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(71) Applicant *(for all designated States except US)*: **SAMSUNG ELECTRONICS CO., LTD.** [KR/KR]; 416, Maetan-dong, Yeongtong-gu, Suwon-si, Gyeonggi-do 442-742 (KR).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **JAMADAGNI, Satish Nanjunda Swamy** [IN/IN]; Bagmane Lakeview, Block 'B', No. 66/1, Bagmane Tech Park, C V Raman Nagar, Byrasandra, Bangalore 560093 (IN). **GANAPATHI, Sarvesha Anegundi** [IN/IN]; Bagmane Lakeview, Block 'B', No. 66/1, Bagmane Tech Park, C V Raman Nagar, Byrasandra, Bangalore 560093 (IN). **HIRISAVE, Pradeep Krishnamurthy** [IN/IN]; Bagmane Lakeview, Block 'B', No. 66/1, Bagmane Tech Park, C V Raman Nagar, Byrasandra, Bangalore 560093 (IN).

(74) Agent: **LEE, Keon-Joo**; Mihwa Bldg., 110-2, Myongryun-dong 4-ga, Chongro-gu, Seoul 110-524 (KR).

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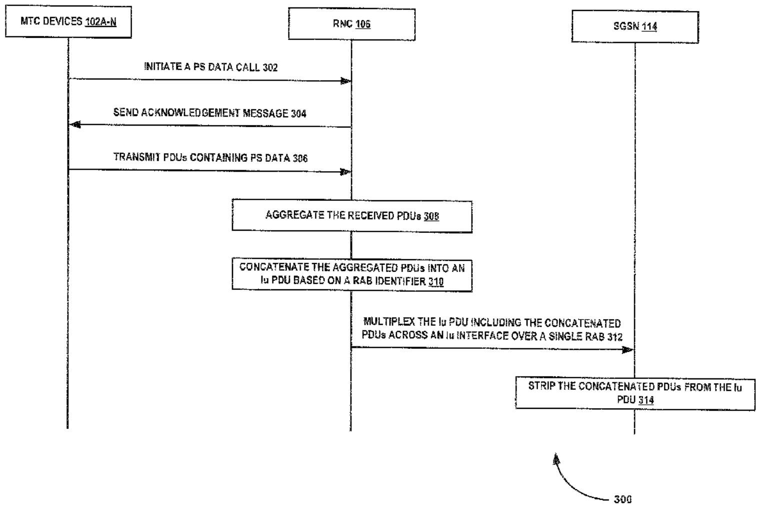
(54) Title: METHOD AND APPARATUS OF COMMUNICATING MACHINE TYPE COMMUNICATION DATA OVER AN IU INTERFACE IN A UNIVERSAL MOBILE TELECOMMUNICATIONS SYSTEM

[Fig. 3]



(57) Abstract: The present invention provides a method and apparatus for communicating machine type communication (MTC) data across an Iu interface in an universal mobile telecommunications system (UMTS) network environment. In one embodiment, PDUs associated with one or more MTC devices are aggregated by a radio network controller. Then, the aggregated PDUs associated with the one or more MTC devices are concatenated into an Iu PDU based on a radio access bearer (RAB) identifier associated with the one or more MTC devices. The Iu PDU including the aggregated PDUs is transmitted to a core network across an Iu-PS interface that connects the radio network controller and the core network.

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Description

Title of Invention: METHOD AND APPARATUS OF COMMUNICATING MACHINE TYPE COMMUNICATION DATA OVER AN IU INTERFACE IN A UNIVERSAL MOBILE TELECOMMUNICATIONS SYSTEM

Technical Field

[1] The present invention relates to the field of Universal Mobile Telecommunications System, and more particularly relates to communicating machine type communication data over an Iu interface in an Universal Mobile Telecommunications System.

Background Art

[2] Universal Mobile Telecommunications System (UMTS) is a third generation mobile cellular technology based on GSM standard. The UMTS is roughly divided into user equipments, a Universal Terrestrial Radio Access Network (UTRAN), and a core network. UTRAN is a communication network (commonly referred to as 3G) which allows connectivity between the user equipments and the core network for providing circuit switched (CS) service and packet switched (PS) service. For example, a general voice conversation service is a circuit switched service, while a smart metering service via an Internet Protocol connection is classified as a packet switched (PS) service.

[3] Typically, the UTRAN includes one or more radio network sub-systems (RNSs). Each RNS includes a radio network controller (RNC) and one or more Node Bs managed by the RNC. Each RNC typically assigns and manages radio resources, and operates as an access point with respect to the core network. The one or more Node Bs receive information sent by the user equipments through an uplink and transmit data to the respective user equipments through downlink. In other words, the Node Bs acts as access points of the UTRAN for the user equipments.

[4] The core network includes a mobile switching center (MSC) and a gateway mobile switching center (GMSC) connected together for supporting a circuit switched (CS) service. The core network also includes a serving GPRS support node (SGSN) and a gateway GPRS support node connected together for supporting a packet switched (PS) services.

[5] For supporting circuit switched services, the RNCs are connected to the MSC of the core network and the MSC is connected to the GMSC that manages the connection with other networks. For supporting packet switched services, the RNCs are connected to the SGSN and the GGSN of the core network. The SGSN supports packet communications with the RNCs and the GGSN manages the connection with other packet

switched networks, such as the Internet.

[6] Various types of interfaces exist between network components to allow the network components to transmit and receive information with each other. An interface between the RNC and the core network is defined as Iu interface. In particular, the lu interface between the RNCs and the core network for packet switched systems is defined as "lu-PS" and the lu interface between the RNCs and the core network for circuit switched systems is defined as "lu-CS".

[7] The user equipments availing CS/PS services from the core network via the UTRAN includes legacy devices or non-legacy devices such as Machine to Machine communication (M2M) devices. Legacy devices are devices which access CS and PS services such as mobile phones. Machine-to-Machine (M2M) communication (also referred to as "machine-type communication" or "MTC") is a form of data communication between devices that do not necessarily need human interaction (commonly known as MTC devices) unlike legacy devices.

[8] For example, in an M2M communication, a MTC device (such as a sensor or smart-meter) may capture an event data which is then relayed through a Node B as PS data to an application residing in the core network via a 'Iu-PS' interface for analysis and necessary action. M2M communication may be used in a variety of areas such as smart metering systems (e.g., in applications related to power, gas, water, heating, grid control, and industrial metering), surveillance systems, order management, gaming machines, and health care communication. Additionally, M2M communication based on MTC technology may be used in areas such as customer service.

[9] Currently, a large number of MTC devices are being deployed in a UMTS for availing PS services from the core network. For example, in New York City/ Washington DC, approximately 15000 smart meters having machine to machine communications enabled are being installed per Node B for supporting smart grid application. Therefore, a large number of M2M data (e.g., M2M calls) is expected to be exchanged between the RNCs and the core network across the Iu-PS interface. However, the M2M data exchanged between the core network and the MTC devices over the UTRAN is small sized data (e.g., around 20KB). Thus, large number of low sized data communicated between the UTRAN and the core network across the Iu-PS interface may result in overloading the Iu-PS interface, thereby effecting throughput of the UMTS.

Disclosure of Invention

Technical Problem

[10] An aspect of the present invention is to communicate machine type communication data over an Iu interface in a universal mobile telecommunications system.

Solution to Problem

[11] In accordance with an aspect of the present invention, a method of communicating machine type communication (MTC) data across an Iu interface in an universal mobile telecommunication system (UMTS), comprising: aggregating packet data units (PDUs) associated with one or more MTC devices in a UMTS network environment; concatenating the aggregated PDUs associated with the one or more MTC devices into an Iu PDU; and multiplexing the Iu PDU including the concatenated PDUs across an Iu-PS interface connecting a radio network controller and a core network.

[12] In accordance with another aspect of the present invention, an apparatus comprising: a processor; and memory coupled to the processor, wherein the memory includes a PDU concatenation module configured for: aggregating packet data units (PDUs) associated with one or more machine type communication (MTC) devices in a universal mobile telecommunication system (UMTS) network environment; concatenating the aggregated PDUs associated with the one or more MTC devices into an Iu PDU; and multiplexing the Iu PDU including the concatenated PDUs across an Iu-PS interface.

Brief Description of Drawings

[13] Figure 1 illustrates a block diagram of an exemplary universal mobile telecommunications system (UTMS) for communicating machine type communication (MTC) data across an Iu-PS interface, according to one embodiment.

[14] Figure 2 is a process flow diagram illustrating an exemplary method of establishing a radio access bearer (RAB) between a MTC device and a radio network controller (RNC), according to one embodiment.

[15] Figure 3 is a process flow diagram illustrating an exemplary method of communicating MTC data over the Iu-PS interface, according to one embodiment.

[16] Figure 4 is a schematic representation of an exemplary initialization control frame, according to one embodiment.

[17] Figure 5 illustrates a block diagram of the RNC showing various components for implementing embodiments of the present subject matter.

[18] The drawings described herein are for illustration purposes only and are not intended to limit the scope of the present disclosure in any way.

Mode for the Invention

[19] The present invention provides a method and apparatus for communicating machine type communication (MTC) data across an Iu interface in an universal mobile telecommunications system (UMTS) network environment. In the following detailed description of the embodiments of the invention, reference is made to the accompanying drawings that form a part hereof, and in which are shown by way of illustration specific embodiments in which the invention may be practiced. These embodiments

are described in sufficient detail to enable those skilled in the art to practice the invention, and it is to be understood that other embodiments may be utilized and that changes may be made without departing from the scope of the present invention. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present invention is defined only by the appended claims.

[20] Figure 1 illustrates a block diagram of an exemplary UTMS 100 for communicating MTC data across an Iu-PS interface, according to one embodiment. In Figure 1, the UMTS 100 includes MTC devices 102A-N, a Node B 104, a radio network controller (RNC) 106, and a core network 110. The MTC devices 102A-N and the Node B 104 are connected via a wireless link (not shown). The RNC 106 and the core network 110 are connected via an Iu-PS interface 112. It is appreciated that, the Node B and the RNC 106 are part of Universal Terrestrial Radio Access Network (UTRAN). For the purpose of illustration, only one Node B is illustrated as part of the UMTS 100. However, one skilled in the art can realize that there can be more than one Node Bs in the UMTS 100. Also, each of the Node Bs is configured for supporting MTC devices and/or legacy devices. The RNC 106 includes a PDU concatenation module 108 operable for efficiently communicating MTC data across the Iu-PS interface 112, according to an embodiment of the present invention.

[21] Consider that, the RNC 106 receives one or more PDUs containing packet switched (PS) data from the MTC devices 102A-N (e.g., sensors or smart-meters) via the Node B 104. For example, the MTC devices 102A-N may capture an event data associated with an event and relay the event data to the RNC 106 for communicating with an application residing in the core network 110.

[22] In an exemplary operation, the PDU concatenation module 108 stores the PDUs received from the MTC devices 102A-N for a period of time. In some embodiments, a core network element (e.g., Serving GPRS Support Node (SGSN)) 114 may instruct the PDU concatenation module 108 to store the PDUs associated with the MTC device 102A or the group of MTC devices 102A-N based on a predefined criterion. The predefined criterion may be based on a group identifier associated with the MTC devices 102A-N, a RAB identifier, an overload condition of the Iu-PS interface 112, time period, priority of the aggregated PDUs, and so on. In these embodiments, the PDU concatenation module 108 aggregates the received PDUs based on the instructions and concatenates the aggregated PDUs received from the MTC devices 102A-N in an Iu PDU. Accordingly, the PDU concatenation module 108 multiplexes the Iu PDU including the concatenated PDUs to the SGSN 114 over the Iu-PS interface 112. The process steps performed by the PDU concatenation module 108 in uplink are described in greater detail in Figure 3.

[23] Although, Figure 1 illustrates that the PDU concatenation module 108 resides in the

RNC 106, one can envision that the core network 110 can also have the PDU concatenation module 108. For example, when the PDU concatenation module 108 resides in the SGSN 114, the PDU concatenation module 108 may concatenate PDUs intended for one or more MTC devices 102A-N in an Iu PDU and multiplexes the Iu PDU containing the concatenated PDUs to the RNC 106 over the Iu-PS interface 112. In one embodiment, the PDU concatenation module 108 concatenates the aggregated PDUs and multiplexes the concatenated PDUs across the Iu interface based on an overload indication associated with the Iu-PS interface 112.

[24] Figure 2 is a process flow diagram 200 illustrating an exemplary method of establishing a radio access bearer (RAB) between a MTC device 102A and the RNC 106, according to one embodiment. At step 202, the MTC device 102A transmits an session management (SM) activate packet data protocol (PDP) context request along with a PS data call indication to the RNC 106 via the Node B 104. For example, the SM activate PDP context request is transmitted in a radio resource connection (RRC) direct transfer message. In one embodiment, the PS data call indication may enable the PDU concatenation module 108 to aggregate PDUs received from the MTC device 102A or the group of MTC devices 102A-N and reuse the existing RAB for multiplexing the aggregated PDus across the Iu-PS interface 112. In such case, the MTC devices 102A-N are grouped together and assigned a RAB identifier associated with the existing RAB for concatenating the aggregated PDUs based on the RAB identifier. In one embodiment, unique RFCI and associated subflows corresponding to the RAB identifier are allocated to each of the MTC devices 102A-N in such a way that multiple RFCIs represent multiples MTC devices in the same RAB. In another embodiment, multiple subflows across RFCIs corresponding to the RAB identifier are allocated to each of the MTC devices 102A-N.

[25] At step 204, the RNC 106 relays the SM activate PDP context request along a RAB reuse indication in a Radio Access Network Application Part (RANAP) direct transfer message to the SGSN 114. At step 206, the RNC 106 sends a radio bearer setup message to the MTC device 102A. At step 208, the MTC device 102A sends a radio bearer complete message to the RNC 106 upon successful radio bearer establishment. At step 210, the SGSN 114 sends an SM activate PDP context accept message to the RNC 106 without performing a Iu-PS bearer establishment procedure. At step 212, the RNC 106 forwards the SM activate PDP context accept message to the MTC device 102A.

[26] Figure 3 is a process flow diagram 300 illustrating an exemplary method of communicating MTC data over the Iu-PS interface 112, according to one embodiment. At step 302, one of the MTC devices 102A-N initiates a PS data call with the RNC 106 via the Node B 104. The PS data call may be initiated by sending a service request message to

the RNC 106. The service request message may indicate that the MTC devices 102A-N intend to communicate PS data with the core network 110 during the PS data call. Alternatively, the RNC 106 may determine that call is from the MTC device 102A through a random access channel (RACH) call cause or radio link control (RLC)/medium access control (MAC) indication.

[27] At step 304, the RNC 106 sends an acknowledgement message in response to initiation of the PS data call. At step 306, each of the MTC devices 102A-N transmits PDU(s) containing PS data to the RNC 106. At step 308, the RNC 106 aggregates the PDUs received from the MTC devices 102A-N for a predefined time period. The predefined time period may be communicated by one of the MTC devices 102A-N in response to the acknowledgment message or determined by the RNC 106.

[28] At step 310, the RNC 106 concatenates the aggregated PDUs into an Iu PDU based on a RAB identifier assigned to the MTC devices 102A-N during the radio bearer establishment. At step 312, the RNC 106 multiplexes the Iu PDU containing the concatenated PDUs to the SGSN 114 across the Iu-PS interface 112 over an single RAB associated with the assigned RAB identifier. At step 314, the SGSN 114 stripes the concatenated PDUs in the Iu PDU for further processing the PS data.

[29] Figure 4 is a schematic representation of an exemplary initialization control frame 400, according to one embodiment. In particular, the control frame 400 includes a subflow identifier field 402, and a PDU type field 404. The subflow identifier field 402 includes subflow identifiers associated with subflow allocated to each of the MTC devices 102A-N. The subflow identifier field 402 indicates mapping between RFCIs and subflows allocated to different MTC devices 104A-N within a single RAB. The PDU type field 404 indicates whether the PDUs are concatenated into an Iu PDU or not.

[30] Figure 5 illustrates a block diagram of the RNC 106 showing various components for implementing embodiments of the present subject matter. In Figure 5, the RNC 106 includes a processor 502, memory 504, a read only memory (ROM) 506, a transceiver 508, and a bus 510.

[31] The processor 502, as used herein, means any type of computational circuit, such as, but not limited to, a microprocessor, a microcontroller, a complex instruction set computing microprocessor, a reduced instruction set computing microprocessor, a very long instruction word microprocessor, an explicitly parallel instruction computing microprocessor, a graphics processor, a digital signal processor, or any other type of processing circuit. The processor 502 may also include embedded controllers, such as generic or programmable logic devices or arrays, application specific integrated circuits, single-chip computers, smart cards, and the like.

[32] The memory 504 may be volatile memory and non-volatile memory. The memory

504 includes the PDU concatenation module 108 for aggregating PDUs received from the one or more MTC devices 102A-N and concatenating the aggregated PDUs into a single Iu PDU, according to the embodiments of the present subject matter. A variety of computer-readable storage media may be stored in and accessed from the memory elements. Memory elements may include any suitable memory device(s) for storing data and machine-readable instructions, such as read only memory, random access memory, erasable programmable read only memory, electrically erasable programmable read only memory, hard drive, removable media drive for handling memory cards, Memory Sticks™, and the like.

[33] Embodiments of the present subject matter may be implemented in conjunction with modules, including functions, procedures, data structures, and application programs, for performing tasks, or defining abstract data types or low-level hardware contexts. Machine-readable instructions stored on any of the above-mentioned storage media may be executable by the processor 502. For example, a computer program may include machine-readable instructions capable of aggregating PDUs received from one or more MTC devices 102A-N and concatenating the aggregated PDUs into a single Iu PDU, according to the teachings and herein described embodiments of the present subject matter. In one embodiment, the computer program may be included on a storage medium and loaded from the storage medium to a hard drive in the non-volatile memory. The transceiver 508 is configured for multiplexing the Iu PDU including the concatenated PDUs across the Iu interface 112 over a single RAB.

[34] In various embodiments, the method and apparatus described in Figures 1-4 enables communication of MTC data across the Iu-PS interface both in uplink (the RNC 106 to the SGSN 114) and downlink (the SGSN 114 to the RNC 106) directions. Further, PDUs received from one or more MTC devices 102A-N are concatenated into an Iu PDU prior to multiplexing across the Iu-PS interface 112 based on an overload indication associated with the Iu-PS interface 112. For example, the SGSN 114 can send an overload indication to the RNC 106 for initializing concatenation of PDUs. Alternatively, the RNC 106 can send an overload indication to the SGSN 114 suggesting a need to concatenate PDUs in an Iu PDU. One skilled in the art will realize that the PDUs that are concatenated are associated with a single MTC device or multiple MTC devices belonging to a group of MTC devices.

[35] The present embodiments have been described with reference to specific example embodiments, it will be evident that various modifications and changes may be made to these embodiments without departing from the broader spirit and scope of the various embodiments. Furthermore, the various devices, modules, selectors, estimators, and the like described herein may be enabled and operated using hardware circuitry, for example, complementary metal oxide semiconductor based logic circuitry,

firmware, software and/or any combination of hardware, firmware, and/or software embodied in a machine readable medium. For example, the various electrical structure and methods may be embodied using transistors, logic gates, and electrical circuits, such as application specific integrated circuit.

Claims

[Claim 1] A method of communicating machine type communication (MTC) data across an Iu interface in an universal mobile telecommunication system (UMTS), comprising:
aggregating packet data units (PDUs) associated with one or more MTC devices in a UMTS network environment;
concatenating the aggregated PDUs associated with the one or more MTC devices into an Iu PDU; and
multiplexing the Iu PDU including the concatenated PDUs across an Iu-PS interface connecting a radio network controller and a core network.

[Claim 2] The method of claim 1, further comprising:
notifying to a core network element that PDUs associated with the one or more MTC devices are to be aggregated.

[Claim 3] The method of claim 1, wherein aggregating the PDUs associated with the one or more MTC devices in the UMTS network environment comprises:
receiving a notification from a core network element indicating that the Iu-PS interface connecting the radio network controller and the core network is overloaded; and
aggregating PDUs received from the one or more MTC devices by the radio network controller based on the notification.

[Claim 4] The method of claim 1, wherein aggregating the PDUs associated with the one or more MTC devices in the UMTS network environment comprises:
determining an overload condition associated with an Iu-PS interface connecting the radio network controller and the core network; and
aggregating PDUs associated with the one or more MTC devices by a core network element based on the determination.

[Claim 5] The method of claim 1, further comprising:
assigning a radio access bearer (RAB) identifier to the one or more MTC devices.

[Claim 6] The method of claim 5, wherein assigning the RAB identifier to the one or more MTC devices comprises:
allocating a unique RFCI and associated subflows that corresponds to the RAB identifier to each of the one or more MTC devices.

[Claim 7] The method of claim 5, wherein assigning the RAB identifier to the one

or more MTC devices comprises:
allocating multiple subflows across RFCIs corresponding to the RAB identifier to each of the one or more MTC devices.

[Claim 8] The method of claim 5, wherein concatenating the aggregated PDUs associated with the one or more MTC devices into the Iu PDU comprises:
concatenating the aggregated PDUs associated with the one or more MTC devices into the Iu PDU based on the RAB identifier.

[Claim 9] The method of claim 8, wherein multiplexing the Iu PDU including the concatenated PDUs across the Iu-PS interface comprises:
multiplexing the Iu PDU including the concatenated PDUs across the Iu-PS interface over an RAB associated with the RAB identifier.

[Claim 10] An apparatus comprising:
a processor; and
memory coupled to the processor, wherein the memory includes a PDU concatenation module configured for:
aggregating packet data units (PDUs) associated with one or more machine type communication (MTC) devices in a universal mobile telecommunication system (UMTS) network environment;
concatenating the aggregated PDUs associated with the one or more MTC devices into an Iu PDU; and
multiplexing the Iu PDU including the concatenated PDUs across an Iu-PS interface.

[Claim 11] The apparatus of claim 10, wherein the PDU concatenation module is configured for notifying to a core network element that PDUs associated with the one or more MTC devices are to be aggregated.

[Claim 12] The apparatus of claim 10, wherein the PDU concatenation module is configured for:
receiving a notification from a core network element indicating that the Iu-PS interface is overloaded; and
aggregating PDUs received from the one or more MTC devices based on the notification.

[Claim 13] The apparatus of claim 10, wherein the PDU concatenation module is configured for:
determining an overload condition associated with an Iu-PS interface; and
aggregating PDUs associated with the one or more MTC devices based on the determination.

[Claim 14] The apparatus of claim 10, wherein the PDU concatenation module is configured for assigning a radio access bearer (RAB) identifier to the one or more MTC devices.

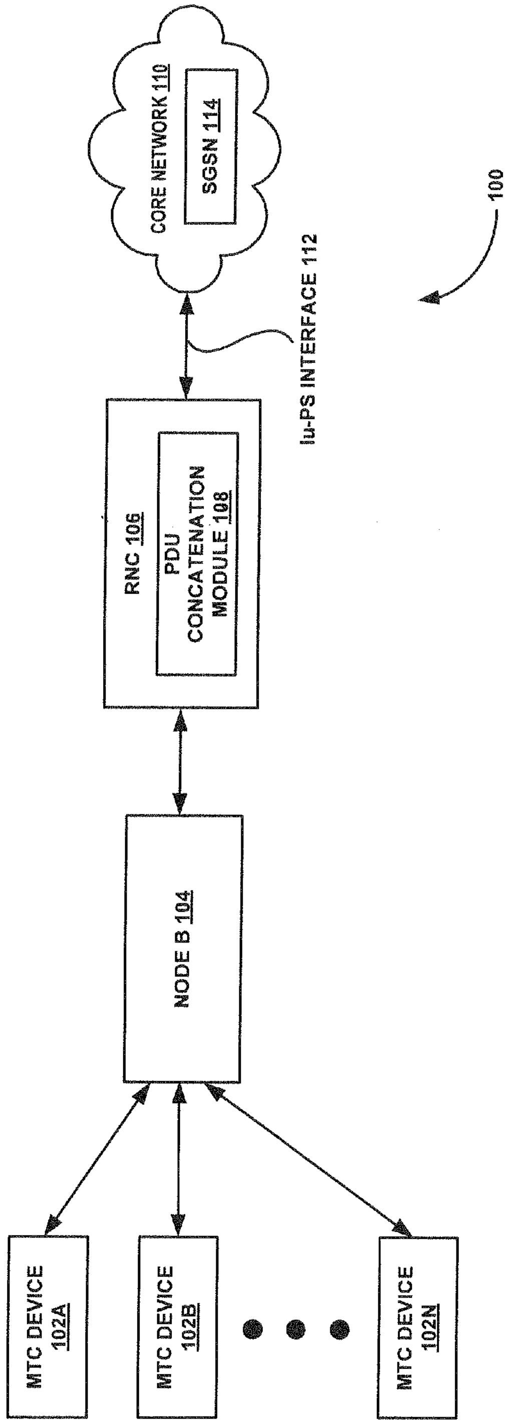
[Claim 15] The apparatus of claim 14, wherein the PDU concatenation module is configured for allocating a unique RFCI and associated subflows that corresponds to the RAB identifier to each of the one or more MTC devices.

[Claim 16] The apparatus of claim 14, wherein the PDU concatenation module is configured for allocating multiple subflows across RFCIs corresponding to the RAB identifier to each of the one or more MTC devices.

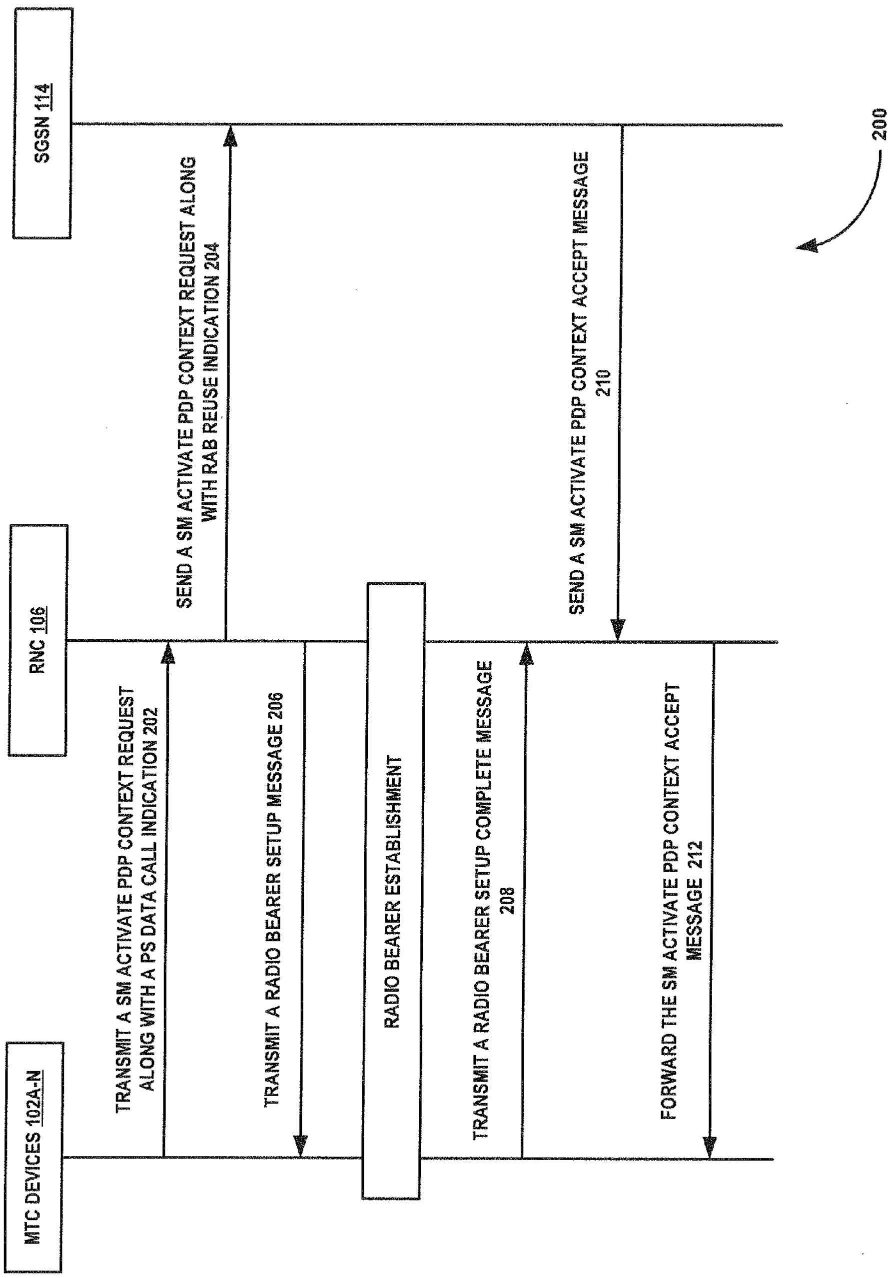
[Claim 17] The apparatus of claim 14, wherein in concatenating the aggregated PDUs associated with the one or more MTC devices into the Iu PDU, the PDU concatenation module concatenates the aggregated PDUs associated with the one or more MTC devices into the Iu PDU based on the RAB identifier.

[Claim 18] The apparatus of claim 17, wherein in multiplexing the Iu PDU including the concatenated PDUs across the Iu-PS interface, the PDU concatenation module multiplexing the Iu PDU including the concatenated PDUs across the Iu-PS interface over an RAB associated with the RAB identifier.

[Fig. 1]


CORE NETWORK 110
SGSN 114
100
Iu-PS INTERFACE 112
RNC 106
PDU CONCATENATION MODULE 108
NODE B 104
MTC DEVICE 102A
MTC DEVICE 102B
MTC DEVICE 102N

[Fig. 2]


SGSN 114
RNC 106
MTC DEVICES 102A-N
200
TRANSMIT A SM ACTIVATE PDP CONTEXT REQUEST ALONG WITH A PS DATA CALL INDICATION 202
SEND A SM ACTIVATE PDP CONTEXT REQUEST ALONG WITH RAB REUSE INDICATION 204
TRANSMIT A RADIO BEARER SETUP MESSAGE 206
RADIO BEARER ESTABLISHMENT
TRANSMIT A RADIO BEARER SETUP COMPLETE MESSAGE 208
SEND A SM ACTIVATE PDP CONTEXT ACCEPT MESSAGE 210
FORWARD THE SM ACTIVATE PDP CONTEXT ACCEPT MESSAGE 212

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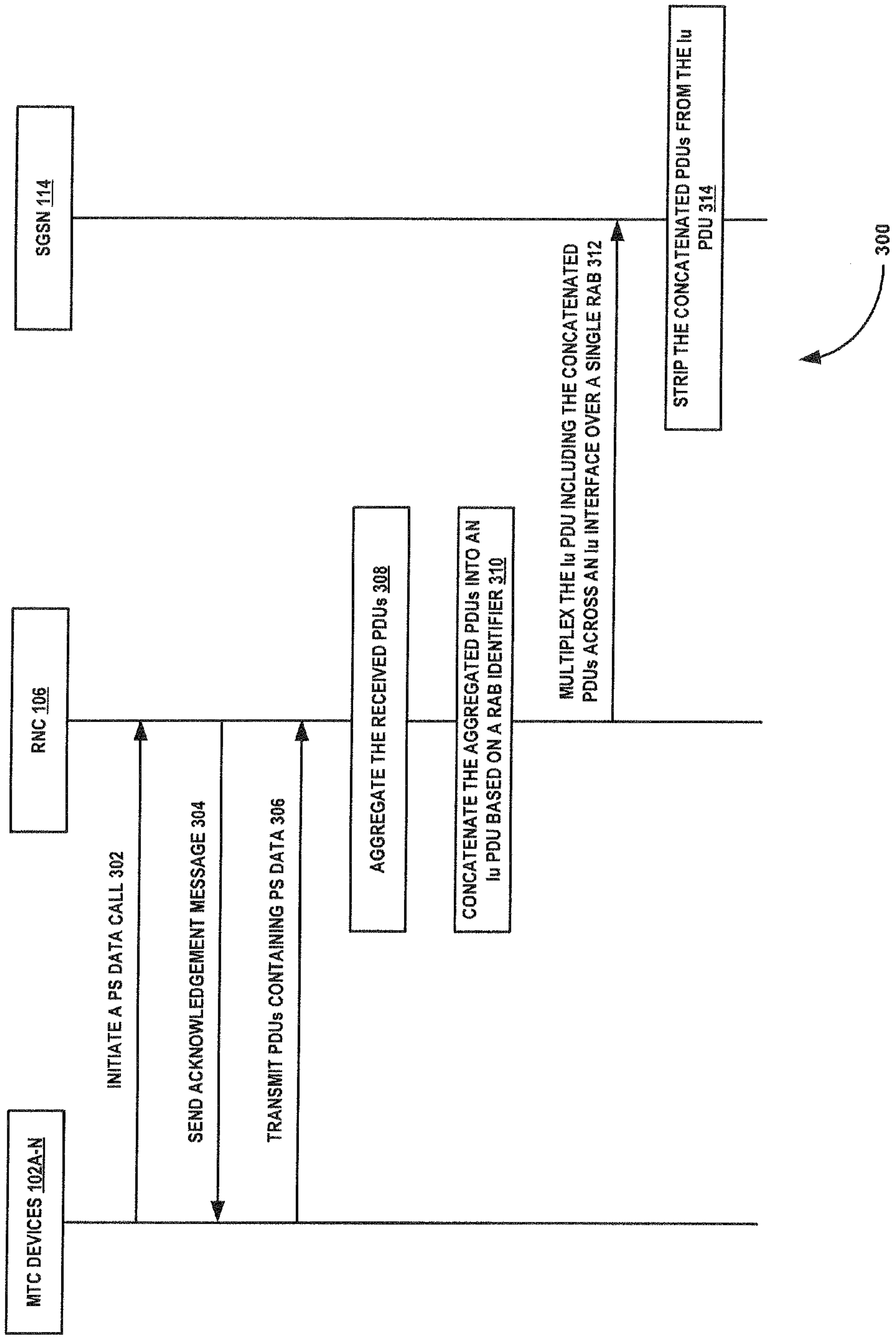
[Fig. 3]

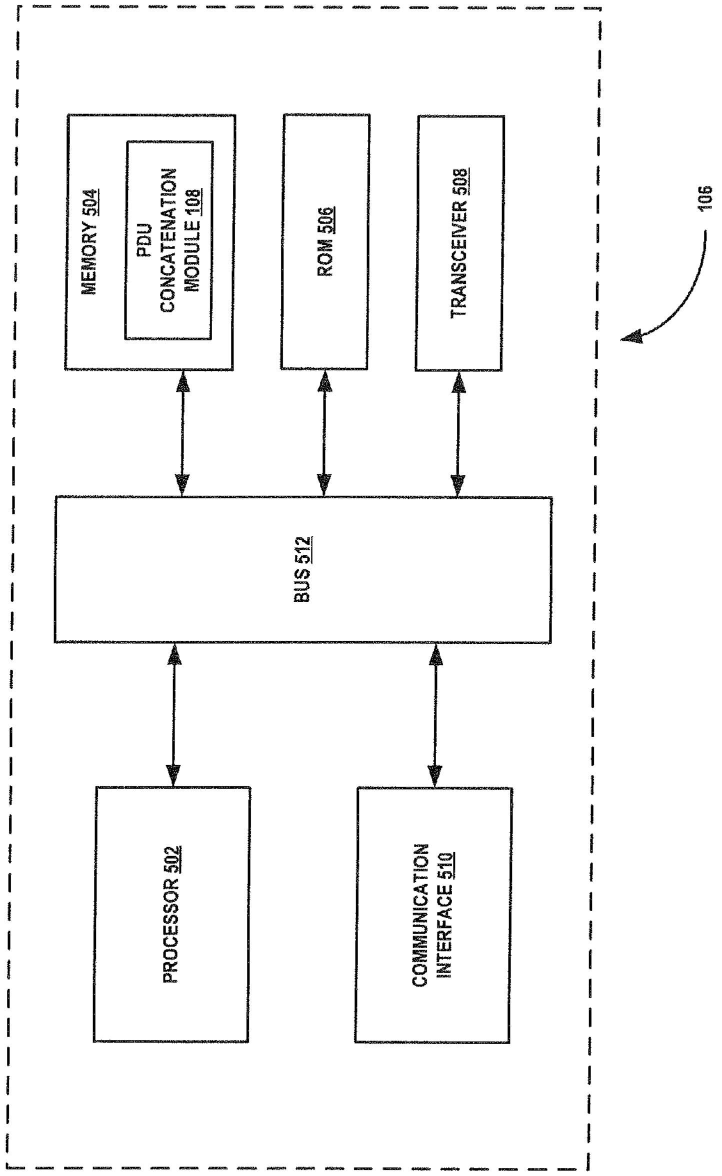


[Fig. 4]

Bits								Number of Octets	
7	6	5	4	3	2	1	0		
PDU Type (=14)				Ack/Nack (=0. I.e. Procedure)		PDU Type 14 Frame Number		1	Frame Control Part
Iu UP Mode version				Procedure Indicator (=0)				1	
Header CRC						Payload CRC		2	Frame Checksum part
Payload CRC									
SUBFLOW-MTC ID1 402			TI	Number of subflows per RFCI (N)		Chain Ind		1	Frame payload part
						SUBFLOW-MTC ID2 402			
...									
Spare						**SUBFLOW-MTC IDN 402**			
LRI	LI	1st RFCI						1	
Length of subflow 1								1 or 2 (dep. LI)	
Length of subflow 2 to N								(N-1)x(1 or 2)	
LRI	LI	2nd RFCI						1	
Length of subflow 1								1 or 2 (dep. LI)	
Length of subflow 2 to N								(N-1)x(1 or 2)	
...									
IPTI of 1st RFCI				...				0 or M/2 (M: Number of RFCIs in frame). Ended by 4 padding bits if M is odd.	
...				IPTI of Mth RF CI or Padding					
Iu UP Mode Versions supported (bitmap)								2	
PDU TYPE 404				Spare				1	
Spare extension								0-32	

400

[Fig. 5]


MEMORY 504
PDU CONCATENATION MODULE 108
ROM 506
TRANSCEIVER 508
106
BUS 512
PROCESSOR 502
COMMUNICATION INTERFACE 510