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(54) **SLOW MAC-E FOR AUTONOMOUS TRANSMISSION IN HIGH SPEED UPLINK PACKET ACCESS (HSUPA) ALONG WITH SERVICE SPECIFIC TRANSMISSION TIME CONTROL**

LANGSAMER MAC-E FÜR AUTONOMES SENDEN ÜBER EINEN HOCHGESCHWINDIGKEITS-
UPLINK-PAKETZUGANG SOWIE DIENSTESPEZIFISCHE SENDEZEITSTEUERUNG

MAC-E LENT POUR EMISSION AUTONOME DANS UN ACCES DE PAQUETS DE LIGNE
MONTANTE HAUTE VITESSE (HSUPA) AVEC COMMANDE TEMPORELLE D'EMISSION
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EP 1 797 659 B1

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The invention is related to the 3rd Generation Partnership Project (3GPP) radio access network (RAN) standards, high speed uplink packet access (HSUPA) and high speed downlink packet access (HSDPA), and 3GPP Core Network and Speech Codecs and, more particularly, to a system and methods for slow medium access control entity (MAC-e) for autonomous transmission during HSUPA, an for service specific transmission time control in HSUPA.

2. Description of the Related Art

[0002] The Third Generation Partnership Project (3GPP) Technical Specification (TS) 25.309, "Frequency Division Duplex (FDD) Enhanced Uplink; Overall description; Stage 2 TS" has established that some level of enhanced dedicated channel (E-DCH) minimum set support is required to provide backward system compatibility. With a minimum set, autonomous transmission of data packets can occur in an uplink signal without prior allocation of resources by a base station (i.e., Node B) scheduler. In other words, for each user equipment (UE), the minimum set defines a set of transport formats (TFs) for which a valid scheduling grant is not required in order for packets to be transmitted. In normal conditions, the Node B allocates a share of an uplink resource to the UE via a scheduling grant. Only after this allocation of resources occurs is it possible for the UE to transmit packets in the uplink signal. The defined minimum set always guarantees a minimum bit rate, which is typically used for signaling purposes.

[0003] From the perspective of the Node B scheduler, the possibility for non-scheduled UEs to autonomously transmit a set of TFs has implications on Node B processing resources, because Node Bs must be continuously ready to process transmissions made from all such UEs, irrespective of the number of UEs that actually perform an autonomous transmission. As a result, the ability of the Node Bs to optimize the use of available Node B processing resources via scheduling becomes limited. Consequently, the complexity of the Node B for processing a given number of TFs may become increased.

[0004] The potential for a number of UEs to perform unscheduled autonomous transmissions may require the reservation of a "Rise over Thermal" (RoT) margin for these UEs. In the case of a 2 ms transmission time interval (TTI), a medium access control entity (MAC-e) protocol data unit (PDU) size of 360 bits, and n non-scheduled UEs, the worst case combined data rate in the cell due to autonomous transmission is $n * 45$ kb/sec for a fixed total number of retransmissions of 4. Here, an assumption is made that the 45 kb/sec rate is achieved by

transmitting at 180 kb/sec four times, at a reduced power level. With a large number of UEs, the required RoT margin may become significant, which would then degrade the performance of the scheduled transmissions.

[0005] The R1-041069 specification, "Signaling Radio Bearer (SRB) Mapping, E-DCH Minimum Set and Node B Complexity Issues", developed by Motorola, Inc., includes proposed solutions to the foregoing problems, such as restricting the scenarios in which the minimum set applies to cases where, for example, there is no dedicated physical data channel (DPDCH). In the R1-041087 specification, "Autonomous Transmission with Time Division Multiplex (TDM)", developed by Samsung, the technique disclosed uses a TDM based solution, where autonomous transmissions are only allowed in a subset of TTIs. Another solution proposed in the R1-041211 specification, "Support of Low Minimum Rate for E-DCH", developed by Lucent Technologies, involves increasing the permitted number of hybrid automatic repeat request (HARQ) transmissions for autonomous transmission rates, or restricting the number of HARQ processes that the UE is permitted to use for autonomous transmissions. However, each of these solutions is less than optimal because they all require a high level of complexity.

[0006] The concept of enhanced dedicated channels (E-DCH) support was introduced in 3GPP Rel-6. For an E-DCH transmission, a grant is required, i.e., a non-scheduled grant is required for non-scheduled medium access control dedicated (MAC-d) flows and a serving grant is required for a scheduled transmission. For the scheduled MAC-d data flows, the Node B controls when the UE is allowed to transmit packets and the maximum enhanced dedicated physical data channel (E-DPDCH) to dedicated physical control channel (DPCCH) power ratio that the UE is allowed to use for scheduled data in the following transmission. For the non-scheduled MAC-d flows, the network is permitted to define a maximum number of bits that can be included in a MAC-e PDU for specific MAC-d flows.

[0007] In the case of a 2 ms E-DCH TTI, each non-scheduled grant is applicable for the specific set of HARQ processes indicated by radio resource control (RRC), where the RRC can also restrict the set of HARQ processes for which scheduled grants are applicable. Here, the data mapped on non-scheduled MAC-d flows is transmitted as soon as possible by the possible HARQ process restrictions and the possible available power restrictions, with the rate defined by the non-scheduled grant.

[0008] The Universal Telecommunication Radio Access Network (UTRAN) is limited in its ability to control the uplink (UL) transmission interval on an E-DCH. The UTRAN can select the TTI to be either 2 ms or 10 ms, when 2 ms TTI is supported by the UE. In the case of a 2 ms TTI, the UTRAN can define the permitted processes for scheduled MAC-d flows and non-scheduled MAC-d flows. Here, it is the base transceiver station (BTS) that decides the scheduling grants of scheduled transmission.

[0009] The transmission of a low bit rate service over E-DCH introduces the requirement for large control overhead due to several control channels in the uplink (UL) and the downlink (DL), and because the amount of control bits per TTI is the same for all packet sizes. For example, for each transport block (TB) that is transmitted on an E-DCH, an acknowledge/non-acknowledge (ACK/NACK) is transmitted in the DL and the enhanced transport format combination indicator (E-TFCI), in a robust secure network (RSN), and a 'Happy bit' is transmitted in the UL. It is possible to reduce the control overhead by transmitting more packets in the same transport block but less often. However, the payload in the TB and the TTI would be increased.

[0010] Preferably, the UTRAN could increase the transmission interval for specific services (e.g. voice over Internet protocol (VoIP)) in the UTRAN in order to increase transmission capacity. Here, the UTRAN should take into account the characteristics of the service, e.g. an assumed or known bit rate, delay requirement possibly known service data unit (SDU) arrival rates, etc, when defining the transmission interval.

[0011] For example, according to rules set forth in chapter 5.1.1. of TS 26.236, in the case of 3GPP adaptive multi-rate (AMR) and AMR-Wideband (WB) codecs in conversational voice over Internet protocol (VoIP) connections, there is one user datagram protocol/real-time transport protocol/Internet protocol (UDP/RTP/IP) packet per speech frame, i.e., one packet in 20 ms. On E-DCH, this leads to a rate of one transport block (TB) transmission per 20 ms because the current MAC specification requires the UE to maximize the throughput of the highest priority data. Speech is typically high priority and thus, MAC tries to send the speech packet as soon as possible when received from the higher layers. However, the service tolerates some additional delay in the radio interface. As a result, the packets could be sent once in every 40 or 60 ms in order to improve transmission capacity. Here, it is possible to assume the additional transmission delay of 20 to 40 ms has an unnoticeable impact in the speech quality.

[0012] US2004160914 relates to congestion control in a wireless data network.

SUMMARY OF THE INVENTION

[0013] The present invention relates to enhancing the uplink dedicated channel (E-DCH) for packet data traffic during Third Generation Partnership Project (3GPP) High Speed Uplink Packet Access (HSUPA), the 3GPP TR 25.808, specification "frequency division duplex (FDD) Enhanced Uplink; Physical Layer Aspects" and during the 3GPP TS 25.309, "Frequency Division Duplex (FDD) Enhanced Uplink; Overall description; Stage 2".

[0014] In accordance with the invention, a control parameter that is independent from an air interface transmission time interval (TTI), hybrid automatic repeat request (HARQ) processes or enhanced dedicated trans-

port channel (E-DCH) scheduling is used. This control defines the minimum time interval between subsequent new transmissions. The control has no impact on retransmissions, which are performed normally.

[0015] For every MAC-e PDU, a check is made to determine whether the transmission is autonomous. If the transmission is not autonomous, a check is continually performed until an autonomous transmission occurs. That is, a continuous loop is performed. If an autonomous transmission is detected, then the exchange rate between the MAC-e and the physical layer (layer one) is slowed down, i.e. the exchange rate is decelerated. In accordance with the present invention, the slow down of the exchange rate between the MAC-e and the physical layer occurs when the MAC-e layer, i.e., the sub-layer of Layer Two sends a MAC-e PDU to the Layer One (i.e., the physical layer). The MAC-e PDU is sent to the physical layer every $n \cdot \text{TTI}$, instead of once every transmission time interval (TTI).

[0016] Alternatively, the rate at which the MAC-e sends protocol data units (PDUs) to the physical layer for the transport format (TF(s)) belonging to a minimum set is decelerated so as to reduce the impact of the minimum set over a "Rise over Thermal" (RoT). For each user equipment (UE), the minimum set defines a set of transport formats (TFs) for which a valid scheduling grant is not required in order for packets to be transmitted. In normal conditions, a Node B (i.e., a base station) allocates a share of an uplink resource to the UE via a scheduling grant. From the perspective of layer one, the method of the invention is transparent, i.e., it appears that packets are only sent occasionally (e.g. once in a while).

[0017] As the value of n is increased, the effective bit rate and the impact of the autonomous transmission on the RoT become smaller. In accordance with the present invention, synchronous HARQ is used. As a result, it becomes possible to always use the same hybrid automatic repeat request (HARQ) process if n is selected as a multiple of the number of HARQ processes. In addition, different HARQ processes can be used based on a different value of n . Here, the value of n may be selected by specification, signaled to UEs (i.e., a common value is signaled to the UEs) or UE dependant (i.e., a specific value that is signaled to a specific UE). The method of the invention is advantageously simpler than conventional methods for performing scheduling grants for scheduled transmissions. Moreover, the present invention is transparent to Layer One, and provides a minimum impact on Layer Two.

[0018] In an embodiment of the invention, a new control parameter is implemented in either a packet data protocol (PDP) context/radio access bearer (RAB) layer or in the MAC layer. When the invention is implemented in the PDP context/radio access RAB layer, a new PDP context/ quality of signal (QoS) parameter is used. In the preferred embodiment, the new parameter is a "service data unit (SDU) inter-arrival rate" that establishes the minimum required time interval between consecutive

SDUs that are transmitted on a specific RAB. In accordance with the present embodiment, the parameter is signaled in different interfaces than the existing PDP context/RAB QoS parameters. As a result, the application does not deliver SDUs to the MAC layer at a higher rate than the rate specified by the parameter. If the data source produces several packets within this time interval, the packets are grouped into a single SDU. Grouping the packets in the MAC layer provides the ability to obtain the benefits associated with optimizing the packet header overhead, such as more efficiently sharing the uplink power resource between packet data users.

[0019] Alternatively, it is possible to introduce a new MAC parameter in the MAC-d layer. In the preferred embodiment, the new parameter is a "virtual TTI" that defines the minimum time interval between subsequent new transmissions for a MAC-d flow. A first transmission would be permitted only once, during the virtual TTI. The virtual TTI could be signaled to the UE by the radio network controller (RNC). The UE could then implement the virtual TTI in the MAC-d layer. Claim 1 defines a method according to an aspect of the invention. Claim 12 defines a computer program product according to another aspect of the invention. Claim 23 defines a mobile station according to yet another aspect of the invention.

[0020] Other objects and features of the present invention will become apparent from the following detailed description considered in conjunction with the accompanying drawings. It is to be understood, however, that the drawings are designed solely for purposes of illustration and not as a definition of the limits of the invention, for which reference should be made to the appended claims. It should be further understood that the drawings are merely intended to conceptually illustrate the structures and procedures described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The foregoing and other advantages and features of the invention will become more apparent from the detailed description of the preferred embodiments of the invention given below with reference to the accompanying drawing in which:

FIG. 1 is an exemplary block diagram of a wireless communication system in which the method of the invention is implemented;

FIG. 2 is an exemplary flow chart illustrating the steps of the method of the invention in accordance with an embodiment of the invention;

FIGS. 3 and 4 are exemplary timing diagrams associated with the introduction of a packet data protocol (PDP) context/ radio access bearer (RAB) Quality of Service (QoS) parameter in the PDP context/RAB layer in accordance with an embodiment of the invention for a 10 ms and 2 ms transmission time interval (TTI), respectively;

FIGS. 5 and 6 are exemplary timing diagrams asso-

ciated with the introduction of a new medium access control (MAC) parameter can be introduced in the medium access control dedicated (MAC-d) layer in accordance with an embodiment of the invention for a 10 ms and 2 ms transmission time interval, respectively; and

FIG. 7 is an exemplary timing diagram associated with the embodiment of FIG. 5 in accordance with an alternative embodiment of the invention.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

[0022] The present invention relates to a system and methods for slow medium access control entity (MAC-e) for autonomous transmission in HSUPA, along with service specific transmission time control. In accordance with the invention, a control parameter that is independent from the air interface transmission time interval (TTI), hybrid automatic repeat request (HARQ) processes or enhanced dedicated transport channel (E-DCH) scheduling is used. This control defines the minimum time interval between subsequent new transmissions. The control has no impact on retransmissions, which are performed normally.

[0023] FIG. 1 shows an exemplary network operator 2 having, for example, a mobile switching center (MSC) 3 for connecting to a telecommunications network, such as the Public Switched Telephone Network (PSTN), at least one base station controller (BSC) 4, and a plurality of base transceiver stations (BTS) 5 that transmit in a forward or downlink direction both physical and logical channels to the mobile stations 10 in accordance with a predetermined air interface standard. It is assumed that a reverse or uplink communication path exists from the mobile station 10 to the network operator, which conveys mobile originated access requests and traffic, as well as signaling for implementing the invention. The BTSs 5 define cells, which can be different sizes, different frequencies and so forth.

[0024] The air interface standard may conform to a Time Division Multiple Access (TDMA) air interface, and the network may be a Universal Mobile Telecommunications System (UMTS) network or other type of network. However, the teachings of the present invention apply equally to Code Division Multiple Access (CDMA) networks, as well as to other network types.

[0025] The network operator 2 can include a Message Service Center (MSCT) 6 that receives and forwards messages for the MS 10, such as Short Message Service (SMS) messages, or any wireless messaging technique including e-mail and Supplementary Data Services. Furthermore, enhancements to SMS can be used, such as one under development and known as Multimedia Messaging Service (MMS), wherein image messages, video messages, audio messages, text messages, executables and the like, and combinations thereof, can be transferred between a network and a mobile station.

[0026] The mobile station (MS) 10 typically includes a micro-control unit (MCU) 12 having an output coupled to an input of a display 14 and an input coupled to an output of a keyboard or keypad 16. The MS 10 may be considered a handheld radiotelephone, such as a cellular, mobile telephone or a personal digital assistant (PDA), and may have a microphone and a speaker (not shown) for conducting voice communications. The MS 10 could also be contained within a card or module that is connected during use to another device. For example, the MS 10 could be contained within a PCMCIA or similar type of card or module that is installed during use within a portable data processor, such as a laptop or notebook computer, or even a computer that is wearable by the user.

[0027] The MCU 12 is assumed to include or be coupled to some type of a memory 13, including a read-only memory (ROM) for storing an operating program, as well as a random access memory (RAM) for temporarily storing required data, scratchpad memory, received data packets and data packets prepared for transmission, etc. The memory 13 is assumed to store the various parameters that are used by the MS 10 for performing cell reselection.

[0028] A separate, removable SIM (not shown) can be also be provided, the SIM storing, for example, a preferred Public Land Mobile Network (PLMN) list and other subscriber-related information. The ROM is assumed, for the purposes of this invention, to store a program enabling the MCU 12 to execute the software routines required to operate in accordance with the presently preferred embodiments of the present invention.

[0029] The MS 10 also contains a wireless section that includes a digital signal processor (DSP) 18, or equivalent high speed processor, as well as a wireless transceiver comprised of a transmitter 20 and a receiver 22, both of which are coupled to an antenna 24 for communication with the network operator 2. The receiver 22 is used for making signal measurements used in the cell reselection process.

[0030] In conventional system architectures, packet schedulers are located in the Radio Network Controller (RNC) (not shown). In addition, the Radio Resource Control (RRC) signaling interface between the RNC and the user equipment (UE) has bandwidth constraints. As a result, the packet scheduler is limited in its ability to adapt to instantaneous traffic changes. Hence, to accommodate this variation in network traffic, the packet scheduler must conservatively allocate uplink power to take into account the influence from inactive users during a subsequent scheduling period. However, this solution is spectrally inefficient for high allocated data-rates and long-release timer values.

[0031] Along with enhanced dedicated channel (E-DCH), the present invention utilizes the Node B (i.e., the base station) to handle the allocation of uplink resources, i.e. it performs Node B scheduling. Here, the UE selects a transport format combination (TFC) that is optimal for the amount of data to be transmitted in the radio link

control (RLC) buffer of the UE in order to transmit data. However, the selection of the TFC is subject to constraints on the maximum transmission power of the UE and the maximum allowed TFC. However, if needed, the UE can request a higher bit rate, and the Node B will then decide whether to grant additional resources. In certain embodiments, the Node B may adjust the resources allocated to all UEs based on the current cell load.

[0032] FIG. 2 is an illustration of the steps associated with the method of the present invention. For every MAC-e PDU, a check is made to determine whether the transmission is autonomous, as indicated in step **200**. If the transmission is not autonomous, a check is continually performed until an autonomous transmission occurs, that is the method continues in a loop. If an autonomous transmission is detected, then the exchange rate between the MAC-e and the physical layer (layer one) is slowed down, i.e. the exchange rate is decelerated, as indicated in step **210**. In accordance with the invention, the slow down of the exchange rate between the MAC-e and the physical layer occurs when the MAC-e layer, i.e., the sub-layer of Layer Two as described in the 3GPP IS 25. 309 specification, "frequency division duplex (FDD) Enhanced Uplink; Overall description; Stage 2", sends a MAC-e PDU to the layer one (i.e., the physical layer), as indicated in step **220**. The MAC-e PDU is sent to the physical layer every $n \cdot \text{TTI}$, instead of once every transmission time interval (TTI), as indicated in step **230**.

[0033] Alternatively, the rate at which the MAC-e sends protocol data units (PDUs) to the physical layer for the transport format (TF(s)) belonging to a minimum set is decelerated so as to reduce the impact of the minimum set over a "Rise over Thermal" (RoT). For each user equipment (UE), the minimum set defines a set of transport formats (TFs) for which a valid scheduling grant is not required in order for packets to be transmitted. In normal conditions, the Node B allocates a share of an uplink resource to the UE via a scheduling grant. From the perspective of layer one, the method of the invention is transparent, i.e., it appears that packets are only sent occasionally (e.g. once in a while).

[0034] As the value of n is increased, the effective bit rate and the impact of the autonomous transmission on the RoT become smaller. In accordance with the present invention, synchronous HARQ as defined in the 3GPP TR 25.808, specification "frequency division duplex (FDD) Enhanced Uplink; Physical Layer Aspects" is used. As a result, it becomes possible to always use the same hybrid automatic repeat request (HARQ) process if n is selected as a multiple of the number of HARQ processes. In addition, different HARQ processes can be used based on a different value of n . Here, the value of n may be selected by specification, signaled to UEs (i.e., a common value is signaled to the UEs) or UE dependant (i.e., a specific value that is signaled to a specific UE). The method of the invention is advantageously simpler than conventional methods for performing scheduling grants for scheduled transmissions. Moreover, the

present invention is transparent to Layer One, and provides a minimum impact on Layer Two.

[0035] In an embodiment of the present invention, the method of the invention is implemented as a new control parameter in either a packet data protocol (PDP) context/radio access bearer (RAB) layer or in the MAC layer. When the invention is implemented in the PDP context/radio access RAB layer, a new PDP context/ Quality of Service (QoS) parameter is used. In the preferred embodiment, the new parameter is a "service data unit (SDU) inter-arrival rate" that establishes the minimum required time interval between consecutive SDUs that are transmitted on a specific RAB. In accordance with the present embodiment, the parameter is signaled in different interfaces than the existing PDP context/RAB QoS parameters. As a result, the application does not deliver SDUs to the MAC layer at a higher rate than the rate specified by the parameter. If the data source produces several packets within this time interval, the packets are grouped into a single SDU. Grouping the packets in the MAC layer provides the ability to obtain the benefits associated with optimizing the packet header overhead, such as more efficiently sharing the uplink power resource between packet data users.

[0036] When larger sized SDUs are used instead of more frequently transmitted smaller sized SDUs, it becomes possible to decrease the processing load in the UE, the core network and the radio access network. However, it may not always be possible to consider the SDU inter-arrival rate parameter and perform such a grouping within the application layer, depending on how transparent the radio network is to the application layer. FIGS. 3 and 4 are exemplary timing diagrams associated with the introduction of a packet data protocol (PDP) context/ radio access bearer (RAB) Quality of Signal (QoS) parameter in the PDP context/RAB layer in accordance with an embodiment of the invention for a 10 ms and 2 ms air interface transmission time interval (TTI), respectively. In each case, the SDU inter-arrival rate is 40 ms.

[0037] With reference to FIG. 3, for a 10 ms air interface TTI of 10 ms, 2 VoIP packets (i.e., 1 RLC SDU) are transmitted every 40 ms. In this case, a single VoIP packet is transmitted from the source every 20 ms. That is, the data source produces several (i.e. two) data packets within the 40 ms SDU inter-arrival rate that are grouped into the single SDU. One retransmission is shown for RLC SDUs #1 and #2, both containing 2 VoIP packets. The SDU inter-arrival rate of 40 ms ensures that the subsequent new RLC SDU #2 (B) will be transmitted after a delay of at least 40 ms after the RLC SDU #1 (A), and that the 2 VoIP packets produced by the source during the 40 ms period are grouped into single RLC SDU #2 (B). Due to retransmission (C) of the RLC SDU #1 (A), the delay for the first generated packet in the RLC SDU #1 (A) is 70 ms and the delay for the packet in the RLC SDU #1 (A) that is subsequently generated 20 ms later is 50 ms, i.e., both packets in the single RLC SDU are retransmitted. Here, a retransmission of RLC SDU #2

(B) has also occurred. As a result, the 2 VoIP packets in B are delayed 80 ms and 60 ms, where the additional one air interface TTI (10ms) delay is due to the retransmission (C) of the RLC SDU #1 (A) occurring when the RLC SDU #2 (B) would first be allowed. In accordance with the contemplated embodiments, a packet refers to a VoIP packet from the source (e.g., voice codec) and the numbers with the boxes (A, B) refers to RLC SDU numbers. As shown in FIG. 4 for a 2 ms air interface TTI, there is no additional delay for the RLC SDU #2 (B) due to retransmissions of RLC SDU #1 (A), and the RLC SDU #2 (B) is transmitted 40 ms later than RLC SDU #1 (A) since the retransmissions RLC SDU #1 (A) occur in different HARQ processes than the transmission of RLC SDU #2 (B). Due to 3 retransmissions of the the RLC SDU #1 (A), the delay for the first generated packet in the RLC SDU #1 (A) is 70 ms and the delay for the VoIP packet in the RLC SDU #1 (A) that is subsequently generated 20 ms later is 50 ms, i.e., both packets in the single RLC SDU are retransmitted 3 times.

[0038] The preferred transmission interval would be an optimization for radio access network purposes and depends on, for example, the transport channel that is used. Consequently, the PDP context/RAB QoS parameter may not be the best place in which to define the transmission interval. Alternatively, it is possible to introduce a new MAC parameter in the MAC-d layer. In the preferred embodiment, the new parameter is a "virtual TTI" that defines the minimum time interval between subsequent new transmissions for a MAC-d flow. A first transmission would be permitted only once, during the virtual TTI. The virtual TTI could be signaled to the UE by the radio network controller (RNC). The UE could then implement the virtual TTI in the MAC-d layer.

[0039] With reference to FIG. 5, for a 10 ms air interface and a TTI of 10 ms, VoIP packets are transmitted every 20 ms. With a 40 ms virtual TTI in MAC-d, 2 VoIP packets are transmitted in the same air interface TTI every 40 ms. In this case, a single packet is transmitted from the source every 20 ms and each RLC SDU contains one VoIP packet. That is, RLC SDUs, each containing a single VoIP packet, are delivered from the application to MAC every 20 ms. Here, packets #1 (A) and packets #2 (B) are delivered to MAC layer in their own separate RLC SDUs with a 20 ms time difference, and grouped at MAC-d layer for transmittal in the same single 10 ms air interface TTI.

[0040] The subsequent new packets #3 and #4 are grouped together in MAC-d for transmittal in the same 10 ms air interface TTI, because the 40 ms virtual TTI prevents this transmission before 40 ms after the start of the previous transmission has elapsed. The packets #1 (A) and #2 (B) are retransmitted (C and D). The packet #1 (A) is transmitted from the source 20 ms earlier than packet #2 (B), but is not allowed to be transmitted before the 40 ms virtual TTI has elapsed after the start of the previous packet first transmission. As a result; the delay for the packet #1 (A) with one retransmission (C) is 70

ms and the delay for the packet #2 (B) with one retransmission (D) is 50 ms.

[0041] Here, a retransmission of packets #1 (A) and #2 (B) has occurred. As a result, packet #3 (E) is delayed 80 ms and packet #4 (F) is delayed 60 ms, where the additional one air interface TTI (i.e., 10ms) delay, in comparison to packets #1 (A) and #2 (B) with the same number of retransmissions, is due to the retransmissions of the packets #1 (A) and #2 (B) occurring when the transmission of the packets #3 (C) and #4 (D) would first be allowed. In accordance with the contemplated embodiments, a packet refers to a VoIP packet from the source (e.g., voice codec) and the numbers with the boxes (A, B, C, D) refers to both packet and RLC SDU numbers.

[0042] In FIG. 6, for a 2 ms air interface TTI, packets #1 (A) and #2 (B) are transmitted in the same 2 ms air interface TTI and are retransmitted 3 times. The delay for packet #1 (A) is 70 ms and the delay for packet #2 (B) is 50 ms. Here, the first transmission for the packet #1 (A) is allowed only 40 ms later than the previous packet first transmission and is thus, delayed an additional 20 ms in comparison to packet #2 (B) that can be transmitted without additional delay. The packets #3 (C) and #4 (D) are transmitted at the 40 ms virtual TTI later than the first transmission of the packets #1 (A) and #2 (B).

[0043] Additionally, it is possible to take into account the "virtual TTI" in the application layer to optimize the protocol header overhead, as discussed below. Defining the parameter in the MAC layer advantageously supports the elimination of the dependency on the radio access network, as compared to the case where the transmission interval is defined in the PDP context/RAB parameter. If several radio bearers (RB) are multiplexed into the same transport channel, it should be possible to separately define a "virtual TTI" for each RB.

[0044] In the latter case, the RNC uses the parameters delivered by the serving general packet radio service (GPRS) support node (SGSN) to identify the specific services. It should be noted, however, the control (i.e., the calculated delay) is not based on the specific service, but rather the delay is based on the QoS parameters of the service. In addition, other available information can be used to determine the most optimal virtual TTI length. For example, the QoS values such as "source statistics descriptor" (SSD), "traffic class", and "transfer delay" can be used to calculate the delay. In certain embodiments of the invention, if SSD has value indicative of "speech" and the traffic class is conversational, then the virtual TTI is determined to be 40 ms. In addition, the load in the radio access network (RAN) can be included as another criterion for determining the most optimal virtual TTI length. In this case, the lower the load level, the shorter the virtual TTI that is used. The present invention is not to be limited to the examples based on the QoS and the like, i.e., the general approach regarding RNC algorithms in 3GPP. It is to be appreciated that other specific implementations are possible, which are based on specific RNC algorithms as required by each specific implemen-

tation.

[0045] In the downlink direction (DL), the invention is implemented in a high speed downlink shared transport channel (HS-DSCH). Here, the RAB attribute 'SDU inter-arrival rate' in the DL would permit the UTRAN to optimize its DL resources. In addition, the UTRAN is permitted to determine whether to use a 'virtual TTI' in the DL in the MAC layer. The advantage of signaling the 'virtual TTI' to the UE in the DL is that the UE can switch the receiver off during the inter-arrival period, even though it is possible to provide this functionality in the DL without signaling it to the UE. As a result, an alternative periodicity parameter T can be used to define the HS-SCCH decoding period instead of the HS-DSCH decoding period.

[0046] The radio network controller (RNC) and base station (i.e., Node B), as defined in the current 3GPP specified network are exemplary. Therefore, the present invention is not to be limited to such a device. Rather, the present invention may be implemented in other packet switched (PS) networks, e.g., in an evolved 3GPP network depending on their frame structure and flexibility of the structure.

[0047] In an alternative embodiment of the present invention, the UE decides whether to use a 40 ms virtual TTI when it detects that the underlying RAN network is HSUPA. i.e., signalling of the parameters (i.e., the transmission interval) is not performed by the network, but is implemented internally in the UE. In accordance with the present embodiment, the UE may decide to use the 40 ms virtual TTI when it detects that the underlying RAN network is HSUPA.

[0048] In another embodiment of the present invention, the virtual TTI is signalled by the network, and used on the MAC level as describe above. In addition, the information pertaining to the virtual TTI is conveyed to a unit that controls the packetization of packets from the data source into SDUs, for example, packetization of speech frames (in real-time transport protocol (RTP) payload). In accordance with the present embodiment, based on the length of the virtual TTI, it is possible to modify the packetizing rules so as to optimise the speech connection to the virtual TTI. For example, in the default operation, one 20 ms speech frame is placed into one user datagram protocol/real-time transport protocol/Internet protocol (UDP/RTP/IP) packet. If the virtual TTI is known to have a length of 40 ms, it is possible to insert two 20 ms frames into one UDP/RTP/IP packet and thus, reduce the UDP/RTP/IP protocol overhead and processing load in UE and the network.

[0049] A single speech packet per radio link control (RLC) service data unit (SDU) or UDP/RTP/IP packet potentially provides a greater level of flexibility than embodiments of the invention in which several speech packets are combined into one RTP/UDP/IP packet. For example, if the downlink portion of a call uses highspeed downlink packet access (HSDPA) that has different speech packets in separate RLC SDUs, then a greater level of flexibility is provided for the HSDPA scheduler.

In addition, for high speed uplink access (HSUPA), each speech packet in separate RLC SDUs permits the sending of only one speech packet per air interface TTI of 2 ms or 10 ms. This would be the case if, e.g., the transmission of higher priority packets from another radio link control (RLC) buffer, such as the signalling radio bearer (SRB), prohibits the transmittal of large transport block (TB) that contains several speech packets. Moreover, the size of the RLC SDU is more regular and predictable if only one speech frame is included into one RLC SDU.

[0050] In accordance with the present contemplated embodiments, the UE power limitations in bad radio conditions, such as the UE running out of transmission power, are taken into account so that it then becomes possible to send a single speech packet per air interface TTI of 2 ms or 10 ms. Here, the MAC-d would check the RLC buffer of the UE once per virtual TTI, i.e., at the same interval as a normal TTI as defined in the 3GPP IS 25.309 specification. As a result, packets received during the virtual TTI would be buffered at the RLC level. In addition, the MAC is permitted to check the RLC buffer more frequently in certain special cases, such as when it is not possible to clear the RLC buffer due to power limitations, the transmission of higher priority packets from other RLC buffer (e.g. SRB) or if there are bigger RLC SDUs (e.g., non-compressed headers or real time control protocol (RTCP) packets) that cannot be transmitted within one air interface TTI.

[0051] With reference to FIG. 7, for a 10 ms air interface and a virtual TTI of 40 ms, two VoIP packets are transmitted every 40 ms. Here, packets #1 (A) and packets #2 (B) are grouped together into a single SDU since the subsequent new packet #2 (B) is transmitted within the 40 ms time period. A single transmission for packets #1 (C) and #2 (D) and #3 (E) and #4 (F) is shown. However, it is not possible to transmit subsequent new packets #3(E) and #4 (F) during a single TTI. As a result, these packets are grouped together and transmitted in separate TTIs.

[0052] Examples of the operation of the UE MAC under such conditions are as follows: (i) if the MAC is able to empty the RLC buffer during this air interface TTI, then the MAC will check the RLC buffer at the next predetermined subsequent time interval after the virtual TTI; (ii) if the MAC is not able to empty the buffer, then the MAC will also check the RLC buffer for the next air interface TTI. This permits rapid clearing of the RLC buffers when required, i.e., when large SDUs are utilized. However, the frequency of transmissions during normal operation remains limited. In certain embodiments, the implementation of the present contemplated embodiment is permitted based on the configuration of the network, e.g., the network is configured to restrict the transmissions only to instances of times that are established by the virtual TTI or the network is configured to permit the above previously described operations.

[0053] Conventional systems and methods require either limiting the number of available HARQ processes or

the scheduling of scheduled transmissions. With the conventional TTI, the transmission interval can be limited only up to 10 ms, and the TTI will impact all the MAC-d flows and all the services. Therefore, limiting the TTI is not a viable service specific solution *per se*. Limiting the available HARQ processes has the negative impact of eliminating the flexibility associated with HARQ process handling in multi-service cases. In the case of packet retransmissions, the number of available HARQ processes should be increased. If this increase does not occur, the transmission interval for new transmissions will become increased from what was originally intended. In case of a 2 ms TTI, the transmission can be limited by controlling HARQ processes only up to every 16 ms, and in case of a 10 ms TTI up to 40 ms. It is also possible to control the TTI of scheduled transmissions by scheduling. However, this introduces large control overhead, i.e., two scheduled grants per single transmission occur.

[0054] The present invention advantageously conserves control overhead. Specifically, the downlink E-DCH HARQ Indicator Channel (HICH) (i.e., the HARQ ACK/NAK is sent on E-HICH) overhead can be reduced because ACK/NAKs are needed less frequently. Also, the E-DCH dedicated physical control channel (E-DPCCH) overhead is reduced. In addition, a further savings in overhead is possible if the uplink dedicated physical control channel (UL DPCCH) gating is introduced. In this case, the DPCCH is not transmitted continuously but only when other UL channels are transmitted. In addition to the savings in system capacity, another advantage of the present invention is that battery power of the UE is conserved, since the UE needs to transmit and receive less often when a virtual TTI is used.

[0055] While there have shown and described and pointed out fundamental novel features of the invention as applied to presently preferred embodiments thereof, it will be understood that various omissions and substitutions and changes in the form and details of the components illustrated, and in their operation may be made by those skilled in the art without departing from the scope of the invention, as defined by the appended claims.

Claims

1. A method which is executed by a mobile station for autonomous enhanced uplink transmission in which a scheduling grant from a network is not required, comprising:

determining a virtual transmission time interval for a medium access control entity, which virtual transmission time interval defines a minimum time interval that is allowed between enhanced uplink transmissions;
checking to determine whether the medium access control entity is transmitting data packets in a current air interface transmission time inter-

- val; and
for the case where it is determined that the medium access control entity is not transmitting in the current air interface transmission time interval, transmitting a next data packet only after a period determined by the virtual transmission time interval is determined to have elapsed.
2. The method of claim 1, wherein the virtual transmission time interval is independent from air interface transmission time interval.
 3. The method of claim 1, wherein the next data packet comprises at least one protocol data unit.
 4. The method of claim 1, wherein checking to determine whether the medium access control entity is transmitting data packets in a current air interface transmission time interval comprises checking to determine if the medium access control entity emptied its radio link control buffer.
 5. The method of claim 4, wherein transmitting comprises transmitting at least one protocol data unit from the buffer.
 6. The method of claim 5, wherein transmitting the at least one protocol data unit comprises selecting a transport format combination as a function of the virtual transmission time interval.
 7. The method of claim 6, wherein selecting the transport format combination is a function of occupancy of the radio link control buffer and the virtual transmission time interval.
 8. The method of claim 1, wherein transmitting the at least one protocol data unit comprises transmitting it over a dedicated channel.
 9. The method of claim 1, wherein determining the virtual transmission time interval comprises receiving from a network element the virtual transmission time interval.
 10. The method of claim 1, wherein determining the virtual transmission time interval is without explicit network signaling.
 11. The method of claim 1, wherein the mobile station is further configured to implement the virtual transmission time interval in an medium access control dedicated layer
 12. A computer program product embodied on a computer readable medium and executable by a processor for performing actions by a mobile station for autonomous enhanced uplink transmission in which
 - a scheduling grant from a network is not required, said actions comprising:
 - determining a virtual transmission time interval for a medium access control entity, which virtual transmission time interval is independent from the air interface transmission time interval and defines a minimum time interval that is allowed between enhanced uplink transmissions;
 - checking to determine whether the medium access control entity is transmitting data packets in a current air interface transmission time interval; and
 - for the case where it is determined that the medium access control entity is not transmitting in the current air interface transmission time interval, transmitting a next data packet only after a period determined by the virtual transmission time interval is determined to have elapsed.
 13. The computer program product of claim 12, wherein the virtual transmission time interval is independent from air interface transmission time interval.
 14. The computer program product of claim 12, wherein the next data packet comprises at least one protocol data unit.
 15. The computer program product of claim 12, wherein checking to determine whether the medium access control entity is transmitting data packets in a current air interface transmission time interval comprises checking to determine if the medium access control entity emptied its radio link control buffer.
 16. The computer program product of claim 15, wherein transmitting comprises transmitting at least one protocol data unit from the buffer.
 17. The computer program product of claim 16, wherein transmitting the at least one protocol data unit comprises selecting a transport format combination as a function of the virtual transmission time interval.
 18. The computer program product of claim 17, wherein selecting the transport format combination is a function of occupancy of the radio link control buffer and the virtual transmission time interval.
 19. The computer program product of claim 12, wherein transmitting the at least one protocol data unit comprises transmitting it over a dedicated channel.
 20. The computer program product of claim 12, wherein determining the virtual transmission time interval comprises receiving from a network element the virtual transmission time interval.

21. The computer program product of claim 12, wherein determining the virtual transmission time interval is without explicit network signaling.
22. The computer program product of claim 12, configured to cause the mobile station to implement the virtual transmission time interval in a medium access control dedicated layer.
23. A mobile station comprising:
- a memory adapted to store computer program instructions and a virtual transmission time interval that is independent from the air interface transmission time interval and defines a minimum time interval that is allowed between enhanced uplink transmissions;
- a wireless transceiver;
- a processor coupled to the memory and to the wireless transceiver, and adapted to:
- check to determine whether the mobile station is transmitting data packets in a current air interface transmission time interval; and
- for the case where it is determined that the mobile station is not transmitting in the current air interface transmission time interval, to cause the transmitter to transmit a next data packet only after a period determined by the virtual transmission time interval is determined to have elapsed, wherein the virtual transmission time interval is used for autonomous enhanced uplink transmission in which a scheduling grant from a network is not required.
24. The mobile station of claim 23, wherein the virtual transmission time interval is independent from air interface transmission time interval.
25. The mobile station of claim 23, wherein the next data packet comprises at least one protocol data unit.
26. The mobile station of claim 23, further comprising a radio link control buffer coupled to the wireless transceiver,
- and wherein the check to determine whether the mobile station is transmitting data packets in a current air interface transmission time interval comprises a check to determine if the radio link control buffer is empty.
27. The mobile station of claim 26, wherein the next data packet comprises at least one protocol data unit sent from the buffer to the transceiver.
28. The mobile station of claim 27, wherein the processor is adapted to cause the transceiver to transmit

the at least one protocol data unit comprises the processor adapted to select a transport format combination as a function of the virtual transmission time interval.

29. The mobile station of claim 28, wherein the transport format combination is a function of occupancy of the radio link control buffer and the virtual transmission time interval.
30. The mobile station of claim 23, wherein the transmitter is adapted to transmit the next data packet over a dedicated channel.
31. The mobile station of claim 23, wherein the virtual transmission time interval is received from a network element via the wireless transceiver.
32. The mobile station of claim 23, wherein the virtual transmission time interval is determined by the processor without explicit network signaling.
33. The mobile station of claim 23, further configured to implement the virtual transmission time interval in an medium access control dedicated layer.

Patentansprüche

1. Verfahren, das durch eine Mobilstation für eine autonome erweiterte Aufwärtsstreckenübertragung, bei der eine Ablaufplanungsgewährung von einem Netzwerk nicht benötigt wird, durchgeführt wird, mit einem Bestimmen eines virtuellen Übertragungszeitintervalls für eine Medienzugriffssteuereinheit, wobei das virtuelle Übertragungszeitintervall ein Minimalzeitintervall festlegt, das zwischen erweiterten Aufwärtsstreckenübertragungen erlaubt ist, einem Überprüfen, um zu bestimmen, ob die Medienzugriffssteuereinheit Datenpakete in einem gegenwärtigen Luftschnittstellenübertragungszeitintervall überträgt, und für den Fall, in dem bestimmt ist, dass die Medienzugriffssteuereinheit nicht in dem gegenwärtigen Luftschnittstellenübertragungszeitintervall überträgt, mit einem Übertragen eines nächsten Datenpakets erst nachdem eine durch das virtuelle Übertragungszeitintervall bestimmte Periode als verstrichen bestimmt ist.
2. Verfahren nach Anspruch 1, wobei das virtuelle Übertragungszeitintervall unabhängig von einem Luftschnittstellenübertragungszeitintervall ist.
3. Verfahren nach Anspruch 1, wobei das nächste Datenpaket zumindest eine Protokolldateneinheit aufweist.

4. Verfahren nach Anspruch 1, wobei das Überprüfen, um zu bestimmen, ob die Medienzugriffssteuereinheit Datenpakete in einem gegenwärtigen Luftschnittstellenübertragungszeitintervall überträgt, ein Überprüfen umfasst, um zu bestimmen, ob die Medienzugriffssteuereinheit deren Funkverbindungssteuerpuffer geleert hat. 5
5. Verfahren nach Anspruch 4, wobei ein Übertragen ein Übertragen von zumindest einer Protokolldateneinheit aus dem Puffer aufweist. 10
6. Verfahren nach Anspruch 5, wobei ein Übertragen der zumindest einen Protokolldateneinheit ein Auswählen einer Transportformatkombination als eine Funktion des virtuellen Übertragungszeitintervalls umfasst. 15
7. Verfahren nach Anspruch 6, wobei ein Auswählen der Transportformatkombination eine Funktion einer Belegung des Funkverbindungssteuerpuffers und des virtuellen Übertragungszeitintervalls ist. 20
8. Verfahren nach Anspruch 1, wobei ein Übertragen der zumindest einen Protokolldateneinheit deren Übertragen über einen dedizierten Kanal umfasst. 25
9. Verfahren nach Anspruch 1, wobei ein Bestimmen des virtuellen Übertragungszeitintervalls ein Empfangen des virtuellen Übertragungszeitintervalls von einem Netzwerkelement umfasst. 30
10. Verfahren nach Anspruch 1, wobei ein Bestimmen des virtuellen Übertragungszeitintervalls ohne explizite Netzwerksignalisierung stattfindet. 35
11. Verfahren nach Anspruch 1, wobei die Mobilstation ferner dazu eingerichtet ist, um das virtuelle Übertragungszeitintervall in einer Medienzugriffssteuerung zugeordneten Schicht zu implementieren. 40
12. Computerprogrammprodukt, das auf einem Computer lesbaren Medium ausgebildet ist und durch einen Prozessor ausführbar ist, um Aktionen durch eine Mobilstation für eine autonome erweiterte Aufwärtsstreckenübertragung, bei der eine Ablaufplanungsgewährung von einem Netzwerk nicht benötigt wird, durchzuführen, wobei die Aktionen umfassen ein Bestimmen eines virtuellen Übertragungszeitintervalls für eine Medienzugriffssteuereinheit, wobei das virtuelle Übertragungszeitintervall unabhängig von einem Luftschnittstellenübertragungszeitintervall ist und ein Minimalzeitintervall festlegt, das zwischen erweiterten Aufwärtsstreckenübertragungen erlaubt ist, ein Überprüfen, um zu bestimmen, ob die Medienzugriffssteuereinheit Datenpakete in einem gegenwärtigen Luftschnittstellenübertragungszeitintervall überträgt, und für den Fall, in dem bestimmt ist, dass die Medienzugriffssteuereinheit nicht in dem gegenwärtigen Luftschnittstellenübertragungszeitintervall überträgt, ein Übertragen eines nächsten Datenpakets erst nachdem eine durch das virtuelle Übertragungszeitintervall bestimmte Periode als verstrichen bestimmt ist. 50
13. Computerprogrammprodukt nach Anspruch 12, wobei das virtuelle Übertragungszeitintervall unabhängig von einem Luftschnittstellenübertragungszeitintervall ist. 55
14. Computerprogrammprodukt nach Anspruch 12, wobei das nächste Datenpaket zumindest eine Protokolldateneinheit aufweist.
15. Computerprogrammprodukt nach Anspruch 12, wobei das Überprüfen, um zu bestimmen, ob die Medienzugriffssteuereinheit Datenpakete in einem gegenwärtigen Luftschnittstellenübertragungszeitintervall überträgt, ein Überprüfen umfasst, um zu bestimmen, ob die Medienzugriffssteuereinheit deren Funkverbindungssteuerpuffer geleert hat.
16. Computerprogrammprodukt nach Anspruch 15, wobei ein Übertragen ein Übertragen von zumindest einer Protokolldateneinheit aus dem Puffer aufweist.
17. Computerprogrammprodukt nach Anspruch 16, wobei ein Übertragen der zumindest einen Protokolldateneinheit ein Auswählen einer Transportformatkombination als eine Funktion des virtuellen Übertragungszeitintervalls umfasst.
18. Computerprogrammprodukt nach Anspruch 17, wobei ein Auswählen der Transportformatkombination eine Funktion einer Belegung des Funkverbindungssteuerpuffers und des virtuellen Übertragungszeitintervalls ist.
19. Computerprogrammprodukt nach Anspruch 12, wobei ein Übertragen der zumindest einen Protokolldateneinheit deren Übertragen über einen dedizierten Kanal umfasst.
20. Computerprogrammprodukt nach Anspruch 12, wobei ein Bestimmen des virtuellen Übertragungszeitintervalls ein Empfangen des virtuellen Übertragungszeitintervalls von einem Netzwerkelement umfasst.
21. Computerprogrammprodukt nach Anspruch 12, wobei ein Bestimmen des virtuellen Übertragungszeitintervalls ohne explizite Netzwerksignalisierung stattfindet.

22. Computerprogrammprodukt nach Anspruch 12, das dazu eingerichtet ist, um die Mobilstation dazu zu bringen, das virtuelle Übertragungszeitintervall in einer Medienzugriffssteuerung zugeordneten Schicht zu implementieren. 5
23. Mobilstation, mit einem Speicher, der dazu eingerichtet ist, um Computerprogrammanweisungen und ein virtuelles Übertragungszeitintervall zu speichern, das unabhängig von einem Luftschnittstellenübertragungszeitintervall ist und ein Minimalzeitintervall festlegt, das zwischen erweiterten Aufwärtsstreckenübertragungen erlaubt ist, einem Drahtlosempfänger, einem Prozessor, der mit dem Speicher und dem Drahtlossendeempfänger gekoppelt ist, und dazu eingerichtet ist, um zu überprüfen, um zu bestimmen, ob die Mobilstation Datenpakete in einem gegenwärtigen Luftschnittstellenübertragungszeitintervall überträgt, und für den Fall, in dem bestimmt ist, dass die Mobilstation nicht in dem gegenwärtigen Luftschnittstellenübertragungszeitintervall überträgt, um den Sender dazu zu bringen, ein nächste Datenpaket erst nachdem eine durch das virtuelle Übertragungszeitintervall bestimmte Periode als verstrichen bestimmt ist, zu übertragen, wobei das virtuelle Übertragungszeitintervall für eine autonome erweiterte Aufwärtsstreckenübertragung, bei der eine Ablaufplanungsgewährung von einem Netzwerk nicht benötigt wird, verwendet ist. 10 15 20 25 30
24. Mobilstation nach Anspruch 23, wobei das virtuelle Übertragungszeitintervall unabhängig von einem Luftschnittstellenübertragungszeitintervall ist. 35
25. Mobilstation nach Anspruch 23, wobei das nächste Datenpaket zumindest eine Protokolldateneinheit aufweist. 40
26. Mobilstation nach Anspruch 23, ferner mit einem mit dem Drahtlossendeempfänger gekoppelten Funkverbindungssteuerpuffer, und wobei die Überprüfung, um zu bestimmen, ob die Mobilstation Datenpakete in einem gegenwärtigen Luftschnittstellenübertragungszeitintervall überträgt, eine Überprüfung umfasst, um zu bestimmen, ob der Funkverbindungssteuerpuffer leer ist. 45 50
27. Mobilstation nach Anspruch 26, wobei das nächste Datenpaket zumindest eine von dem Puffer zu dem Sendeempfänger gesendete Protokolldateneinheit aufweist. 55
28. Mobilstation nach Anspruch 27, wobei der Prozessor dazu eingerichtet ist, um den Sendeempfänger dazu zu bringen, die zumindest eine Protokolldateneinheit zu übertragen, was umfasst, dass der Prozessor dazu eingerichtet ist, um eine Transportformatkombination als eine Funktion des virtuellen Übertragungszeitintervalls auszuwählen.
29. Mobilstation nach Anspruch 28, wobei die Transportformatkombination eine Funktion einer Belegung des Funkverbindungssteuerpuffers und des virtuellen Übertragungszeitintervalls ist.
30. Mobilstation nach Anspruch 23, wobei der Sender dazu eingerichtet ist, um das nächste Datenpaket über einen dedizierten Kanal zu übertragen.
31. Mobilstation nach Anspruch 23, wobei das virtuelle Übertragungszeitintervall von einem Netzwerkelement mittels des Drahtlossendeempfängers empfangen ist.
32. Mobilstation nach Anspruch 23, wobei das virtuelle Übertragungszeitintervall durch den Prozessor ohne explizite Netzwerksignalisierung bestimmt ist.
33. Mobilstation nach Anspruch 23, ferner dazu eingerichtet, um das virtuelle Übertragungszeitintervall in einer Medienzugriffssteuerung zugeordneten Schicht zu implementieren.

Revendications

- Procédé qui est exécuté par une station mobile pour une émission en liaison montante améliorée autonome dans lequel une autorisation d'ordonnement en provenance d'un réseau n'est pas requise, comprenant les étapes consistant à :

déterminer un intervalle de temps d'émission virtuel pour une entité de commande d'accès au support, lequel intervalle de temps d'émission virtuel définit un intervalle de temps minimum qui est autorisé entre les émissions en liaison montante améliorées ;
procéder à une vérification pour déterminer si l'entité de commande d'accès au support émet des paquets de données dans un intervalle de temps d'émission d'interface radio en cours ; et pour le cas où il est déterminé que l'entité de commande d'accès au support n'émet pas dans l'intervalle de temps d'émission d'interface radio en cours, émettre un paquet de données suivant uniquement après qu'une période déterminée par l'intervalle de temps d'émission virtuel ait été déterminée comme étant passée.
- Procédé selon la revendication 1, dans lequel l'intervalle de temps d'émission virtuel est indépendant

- de l'intervalle de temps d'émission d'interface radio.
3. Procédé selon la revendication 1, dans lequel le paquet de données suivant comprend au moins une unité de données de protocole. 5
 4. Procédé selon la revendication 1, dans lequel l'étape de vérification pour déterminer si l'entité de commande d'accès au support émet des paquets de données dans un intervalle de temps d'émission d'interface radio en cours comprend une vérification pour déterminer si l'entité de commande d'accès au support a vidé sa mémoire tampon de commande de liaison radio. 10
 5. Procédé selon la revendication 4, dans lequel l'étape consistant à émettre comprend l'émission d'au moins une unité de données de protocole à partir de la mémoire tampon. 15
 6. Procédé selon la revendication 5, dans lequel l'émission de ladite au moins une unité de données de protocole comprend l'étape consistant à sélectionner une combinaison de formats de transport en fonction de l'intervalle de temps d'émission virtuel. 20
 7. Procédé selon la revendication 6, dans lequel l'étape consistant à sélectionner la combinaison de formats de transport est réalisée en fonction de l'occupation de la mémoire tampon de commande de liaison radio et de l'intervalle de temps d'émission virtuel. 25
 8. Procédé selon la revendication 1, dans lequel l'émission de ladite au moins une unité de données de protocole comprend l'étape consistant à émettre cette dernière sur un canal dédié. 30
 9. Procédé selon la revendication 1, dans lequel l'étape consistant à déterminer l'intervalle de temps d'émission virtuel comprend la réception en provenance d'un élément de réseau de l'intervalle de temps d'émission virtuel. 35
 10. Procédé selon la revendication 1, dans lequel l'étape consistant à déterminer l'intervalle de temps d'émission virtuel est réalisée sans signalisation de réseau explicite. 40
 11. Procédé selon la revendication 1, dans lequel la station mobile est en outre configurée pour mettre en oeuvre l'intervalle de temps d'émission virtuel dans une couche dédiée de commande d'accès au support. 45
 12. Produit de programme informatique incorporé sur un support lisible par ordinateur et exécutable par un processeur pour la réalisation d'actions par une station mobile pour une émission en liaison montante améliorée autonome dans lequel une autorisation d'ordonnancement en provenance d'un réseau n'est pas requise, lesdites actions comprenant : 50
 - la détermination d'un intervalle de temps d'émission virtuel pour une entité de commande d'accès au support, lequel intervalle de temps d'émission virtuel est indépendant de l'intervalle de temps d'émission d'interface radio et définit un intervalle de temps minimum qui est autorisé entre les émissions en liaison montante améliorées ;
 - une vérification pour déterminer si l'entité de commande d'accès au support émet des paquets de données dans un intervalle de temps d'émission d'interface radio en cours ; et
 - pour le cas où il est déterminé que l'entité de commande d'accès au support n'émet pas à l'interface air intervalle de temps d'émission en cours, l'émission d'un paquet de données suivant uniquement après une période déterminée par l'intervalle de temps d'émission virtuel est déterminée comme ayant passé.
 13. Produit de programme informatique selon la revendication 12, dans lequel l'intervalle de temps d'émission virtuel est indépendant de l'intervalle de temps d'émission d'interface radio. 55
 14. Produit de programme informatique selon la revendication 12, dans lequel le paquet de données suivant comprend au moins une unité de données de protocole.
 15. Produit de programme informatique selon la revendication 12, dans lequel l'étape de vérification pour déterminer si l'entité de commande d'accès au support émet des paquets de données dans un intervalle de temps d'émission d'interface radio en cours comprend une vérification pour déterminer si l'entité de commande d'accès au support a vidé sa mémoire tampon de commande de liaison radio.
 16. Produit de programme informatique selon la revendication 15, dans lequel l'étape consistant à émettre comprend l'émission d'au moins une unité de données de protocole à partir de la mémoire tampon.
 17. Produit de programme informatique selon la revendication 16, dans lequel l'émission de ladite au moins une unité de données de protocole comprend l'étape consistant à sélectionner une combinaison de formats de transport en fonction de l'intervalle de temps d'émission virtuel.
 18. Produit de programme informatique selon la revendication 17, dans lequel l'étape consistant à sélectionner la combinaison de formats de transport est

réalisée en fonction de l'occupation de la mémoire tampon de commande de liaison radio et de l'intervalle de temps d'émission virtuel.

19. Produit de programme informatique selon la revendication 12, dans lequel l'émission de ladite au moins une unité de données de protocole comprend l'étape consistant à émettre cette dernière sur un canal dédié.
20. Produit de programme informatique selon la revendication 12, dans lequel l'étape consistant à déterminer l'intervalle de temps d'émission virtuel comprend la réception, en provenance d'un élément de réseau, de l'intervalle de temps d'émission virtuel.
21. Produit de programme informatique selon la revendication 12, dans lequel l'étape consistant à déterminer l'intervalle de temps d'émission virtuel est réalisée sans signalisation de réseau explicite.
22. Produit de programme informatique selon la revendication 12, configuré pour amener la station mobile à mettre en oeuvre l'intervalle de temps d'émission virtuel dans une couche dédiée de commande d'accès au support.
23. Station mobile comprenant :

une mémoire agencée pour stocker des instructions de programme informatiques et un intervalle de temps d'émission virtuel qui est indépendant de l'intervalle de temps d'émission d'interface radio et qui définit un intervalle de temps minimum qui est autorisé entre des émissions en liaison montantes améliorée ;
un émetteur-récepteur sans fil ;
un processeur couplé à la mémoire et à l'émetteur-récepteur sans fil, et agencé pour :

procéder à une vérification pour déterminer si l'entité de commande d'accès au support émet des paquets de données dans un intervalle de temps d'émission d'interface radio en cours ; et
pour le cas où il est déterminé que l'entité de commande d'accès au support n'émet pas dans l'intervalle de temps d'émission d'interface radio en cours, émettre un paquet de données suivant uniquement après qu'une période déterminée par l'intervalle de temps d'émission virtuel ait été déterminée comme étant passée, dans lequel l'intervalle de temps d'émission virtuel est utilisé pour une émission en liaison montante améliorée autonome dans lequel une autorisation d'ordonnancement en provenance d'un réseau n'est pas requise.

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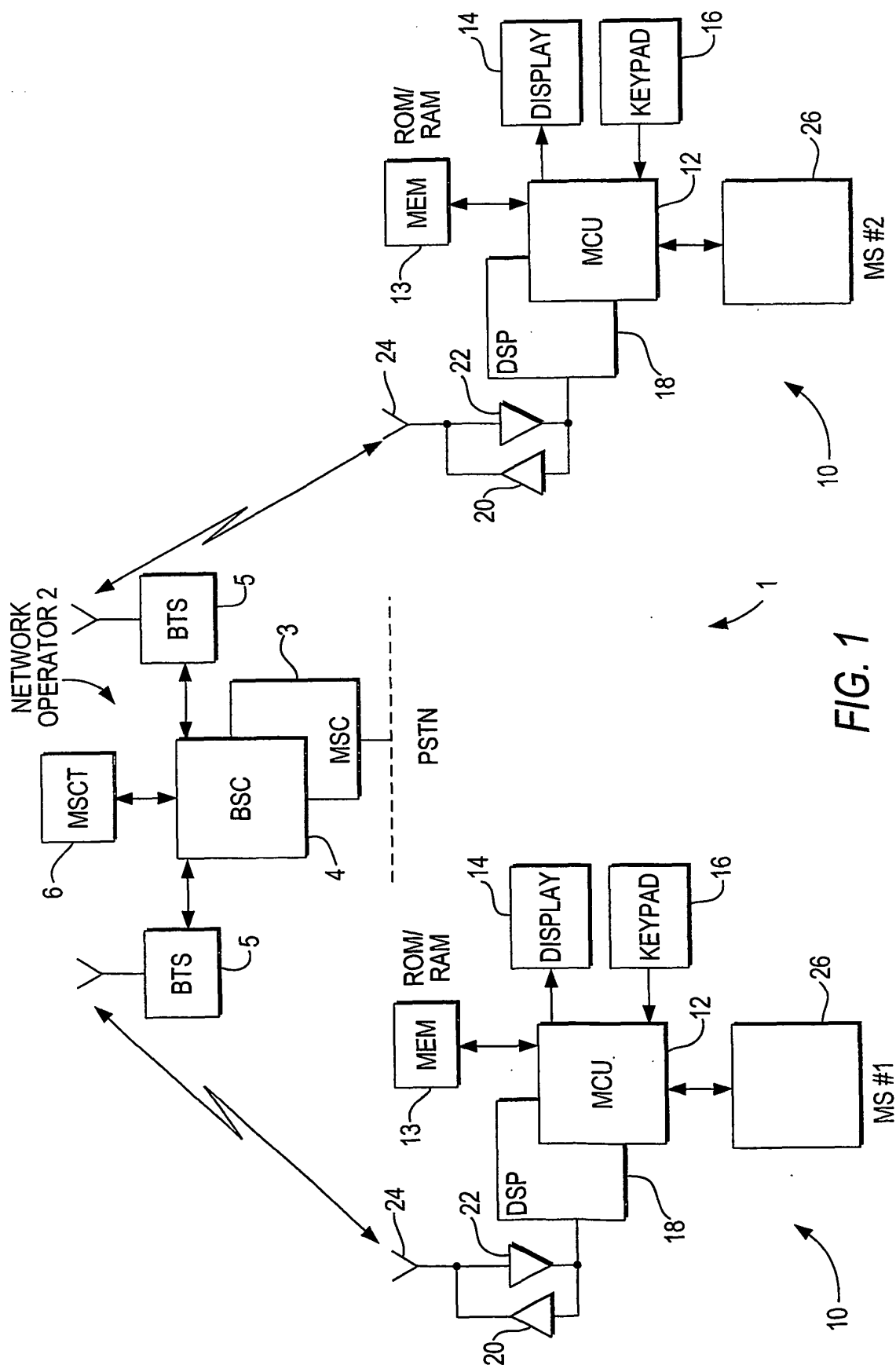
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24. Station mobile selon la revendication 23, dans lequel l'intervalle de temps d'émission virtuel est indépendant de l'intervalle de temps d'émission d'interface radio.
25. Station mobile selon la revendication 23, dans lequel le paquet de données suivant comprend au moins une unité de données de protocole.
26. Station mobile selon la revendication 23, comprenant en outre une mémoire tampon de commande de liaison radio couplée à l'émetteur-récepteur sans fil, et dans lequel la vérification pour déterminer si la station mobile émet des paquets de données dans un intervalle de temps d'émission d'interface radio en cours comprend une vérification pour déterminer si la mémoire tampon de commande de liaison radio est vide.
27. Station mobile selon la revendication 26, dans lequel le paquet de données suivant comprend au moins une unité de données de protocole envoyée à partir de la mémoire tampon à destination de l'émetteur-récepteur.
28. Station mobile selon la revendication 27, dans lequel le processeur est agencé pour amener l'émetteur-récepteur à émettre ladite au moins une unité de données de protocole et comprend le fait que le processeur est agencé pour sélectionner une combinaison de formats de transport en fonction de l'intervalle de temps d'émission virtuel.
29. Station mobile selon la revendication 28, dans lequel la combinaison de formats de transport est réalisée en fonction de l'occupation de la mémoire tampon de commande de liaison radio et de l'intervalle de temps d'émission virtuel.
30. Station mobile selon la revendication 23, dans lequel l'émetteur est agencé pour émettre le paquet de données suivant sur un canal dédié.
31. Station mobile selon la revendication 23, dans lequel l'intervalle de temps d'émission virtuel est reçu en provenance d'un élément de réseau par l'intermédiaire de l'émetteur-récepteur sans fil.
32. Station mobile selon la revendication 23, dans lequel l'intervalle de temps d'émission virtuel est déterminé par le processeur de réseau sans signalisation de réseau explicite.
33. Station mobile selon la revendication 23, configurée en outre pour mettre en oeuvre l'intervalle de temps d'émission dans une couche virtuelle dédiée de commande d'accès au support.



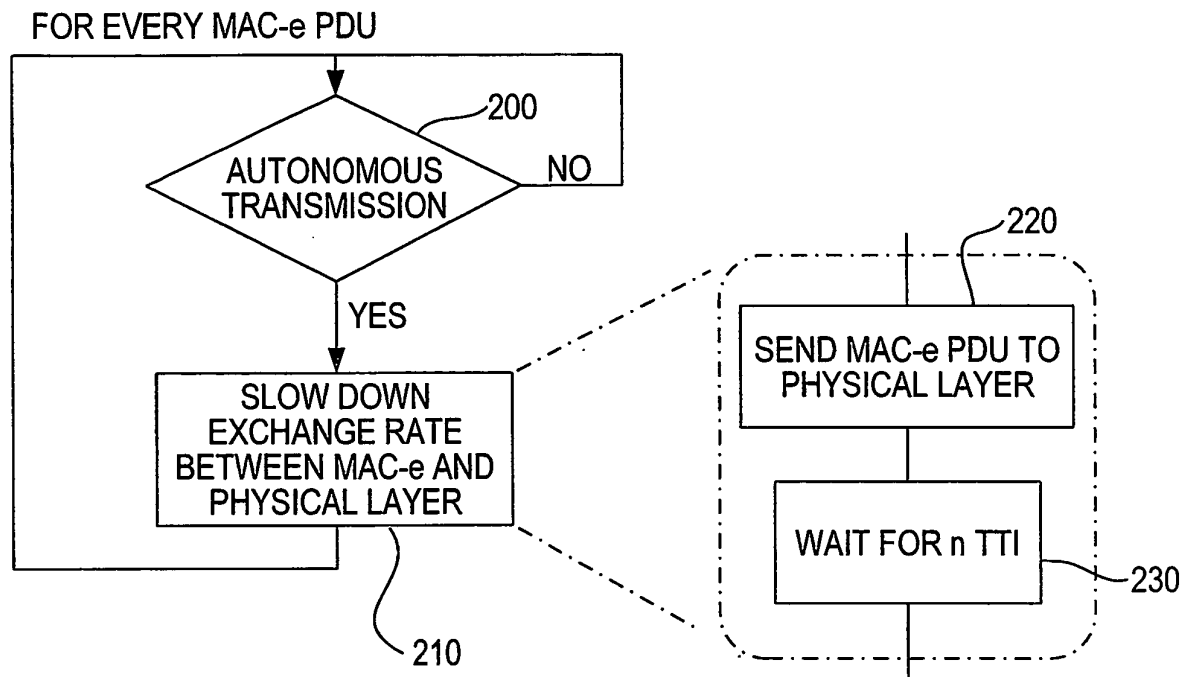
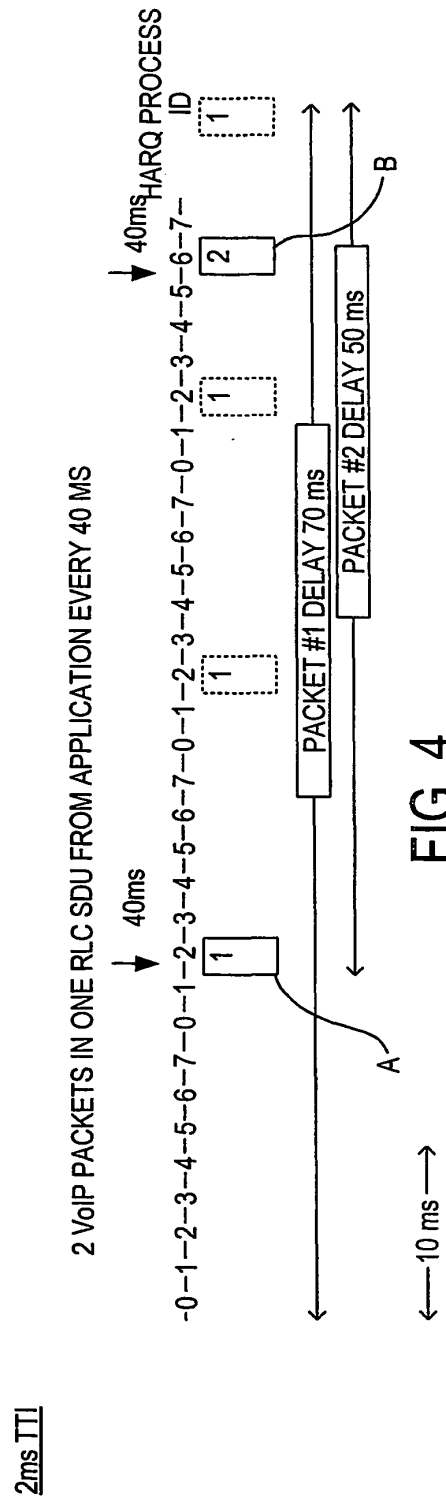
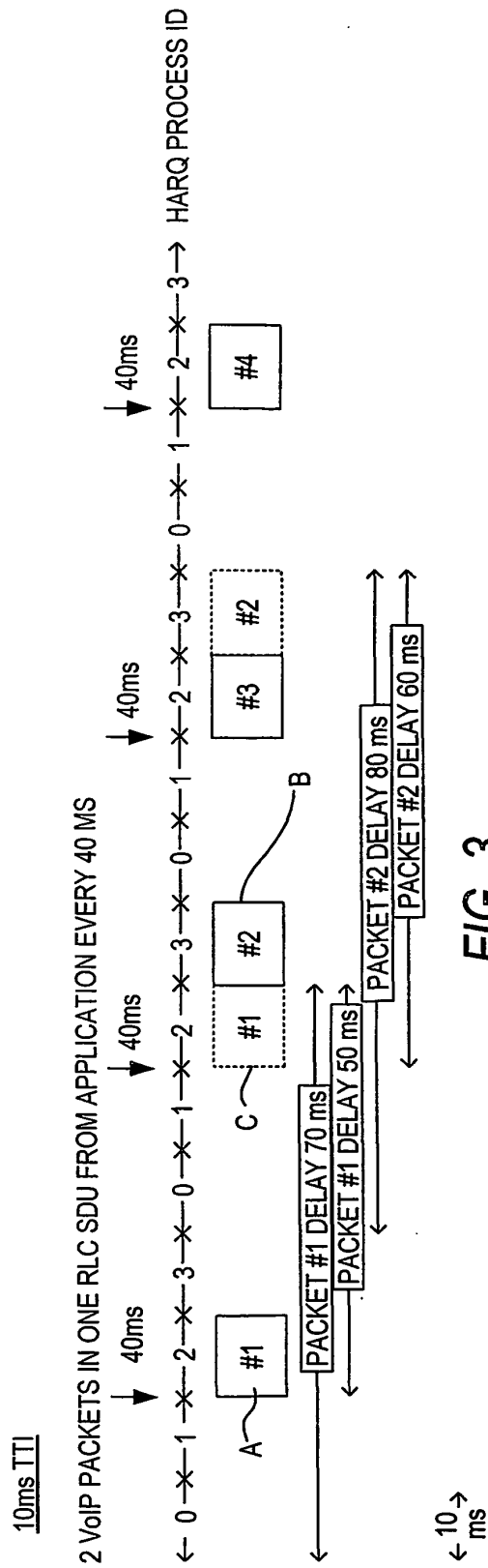


FIG. 2



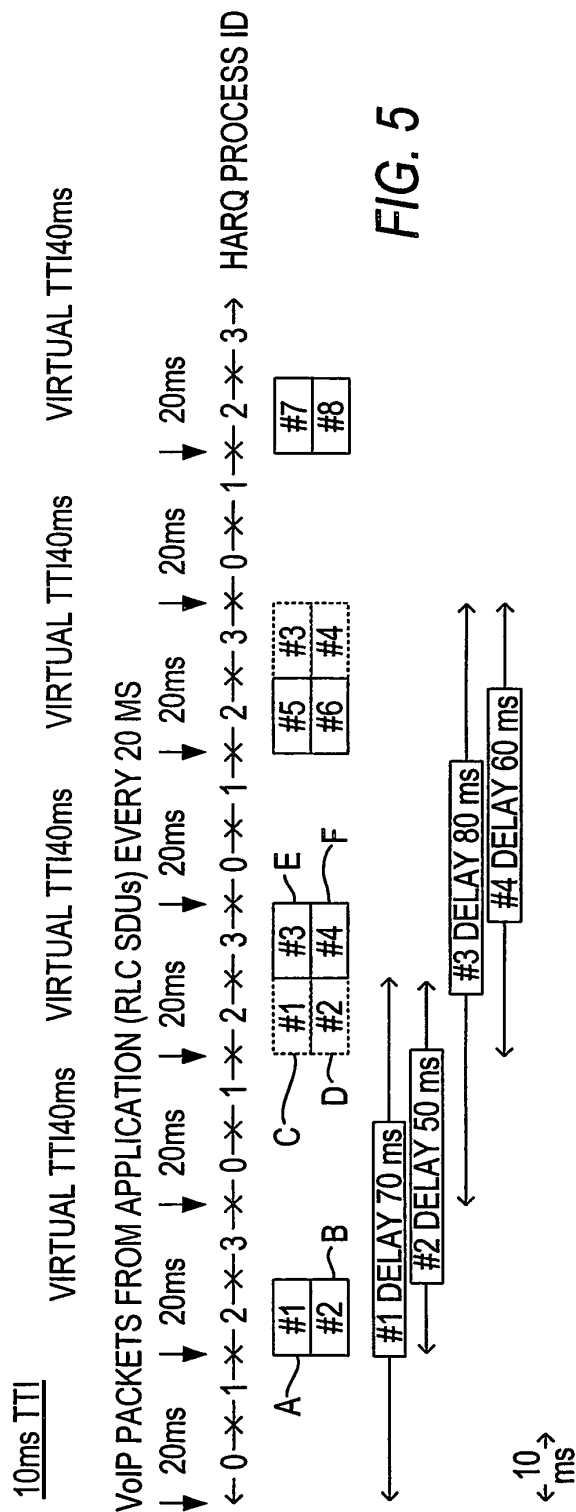


FIG. 5

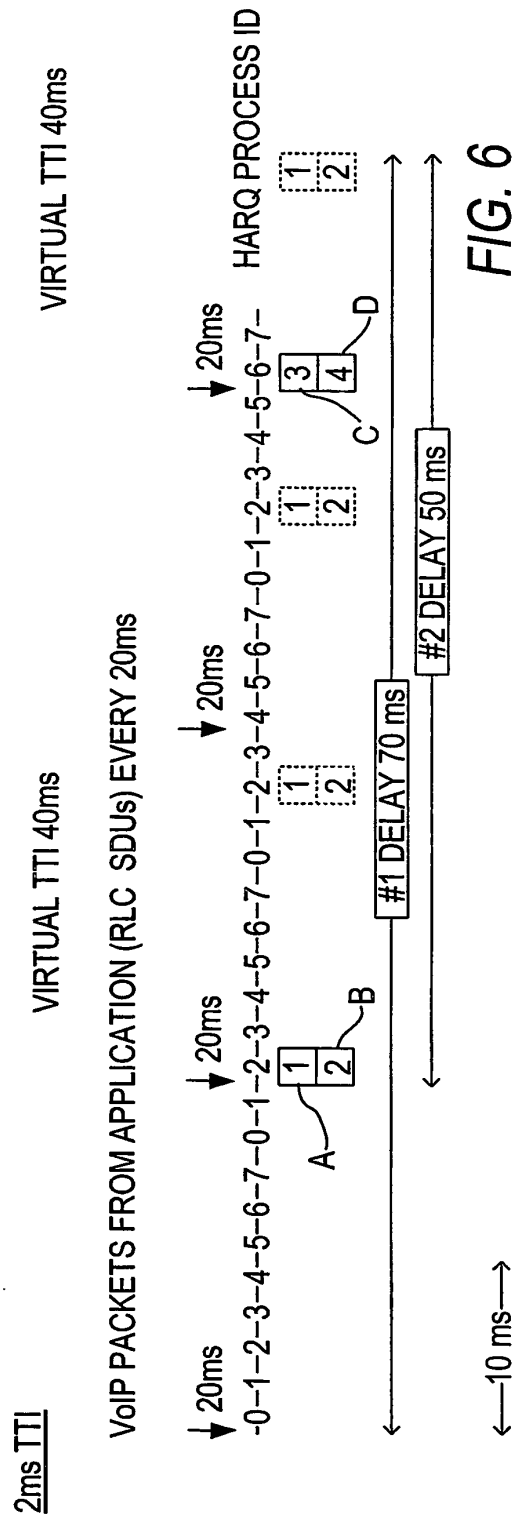


FIG. 6

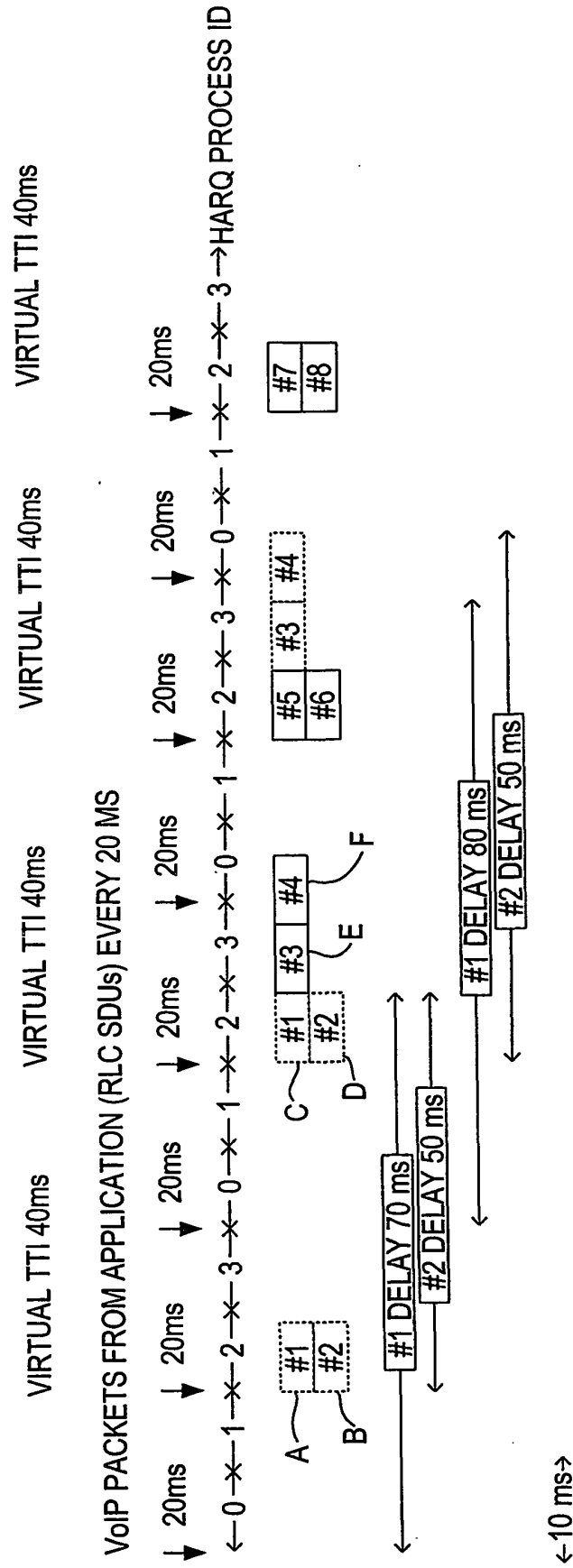


FIG. 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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