provide a radio communication handling device that enables avoiding of unnecessary radio resource use by a mobile station.

10 This object is according to a second aspect achieved through a radio communication handling device handling communication for an application running in a mobile station and communicating with an application server via a mobile communication network. The radio

15 communication handling device comprises:

a radio resource determination unit configured to determine a state transition for the radio resources between the mobile station and the mobile communication network from a first current state to a second state,

20 where the first state involves communication with a higher bandwidth than the second state, and inform, prior to the transition, at least one application communication control unit about the transition in order to allow the application

25 communication control unit to release unused application communication connections before the transition.

Yet another object is to provide a computer program
30 product that enables avoiding of unnecessary radio resource use by a mobile station having an application communicating with an application server.

This object is according to a third aspect obtained through a computer program product for enabling avoiding of unnecessary radio resource use by a mobile station having an application communicating with an application server via a mobile communication network using an application communication protocol, the computer program product comprising a computer readable storage medium comprising computer program code causing a radio resource determination unit of a radio communication handing device to:

determine a state transition for the radio resources between the mobile station and the mobile communication network from a first current state to a second state, where the first state involves communication with a higher bandwidth than the second state, and inform, prior to the transition, at least one application communication control unit about the transition in order to allow the application communication control unit to release unused application communication connections before the transition.

According to a first variation of the first aspect, the method further comprises disregarding, by the radio resource determination unit, connectivity control commands from an application handling unit in relation to a state transition.

According to a first variation of the second aspect, the radio resource determination unit is further configured to disregard connectivity control commands

from an application handling unit in relation to a state transition.

The state change determination may be based on
5 estimating the time of expiry of at least one state change timer of the mobile communication network.

The radio resource determination unit may because of this comprise a network state change estimating element
10 configured to estimate the time of expiry of at least one state change timer of the mobile communication network.

According to another variation of the first aspect, the
15 method further comprises sending, by the radio resource determination unit to the application communication control unit, an indication of the current state and considering, in the application communication control unit, the current state when releasing application
20 communication connections.

According to a corresponding variation of the second aspect, the application communication control unit is further configured to receive an indication of the
25 current state from the radio resource determination unit and consider the current state when releasing application communication connections.

According to another variation of the second aspect,
30 the radio communication handling device further comprises at least one of the application communication control units, which is configured to determine whether

to release an application communication connection or not based on the informing.

According to a further variation, the considering of
5 the current state comprises sequentially initiating the release of multiple application communication connections.

The application communication control unit may
10 therefore be configured to determine whether to release an application communication connection or not based on knowledge of the connection release behaviour of the corresponding application server.

15 According to a further variation of the first aspect, the method further comprises, determining, by the application communication control unit, whether to release an application communication connection or not based on knowledge of the connection release behaviour
20 of a corresponding application server.

According to another variation the radio communication handling device is the mobile station and therefore the radio resource determination unit is provided in the
25 mobile station, the application communication control unit is a connection handling unit in the mobile station and the state transition is determined based on a low activity indicator of the mobile station. The radio resource determination unit may comprise a local
30 state change element configured to determine the state transition based on this low activity indicator.

According to another variation of the first aspect, the low activity indicator is obtained based on investigating the amount of data of a transmission buffer of the mobile station or the amount of data sent 5 or received during a time period.

According to a corresponding variation of the radio communication handling device, the local state change element is configured to determine the low activity 10 indicator based on investigating the amount of data of a transmission buffer of the mobile station or the amount of data sent or received during a time period.

This low activity indicator may be obtained based on a 15 low activity level of a user interface. Therefore the local state change element is configured to determine the low activity indicator based on this low activity level of the user interface.

20 The resource determination unit may be provided in a node of the mobile communication network and one application communication control unit may be a proxy unit in the mobile communication network handling communication of an application with a corresponding 25 application server. In this case the informing may be an informing of the proxy unit of the determined state transition, in order to let the proxy unit release at least one application communication connection.

30 In another variation of the first aspect, the method comprises releasing, by the proxy unit, at least one application communication connection before the

transition to the second state, thereby making the application also release at least one application communication connection.

5 In a corresponding variation of the fourth aspect the radio communication handling device comprises said proxy unit, the proxy unit is further configured to release at least one application communication connection before the transition to the second state,
10 thereby making the application also release at least one application communication connection.

Another object of the invention is to provide a method for controlling the release of application
15 communication connections for an application in a mobile station, where unnecessary radio resource use by a mobile station is avoided.

This object is according to a fourth aspect of the
20 invention, achieved by a method for controlling the release of application communication connections for an application in a mobile station, where the application communicating with a corresponding application server via a mobile communication network using an application
25 communication protocol. The method is performed in an application communication control unit and comprises: receiving, from a radio resource determination unit for radio communication involving the mobile station, information about a following state transition for the
30 radio communication between the mobile station and the mobile communication network from a first current state to a second state, where the first state involves

communication with a higher bandwidth than the second state, and
determining whether to release an application communication connection or not based on the
5 information.

Another object is to provide a connection releasing device for controlling the release of application communication connections for an application in a
10 mobile station, where unnecessary radio resource use by a mobile station is avoided.

This object is according to a sixth aspect achieved through a connection releasing device for controlling
15 the release of application communication connections for an application in a mobile station. The application communicates with a corresponding application server via a mobile communication network using an application communication protocol. The connection releasing device
20 comprises an application communication control unit configured to:

receive, from a radio resource determination unit for radio communication involving the mobile station, information about a following state transition for the
25 radio communication between the mobile station and the mobile communication network from a first current state to a second state, where the first state involves communication with a higher bandwidth than the second state and
30 determine whether to release an application communication connection or not based on the information.

Another object is to provide a computer program product for controlling the release of application communication connections for an application in a mobile station where unnecessary radio resource use by a mobile station is avoided.

This object is according to a sixth aspect achieved through a computer program product for controlling the release of application communication connections for an application in a mobile station. The application communicates with a corresponding application server via a mobile communication network using an application communication protocol. The computer program product comprises a computer readable storage medium comprising computer program code causing an application communication control unit of a connection releasing device to:

receive, from a radio resource determination unit for radio communication involving the mobile station, information about a following state transition for the radio communication between the mobile station and the mobile communication network from a first current state to a second state, where the first state involves communication with a higher bandwidth than the second state and determine whether to release an application communication connection or not based on the information.

30

According to a first variation of the fourth aspect, the method further comprises receiving an indication of

the current state and considering the state when releasing application communication connections.

According to a first variation of the fifth aspect, the
5 application communication control unit is further configured to receive an indication of the current state and consider the state when releasing application communication connections.

10 According to a second variation of the fourth and fifth aspects, the considering of the state comprises sequentially initiating the release of multiple application communication connections.

15 According to a third variation of the fourth aspect, the determining of whether to release an application communication connection or not is based on knowledge of the connection release behaviour of the corresponding application server.

20

According to a third variation of the fifth aspect, the application communication control unit is further configured to determine whether to release an application communication connection or not based on
25 knowledge of the connection release behaviour of the corresponding application server.

The connection releasing device may be a network node. The application communication control unit may be a
30 proxy unit in the mobile communication network handling communication of the application with the application server.

According to a fourth variation of the fourth aspect,
the method may then further comprise releasing, by the
proxy unit, at least one application communication
connection before the transition to the second state
5 thereby making the application in the mobile station
also release at least one application communication
connection.

According to a fourth variation of the fifth aspect,
10 the proxy unit is further configured to release at
least one application communication connection before
the transition to the second state thereby making the
application in the mobile station also release at least
one application communication connection.

15

The application communication connection releasing
device may also be a mobile station and the application
communication control unit may be a connection handling
unit in the mobile station.

20

The invention has a number of advantages. The invention
employs dynamic release of unused application
communication connections. Because of this battery
drain and radio network load can be minimized and at
25 the same time keep some of the advantages of having
long application communication connection release
timeout.

One aspect of the invention is directed towards
30 coupling the handling of application communication
connection releases to the state of the radio access
network. Thereby the following objectives are achieved:

- minimize power consumption in the device
 - minimize load on the radio access network
- And at the same time minimize any impact on user experience.

5

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail in relation to the enclosed drawings, in which:

- 10 fig. 1 schematically shows a mobile station and an application server communicating with a mobile communication system,
- fig. 2 schematically shows a first realization of the mobile station,
- 15 fig. 3 schematically shows a second realization of the mobile station,
- fig. 4 schematically shows the transitions between a number of radio states,
- fig. 5 schematically shows one realization of a radio
- 20 resource determining unit,
- fig. 6 shows method steps in a method for enabling avoiding of unnecessary radio resource use by a mobile station, being performed in a radio resource determination unit,
- 25 fig. 7 shows a number of method steps in a method for controlling the release of application communication connections for an application in a mobile station, being performed in a application communication control unit,
- 30 fig. 8 shows method steps in a method for enabling avoiding of unnecessary radio resource use by a mobile

station, being performed in a radio resource
determination unit,
fig. 9 shows method steps in a method for controlling
the release of application communication connections
5 for an application in a mobile station, being performed
in a application communication control unit,
fig. 10 shows another realization of the radio resource
determination unit provided in the network, and
fig. 11 shows a computer program product in the form of
10 computer program code for implementing the radio
resource determination unit and/or the application
communication control unit.

DETAILED DESCRIPTION

15

The invention will in the following be described in
relation to a Wideband Code Division Multiple Access
(WCDMA) mobile communication system. It should however
be realized that the invention could be used in
20 relation to other systems such as Long Term Evolution
(LTE). Consequently the entity Radio Network Controller
(RNC) described below could be a base station (eNodeB)
instead.

25 Fig. 1 schematically shows a mobile station 10
communicating with a base station 12 of a mobile
communication system. The base station 12 in turn
communicates with an RNC 14. There is also an
application server 16 connected to the system 18. The
30 mobile station 10 and application server 16 are in this
variation of the invention not parts of the system 18.

Fig. 2 schematically shows a first realization of the mobile station 10. The mobile station 10 according to this first realization comprises an antenna 20 and a radio communication unit 22 providing radio communication according to the radio communication technology of the system or network 18, here Wideband Code Multiple Access (WCDMA). The mobile station 10 also comprises a radio resource determination unit 24, which is connected to an application 26. The application 26 comprises a communication control unit, which in this realization is a communication handling unit for the application, such as a TCP engine, in the following termed TCP part. In this first realization the TCP engine is a part of the application.

Fig. 3 shows a second realization of the mobile station 10'. In this second realization the application 26' is connected to an application communication control unit, also in the form of a communication handling unit for the application. This communication handling unit is also here a Transmission Control Protocol (TCP) engine or TCP part that is a part 28 of an operating system OS of the mobile terminal. In this second realization there is also a communication handling unit, which is a part 28 of the operating system OS of the mobile station. There is also a buffer, a transmission buffer 30, and the radio resource determining unit 24. Both the radio resource determining unit 24 and transmission buffer 30 are connected to the communication handling unit 28. The radio resource determining unit 24 is also connected to the transmission buffer 30, which is

further connected to the radio communication unit 22 leading to the antenna 20.

Fig. 4 schematically shows a number of radio states S0, S1, S2 and S3, where state S0 is an idle state, state S1 is a URA (UTRAN Registration Area) Paging Channel/Cell Paging Channel (URA_PCH/CELL_PCH) state, state S2 is a Cell Forward Access Channel (CELL_FACH) state and state S3 is a Dedicated Channel High Speed (DCH/HS) state. The time t at the state axis is here as time at which a current transaction ends. The figure more particularly shows the change from state S3 to state S2, from state S2 to state S1 and from state S1 to state S0 together with network timers T1 and T2 and an arrow indicating a fast dormancy mode FD of the mobile station 10. State transition after the end of an application transaction here depends on the timers T1 and T2, the fast dormancy strategy of the mobile station and the activity of other applications. As can be seen there is a state transition at a time corresponding to the time of the first timer T1 from state S3 to state S2 after the end of the current transaction. There is furthermore a change from state S2 to S1 that may be based on a fast dormancy strategy FD or based on a second timer T2.

Fig. 5 shows one realization of the radio resource determining unit 24. It comprises a local state change element 32 that obtains a low activity indicator in the form of information about user data flow UDF, display keypad activity information DKAI and radio state technology RST. It also comprises a network state

change estimating element 34 configured to obtain information of user data flows UDF, radio state technology RST and state transitions ST. These two elements 32 and 34 are furthermore connected to a
5 combining element 36, which in turn is connected to the TCP part 28 connected to the application 26.

The mobile station 10 or user equipment is provided with the application 26 and communicates with the
10 application server 16 via the mobile communication network 18 using an application communication protocol, which is here TCP. Furthermore in this communication, the application uses application communication connections that are being set up between the
15 application server and the application in the mobile station. The application in the mobile station is normally also termed a client.

These application communication connections are
20 connections set up according to the communication protocol and in this example thus TCP connections, which connections are transported using the radio resources between the mobile station and the network.

25 For this reason, the network 18 comprises the base station 12 communicating with the mobile station and the RNC 14 handling the communication between the base station 12 and the mobile station 10. These network units are provided in a radio access network. There is
30 also a core network, which has been omitted for simplifying the description of the invention.

In a first variation of the invention the mobile station 10 is a radio communication handling device that handles communication for the application 26 running in the mobile station. In order to handle the radio communication the device comprises the antenna 20 and the radio communication unit 22 providing radio communication according to the radio communication technology of the system or network 18, here WCDMA. The mobile station 10 also comprises the radio resource determination unit 24. It may here also be mentioned that in a second variation of the invention a network node, like an RNC, forms a radio communication handling device.

In the communication the radio resources may be provided according to communication states as seen in fig. 4, where a higher vertical level indicates a higher bandwidth and a lower vertical level a lower bandwidth. Bandwidth is here assigned by the radio communication unit 22 based on need. The radio resources may here be resources in layer L1 and L2 of the OSI model, i.e. in the data link and physical layers. Such states and more particularly a transition from a higher state to a lower may be set by the radio communication unit 22 of the mobile station (fast dormancy) or by the network, typically RNC 14, (state change timers T1, T2).

This means that a fast dormancy decision taken by the radio communication unit 22 or a corresponding decision of the RNC 14 caused by the expiry of a timer T1 or T2 causes a state transition from a first current level or

state to a second following level or state, where the first state involves communication with a higher bandwidth than the second state. A state change may in the example of fig. 4 be from the state S3 of the level DCH/HS to state S2, CELL_FACH, state S1, URA_PCH/CELL_PCH, or state S0, idle. It can also be from state S2 to S1 or S0 or corresponding levels in LTE.

Now a first embodiment will be described with reference being made to fig. 6 and 7, where fig. 6 shows method steps in a method for enabling avoiding of unnecessary radio resource use by a mobile station, being performed in a radio resource determination unit and fig. 7 shows a number of method steps in a method for controlling the release of application communication connections for an application in a mobile station, being performed in an application communication control unit 28.

The radio resource determination unit 24 determines a state transition for the radio resources between the mobile station and the mobile communication network, step 42, for instance through estimating when a state change or a state transition is to occur, where this state transition is a transition from a first current state to a second state, where the first state involves communication with a higher bandwidth than the second state, and informs an application communication control unit about the following or ensuing state transition, step 44. This information is given to the application communication control unit prior to the change of state or state transition, which enables the application

communication control unit to close down or release unused application communication connections.

The application in this way receives the information
5 about a following state transition for the radio communication between the mobile station and the network from the first to the second state, step 46, and determines whether to release an application communication connection or not based on the
10 information, step 48.

The application communication control unit may be a communication handling unit for the application, such as a TCP engine, in the following termed TCP part. This
15 may be a part of the application itself, which is understood from fig. 2, or it may be a part 28 of the operating system OS of the mobile station as indicated in fig. 3. The application communication control unit is thus a unit that handles connections for an
20 application for instance the release of such connections. Application communication connections may here be connections in the transport layer according to the OSI model, layer 4, and are here TCP connections. However the invention may in some variations be used
25 also for layers 5 - 7 of the model, i.e. for the session, presentation and application layers.

Now a second embodiment of the invention will be described with reference being made to fig. 8 and 9,
30 where fig. 8 shows method steps in a method for enabling avoiding of unnecessary radio resource use by a mobile station, being performed in the radio resource

determination unit and fig. 9 shows a number of method steps in a method for controlling the release of application communication connections for an application in a mobile station, being performed in the application communication control unit 28.

The radio resource determination unit 24 determines a state transition for the radio resources between the mobile station and the mobile communication network.

10 The determination of a state transition, step 56, may be based on a low activity indicator. A low activity indicator may be obtained, step 54, based on investigating the amount of data of a buffer 30 of the mobile station, such as a transmission buffer as shown

15 in fig. 3, or measuring the amount of data packets being sent or received. Alternatively, or in addition, it may also be based on a low activity level of a user interface like a display or keyboard/keypad, step 52. The low activity level for the display may be that the

20 display has been having a reduced energy level for a certain amount of time while the low activity level of the keypad may be that no or a limited number of user inputs have been detected for a certain amount of time. When a transmitting buffer is used, the low activity

25 indicator may be obtained through the amount of data in the buffer being below a threshold for a certain amount of time. When measuring the amount of data packets, the low activity indicator may be obtained by detecting no data packets being sent or received for more than a

30 certain amount of time.

The radio resource determination unit 24 may here be provided with a local state change element 32 that obtains a low activity indicator in the form of user data flow (for instance as determined through data in
5 the transmitting buffer) and/or display keypad activity information as well as radio state technology, in order to determine a state transition caused by the mobile station, see fig. 5.

10 The radio resource determination unit 24 may optionally also be provided with a network state change estimating element 34 configured to estimate the time of expiry of at least one state change timer of the mobile communication network, like for instance estimating the
15 time of expiry of the timers T1 and/or T2, step 56. This may be done through investigating previous circumstances in the mobile station at which the system has decided on a state change and estimating that a state change is imminent if the same or a similar
20 circumstance occurs.

There may also be a combining unit 36 combining these estimations and which determines that a state change is imminent if one of the elements indicates that a state
25 change is to be made, step 58. An indication of an imminent state change is then sent to the application communication control unit 28, step 59.

As the application communication control unit 28
30 receives the indication, step 60, it may then decide to release a TCP connection ahead of the time used by the regular TCP timer, step 62. This may save energy,

because if the TCP connection is to be released when the radio resource usage is low in the second state, it may be necessary to move back up to the first state using more radio resources perhaps only for this
5 releasing of the TCP connection.

A method to optimize release of TCP connections together with a radio state machine may comprise one or more of the following:

10

- triggering release of TCP connections immediately before down switching radio state
- disregard TCP messages for releasing a TCP connection as data activity, to not prolong UE duration in high

15 radio state

- special handling of TCP messages for releasing a TCP connection to avoid up switching to a higher radio state than necessary (for example in WCDMA, stay in Cell_FACH to release one or more TCP connections).

20

The release of a TCP connection is not governed by a fixed timer alone without consideration to current state of the radio access network.

25 The TCP release timer is set to a value optimized for the particular use case irrespectively of any release cost in the radio access network. However the radio access is continuously monitored and predicted in order to be able to release TCPs before the radio state
30 change to a state where the cost of the release would be high/non-optimal.

Two different criteria can lead to that the TCPs are released ahead of the TCP inactivity timer expiry:

- The UE Fast Dormancy evaluation, based on the low activity indicator triggers to transition the UE to URA_PCH/Cell_PCH/Idle. Ahead of the signal being sent to the network the TCP part of the application is informed about the transition to be able to release its TCPs. As a further optimization the TCP part can be informed about the current radio state and access technology used in order to optimize the scheduling of multiple TCP releases.
- The UEs prediction of state transitions initiated by the Radio Network triggers to inform the TCP part of the application that a state transition is imminent and that the TCPs should be released. As a further optimization the TCP part can be informed about the current radio state and access technology used in order to optimize the scheduling of multiple TCP releases.

For the further optimization above, the information about current state may be considered by the application communication control unit when releasing application communication connections. The information may more particularly be used so that the release will not cause a state transition to a higher level requiring more resources than the current level provides. This means that if the current level as an example is the level CELL_FACH in fig. 4, and a state

transition to Idle is imminent, then a decision of an application communication control unit to release a number of TCP connections simultaneously may lead to a transition to the DCH/HS level having to be made
5 instead. This situation may for instance be avoided through sequentially releasing multiple application communication connections. As an example, for WCDMA, the release of multiple TCP connections when in the Cell_FACH state could be done sequentially to not
10 trigger upswitch to Cell_DCH. Conversely, in the Cell_DCH state, multiple TCP connections can be released together. Note that "sequentially" does not necessarily mean that one connection is completely closed before requesting the next to close. It is
15 enough (and preferable) that the requests (e.g. TCP FIN or TCP RST) to close connections are sent with a sufficient time interval between them to not trigger upswitch to Cell_DCH, i.e. the mobile does not need to wait for FIN ACK before sending FIN for the next TCP.
20 The initiation of the release of multiple application communication connections may thus be sequential or made with a time-interval in between depending on the current state.

25 The above methods depicts what decisions can be taken on the UE side of the connection. It is also possible to have the application communication control unit as a proxy unit 38 or TCP proxy deployed in the path between the client 26 and the server 16, for instance in the
30 RNC 14, see fig. 6. In this way the release of TCPs towards the UE can be terminated from the radio access

network by controlling the proxy behaviour from the RNC.

Here it is also possible that the radio resource
5 determination unit is provided in the network. It may
here be a unit 40 in the network that estimates the
timer T1 and T2. The unit 40 may be provided in the RNC
14. As an alternative it may be the network unit
responsible for determining the timer T1 and T2. The
10 unit 40 may then be set to inform the proxy unit 38
about the imminent change in radio resource state and
the proxy unit may then decide to release connections.
In this way the RNC 14 can take the decision to release
the TCPs before the mobile station 10 is ordered to a
15 different radio state. If the proxy unit 38 does
release a TCP connection, also the application 26 will
release a TCP connection.

In fig. 6 the proxy unit and radio resource
20 determination unit are provided in the same node. It
should however be realized that they may be provided in
different network nodes

Furthermore a device providing an application
25 communication control unit may also be considered to be
a connection releasing device, which may be a mobile
terminal or a network node, like an RNC.

Such information regarding the state change is not
30 limited to being sent to a proxy unit in the network.
The information may also be sent to the server 16,
which may in turn decide to release TCP connections.

This means that also the application server 16 may be or comprise an application communication control unit

To further reduce the impact of TCP releases on the
5 radio access network it is possible to disregard and introduce special handling on a number of specially flagged TCP packets, Finished (FIN) and Reset (RST) and acknowledgement (ACK). It may thus be seen that connectivity control commands of an application
10 handling unit sent according to the application communication protocol, such as connection releasing commands, may be disregarded.

- Whenever FIN or RST is sent on the link these
15 packets may be disregarded so that they do not reset timers for Fast Dormancy or the T1/T2 timers in the network.
- Whenever FIN or RST is sent on the link these may be not be considered to be user data and therefore they
20 will not cause an up switch to a higher radio state requiring more bandwidth.

Further on it is possible to let the client learn the behaviour of certain servers, certain servers have long
25 TCP inactivity timer and that knowledge is used to postpone the release of the TCP to a later point in time when the UE again has an active radio connection. This means that the connection handling unit can determine whether to release an application
30 communication connection or not based on knowledge of the connection release behaviour of a corresponding

application server. This functionality could also optionally be provided in the proxy unit.

There are several advantages associated with the various aspects of the invention. Today's uncoordinated TCP release handling introduces unnecessary radio network load and unnecessary UE battery drain. By making the TCP release dynamic, instead of a static timer choice, towards the underlying radio access network state the battery drain and radio network load can be minimized and at the same time keep some of the advantages of having long TCP release timeout.

The obvious simple solution would be to reduce the static timer to a small time value but then the advantage of persistent TCPs would never be present, in the invention this advantage is maximized without compromising battery and radio network load.

The radio resource determination unit and application communication control unit may both be provided in the form of a processor with associated program memory including computer program code for performing the functionality of these units.

25

Such a computer program may also be a computer program product, for instance in the form of a computer readable storage medium or data carrier, like a CD ROM disc or a memory stick, carrying such a computer program with the computer program code, which will implement the function of the above-described unit or units when being loaded into a mobile station or a

network node. One such computer program product in the form of a CD ROM disc 64 with the above-mentioned computer program code 66 is schematically shown in fig. 11. It may also be provided on a memory stick or a
5 server from which it may be downloaded.

While the invention has been described in connection with what is presently considered to be most practical and preferred embodiments, it is to be understood that
10 the invention is not to be limited to the disclosed embodiments, but on the contrary, is intended to cover various modifications and equivalent arrangements. Therefore the invention is only to be limited by the following claims.

15

CLAIMS

1. A method for enabling avoiding of unnecessary radio resource use by a mobile station (10) having an application (26; 26') communicating with an application server (16) via a mobile communication network (18) using an application communication protocol, the method being performed for radio communication involving the mobile station and comprising:
 - determining (42; 58), in a radio resource determination unit (24; 40), a state transition for the radio resources between the mobile station and the mobile communication network from a first current state to a second state, where the first state involves communication with a higher bandwidth than the second state, and
 - informing (44; 59), by the radio resource determination unit and prior to the transition, at least one application communication control unit (26; 28; 38) about the transition in order to allow the application communication control unit to release unused application communication connections before the transition.
2. The method according to claim 1, further comprising disregarding, by the radio resource determination unit, connectivity control commands from an application handling unit in relation to a state transition.

3. The method according to any previous claim, wherein the state change determination is based on estimating (56) the time of expiry of at least one state change timer (T1, T2) of the mobile communication network.
- 5
4. The method according to any previous claim, further comprising sending, by the radio resource determination unit to the application communication control unit, an indication of the current state and considering, in the application communication control unit, the current state when releasing application communication connections.
- 10
5. The method according to claim 4, wherein the considering of the current state comprises sequentially initiating the release of multiple application communication connections.
- 15
6. The method according to any previous claim, further comprising, determining (48; 62), by the application communication control unit whether to release an application communication connection or not based on knowledge of the connection release behaviour of a corresponding application server.
- 20
- 25
7. The method according to any previous claim, wherein the radio resource determination unit is provided in the mobile station, the application communication control unit is a connection handling unit in the mobile station and the state transition is
- 30

determined based on a low activity indicator of the mobile station.

8. The method according to claim 7, wherein the low
5 activity indicator is obtained based on
investigating the amount of data of a transmission
buffer of the mobile station or the amount of data
sent or received during a time period.
- 10 9. The method according to claim 7 or 8, wherein the
low activity indicator is obtained based on a low
activity level of a user interface.
10. The method according to any of claims 1 - 6,
15 wherein the radio resource determination unit is
provided in a node of the mobile communication
network and one application communication control
unit is a proxy unit in the mobile communication
network handling communication of an application
20 with a corresponding application server, where the
informing is an informing of the proxy unit of the
determined state transition, in order to let the
proxy unit release at least one application
communication connection.
- 25
11. The method according to claim 10, further
comprising releasing, by the proxy unit, at least
one application communication connection before the
transition to the second state, thereby making the
30 application also release at least one application
communication connection.

12. A radio communication handling device (10; 14) handling communication for an application running in a mobile station (10) and communicating with an application server (16) via a mobile communication network (18), the radio communication handling device comprising:
a radio resource determination unit (24; 40) configured to
determine a state transition for the radio resources between the mobile station and the mobile communication network from a first current state to a second state, where the first state involves communication with a higher bandwidth than the second state, and
inform, prior to the transition, at least one application communication control unit (26; 28; 38) about the transition in order to allow the application communication control unit to release unused application communication connections before the transition.
13. The radio communication handling device according to claim 12, wherein the radio resource determination unit (24; 40) is further configured to disregard connectivity control commands from an application handling unit in relation to a state transition.
14. The radio communication handling device according to claim 12 or 13, wherein the radio resource determination unit (24; 40) comprises a network

state change estimating element (34) configured to estimate the time of expiry of at least one state change timer of the mobile communication network.

5 15. The radio communication handling device according to any of claims 12 - 14, further comprising at least one of said application communication control units (26; 28) being configured to determine whether to release an application communication connection
10 or not based on said informing.

16. The radio communication handling device according to claim 15, said application communication control unit being configured to determine whether to
15 release an application communication connection or not based on knowledge of the connection release behaviour of the corresponding application server.

17. The radio communication handling device according to claim 15 or 16, the application communication control unit being further configured to receive an indication of the current state from the radio resource determination unit and consider the current state when releasing application communication
20 connections.
25

18. The radio communication handling device according to claim 17, wherein the considering of the state comprises sequentially initiating the release of
30 multiple application communication connections.

19. The radio communication handling device according to any of claims 12 - 18, wherein the radio communication handling device is the mobile station and the application communication control unit is a connection handling unit (26, 28) in the mobile station.
20. The radio communication handling device according to claim 19, wherein the radio resource determination unit comprises a local state change element (32) configured to determine the state transition based on a low activity indicator of the mobile station.
21. The radio communication handling device according to claim 20, wherein the local state change element is configured to determine the low activity indicator based on investigating the amount of data of a transmission buffer of the mobile station or the amount of data sent or received during a time period.
22. The radio communication handling device according to claim 20 or 21, wherein the local state change element is configured to determine the low activity indicator based on a low activity level of a user interface.
23. The radio communication handling device according to any of claims 12 - 18, where the radio communication handling device (14) is provided in a network node.

24. The radio communication handling device (14) according to claim 23, wherein the application communication control unit is a proxy unit (38) provided in a network node, said proxy unit handling communication of an application in the mobile station with a corresponding application server (16).
25. The radio communication handling device according to claim 24, the radio communication handling device comprises said proxy unit, said proxy unit being further configured to release at least one application communication connection before the transition to the second state, thereby making the application also release at least one application communication connection.
26. A computer program product for enabling avoiding of unnecessary radio resource use by a mobile station (10) having an application (26) communicating with an application server (16) via a mobile communication network (18) using an application communication protocol, the computer program product comprising a computer readable storage medium (64) comprising computer program code (66) causing a radio resource determination unit (24; 40) of a radio communication handling device (10; 14) to:
- determine a state transition for the radio resources between the mobile station and the mobile communication network from a first current state to

a second state, where the first state involves communication with a higher bandwidth than the second state, and inform, prior to the transition, at least one application communication control unit (26; 28; 38) about the transition in order to allow the application communication control unit to release unused application communication connections before the transition.

10

27. A method for controlling the release of application communication connections for an application (26, 26') in a mobile station (10), said application communicating with a corresponding application server (16) via a mobile communication network (18) using an application communication protocol, the method being performed in an application communication control unit (26; 28; 38) and comprising:

15

receiving(46; 60), from a radio resource determination unit (24; 40) for radio communication involving the mobile station, information about a following state transition for the radio communication between the mobile station and the mobile communication network from a first current state to a second state, where the first state involves communication with a higher bandwidth than the second state, and determining (48; 62) whether to release an application communication connection or not based on the information.

25

30

28. The method according to claim 27, further comprising receiving an indication of the current state and considering the state when releasing application communication connections.

5

29. The method according to claim 28, wherein the considering of the state comprises sequentially initiating the release of multiple application communication connections.

10

30. The method according to any of claims 27 - 29, wherein the determining of whether to release an application communication connection or not is based on knowledge of the connection release behaviour of the corresponding application server.

15

31. The method according to any of claims 27 - 30, wherein the application communication control unit is a proxy unit (38) in the mobile communication network (18) handling communication of the application (26; 26') with the application server (16) and further comprising releasing, by the proxy unit, at least one application communication connection before the transition to the second state thereby making the application in the mobile station also release at least one application communication connection.

20

25

32. The method according to any of claims 27 - 30, wherein the application communication control unit is a connection handling unit (26; 28) in the mobile station.

30

33. A connection releasing device (10; 14) for
controlling the release of application communication
connections for an application (26; 26') in a mobile
station (10), said application communicating with a
5 corresponding application server (16) via a mobile
communication network (18) using an application
communication protocol, the connection releasing
device comprising an application communication
10 control unit (26; 28; 38) configured to:
receive, from a radio resource determination unit
(24; 40) for radio communication involving the
mobile station, information about a following state
transition for the radio communication between the
15 mobile station and the mobile communication network
from a first current state to a second state, where
the first state involves communication with a higher
bandwidth than the second state, and
determine whether to release an application
20 communication connection or not based on the
information.

34. The connection releasing device according to claim
33, wherein the application communication control
25 unit is further configured to receive an indication
of the current state and consider the state when
releasing application communication connections.

35. The connection releasing device according to claim
30 34, wherein the considering of the state comprises
sequentially initiating the release of multiple
application communication connections.

36. The connection releasing device according to any of claims 33 - 35, wherein the application communication control unit is further configured to
5 determine whether to release an application communication connection or not based on knowledge of the connection release behaviour of the corresponding application server.
- 10 37. The connection releasing device according to any of claims 33 - 36, wherein the connection releasing device (14) is a network node and the application communication control unit is a proxy unit (38) handling communication of the application with the
15 application server, the proxy unit being further configured to release at least one application communication connection before the transition to the second state thereby making the application in the mobile station also release at least one
20 application communication connection.
38. The application communication connection releasing device according to any of claims 33 - 36, wherein the application communication connection releasing
25 device is a mobile station (10) and the application communication control unit is a connection handling unit (26, 28) in the mobile station.
39. A computer program product for controlling the
30 release of application communication connections for an application (26) in a mobile station (10), said application communicating with a corresponding

application server (16) via a mobile communication network (18) using an application communication protocol, the computer program product comprising a computer readable storage medium (64) comprising

5 computer program code (66) causing an application communication control unit (26; 28; 38) of a connection releasing device (10; 14) to:

receive, from a radio resource determination unit (24; 40) for radio communication involving the

10 mobile station, information about a following state transition for the radio communication between the mobile station and the mobile communication network from a first current state to a second state, where the first state involves communication with a higher

15 bandwidth than the second state and determine whether to release an application communication connection or not based on the information.

1/5

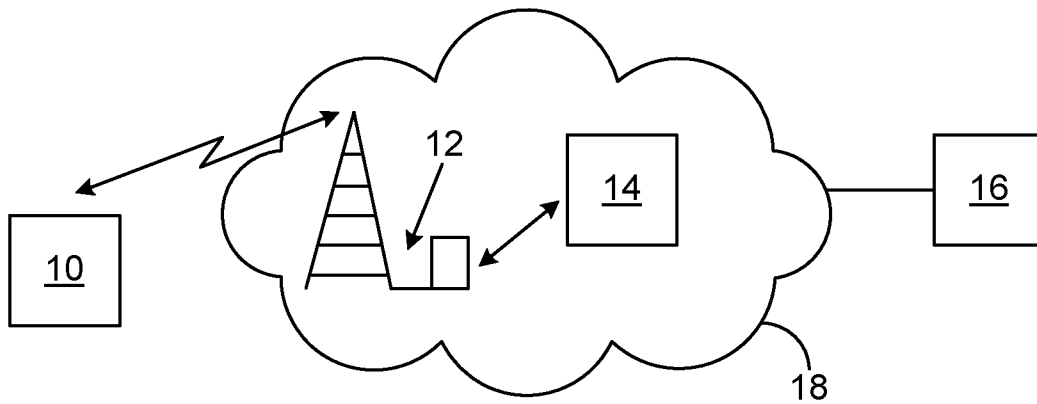


Fig. 1

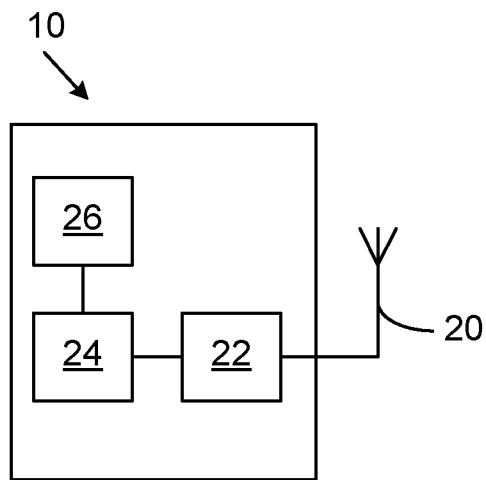


Fig. 2

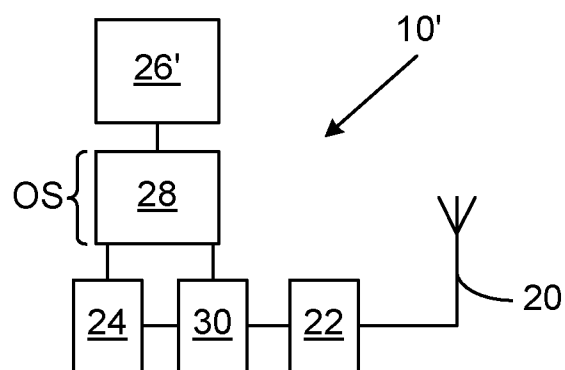


Fig. 3

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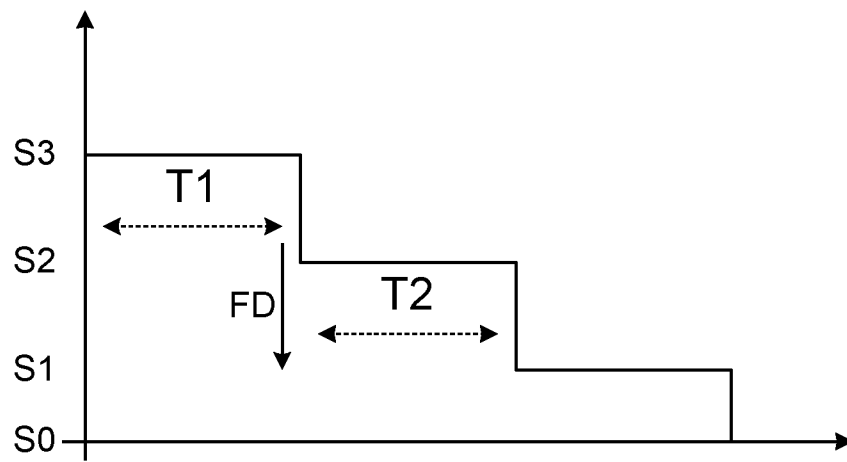


Fig. 4

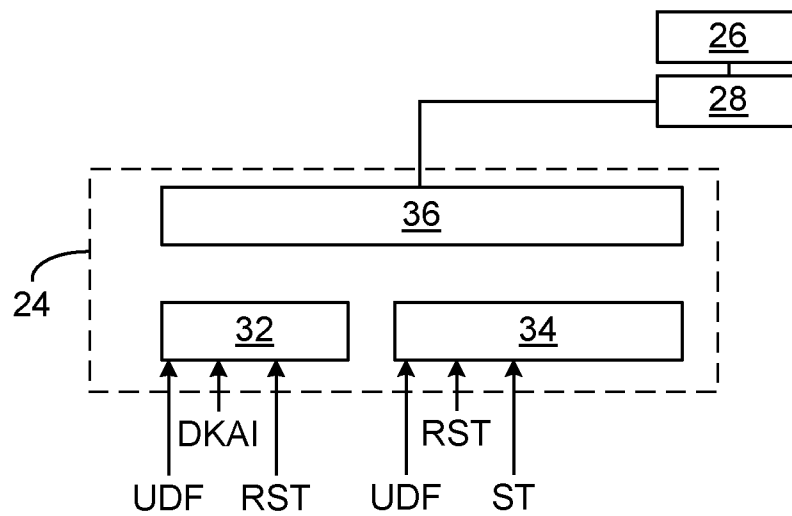


Fig. 5

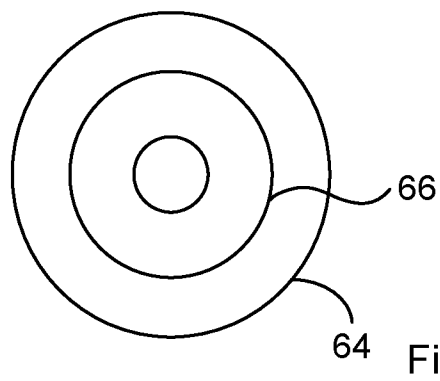


Fig. 11

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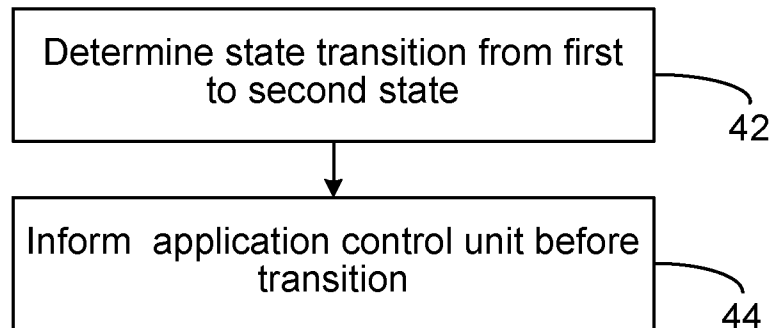


Fig. 6

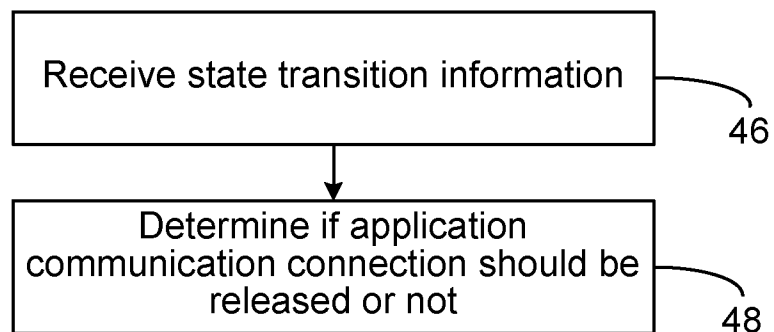


Fig. 7

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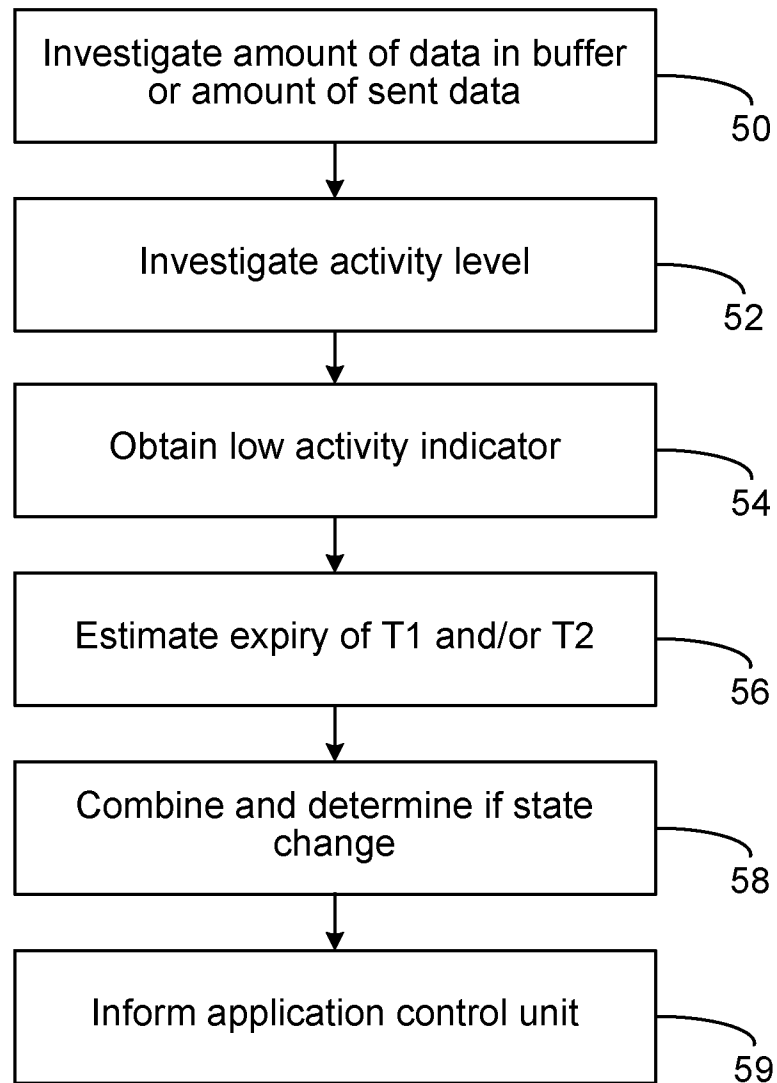


Fig. 8

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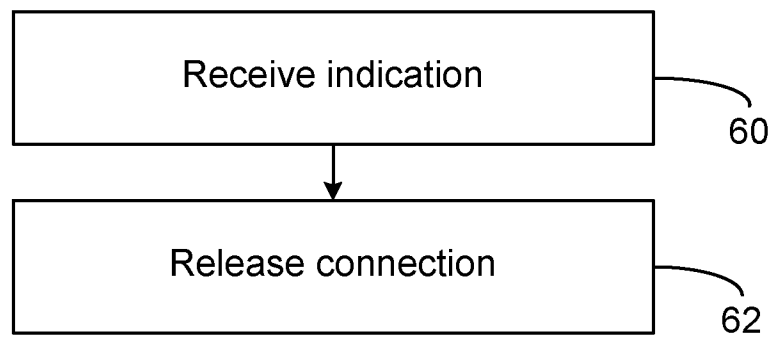


Fig. 9

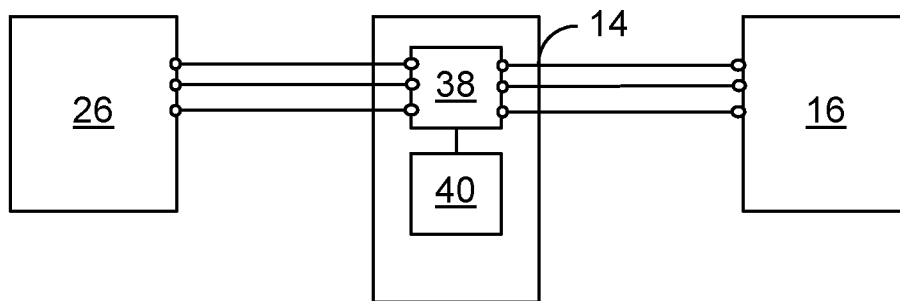


Fig. 10