3GPP TSG GERAN #19 **GP-040873**
Cancun, Mexico; April 19th – 23rd, 2004 **Agenda Item: 7.1.5.5., 7.2.5.4.5.6**
Title: Enabling SIP signalling on GPRS/EDGE: discussion
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Abstract: This document addresses possible radio layer problems associated with GPRS/EDGE applications using the Internet Protocol Multimedia Subsystem (IMS) to carry application level packet-based signalling using Session Initiation Protocol (SIP), such as Push-to-Talk. We propose for consideration the addition of an equivalent of a slow associated control channel (SACCH) to the packet data domain over which measurements related to directing a full packet domain handover may be sent. This method is in contrast to the existing Packet Associated Control Channel (PACCH), which is associated with an active packet data transfer, and terminates when the packet data transfer to which it was associated has terminated. This is an issue for applications such as simplex voice, which comprise multiple, discontinuous talk spurts, but are sensitive to the loss of voice data resulting from the current best effort method of managing packet domain user mobility.

Overview

The General Packet Radio Service (GPRS) and Enhanced Data for Global Evolution (EDGE) for the Global System for Mobile Communication (GSM) have introduced the capability of the user data interchange into mobile wireless products. GPRS, and its superset, EDGE, permit efficient use of radio and network resources when data transmission characteristics are i) packet based, ii) intermittent and non-periodic, iii) possibly frequent, with small transfers of data, e.g. less than 500 octets, or iv) possibly infrequent, with large transfers of data, e.g. more than several hundred kilobytes. User applications may include Internet browsers, electronic mail and so on, [1, 2, 4].

Public Land Mobile Network (PLMN) operators originally saw GPRS and EDGE as means of generating additional revenues based on their excess capacity during non-peak usage period. User applications were originally envisioned to include Internet browsers, electronic mail, file transfers and other applications for which best efforts data transfer are appropriate [1 - 4].

At the time that GPRS was conceived, the industry did not anticipate the adoption of applications such as streaming and push-to-talk (PTT) to make use of GPRS/EDGE as an underlying wireless transport vehicle. Therefore, to maintain system simplicity, there exists no specified real-time handover procedure for best effort packet data transfers over GPRS/EDGE nor has there been any reason to specify how the Internet Protocol Multimedia Subsystem (IMS) will efficiently send and receive application layer signalling using, e.g. Session Initiation Protocol (SIP).

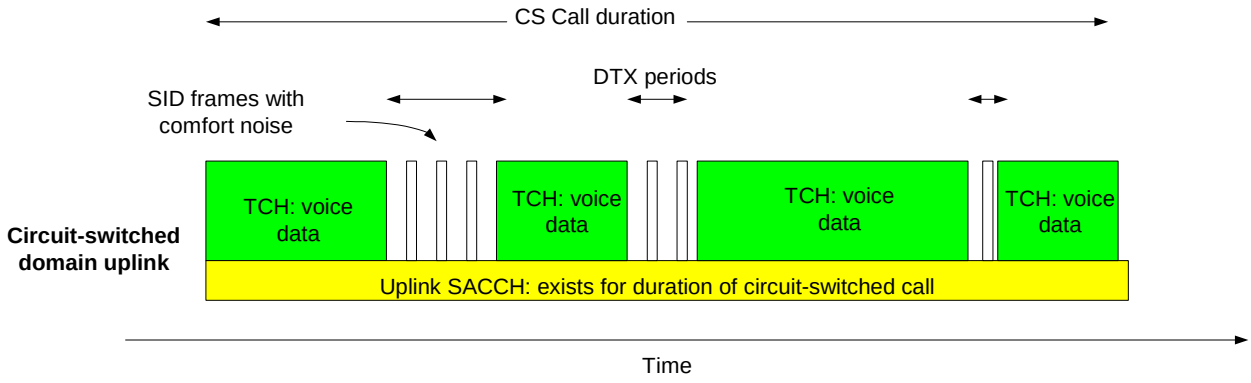
It may therefore necessary to make certain modifications to the underlying wireless transport domain in order for manufacturers and operators to fully leverage the opportunity of IMS applications such as PTT by introducing specialized control channel functionality.

Issue for SIP Signalling

The lack of a persistent control channel in GPRS/EDGE means that there is no continuity in the ability to carry application level signalling such as SIP. For applications such as PTT, this means that during a one-way conversation, when one party is listening, there exists no Temporary Block Flow (TBF) over which signalling may be carried. If SIP signalling is required during such a period, then i) a TBF must be specially set up in the uplink direction or ii) the signalling must be delayed until the listener assumes the talker role. In other words, the GERAN packet domain does not support an equivalent of the Slow Associated Control Channel (SACCH) over which signalling may flow during, and between, packet data transfers comprising half-duplex speech.

About the current Slow Associated Control Channel (SACCH) and Packet Associated Control Channel (PACCH)

The Slow Associated Control Channel (SACCH) is associated with a circuit-switched traffic channel (TCH), primarily to carry handover (HO) measurements to the radio access network (RAN). Although there may be some discontinuity of the uplink voice data due to discontinuous transmission (DTX) operation, the SACCH persists, as may be observed in the following diagram:



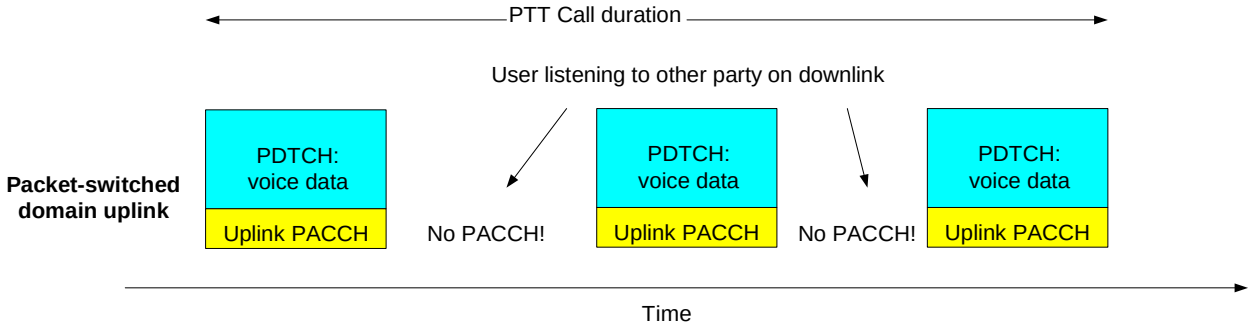
On uplink TCH, circuit-switched voice data flow may exhibit some discontinuities due to DTX operation, but SACCH is preserved for duration of call.

There exists the concept of a Packet Associated Control Channel (PACCH) as specified in [8] in terms of its mapping and [7] in terms of its usage. The purpose of this channel is to exchange system level control information between the mobile and network while the mobile terminal has an ongoing packet data transmission and is mapped below directly to the Packet Data Traffic Channel (PDTCH) as per [8]:

Channel designation	Repeat **length in TDMA frames**	**Interleaved block TDMA frame mapping**
PDTCH/F, PACCH/F	52	B0(0...3), B1(4...7), B2(8...11), B3(13...16), B4(17...20), B5(21..24), B6(26...29), B7(30...33), B8(34...37), B9(39...42), B10(43...46), B11(47...50)

Essentially, the PACCH is a bi-directional control channel associated with a Temporary Block Flow (TBF), [7] which comprises blocks of 4 sequential bursts each that are effectively stolen from the PDTCH over which information such as circuit-switched coordinated paging information, system information and other data are transferred, [8]. The PACCH is generally used to transfer System Information (SI) messages from the network to the mobile terminal, and to transfer SI Status messages from the mobile terminal to the network.

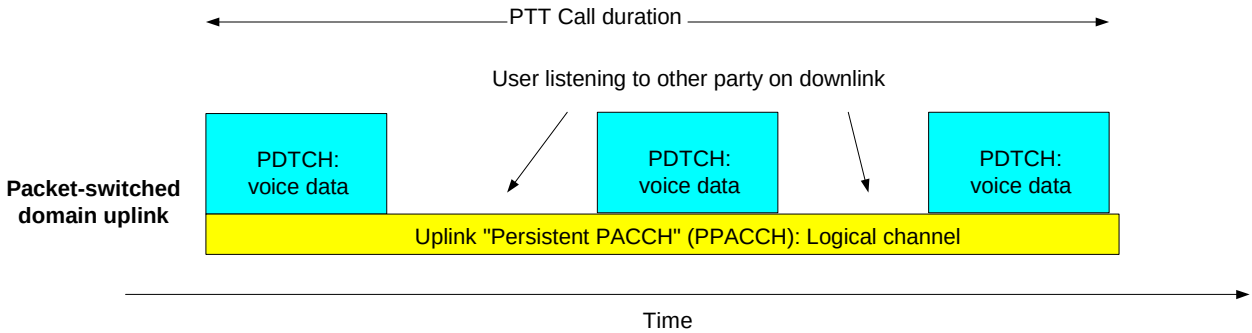
The reason that the existing PACCH is inadequate for the transmission of measurement information relevant to a packet domain handover is because of its discontinuous nature, *viz*. that it goes away with the TBF to which it is associated goes away, in contrast to the SACCH which persists over the lifetime of a CS domain call:



On uplink PDTCH carrying PTT voice data, packet voice data flow only in one direction at a time - the uplink PACCH comes and goes with allocation and deallocation of uplink TBF.

Proposal for consideration

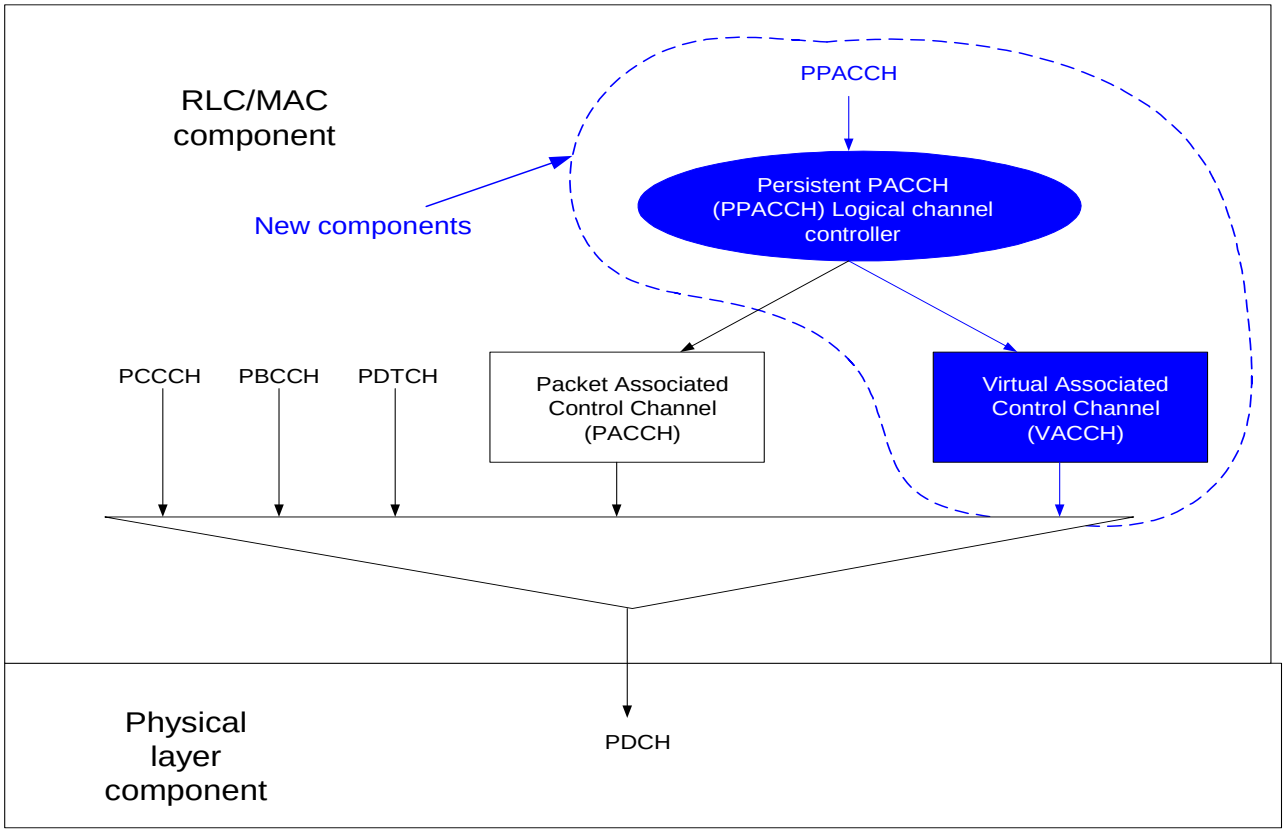
We therefore propose the specification of a specialized uplink SACCH-like channel for the packet domain, i.e. one that will persist over the course of an application session such as PTT, even in the absence of an uplink TBF. This would consist of a regular, periodic associated control channel to the packet domain that would not only function in a similar manner to the existing Packet Associated Control Channel (PACCH), which is associated with a Temporary Block Flow (TBF), but also be active between TBFs carrying temporally discontinuous talk spurts. Ideally, this Persistent Packet Associated Control Channel (PPACCH) would behave conceptually as follows:



Proposed "PPACCH": On uplink PDTCH carrying PTT voice data, packet voice data flow only in one direction at a time - the uplink PPACCH persists until application is terminated.

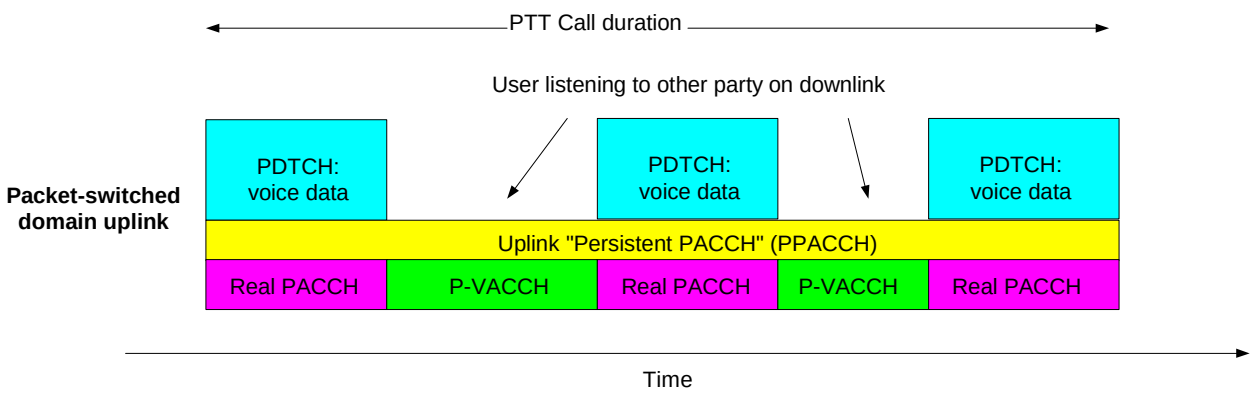
Architecture

The Persistent PACCH (PPACCH) is a logical channel over which uplink measurement may be carried, regardless of whether or not a TBF, and therefore the actual PACCH is available. This concept is realized by mapping the PPACCH to either i) the existing PACCH, when it indeed is active or alternatively ii) a new physical channel during times when the PACCH is not available, *viz*. between TBFs.



Methods

The PPACCH is a logical channel that is carried by PACCH when PACCH is active and by a new "Packet Virtual Associated Control Channel (P-VACCH)" of sorts when PACCH is not available. A temporal view of the activity expressed by the apparatus above may be seen in the following diagram.



Proposed "PPACCH" mapping: Persistent PACCH is mapped over existing PACCH whenever it is active, then over the new "Packet Virtual Associated Control Channel" in absence of PACCH

We present two equally useful and implementable approaches for the Virtual Associated Control Channel (VACCH) in the following sections.

Approach #1: fixed allocation fractional shared uplink channel

The network would create a fixed allocation for an uplink channel having implicit time division multiple access (TDMA) frame numbers on which the mobile terminal has the right to transmit on the uplink. This may be achieved by the following procedure:

1. The mobile transmits a request for a Persistent Packet Associated Control Channel (PPACCH) to the network.

2. The network receives the request and then grants an allocation to the mobile comprising the following parameters: a) the starting Absolute Frame Number (AFN(s)) of the first Virtual Associated Control Channel (VACCH) on which the mobile has the right to transmit, b) the Allocation Divisor "M" which controls when the mobile has the right to transmit and c) the uplink timeslot allocation (0 – 7) to which the VACCH is assigned.

3. The mobile, having the requirement to transmit data over the Persistent Packet Associated Control Channel (PPACCH) but not having the unavailability of the normal Packet Associated Control Channel (PACCH), then (provided AFN > AFN(start)) would a) start transmitting data sent on the PPACCH over the VACCH on the allocated timeslot at NOT (AFN(s) mod M) and b) starting mobile side PPACCH timer T32xx upon transmission of block.

4. The network, after receiving the transmitted block on the VACCH on the allocated timeslot from the mobile would start on the network side a PPACCH timer T32xx upon receipt of block from mobile.

5. If the mobile has availability of the normal Packet Associated Control Channel (PACCH), then it would send signalling information mapped to the PPACCH over the normal PACCH.

6. If the mobile does not have the availability of the normal Packet Associated Control Channel (PACCH), it would a) transmit data sent on the PPACCH over the VACCH on the allocated timeslot at NOT (current AFN mod M) and b) re-start mobile side PPACCH timer T32xx upon transmission of block.

7. Upon receipt of the transmitted block on the VACCH on the allocated timeslot from the mobile, the network would re-start the network side PPACCH timer T32xx.

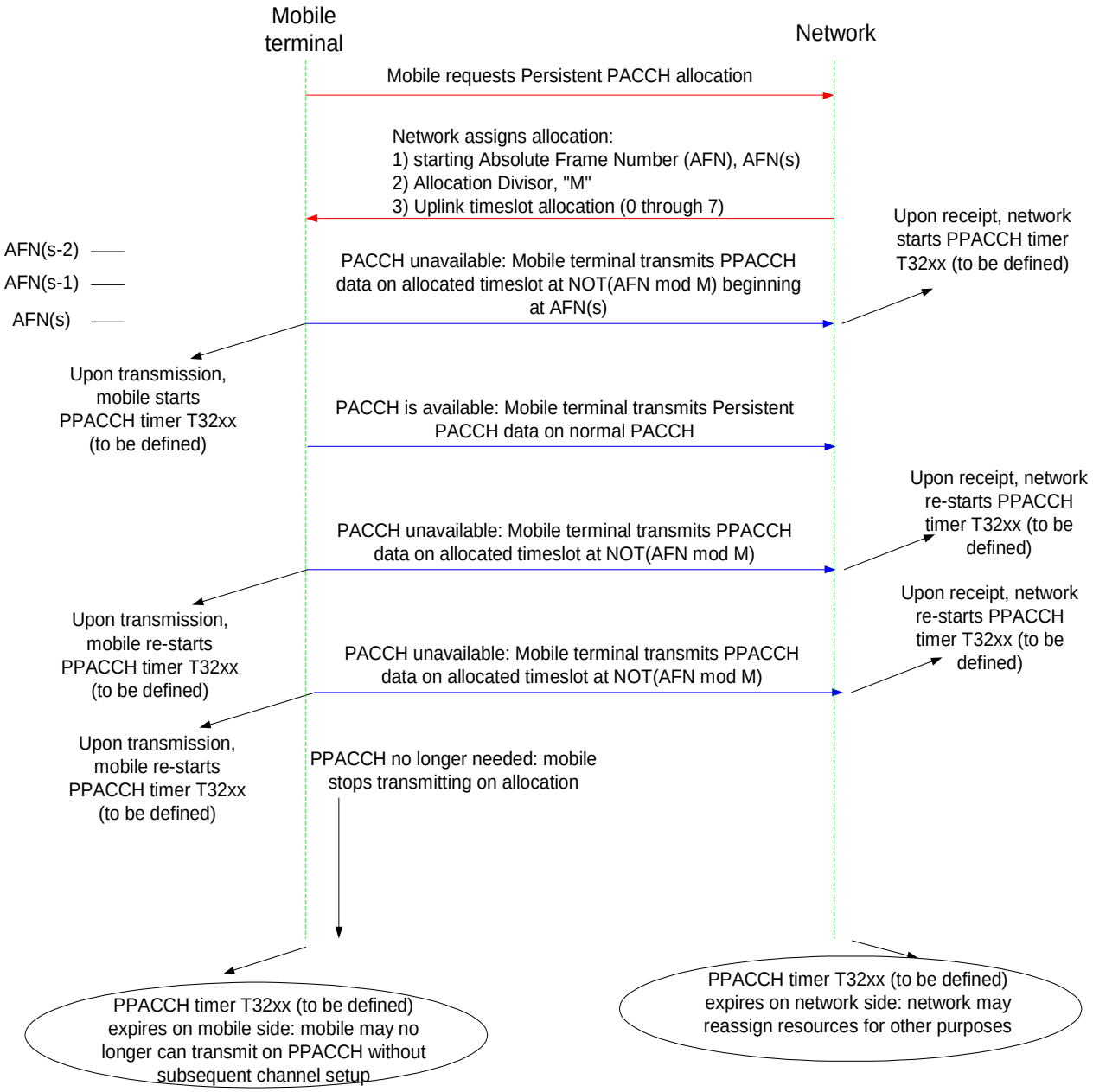
8. If the mobile has not required the transmission of data over the PPACCH and has therefore not transmitted anything on the VACCH for a period equal to or greater than the PACCH timer value, T32xx, the mobile PACCH timer T32xx would expire, indicating a termination of the allocation of resources for the PPACCH. At the same time the network PACCH timer T32xx would expire, indicating availability of previously utilised resources allocated to the PPACCH for subsequent allocation.

Advantages and disadvantages of approach #1:

The primary advantage of approach #1 is that the Divisor "M" may be set by the network to offer a certain data rate. In addition, the network has *a priori* knowledge of the mobile's assignment, enabling a simple algorithm for sharing the uplink timeslot with other mobiles for use by e.g. best effort packet data transfer services. It is also possible to share the uplink timeslot with other mobiles for providing PPACCH service using the VACCH, as the value of *M* sets the maximum number of mobiles that may share the timeslot, only varying AFN(s) for each mobile allocation. The primary disadvantage is that the allocation may not be changed by the network without additional signalling, and additionally requires an additional physical channel definition in the GPRS/EDGE specifications.

Standards Impact:

Modifications are required to the following specifications: 3GPP TS 45.002, 44.060, 44.018



Approach #1: fixed allocation of resources by network

Approach #2: dynamic allocation reusing existing Uplink State Flag (USF)

In this approach, the VACCH would be created under the control of the network using the existing Uplink State Flag (USF) mechanism to allocate uplink resources to the mobile station at a fixed or variable period. In the case, the mobile would request Persistent PACCH operation, and upon granting of this service, the network would then grant the right to transmit to the mobile every "M" TDMA frames via the USF mechanism, where *M* may be a fixed period as in the first approach, or a

variable period having some average value that would permit adequate transmission of the uplink data from mobile to network. The mobile, in response to receiving the acknowledgement of Persistent PACCH setup would then operate as previously, transmitting data sent on the logical PPACCH channel i) over the normal PACCH if it is available or ii) enqueueing it for transmission over the Virtual Associated Control Channel (VACCH) whenever the mobile terminal is granted the right to transmit via the USF mechanism.

The procedure for this approach follows:

1. The mobile station would transmit a request for a Persistent Packet Associated Control Channel (PPACCH) to the network.

2. The network, having received the request from the mobile would then grant an allocation to the mobile comprising the following parameters: a) the mobile station Uplink State Flag (USF) assignment, and b) the uplink timeslot allocation (0 – 7) to which the VACCH is assigned.

3. In the absence of availability of the normal Packet Associated Control Channel (PACCH), the mobile would transmit data on the PPACCH over the VACCH on the allocated timeslot upon receipt of the mobile station's USF.

4. After the network receives the transmitted block on the VACCH on the allocated timeslot from the mobile, it then starts the network side PPACCH timer T32xx upon receipt of block from mobile.

5. If the mobile has the requirement to transmit data over the Persistent Packet Associated Control Channel (PPACCH) and has the availability of the normal Packet Associated Control Channel (PACCH), then it transmits the information sent on the PPACCH over the normal PACCH.

6. Aftrer receiving the transmitted block on the VACCH on the allocated timeslot from the mobile, the network would re-start the network side PPACCH timer T32xx upon receipt of block from mobile.

7. After the mobile no longer requires transmission of data over the PPACCH, it simply stops transmitting on the VACCH, causing the PACCH timer, T32xx, to expire.

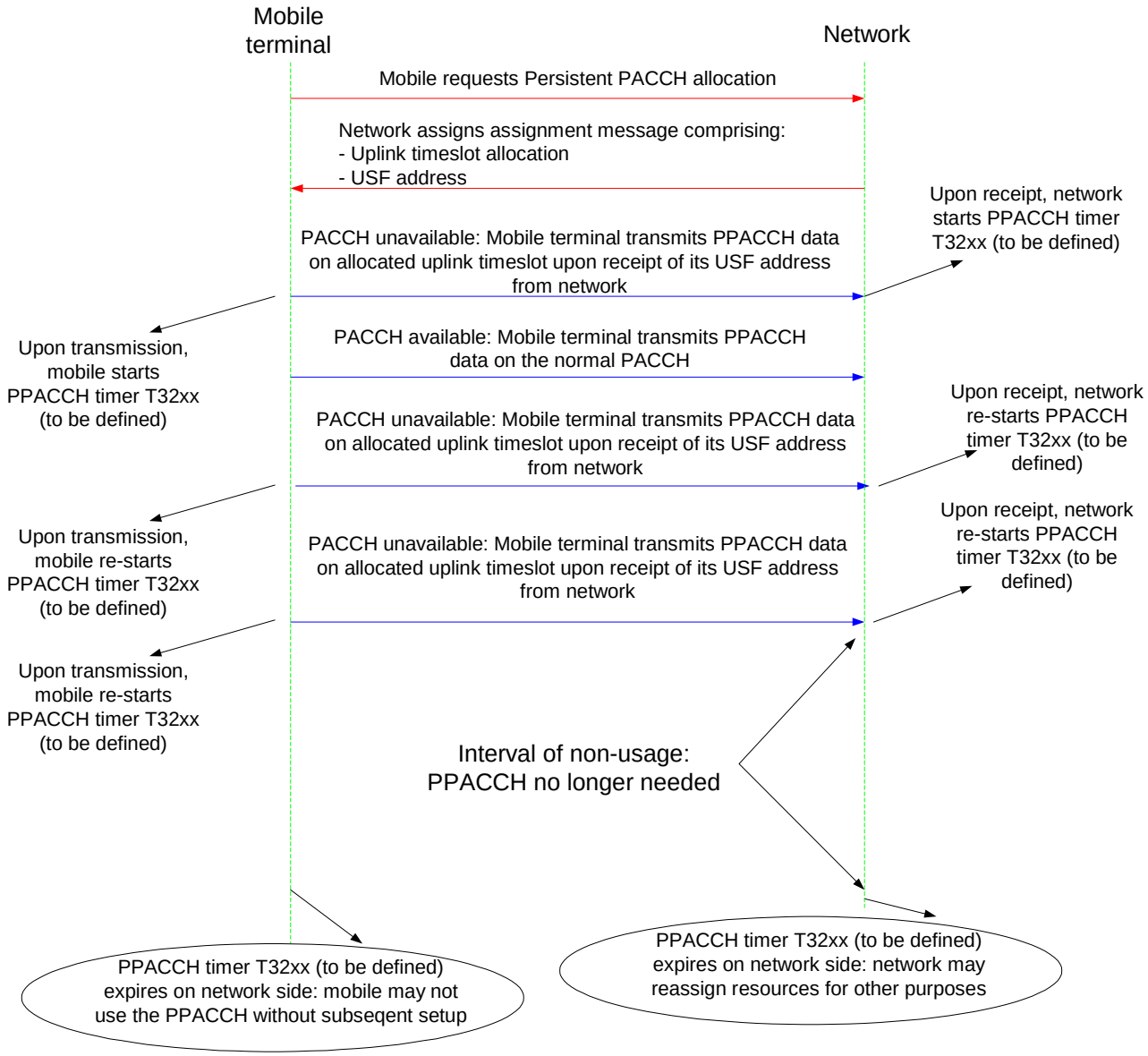
8. After the network PACCH timer T32xx expires, the radio resources allocated to the PPACCH would then be available for subsequent allocation.

Advantages and disadvantages of approach #2:

The primary advantages of approach #2 is that it enables implementation of the virtual channel by re-using much of what appears in the GPRS/EDGE specifications at the present time, plus the ability to vary the assignment of resources dynamically. The primary disadvantage is that dynamic management of the resource assignment is not as straightforward as a fixed assignment, which may present operationally divergent characteristics from one environment to the next.

Standards Impact:

Modifications are required to the following specifications: 3GPP TS 44.060, 44.018



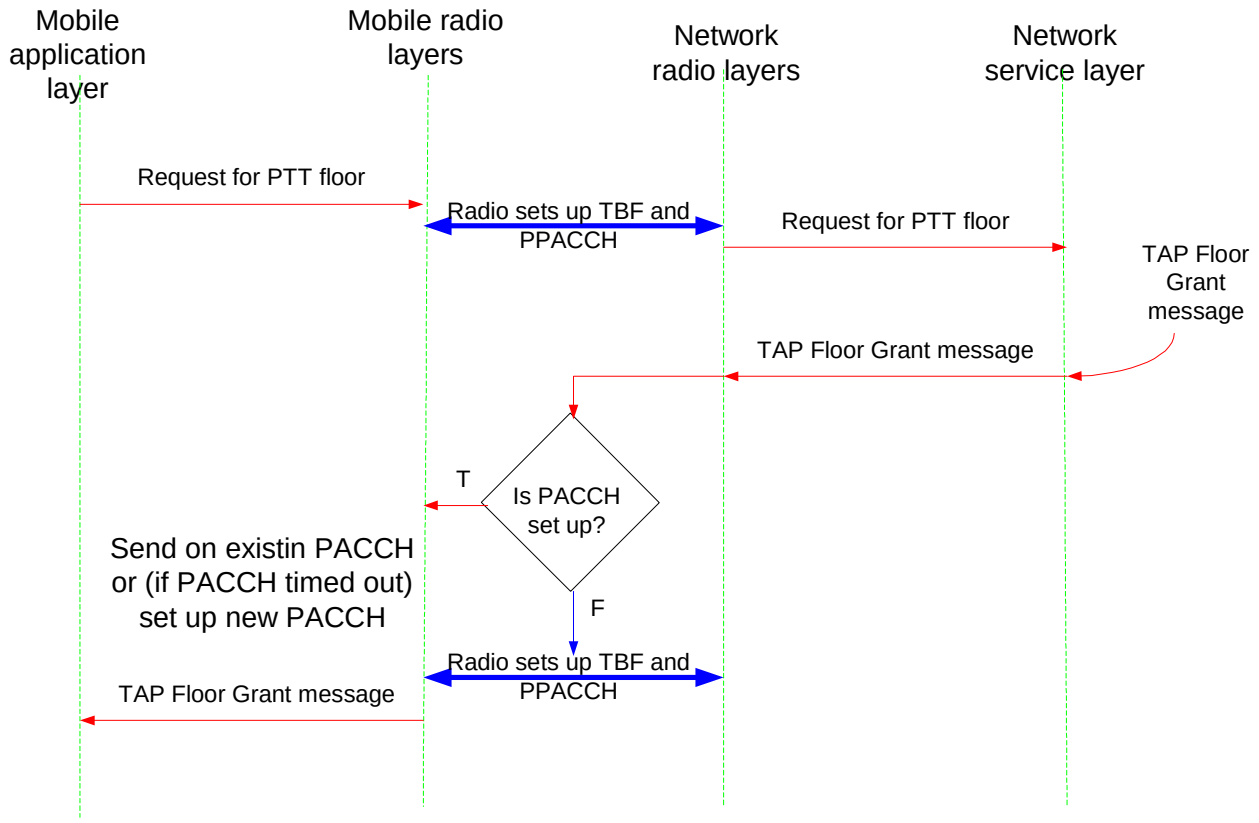
Approach #2: dynamic allocation of resources by network using existing USF mechanism

Example: constructing a simplex traffic channel

Push-to-talk

Here is an example of how the persistent PACCH may be used. A simplex traffic channel (TCH) is a channel that is i) bi-directional only at the physical and control layers and ii) uni-directional at the application and/or service layer. Why is this important? Because wireless systems such as GPRS/EDGE and others require a finite amount of time to initiate a full packet transfer, i.e. for the mobile terminal to access a random control channel, obtain an assignment for a bi-directional control channel, request a packet data traffic channel and then be granted such channel. By utilizing the PPACH for transferring control information sent from e.g. the Talker Arbitration Protocol (TAP) which controls which user has the “floor” in a PTT session, a Floor Grant request is

routed directly over the persistent channel, rather than incurring the overhead required to start a Temporary Block Flow (TBF). This may be implemented as follows:



Using the PPACCH to pass PTT floor control messages

Control: setup, teardown and application-awareness

Our proposal may be applied to push-to-talk (PTT) applications, but is also broadly applicable to many other applications in the Internet Packet Multimedia Subsystem domain. This raises certain questions, and also possibilities, as to how to enable, control and disable Persistent PACCH operation. For this reason it is proposed that the following possibilities for controlling the PPACCH be considered, and even possibly combined in the specifications and/or implementation:

1. Logical binding with applications: Because certain applications such as PTT and streaming would benefit from a packet handover, and therefore operation of the PPACCH, we consider a logical binding between applications and the radio subsystem in the mobile. In this manner, the mobile application may selectively request the services of the PPACCH subsystem.

2. General heuristic for applicability: Although it may be considered on a per-application basis, another method of deciding whether to activate the PPACCH subsystem is to utilize a general heuristic that would activate the PPACCH whenever a simplex TBF is established, and would persist for a certain period of time. Logic would be added to the mobile terminal that would note certain TBF utilization patterns to quickly recognize the initiation of a simplex downlink TBF.

3. Multiple control points: As indicated in the above examples, the mobile terminal would be capable of requesting PPACCH operation, but this approach should in no way limit the scope to this

method of control. The PPACCH should be i) mobile requestable, ii) network requestable and iii) optionally, always available.

4. Keep-alive messages: There may be time periods during which the mobile really does not have any uplink information to transmit to the network prior to the PPACCH supervisory timer expiring. In these instances, the mobile terminal shall send a “keep alive” message to the network as long it intends to utilize the PPACCH.

5. Inadvertent teardown: The mobile terminal shall be capable of detecting whether or not the PPACCH has failed and returned to its quiescent state of inactivity, requiring subsequent setup. This may be achieved by requiring periodic acknowledgements and/or other periodic check pointing information from the network. This is not a problem for the network, since it employs the last received datum on the PACCH virtual channel as checkpoint from the mobile.

Summary

A persistent PACCH may provide a simple method to greatly enhance the user-perception of IMS applications using SIP signalling such as Push-to-Talk. We welcome your comments and feedback regarding whether and how to proceed with standardization.

References

[1], GSM-02.60, "Digital cellular telecommunications system (Phase 2+); General Packet Radio Service (GPRS); Service Description; Stage 1", (European Telecommunications Standards Institute, (ETSI) Global System for Mobile Communications (GSM) specifications).

[2], GSM-03.60, "Digital cellular telecommunications system (Phase 2+); General Packet Radio Service (GPRS); Service Description; Stage 2", (European Telecommunications Standards Institute, (ETSI) Global System for Mobile Communications (GSM) specifications).

[3], GSM-05.01, "Digital cellular telecommunications system (Phase 2+); Physical Layer on the Radio Path; General Description", (European Telecommunications Standards Institute, (ETSI) Global System for Mobile Communications (GSM) specifications).

[4], 3GPP 23.060, "3rd Generation Partnership Project; Technical Specification Group Services and Systems Aspects: General Packet Radio Services (GPRS); Service Description; Stage 2”, (3rd Generation Partnership Project (3GPP); Technical Specification (TS)).

[5], 3GPP 45.008, “Technical Specification; 3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network; Radio subsystem link control”, (3rd Generation Partnership Project (3GPP) Technical Specification (TS)).

[6], 3GPP TS 04.18, “3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network; Mobile radio interface layer 3 specification; Radio Resource Control Protocol”, (3rd Generation Partnership Project (3GPP) Technical Specification (TS)).

[7], 3GPP TS 44.060, **“**3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network; General Packet Radio Service (GPRS); Mobile Station (MS) - Base Station System (BSS) interface; Radio Link Control/Medium Access Control (RLC/MAC) protocol”, (3rd Generation Partnership Project (3GPP) Technical Specification (TS)).

[8], 3GPP TS 45.002, “3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network; Multiplexing and multiple access on the radio path”, (3rd Generation Partnership Project (3GPP) Technical Specification (TS)).