Fast Dormancy Best Practises
Version 1.0
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1 Executive summary

The introduction and mass adoption of smart-phones by customers has led to a change in the way devices interact with networks. This change has come about to accommodate the different ways in which smart-phones use data connections to create the perception of pervasive, on-going applications. However, the reality is that smart-phones activate and deactivate connections on a regular, periodic basis.

The mechanism by which this is done varies across different smart-phone's implementations, with, in some cases, the implementation being optimized to preserve battery life, whilst in others the implementation has been optimized to minimize network signalling. 3GPP developed the Fast Dormancy functionality within Release 8 and has since further enhanced this functionality through its change request (CR) mechanism. However, this defines functionality alone. In this paper, the 'Best Practices' for implementation of 3GPP defined Fast Dormancy functionality are considered, with a number of areas for further investigation identified.

2 Introduction

The following document is an update to the GSMA paper Fast Dormancy Best Practices V1.0 (May 26th, 20101).

The purpose of this non-binding Permanent Reference Document is to provide clarifications to the initial GSMA white paper – reflecting updates in related 3GPP specifications and experiences gained from live network implementations.

3G systems were developed with the idea of "Global Mobile Multimedia" in mind. This resulted in a very efficient system for transport of higher bandwidth bitstreams, video etc. Some start up delay occurs but for high bandwidth systems this is ok.

The last few years has seen the emergence of high volumes of smart-phones which have been sold with unlimited data packages. These smart-phones do not just use 3G networks for high bandwidth bitstreams. A major market for smart-phone use is for small volumes of frequently-updated data:

- Instant Messaging
- Social Media (Twitter/Facebook/MySpace)
- Stock Portfolio updates
- Email / Calendar / Contact synchronisation
- RSS feed readers

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[1]Source: http://www.gsmworld.com/newsroom/document-library/all_documents.htm

Some of these uses are relatively new and were not catered for in the design of 3G. These applications send or receive very small amounts of data, such as a simple Keep-alive or http GET messages of less than 1 kB, but each of these messages require a connection with all its associated signalling.

2.1 Overview

The purpose of this document is to explain the problems that Fast Dormancy tries to reduce.

- The history of the Fast Dormancy mechanisms and its standardization
- The impact on the network and the device battery lifetime of several parameters
- The aspects that still need improvement and some orientations

2.2 Scope

This document is for internal discussion in GSMA and can be released as decided by GSMA

The numbers used in the graphics are examples and are not to be taken as universal or precise values, although they are considered realistic at the time of writing this document.

2.3 Definition of terms

Within this document, these terms are used in the following sense:

"Autonomous Signalling Connection Release" (ASCR): early proprietary implementations of Fast Dormancy, previous to Release 8, and non standard. These mechanisms receive different names from different vendors. This term (ASCR) is not standardized and is not used outside the scope of this document. The intention of using this term in this document is to clearly differentiate between the early proprietary implementations of Fast Dormancy and the standardized Fast Dormancy, using only the words "Fast Dormancy" for the standardized mechanism. It should be clarified that there are many different ASCR mechanisms or implementations; as every vendor uses a different mechanism, even a single vendor can modify its implementation for different models.

"Fast Dormancy" (FD): mechanism standardized by 3GPP in Release 8 ,by which the UE sends a SIGNALLING CONNECTION RELEASE INDICATION (SCRI) message (sent by the UE to the network) with the IE "Signalling Connection Release Indication Cause" present and set to "UE Requested PS Data session end".

3 Status of fast dormancy

3.1 Status before Fast Dormancy existence

Many networks worldwide keep handsets on a high power channel for a significant period in case they need to send/receive more data in the near future. This results in reduced battery life for 3G operation. To fully understand this, a review of the existent Radio Resource Control (RRC) states is needed:

RRC States:

- Idle. In this state the User Equipment (UE) does not transmit, or transmits only rarely: only Location Area Updates and Routing Area Updates, which are extremely infrequent. The UE monitors the radio environment, listening to the Common Pilot Channel (CPICH) of the cell where it is camped and the neighbouring cells, and also the Paging Indicators Channel (PICH) looking only at its Paging Indicator (Boolean flag that indicates if it should read the Paging Channel). The radio is inactive most of the time, "waking up" every Idle Discontinuous Reception (DRX) cycle. In this state the UE has lost its RRC connection with the network and any new data transmission will require re-establishing the control connection first and then sending the actual data.

- **PCH states**. In this states the user equipment is RRC connected to the UTRAN. No user data is sent, but the UE can operate at very low power consumption, which is determined by the DRX cycles of the PCH states. In the following sections the PCH state could be either deployed by using Cell_PCH or URA_PCH or both.

  - Cell Paging Channel (Cell_PCH). In this state the control connection has not been lost: the UE still has a RRC connection but uses it seldom. The UE informs the network whenever it camps in a new cell (of course, this is usually more frequent than informing only when there is a change in Location Area or Routing Area as it happens in Idle). To send these cell updates, the UE needs to switch to Cell Forward Access Channel (Cell_FACH) temporarily. This can (e.g. at cell borders) trigger frequent cell updates even in static situations. The UE listens to the same channels as in Idle. The radio is inactive most of the time, "waking up" every Cell_PCH DRX cycle (this can be configured differently from the Idle DRX cycle). As the control connection is kept, any new data transmission can be made faster and with less signalling, because it will only require sending the actual data.

  - UTRAN Registration Area Paging Channel (URA_PCH). This state is identical to Cell_PCH, except that in URA_PCH, the updates are only sent when there is a change in the UTRAN Registration Area (URA), typically a larger number of cells, instead of when there is a change in the cell. The use of this state results in fewer cell update transmissions by the UE. The extent of the saving depends on the definition of the UTRAN registration areas, and the DRX cycle, which typically should be kept similar to the IDLE DRX cycle. Due to the concept of URA, URAs can be defined so that they overlap in the border regions. This suppresses any ping pong effect in static scenarios.

- **Cell_FACH**. In this state the UE is in connected mode, but using common or shared channels. This state is ideal for transmission and reception of short data packets. For the Uplink the Random Access Channel (RACH) is used and for the Downlink the FACH is used. In this state, the UE may send data on the RACH messages and may receive data on the FACH.

- **Cell Dedicated Channel (Cell_DCH)**. In this state the UE is in connected mode but using a dedicated channel or a share of the High Speed Downlink Shared Channel (HS-DSCH) and/or an Enhanced Dedicated Channel (E-DCH). This state is ideal for transmission and reception of large data volumes.

Battery consumption is different in the RRC states.
Approximately:
Idle = 1 (relative units)
Cell_PCH < 2 (this depends on the DRX ratio with Idle and the mobility)
URA_PCH ≤ Cell_PCH (< in mobility scenarios, = in static scenarios)
Cell_FACH = 40 x Idle
Cell_DCH = 100 x Idle

States transitions workflow (from TS 25.331 [2]):
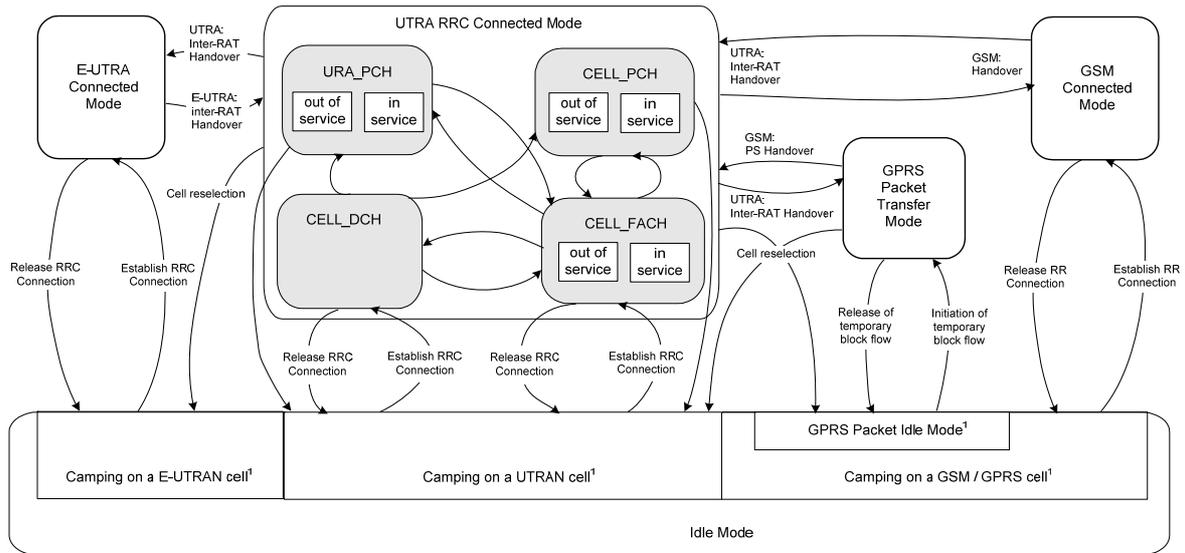
Figure 1: States transitions workflow

To simplify the workflow showing only the 3G states and order from most energy consumption (top) to lowest (bottom), we could use the following diagram:
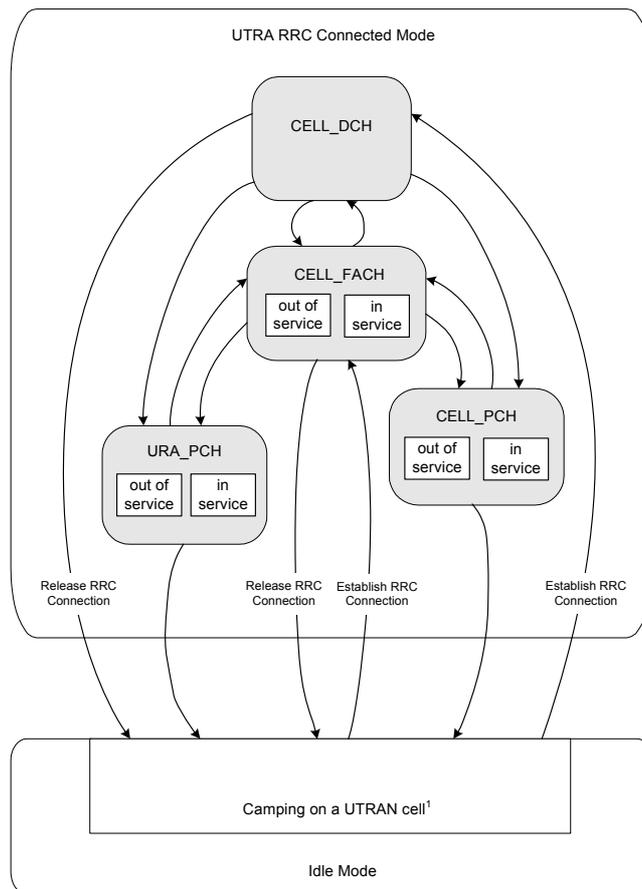
Figure 2: UTRA RRC Connected Mode

The higher the energy used by the UE, the more immediate the communication is required to transmit or receive: staying in Cell_DCH is better for an immediate connection and higher throughput than staying in Cell_FACH, and that in turn is better than staying in the PCH

states, which is in turn better than staying in Idle. On the other hand, the battery lifetime is longer and the load on the network is minimal while it is staying in idle all the time. Thus the network will move the UE to a higher energy states when it is needed to transmit or receive and then direct it back to low energy states when no further transmission is expected.

The Radio Resource Management algorithms that take these decisions are implemented by the network. The UE is directed by the network, in most cases, from one state to another.. There are cases in which the UE may autonomously move from one state to another, for example a transition from a PCH state to CELL_FACH to send CELL_UPDATE messages, or in the case of a radio link failure.

- When the UE is in Cell_DCH state, during a transmission/reception of information, the UE stops transmitting, once there is no more information to exchange. The network keeps it in Cell_DCH (this means that it keeps a dedicated channel or a place in the High Speed Downlink Packet Access (HSDPA) scheduling algorithm) just in case there is more information coming or about to be transmitted. After some time of inactivity, the network usually decides to place the UE in Cell_FACH state. This time of inactivity to leave Cell_DCH can be called "**T1**" (this timer is not standardized as these algorithms are network vendor specific, but it is widely used).

- When the UE is in Cell_FACH state, either transmitting/receiving short packets or because it came from Cell_DCH, a similar inactivity timer used by the network will trigger its transition to a lower energy state. This timer can be called "**T2**". The lower energy state where the UE is placed can be Cell_PCH, URA_PCH or Idle, depending on the availability in that particular network of the Cell_PCH and URA_PCH states.

- For networks supporting Cell_PCH or URA_PCH, there is a third inactivity timer, "**T3**" that triggers the transition to Idle.

The existence of these timers is based on the idea that it is more likely that the UE will need to receive/send additional data soon after recent data transfers. This is why the network keeps the UE in a dedicated channel for some seconds (**T1**) following a data transfer before moving it to the common channels of Cell_FACH. This has a significant impact on the latency that a user perceives. For example with web browsing, the mean reading time in the 3GPP HTTP traffic model is 30 seconds (exponentially distributed). Thus for example when browsing, the existence of a recent transmission/reception may mean that the user is still reading a web page and will soon click on a new link. If the network timers move the UE to a different RRC state prior to the user clicking on a new link then the user will experience a delay in the resumption of the data service. However if the data transmission happened several minutes ago, most likely the user has stopped browsing.

By contrast, for scheduled periodic updates, such as regularly updated Really Simple Syndication (RSS) clients, email checks, keep-alive messages, stock portfolio updates or social networks updates checks, the updates can happen every 2 minutes. With very short network timer settings, enough inactivity time may have passed to allow time for the UE to be transferred from Cell_DCH to Idle. In such cases, the UE would need to re-establish the RRC connection at every occasion: obtain the dedicated or shared channel to transmit a packet of less than 1 kB during less than 1 second and then stay for several seconds (**T1 + T2**) in a high energy state wasting battery, network resources and producing interference for the other UEs.

3.2   Factors Impacting UE Current Consumption

There are many factors which affect UE current consumption when the UE is not accessing the network for data transfers. DRX Cycle Length is one factor and does not necessarily have the greatest impact. Appendix A discusses other UE procedures which can play a significant role in UE current consumption during periods where the UE is not actively transferring data.

3.3   Current Consumption in RRC States

In all RRC states, the current consumption depends on the transmitted signal and the PA power efficiency. However for a given radio environment CELL_DCH it consumes more current than CELL_FACH which consumes more current than the PCH states.   The absolute power consumption of each state may vary from location to location. GSMA TS.09 has developed a Tx power distribution curve for WCDMA for CS using 12.2k AMR. It is possible to further create a mapping of the Tx power (in dBm) to the current consumption (in mA) for any handset.   From this information, an average value of current consumption in the CELL_DCH mode across the Tx Power distribution for WCDMA can be calculated..

3.4   Current Consumption in relation to DRX Cycle Length

Total UE current consumption is not a linear function of the DRX Cycle Length.   As described in Annex A, there are many other radio factors that impact current consumption when the UE is not transferring data.   Additionally there are non radio factors such as LCD and backlight current consumption which impact the total current consumption in all states.   The portion of the current consumption attributable to the awake part of the DRX cycle is proportional to the frequency and duration of the UE awake times, however there are other factors that must be considered when discussing total current consumption and how this is impacted by the DRX Cycle Length. As shown by measurements averaged across nine commercial in-market devices (the screen was not active, the UEs were not asked to make any measurements, and there was no other activity on the UE):

DRX Cycle Length Coefficient	DRX Cycle Time	Median IDLE mode current consumption	Relative Current Consumption
6	640 ms	4.7 mA	188 units (42% increase over DRX Setting 7)
7	1280 ms	3.3 mA	132 units (32% increase over DRX Setting 8)
8	2560 ms	2.5 mA	100 units

Table 1:   Current Consumption and DRX

The measurements have been normalized to units for easier comparison, where 100 units represents the current consumption of a DRX Cycle Length of 2560ms.

The following graph illustrates these concepts for a network not supporting any PCH state (neither Cell_PCH nor URA_PCH). It depicts the power used for the transmission of a packet <1kB every 60 seconds (in this graph, transmission is initiated by higher layers at seconds 3 and 63). This network does not support PCH states and has timers (**T1 = T2 = 10s)**. The transition from Idle to Cell_DCH depends on the network tuning and may take from 1 to 2 seconds: 2 seconds is shown in the following graphs for illustration purposes. The red line shows the useful battery drain (the desired Tx/Rx time), while the blue line shows the actual battery drain. The area under the blue line is the energy used.
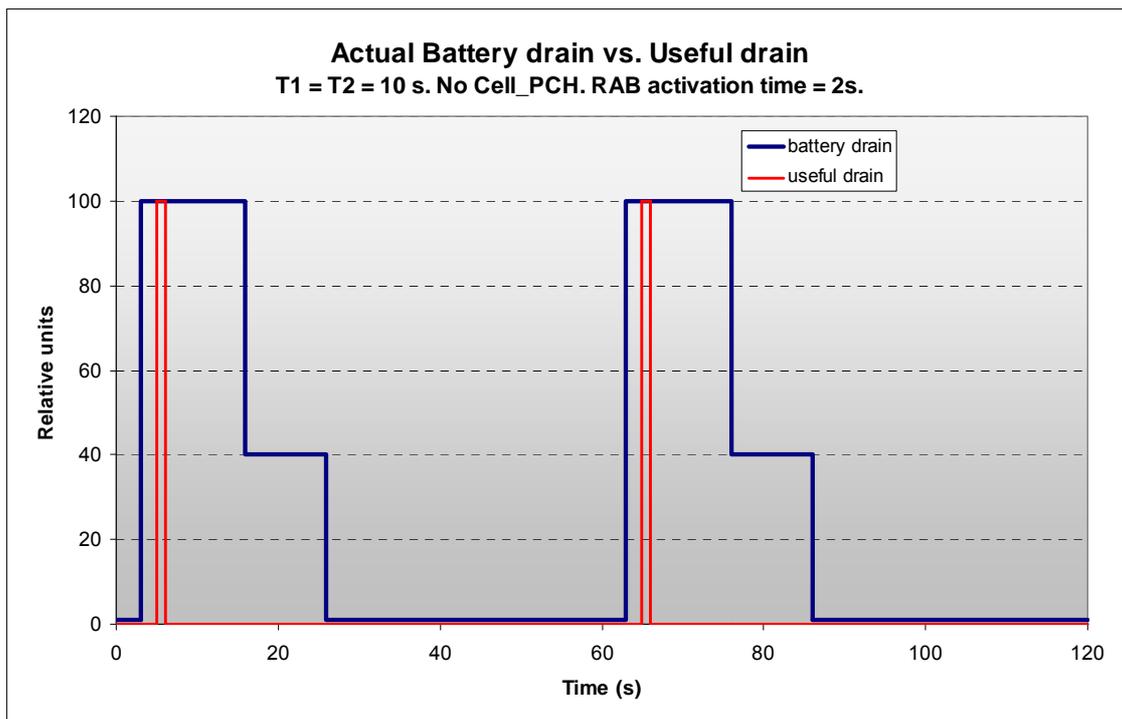
Figure 3: Network Timers - T1=T2= 10 s - No_Cell_PCH

Clearly, the configuration of the timers **T1** and **T2** in the network is critical for the devices battery lifetime. Careful configuration of the network timers by the operator can greatly enhance the battery lifetime perceived by the customers, however this must be balanced with the corresponding increase in latency when a data connection needs to be re-established. In the example below using **T1 = T2 = 5s**, the wasted energy is reduced and the battery lifetime perceived by the customers is increased.
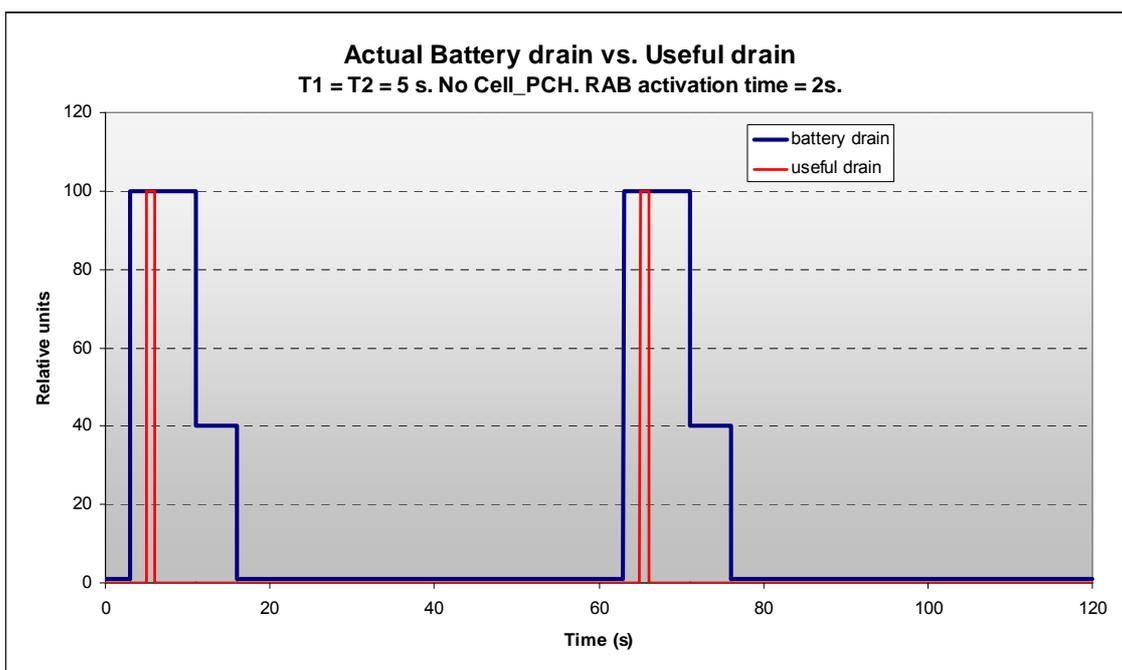
Figure 4: Network Timers - T1=T2= 5 s - No_Cell_PCH

The network operator can configure the network by aggressively reducing **T1** and **T2**. In networks that do not support PCH states, the UE will be moved sooner to the Idle state by the network. That will make the user experience worse for browsing it will take several seconds to read each web page, for every new page visited the UE will need to re-establish the radio bearer, suffering a delay of 1-2 seconds before starting to download the page (see in the graph the time before the red spike when the blue line has already risen – 2 seconds is assumed in this example).

This "lead time" or "Radio Access Bearer (RAB) activation delay" time used to transition from Idle to Cell_DCH is not only inconvenient from the user experience point of view, it also involves many signalling messages (needed to activate the radio bearer and establish the core network links) which puts considerable load on the Radio Network Controllers (RNC) and the UEs.

To avoid this delay in the RAB activation and the associated signalling, PCH states are used in some networks, resulting in a more optimized profile:
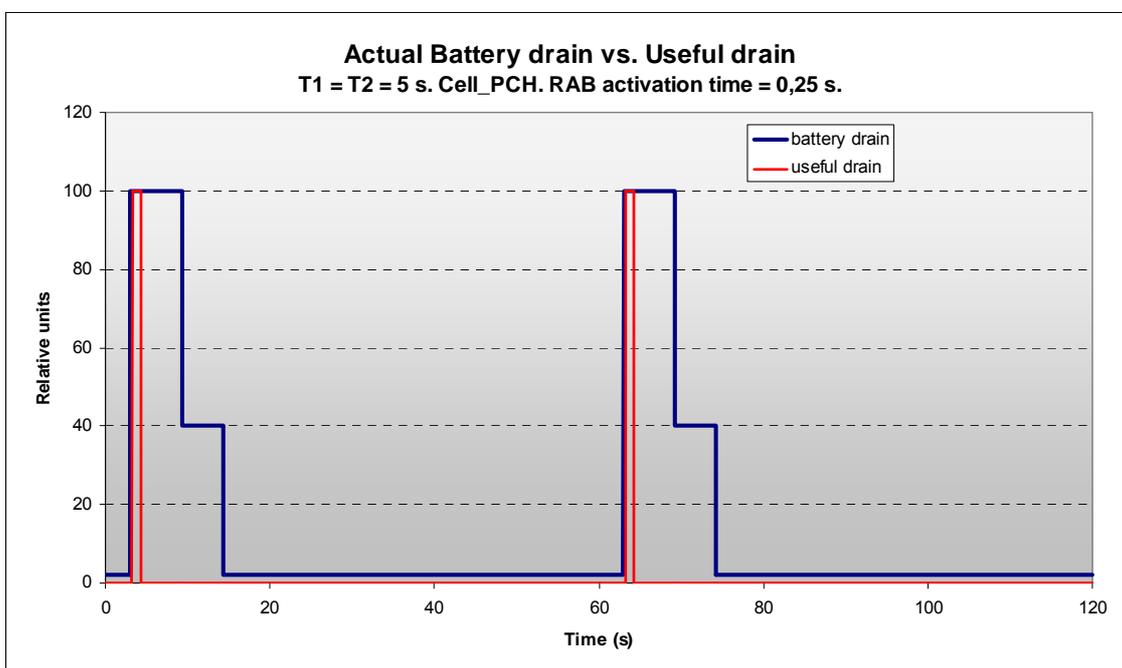
Figure 5: Network Timers - T1=T2= 5 s - Cell_PCH
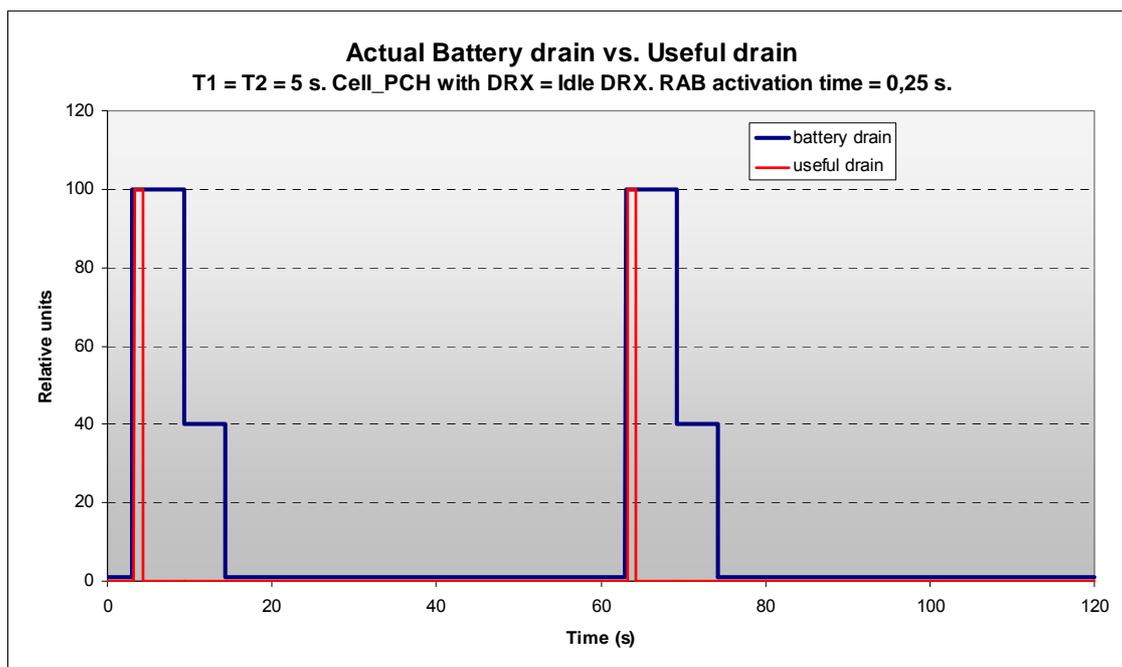
Figure 6: Network Timers - T1=T2= 5 s - Cell_PCH/DRX

By contrast, increasing the PCH DRX time has the disadvantage of making the UE less responsive to network initiated connections (paging). In Release 7 (as an optional feature) two tiers of DRX cycles in PCH state were defined:during the first period until the timer expires, the short DRX cycle is used to make the UE more responsive, but when the timer expires a longer DRX cycle is used.

3.5   Why Fast Dormancy can be useful

In the previous section, it is clear that a certain optimization can be achieved from the network side by tweaking the configuration of timers, using PCH states, adjusting DRX cycles, using the Rel-7 two tiers of DRX cycles in PCH, etc. The network can also be configured so that for transmission of small data packets the UE is placed in Cell_FACH state, instead of in Cell_DCH.

All of the above can be implemented from the network side. **The UE can also contribute to the optimization of resources, because the UE has knowledge that the network does not have**.

The UE knows which application opens each connection, what kind of application it is, and some of the applications know at certain points in time if they plan to transmit/receive any further data. For example, email update checks are done by the email application which, after receiving the server response, knows that it is not going to transmit or receive any further data. At that point the UE can tell the network "I don't need to keep this connection active any more" and the network can immediately move the UE to a low energy state as preferred by the network operator, saving some seconds (**T1+T2**) of wasted battery and network resource.

This dialogue is beneficial for both the UE and the network: the former saves battery and the latter saves network resources (channels) and reduces interference.

3.6   Autonomous Signalling Connection Release: why it can cause signalling congestion to the network

Unfortunately, the dialogue explained in the previous section was not standardized before Release 8. Some terminal vendors implemented a simpler mechanism to enhance battery lifetime. In this document we will call this mechanism Autonomous Signalling Connection

Release (abbreviated as ASCR). There are different implementations of the mechanism depending on the vendor but the core idea is the same for all.

In these ASCR mechanisms, the UE uses an existing message to indicate to the network that it has a high confidence that it has no more data to send, such that the network would move the UE to Idle state. The legacy message that is used by the UE is the SIGNALLING CONNECTION RELEASE INDICATION message. This message has been standardized since Release 99 and is to communicate certain error conditions in the UE to the network.

The inconveniences of ASCR are:
 Decision on when to use the ASCR mechanism is based on different criteria depending on the manufacturer. UE's don't show a uniform behaviour.

1. Because the network is told that there is an error condition, the network must assume that certain aspects of the connection are no longer established (in this case, the PS Signalling Connection). This needs to be re-established the next time a data transfer is requested, whether from Idle or from PCH states which incurs additional signalling compared to the case where the PS Signalling Connection is still intact. Although using ASCR provides significant battery life improvement for some applications, in networks not supporting PCH states (Cell_PCH, URA_PCH, or both), for other applications and in networks supporting PCH states, this causes increased signalling and increased bearer setup time when connecting again. In addition, the reception of the Signalling Connection Release Indication message (which was designed to signal an error condition) has a negative effect on the network PS Key Performance Indicators (KPI).

The battery drain graph, with these ASCR implementations may look like the following:
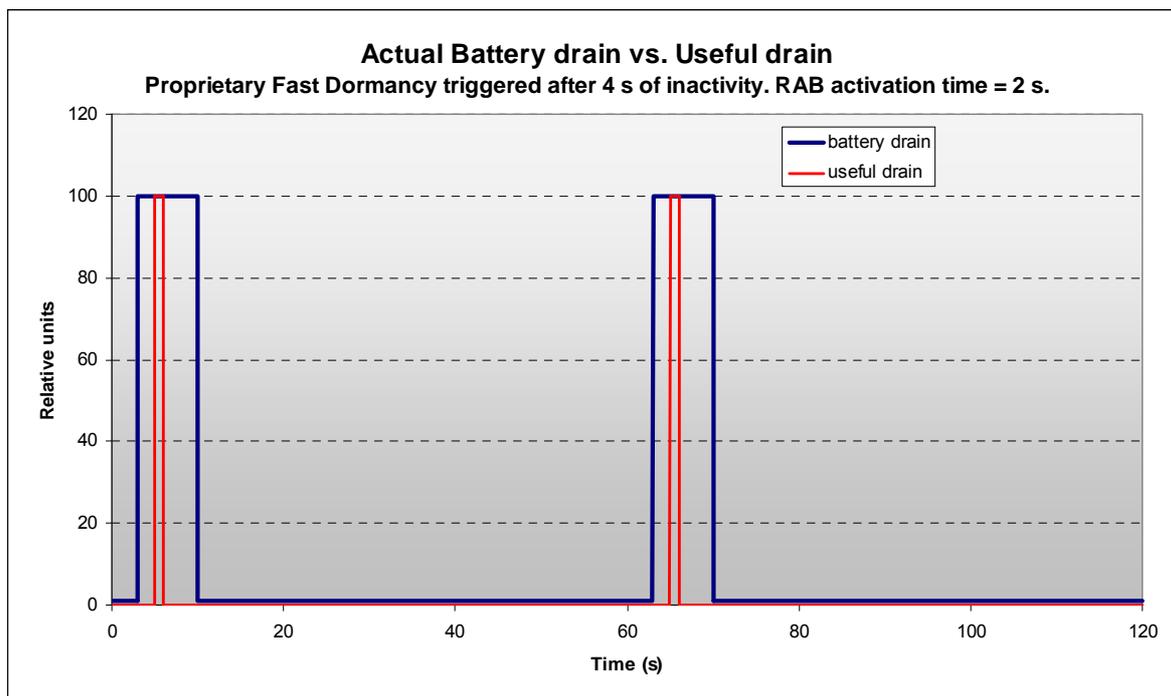
Figure 7: ASCR Triggering

In this graph, the ASCR has been triggered after 4 seconds of inactivity, and the network moves the UE to Idle state. Returning from Idle for a new transmission takes 1-2 seconds to activate the RAB and establish the data tunnel. Comparing this graphic with those in Figures 3, 4, 5 and 6 (without ASCR), it can be seen that:

- Comparing with Figures 3 and 4 (networks without PCH states), it is clear that this ASCR mechanisms can be beneficial. As there is no PCH state (Cell_PCH or URA_PCH), the UE would move to Idle in any case, but later. Consequently, ASCR advances this transition to Idle.

On the positive side, the ASCR mechanism reduces the waste of energy at the UE after the desired transmission (red spike).

On the negative side, the ASCR mechanism results in the network moving the UE to Idle; for subsequent data transmissions the recovery from Idle to CELL_DCH again requires about 1-2 seconds for the RAB activation and tunnel activation before the desired transmission.

This causes:

- Increased signalling and consequential additional current consumption for the RAB activation.
- The bearer re-establishment may also have a negative impact on the user experience, except in the case where automatic periodic connections are not configured in the UE. Hence there is a reduced impact on user experience *if* the ASCR implementation does not trigger the mechanism for connections created by applications executed manually by the user (this is a very important limitation, see section 3.1).
- The RAB activation from Idle requires more signalling than the RB reconfiguration procedure from a PCH state. This is explained in more detail in the following text.

To compare the signalling from a PCH state and from Idle, please consider the following diagrams.

- This is the signalling needed to transmit a heartbeat packet from Cell_PCH or URA_PCH, assuming that the heartbeat packet can be sent in CELL_FACH state. In this case, both the PS Signalling Connection and the PS Data RAB are intact, therefore the UE can only have reached the PCH state by means of network timer (T1 and T2) expiry or by using Release-8 Fast Dormancy:

Resuming Data Session from Low Energy Consumption (PCH) States to CELL_FACH State
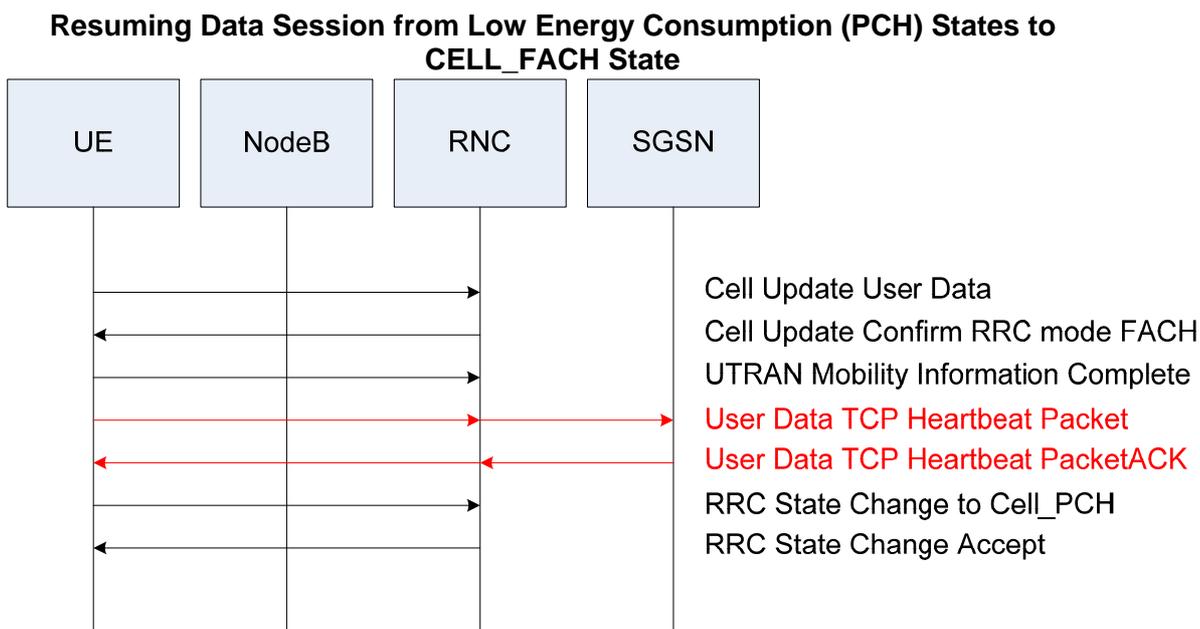
Figure 8: PCH States to Cell_FACH State

Figure 8 illustrates that from CELL_PCH or URA_PCH state, the UE only goes to CELL_FACH state to transmit the heartbeat packet and then moves back to CELL_PCH or URA_PCH state without transitioning to CELL_DCH state.   However the actual behaviour depends on how networks configure their Traffic Volume Measurement behaviour.   The threshold value is part of the Traffic Volume Measurement (TVM) event 4a for RACH. The TVM threshold will determine whether the UE needs to send a TVM measurement report to the network.

Looking at practical network settings, it has been observed that there are many PLMNs in which the TVM e4a threshold is configured to a low value. This means that UEs sending a small data packet could trigger a TVM measurement report to the network. It is then quite likely that the network will move these UEs to CELL_DCH state which then makes the number of signalling messages comparable to the transition from IDLE to CELL_DCH state. If the UE is moved to CELL_DCH for the data transfer, then the signalling flow diagram includes additional messages as shown in Figure 9:

Resuming Data Session from Low Energy Consumption (PCH) States to CELL_DCH State

UE	NodeB	RNC	SGSN	

Cell Update User Data
Cell Update Confirm RRC mode FACH
UTRAN Mobility Information Confirm
Measurement Report (TVM e4a)
RL Setup (NBAP)
RL Setup Complete (NBAP)
AAL2 Establish Request (AAL2 Sig)
AAL2 Setup Complete (AAL2 Sig)
RB Reconfiguration (CELL_DCH)
RB Reconfiguration Complete (CELL_DCH)
User Data TCP Heartbeat Packet
User Data TCP Heartbeat PacketACK
RB Reconfiguration (CELL_FACH)
RB Reconfiguration Complete (CELL_FACH)
RL Release (NBAP)
RL Release Complete (NBAP)
AAL2 Reconfigure Confirm (AAL2 Sig)
RB Reconfiguration (CELL_PCH)
RB Reconfiguration Complete (CELL_PCH)

Figure 9: PCH States to Cell_DCH State

To move a UE from Idle state to CELL_DCH state, more signalling is needed as shown in Figure 10:

Resuming Data Session from IDLE State to CELL_DCH State

UE | NodeB | RNC | SGSN

RRC Connection Request (Control Plane)
RL Setup (CNBAP)
RL Setup Complete (CNBAP)
AAL2 Establish Request (AAL2 Sig)
AAL2 Setup Complete (AAL2 Sig)
RRC Connection Setup (Control Plane)
RL Connection Restore (DNBAP)
RRC Connection Setup Complete (Control Plane)
Initial Direct Transfer/NAS Service Request (CP)
Security Mode Command (Control Plane)
Security Mode Complete (Control Plane)
RAB Setup (Control Plane)
RAB Setup Complete (Control Plane)
RL Reconfigure Prepare (DNBAP)
RL Reconfigure Confirm (DNBAP)
AAL2 Reconfigure (AAL2 Sig)
AAL2 Reconfigure Confirm (AAL2 Sig)
RL Commit (DNBAP)
RB Setup
RB Setup Complete
User Data TCP Heartbeat Packet
User Data TCP Heartbeat PacketACK
RRC State Change to CELL_FACH (Control Plane)
RRC State Change Accept (Control Plane)
RL Release (DNBAP)
RL Release Complete (DNBAP)
AAL2 Reconfigure Confirm (AAL2 Sig)
RRC Signalling Bearer Release Request (Control Plane)
RRC Signalling Bearer Release (User Plane)
RRC Release Complete (User Plane)

Figure 10:   Idle State to CELL_DCH State

For these reasons the ASCR implementations cause significant load issues with some network configurations of the operators supporting PCH states. PCH states are particularly suited for devices making frequent connections for small data transactions where a traffic volume measurement is not triggered, but if those devices use an ASCR implementation that results in the network moving the device to Idle state after every connection, the advantage of supporting the PCH state to reduce the signalling load is lost.

3.7   What happens if the UE uses ASCR and the network moves the UE to PCH state instead of IDLE?

On sending the Signalling Connection Release Indication, the UE will release the PS Signalling connection as per 3GPP TS 25.331 Section 8.1.14, and will remain in RRC Connected Mode with no established signalling connection. According to the standard, the UE will not autonomously release the RRC connection.

The UE assumes that the Iu connection between the RNC and the SGSN is released due to the PS signalling connection release by the UE.

As the PS signalling connection is released, it is expected that the RNC will send a Radio Bearer Release to explicitly release the PS RAB and the corresponding RB.   This Radio Bearer Release could move the UE to URA_PCH or CELL_PCH state or a subsequent reconfiguration procedure could move the UE to URA_PCH or CELL_PCH state.   This behaviour can be referred to as "PCH State after ASCR".

After the transition to URA_PCH or CELL_PCH state, if there is subsequent PS data to send then,   PS data from the UE or from the RNC (Paging Type1 containing Core Network paging) would result in the UE sending an Initial Direct Transfer message (NAS Service Request).   That should result in the establishment of the Iu connection between the RNC and the SGSN.   A PS RAB and corresponding RB could then be established.

In the signalling diagrams above, it can be seen that only five signalling messages are saved with this approach (20 messages required before "heartbeat packet" when moving from IDLE to CELL_DCH, and 15 messages required before "heartbeat packet" when moving from PCH to CELL_DCH after "PCH State after ASCR" solution.   In contrast, with Release-8 Fast Dormancy this number of messages drops to three if the data can be sent in CELL_FACH state, and to ten messages if the UE must move to CELL_DCH state to send the data (whether the UE can move to CELL_FACH or must move to CELL_DCH depends on the requirement and response to the TVM).

The signalling flow diagram for this case is as follows:
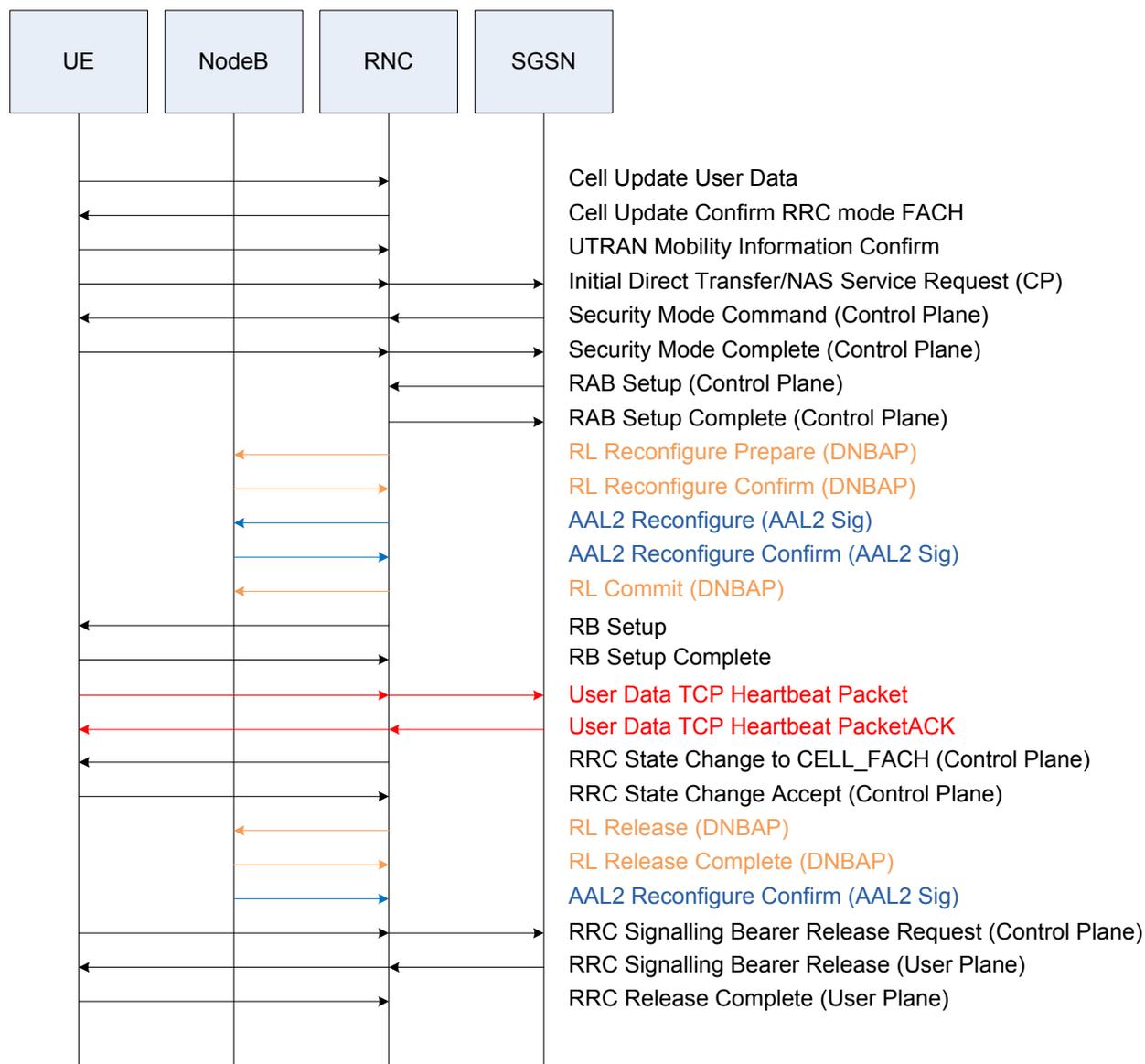
Figure 11:   Signalling Flow Diagram

3.8   What happens if the UE sends a SCRI upon encountering a GMM error and the network moves the UE to PCH state instead of to IDLE?

Legacy devices implementing ASCR encountering a GMM error will send a Signalling Connection Release Indication message to the RNC and release the PS signalling connection as per 3GPP TS 25.331 section 8.1.14. With the pre Rel-8 state of RRC messaging, the RNC cannot determine if the UE is using the SCRI for ASCR or for a genuine GMM error.

Legacy devices sending the SCRI for a GMM error should be able to handle the transition to URA_PCH or CELL_PCH in the same way as described in Section 3 for use of this message for ASCR.

Figure 11 represents the important signalling issues for use of the SCRI for ASCR or for GMM error.

3.9 Network Timer Initiated Transitions to IDLE

The typical values of the CELL_PCH to IDLE transition timers observed in live networks are 10 to 30 minutes.   Based on current user traffic patterns and profiles, it is unlikely that any smartphone will go through such a network initiated transition due to the likelihood for more frequent updates and data transitions.

3.10 Fast Dormancy Standardized in 3GPP Release 8. Status by December 2008/2009

In December 2008, CR 3483 to Release 8 TS 25.331 [2] was approved, standardizing the Fast Dormancy in 3GPP. This CR introduced a simple UE signalling to provide clear indication of UE status to the network.
It added a new Information Element (IE) called "Signalling Connection Release Indication Cause" to the SIGNALLING CONNECTION RELEASE INDICATION message, to provide an indication to the network that the UE has determined that it has concluded active PS data transfer. The value of this IE has to be set to "UE Requested PS Data session end" to mean a Fast Dormancy request.

In other words, a **(Release 8) FD Request** is:

> *« a SIGNALLING CONNECTION RELEASE INDICATION (SCRI) message (sent by the UE to the network) with the IE "Signalling Connection Release Indication Cause" present and set to "UE Requested PS Data session end". »*

UMTS Terrestrial Radio Access Network (UTRAN) may upon reception of this IE decide to trigger an RRC State transition to a more battery efficient state: IDLE, CELL_PCH, URA_PCH or CELL_FACH. This is a fundamental distinction with the ASCR mechanisms. With Release-8 Fast Dormancy the network has a choice: the device says that it has finished the PS (Packet Switched) Data session and would like to release the connection, and waits for the network to place it in the state that the network considers most appropriate.
Also, to enable network control of this feature, the CR defined a network configured and signalled inhibit timer, called T323.
If timer T323 is broadcast in System Information Block type 1, it means that the network supports this Rel-8 mechanism. This timer can take values: (0, 5, 10, 20, 30, 60, 90, 120) seconds. The use of 0 secs indicates no need to apply the inhibit timer. The inhibit timer is started after a Fast Dormancy (FD) Request is sent by the UE, and until the timer is elapsed, the UE can't send a further FD Requests. For example, if T323 = 120, the UE can't send any FD request for 2 minutes after a transmission ends or the transmission of a previous FD request.

3.11 How does this solve the operators concerns?

The mechanism introduced by Release 8 Fast Dormancy provides a standardized and recognizable way for the UE to signal the FD Request, and gives the Network the choice of which state to move the UE to. Thus this CR solved the *second* inconvenience of ASCR implementations described in section 3.3.

The creation of timer T323 solved only partially the *first* inconvenience described in section 3.3: the decision on when to use the FD mechanism is based on different criteria depending on the manufacturer. This timer limits how frequently the FD Requests can be sent. But it does not limit the states from which the FD Requests can be sent. The number of times the FD Request can be sent was not limited.

3.12 3GPP Release 8 latest CR approved in Feb. 2010

In February 2010, CR 4100 was approved to Release 8 TS 25.331 [2]. In this CR, two additional restrictions were added:

1. A UE in CELL_PCH or URA_PCH, with a DRX Cycle Length that is equal to or longer than the Idle DRX Cycle Length (= the shorter of the CN domain DRX Cycle Lengths for the PS domain and CS domain), shall not transmit the FD Request more than once (a new counter, named V316, is created for this purpose).

2. In case the DRX Cycle Length coefficient currently in use by the UE in CELL_PCH or URA_PCH is shorter than the Idle DRX Cycle Length (= the shorter of the CN domain specific DRX Cycle Lengths for the PS domain and CS domain), *the number of transmissions of FD Request should be "limited"* to not affect the battery lifetime or a network signalling load.

The second limitation was added as an informative note, without specifying an upper limit for that "limited" number of transmissions of FD Requests.

4   Improvements to ASCR and Fast Dormancy implementations, proposed best practices

This paper has attempted to discuss typical deployment scenarios and network configurations, and how these deployment scenarios and configurations interact with ASCR and Release 8 Fast Dormancy.   Each network operator faces different challenges and therefore there is no common enhancement which is best for all operators. Some operators are more concerned about highly responsive user experience, and some operators are more concerned about minimizing the signalling in their networks.   The information presented in this paper is to help operators understand what parameters they can use to tailor the Fast Dormancy feature to best suit their network and their subscribers. At the time of writing, Release 8 Fast Dormancy is just starting to be deployed in live networks and handsets incorporating the feature are being tested.

Operators have seen different ASCR implementations; the first Fast Dormancy implementations according to Release 8 are now available. It is desirable to align the ASCR and Fast Dormancy implementations between different manufacturers, so that predictable and consistent behaviour across vendors can be achieved.

This section tries to create a common understanding among manufacturers and operators on what to do and what to avoid. Some of these recommendations are for ASCR implementations and others are for Fast Dormancy implementations, and some are common to both. The following picture gives a summary of some of the different problems that may have been encountered.
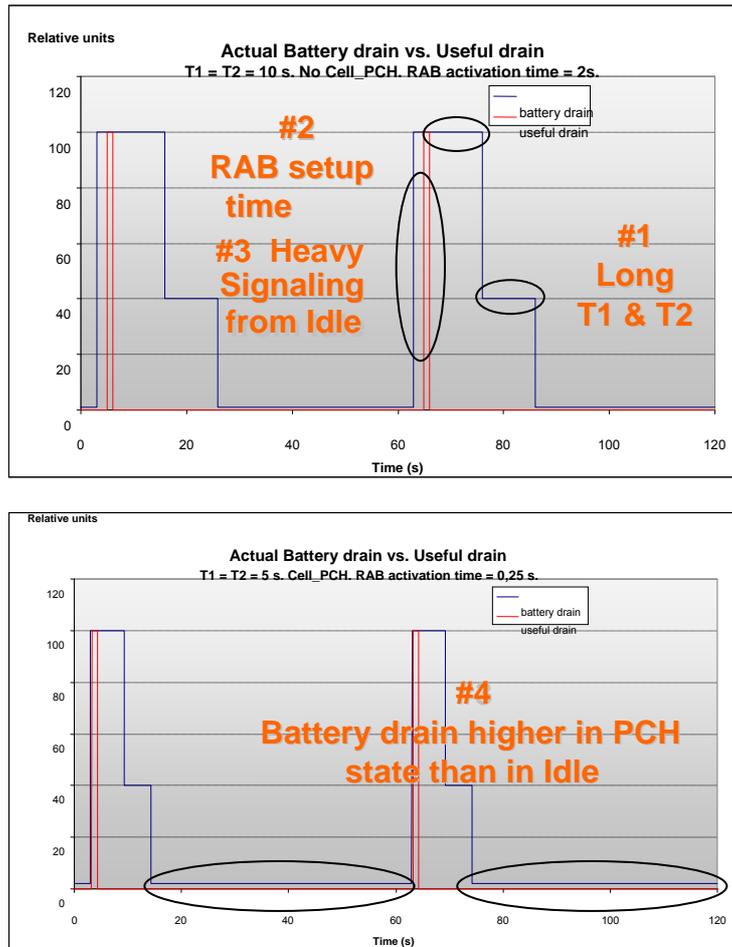
Figure 12:   Battery Drain

The 4 main problems are:

1. Long **T1 &T2** produce considerable battery drain. Solving this problem is the origin and main focus of Fast Dormancy.
2. Long RAB setup time from IDLE
3. Heavy signalling load to set up RAB from IDLE.
4. Battery drain is higher in PCH state than in IDLE. Even if both are very low, if this situation is kept for many hours the difference in battery lifetime can be considerable.

Ideally we would like to avoid these four problems. The table below shows how some of these problems are addressed with ASCR, ASCR with PCH State after ASCR (defined in Section 3.7), and Release 8 Fast Dormancy.

Network configuration	Initial problems	With ASCR and without "PCH State after ASCR" solution	With ASCR and with "PCH State after ASCR" solution	With Release 8 Fast Dormancy
Network not Supporting PCH states (Problem 4 does not apply)	Users suffer problems 1 through 3	Solves problem 1, but does not solve 2 or 3	Does not apply (network does not support PCH states)	Solves problem 1, but does not solve 2 and 3.
Network supporting a PCH state	Users suffer problems 1 and 4	Solves problems 1 and 4, but creates problems 2 and 3 and the network can't avoid it.	Improves problem 1, offers some improvement to problems 2, improves problem 3 by only 5 messages and does not address problem 4	Solves problems 1 and lets the operator choose between problems 2, 3, and 4 through network choice of state to transition to.
Network supporting PCH states with optimized T1 and T2	Problem 1 is minimized but not eliminated, users suffer problem 4	Brings some small additional benefit for problem 1 and 4, but creates problems 2 and 3 and the network can't avoid it.	Improves problem 1, offers some improvement to problems 2 and 3, does not address problem 4	Brings some small benefit for problem 1 and lets the operator choose between problems 2, 3, and 4 through network choice of state to transition to.

Table 1 Network Configurations

From the above comparison table it is clear that to allow the network the greatest choice in which scenario to optimize, it is best for the network to support Release 8 Fast Dormancy.

APPENDIX A

Factors impacting battery consumption in the UE while the UE is not accessing the network for data transactions

4.1   Neighbour Cell Measurements

The neighbour cells of the UE are defined by SIB11, SIB11bis, and SIB 12. Whether or not the UE should measure them is determined by the–SIB3 and SIB4 (connected mode) configuration. If the UE is actively measuring intraFreq, interFreq and interRAT neighbour cells this impacts the current consumption.   Therefore the number of neighbour cells defined in these lists that the UE is required to measure has an impact on the battery life. In addition, the level of current consumption depends on whether the neighbour cells indicated in the SIBs are actually detectable (i.e. the effort that it takes to confirm that a cell is not detectable is high).

Variations may be seen across different devices and platforms, however continuously measuring both intra frequency and inter frequency neighbour cells in IDLE mode could increase the current consumption by over 60%. Increases can also be expected in PCH states. For example, consider that the network setting is such that it forces the UE to measure all inter- and intra- frequency neighbour cells, if they are defined. If there are two inter frequency cells, one of which is detectable and one of which is not, and two intra frequency cells, one of which is detectable and one of which is not, then the current consumption cost of doing measurements is as follows:

- No cells measured – 100 units

- Measure 1 detectable and 1 non detectable intra frequency cell – 120 units

- Measure 1 detectable and 1 non detectable inter frequency cell – 140 units

- Measure 1 detectable and 1 non detectable intra frequency and inter frequency cells (total of 4 neighbour cells) – 160 units.

Note that the actual measurements are normalized to basic units to enable a comparison.

4.2   Paging Reception

The current consumption required for paging reception depends on the traffic in the cell that the UE is in. In IDLE mode, the UE location is known at the location area level. In URA_PCH the UE location is known at the UTRAN registration area level. In Cell_PCH the UE location is known at the cell level. If you assume a roughly consistent number of users per cell, and a number of cells making up a UTRAN registration area, and an even larger number of cells making up a location area, then the number of times that the UE is paged on the physical layer (PICH detection) and where there is no actual page message on the paging channel (PCH) will be highest when the UEs are kept in IDLE and lowest when the UEs are kept in CELL_PCH state. This is because a limited number of paging indicators are used for a large number of UEs, leading to false alarms. Every time the UE in IDLE or one of the PCH states is paged on the physical layer, it will need to activate the secondary common control physical channel (S-CCPCH) to listen to the paging channel (PCH) to determine if there is a page for it.   Such activation and active listening of the S-CCPCH causes significant current consumption.

Document management

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Reference Number	Document Number	Title
[1]	AD02	Confidentiality of GSMA Documents
[2]	3GPP TS 25.331	Radio Resource Control; Protocol Specification