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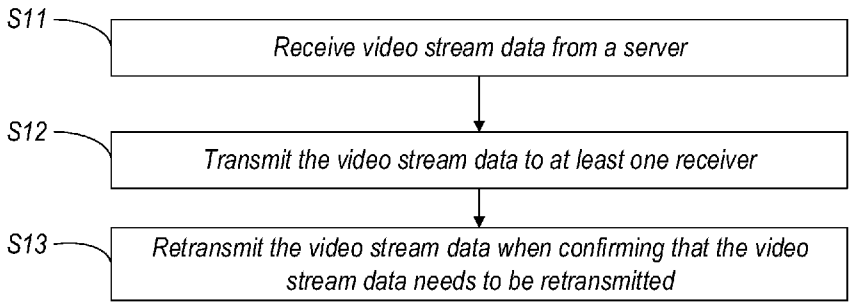


FIG. 1

(57) Abstract: A method for video streaming transmission is disclosed that includes: receiving video stream data from a server; transmitting the video stream data to at least one receiver; and retransmitting the video stream data when confirming that the video stream data needs to be retransmitted. Associated base stations and user equipment are also disclosed. Thereby, the disclosure can retransmit the video stream data that is incorrectly transmitted, so the reliability of video streaming transmission is greatly improved.

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METHODS, BASE STATIONS, AND USER EQUIPMENT FOR RELIABLE VIDEO STREAMING TRANSMISSION

TECHNICAL FIELD

[0001] This disclosure relates generally to communications, and more particularly, to methods, base stations, and user equipment for reliable video streaming transmission.

BACKGROUND

[0002] With the rapid development of mobile communications, data throughput and transmission rate of mobile communications network have experienced a significant growth, enabling the realization of mobile communications network based videostreaming services.

[0003] To meet the real-time requirements, in the prior art UDP (user datagram protocol) is typically employedfor video streaming. Though UDP can provide a high transmission efficiency, its reliability is far inferior to TCP (transmission control protocol), because the potential transmission errors such as loss of packets or decoding errors may drastically reduce the reliability of video streaming transmission.

SUMMARY

[0004] A principal technical problem to be addressed by the disclosure is to provide methods, base stations, and user equipment for video streaming transmission, to overcome the low reliability of video streaming transmission existing in the prior art.

[0005] One technical solution adopted by the disclosure is to provide a method for video streaming transmission that comprises: receiving video stream data from a server; transmitting the video stream data to at least one receiver; and retransmitting the video stream data to the at least one receiver when confirming that the video stream data needs to be retransmitted.

[0006] In some embodiments, the video stream data may comprise akey frame

packet.

[0007] In some embodiments, normal frame packets may also be received from the server during reception of the key frame packets, likewise, the normal frame packets may also be transmitted to at least one receiver during transmission of the key frame packets, and the normal frame packets will not be retransmitted.

[0008] In some embodiments, the block of transmitting the key frame packets toat least one receiver may comprise: transmitting the key frame packets through a first channel having retransmission function, while the block of transmitting the normal frame packets to the at least one receiver may comprise: transmitting the normal frame packets through a second channel absent of retransmission function.

[0009] In some embodiments, the method may further comprise, after the block of receiving the key frame packets and normal frame packets from the server: splitting the received key frame packets and normal frame packets using Deep Packet Inspection (DPI).

[0010] In some embodiments, action of transmitting the video stream data to the at least one receiver may be continuous, and may be independent of action of retransmitting the video stream data to the at least one receiver.

[0011] In some embodiments, the method may further comprise: saving the video stream data; and discarding the video stream data when preservation time of the video stream data exceeds a preset threshold.

[0012] In some embodiments, the block of retransmitting the video stream data to the at least one receiver after confirming it needs to be retransmitted may comprise: retransmitting the video stream data to the at least one receiver upon receiving a signal from the at least one receiver indicating that the video stream data needs to be retransmitted, or retransmitting the video stream data to the at least one receiver if not receiving a signal indicating that the video stream data needs not be retransmitted within a preset period.

[0013] In some embodiments, the signal indicating that the video stream data needs to be retransmitted may comprise a Non-acknowledgment (NACK) signal fed back from the at least one receiver with respect to the key frame packet which is incorrectly

received, while the signal indicating that the video stream data needs not be retransmitted may comprise an Acknowledgment (ACK) signal fed back from the at least one receiver with respect to the key frame packet which is correctly received.

[0014] In some embodiments, the block of receiving the signal from the at least one receiver indicating that the video stream data needs to be retransmitted may comprise: receiving the signal from the at least one receiver indicating that the video stream data needs to be retransmitted over Physical Uplink Control Channel (PUCCH) assigned to the at least one receiver; while the block of receiving the signal from the at least one receiver indicating that the video stream data needs not be retransmitted may comprise: receiving the signal from the at least one receiver indicating that the video stream data needs not be retransmitted over PUCCH assigned to the at least one receiver.

[0015] In some embodiments, the block of receiving the signal from the at least one receiver indicating that the video stream data needs to be retransmitted may comprise: receiving from the at least one receiver the signal indicating that the video stream data needs to be retransmitted in a fourth sub-frame after the sub-frame in which the video stream data is transmitted; while the block of not receiving from the at least one receiver the signal indicating that the video stream data needs not be retransmitted within the preset period may comprise: not receiving from the at least one receiver the signal indicating that the video stream data needs not be retransmitted in the fourth sub-frame after the sub-frame in which the video stream data is transmitted.

[0016] In some embodiments, the video stream data may comprise Enhanced Multimedia Broadcast Multicast Service (eMBMS) data.

[0017] In some embodiments, PUCCH resources assigned to receivers in a same multicast group may use same cyclic shift and/or orthogonal sequence.

[0018] In some embodiments, PUCCH resources assigned to receivers in a same multicast group may correspond to same resource blocks (RBs).

[0019] In some embodiments, the retransmission may adoptHybrid Automatic Repeat Request (HARQ) mechanism, and the at least one receiver may comprise user equipment (UE).

[0020] Another technical solution adopted by the disclosure is to provide a method for video streaming transmission that comprises: receiving video stream data; replying to the sender a signal indicating whether the video stream data needs to be retransmitted; and receiving the video stream data that needs to be retransmitted.

[0021] In some embodiments, the video stream data may comprise a key frame packet.

[0022] In some embodiments, normal frame packets can also be received during reception of the key frame packets, and a signal will not be returned to indicate whether the normal frame packet needs to be retransmitted.

[0023] In some embodiments, the block of receiving the key frame packets may comprise: receiving the key frame packets through a first channel having retransmission function, while the block of receiving the normal frame packets may comprise: receiving the normal frame packets through a second channel absent of retransmission function.

[0024] In some embodiments, the method may further comprise: resequencing and decoding the received key frame packets and normal frame packets.

[0025] In some embodiments, the block of replying to the sender with the signal indicating whether the video stream data needs to be retransmitted may comprise: replying to the sender with only the signal indicating that the video stream data needs to be retransmitted when the video stream data is incorrectly received, so that the sender may retransmit the video stream data upon receiving the signal; or replying to the sender with only the signal indicating that the video stream data needs not be retransmitted when the video stream data is correctly received, so that the sender may retransmit the video stream data if not receiving the signal within a preset period.

[0026] In some embodiments, the signal indicating that the video stream data needs to be retransmitted may comprise a Non-acknowledgment (NACK) signal feedback with respect to the video stream data that is incorrectly received, while the signal indicating that the video stream data needs not be retransmitted may comprise an Acknowledgment (ACK) signal feedback with respect to the video stream data that is correctly received.

[0027] In some embodiments, the method may further comprise: if a current video stream packet is correctly received before a previous video stream packet, then not replying the signal to the sender indicating that the previous video stream packet needs to retransmitted, or replying the signal to the sender indicating that the previous video stream packet needs not be retransmitted.

[0028] In some embodiments, the method may further comprise: if a current video stream packet is correctly received not later than a previous video stream packet, then discarding the previous video stream packet.

[0029] In some embodiments, the block of replying to the sender the signal indicating whether the video stream data needs to be retransmitted may comprise: replying to the sender the signal indicating whether the video stream data needs to be retransmitted through assigned Physical Uplink Control Channel (PUCCH).

[0030] In some embodiments, the block of replying to the sender the signal indicating whether the video stream data needs to be retransmitted may comprise: transmitting the signal indicating whether the video stream data needs to be retransmitted in a fourth sub-frame after the sub-frame in which the video stream data is received.

[0031] In some embodiments, the video stream data may comprise Enhanced Multimedia Broadcast Multicast Service (eMBMS) data.

[0032] In some embodiments, the retransmission may adoptHybrid Automatic Repeat Request (HARQ) mechanism, and the sender may be a base station.

[0033] Yet another technical solution adopted by the disclosure is to provide a base station that comprises: a receiving module configured to receive video stream data from a server; a transmission module configured to transmit the video stream data to at least one receiver; and a retransmission module configured to retransmit the video stream data to the at least one receiver after confirming the video stream data needs to be retransmitted.

[0034] In some embodiments, the video stream data may comprise a key frame packet.

[0035] In some embodiments, the receiving module may further be configured to

receive normal frame packets from the server during reception of the key frame packets, and the transmission module may further be configured to transmit the normal frame packets to the at least one receiver during transmission of the key frame packets. The retransmission module may be configured to not retransmit the normal frame packets.

[0036] In some embodiments, the transmission module may be configured to transmit the key frame packets through a first channel having retransmission function, and the normal frame packets through a second channel absent of retransmission function.

[0037] In some embodiments, the base station may further comprise a detection module configured to split the received key frame packets and normal frame packets using Deep Packet Inspection (DPI).

[0038] In some embodiments, action of transmitting the video stream data to the at least one receiver may be continuous, and may be independent of action of retransmitting the video stream data to the at least one receiver.

[0039] In some embodiments, the base station may further comprise a storage module configured to save the video stream data; and a discarding module configured to discard the video stream data when preservation time of the video stream data exceeds a preset threshold.

[0040] In some embodiments, the retransmission module may be configured to retransmit the video stream data to the at least one receiver upon receiving a signal from the at least one receiver indicating that the video stream data needs to retransmitted, or to retransmit the video stream data to the at least one receiver if not receiving a signal indicating that the video stream data needs not be transmitted within a preset period.

[0041] In some embodiments, the signal indicating that the video stream data needs to be retransmitted may comprise a Non-acknowledgment (NACK) signal fed back from the at least one receiver with respect to a key frame packet that is incorrectly received, while the signal indicating that the video stream data needs not be retransmitted may comprise an Acknowledgment (ACK) signal fed back from the at

least one receiver with respect to a key frame packet that is correctly received.

[0042] In some embodiments, the video stream data may comprise Enhanced Multimedia Broadcast Multicast Service (eMBMS) data.

[0043] In some embodiments, PUCCH resources assigned to receivers in a same multicast group may use same cyclic shift and/or orthogonal sequence.

[0044] In some embodiments, PUCCH resources assigned to receivers in a same multicast group may correspond to same resource blocks (RBs).

[0045] In some embodiments, the retransmission may adoptHybrid Automatic Repeat Request (HARQ) mechanism, and the at least one receiver may comprise user equipment (UE).

[0046] Still another technical solution adopted by the disclosure is to provide a user equipment (UE) that comprises: a first receiving module configured to receive video stream data; a response module configured to reply to the sender with a signal indicating whether the video stream data needs to be retransmitted; and a second receiving module configured to receive the video stream data which needs to be retransmitted.

[0047] In some embodiments, the video stream data may comprise a key frame packet.

[0048] In some embodiments, the first receiving module may further be configured to receive normal frame packets during reception of the key frame packets, and the response module may be configured to not reply the signal to indicate whether the normal frame packet needs to be retransmitted.

[0049] In some embodiments, the first receiving module may be configured to receive the key frame packetsthrough a first channel having retransmission function, and the normal frame packets through a second channel absent of retransmission function.

[0050] In some embodiments, the UE may further comprise a decoding module configured to resequence and decode the received key frame packets and normal frame packets.

[0051] In some embodiments, the response module may be configured to reply to

the sender with only the signal indicating that the video stream data needs to be retransmitted when the video stream data is incorrectly received, so that the sender may retransmit the video stream data upon receiving the signal, or reply to the sender with only the signal indicating that the video stream data needs not be retransmitted when the video stream data is correctly received, so that the sender may retransmit the video stream data if not receiving the signal within a preset period.

[0052] In some embodiments, the signal indicating that the video stream data needs to be retransmitted may comprise a Non-acknowledgment (NACK) signal feedback with respect to the video stream data that is incorrectly received, while the signal indicating that the video stream data needs not be retransmitted may comprise an Acknowledgment (ACK) signal feedback with respect to the video stream data that is correctly received.

[0053] In some embodiments, the response module may be configured to, if a current video stream packet is correctly received before a previous video stream packet, not reply the signal to the senderindicating that the previous video stream packet needs to retransmitted, or reply the signal to the sender indicating that the previous video stream packet needs not be retransmitted.

[0054] In some embodiments, the UE may further comprise a discarding module configured to, if a current video stream packet is correctly received not later than a previous video stream packet, discard the previous stream packet.

[0055] In some embodiments, the video stream data may comprise Enhanced Multimedia Broadcast Multicast Service (eMBMS) data.

[0056] In some embodiments, the retransmission may adoptHybrid Automatic Repeat Request (HARQ) mechanism, and the sender may be a base station.

[0057] Still another technical solution adopted by the disclosure is to provide a base station that comprises a processor and a transceiver coupled to the processor. The processor may be configured to: receive, via the transceiver, video stream data from a server; transmit via the transceiver the video stream data to at least one receiver; and retransmit via the transceiver the video stream data to the at least one receiver after confirming that the video stream data needs to be retransmitted.

[0058] In some embodiments, the video stream data may comprise a key frame packet.

[0059] In some embodiments, the processor may further be configured to: receive via the transceiver normal frame packets during reception of the key frame packets; transmit the normal frame packets to the at least one receiver via the transceiver during transmission of the key frame packets; and not retransmit the normal frame packetsvia the transceiver.

[0060] In some embodiments, the processor may be configured to transmit via the transceiver the key frame packets through a first channel having retransmission function, and transmit via the transceiver the normal frame packets through a second channel absent of retransmission function.

[0061] In some embodiments, the processor may further be configured to, after receiving the key frame packets and normal frame packets from the server, split the received key frame packets and normal frame packets using Deep Packet Inspection (DPI).

[0062] In some embodiments, the action of transmitting via the transceiver the video stream data to the at least one receiver may be continuous, and may be independent of the action of retransmitting via the transceiver the video stream data to the at least one receiver.

[0063] In some embodiments, the processor may further be configured to: save the video stream data; and discard the video stream data when preservation time of the video stream data exceeds a preset threshold.

[0064] In some embodiments, the processor may be configured to retransmit via the transceiver the video stream data to the at least one receiver upon receiving a signal from the at least one receiver indicating that the video stream data needs to retransmitted, or to retransmit via the transceiver the video stream data to the at least one receiver when not receiving a signal via the transceiver indicating that the video stream data needs not be transmitted within a preset period.

[0065] In some embodiments, the signal indicating that the video stream data needs to be retransmitted may comprise a Non-acknowledgment (NACK) signal fed back

from the at least one receiver with respect to a key frame packet that is incorrectly received, while the signal indicating that the video stream data needs not be retransmitted may comprise an Acknowledgment (ACK) signal fed back from the at least one receiver with respect to a key frame packet that is correctly received.

[0066] In some embodiments, the processor may be configured to receive from the at least one receiver via the transceiver the signal indicating the video stream data needs to be retransmitted over Physical Uplink Control Channel (PUCCH) assigned to the at least one receiver, or receive from the at least one receiver via the transceiver the signal indicating the video stream data needs not be retransmitted over PUCCH assigned to the at least one receiver.

[0067] In some embodiments, the processor may be configured to receive from the at least one receiver via the transceiver the signal indicating that the video stream data needs to be retransmitted in a fourth sub-frame after the sub-frame in which the video stream data is transmitted, or may not receive from the at least one receiver via the transceiver the signal indicating that the video stream data needs not be transmitted.

[0068] In some embodiments, the video stream data may comprise Enhanced Multimedia Broadcast Multicast Service (eMBMS) data.

[0069] In some embodiments, PUCCH resources assigned to receivers in a same multicast group may use same cyclic shift and/or orthogonal sequence.

[0070] In some embodiments, PUCCH resources assigned to receivers in a same multicast group may correspond to same resource blocks (RBs).

[0071] In some embodiments, the retransmission may adopt Hybrid Automatic Repeat Request (HARQ) mechanism, and the at least one receiver may comprise user equipment (UE).

[0072] Still another technical solution adopted by the disclosure is to provide a user equipment that comprises a processor and a communications circuit coupled to the processor. The processor may be configured to: receive video stream data via the communications circuit; reply to the sender via the communications circuit with a signal indicating whether the video stream data needs to be retransmitted; and receive via the communications circuit the video stream data that needs to be retransmitted.

[0073] In some embodiments, the video stream data may comprise a key frame packet.

[0074] In some embodiments, the processor may further be configured to receive via the communications circuit normal frame packets during reception of the key frame packets, and to not reply via the communications circuit the signal to indicate whether the normal frame packet needs to be retransmitted.

[0075] In some embodiments, the processor may be configured to receive via the communications circuit the key frame packets over a first channel having retransmission function, and the normal frame packets through a second channel absent of retransmission function.

[0076] In some embodiments, the processor may further be configured to resequence and decode the received key frame packets and normal frame packets.

[0077] In some embodiments, the processor may be configured to reply to the sender via the communications circuit with only the signal indicating that the video stream data needs to be retransmitted when the video stream data is incorrectly received, so that the sender may retransmit the video stream data upon receiving the signal; or reply to the sender via the communications circuit with only the signal indicating that the video stream data needs not be retransmitted when the video stream data is correctly received, so that the sender may retransmit the video stream data when not receiving the signal indicating that the video stream data needs not be retransmitted within a preset period.

[0078] In some embodiments, the signal indicating that the video stream data needs to be retransmitted may comprise a Non-acknowledgment (NACK) signal feedback with respect to the video stream data that is incorrectly received, while the signal indicating that the video stream data needs not be retransmitted may comprise an Acknowledgment (ACK) signal feedback with respect to the video stream data that is correctly received.

[0079] In some embodiments, the processor may further be configured to, if a current video stream packet is correctly received before a previous video stream packet is correctly received, not reply to the sender via the communications circuit the

signal indicating that the previous video stream data needs to be retransmitted, or reply to the sender via the communications circuit the signal indicating that the previous video stream data needs not to be retransmitted.

[0080] In some embodiments, the processor may further be configured to, if a current video stream packet is correctly received not later than a previous video stream packet, discard the previous video stream packet.

[0081] In some embodiments, the processor may be configured to reply to the sender via the communications circuit the signal indicating whether the video stream data needs to be retransmitted through assigned Physical Uplink Control Channel (PUCCH).

[0082] In some embodiments, the processor may be configured to transmit via the communications circuit the signal indicating whether the video stream data needs to be retransmitted in a fourth sub-frame after the sub-frame in which the video stream data is received.

[0083] In some embodiments, the video stream data may comprise Enhanced Multimedia Broadcast Multicast Service (eMBMS) data.

[0084] In some embodiments, the retransmission may adoptHybridAutomatic Repeat Request (HARQ) mechanism, and the sender may be a base station.

[0085] Advantages of the disclosure may follow: by retransmitting the video stream data that is incorrectly transmitted only when confirmingthatit needs to be retransmitted, the reliability of video streaming transmission is greatly improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0086] FIG. 1 is a flowchart illustrating a first embodiment of a method for video streaming transmission according to the disclosure.

[0087] FIG. 2 depicts a group of pictures drawn from a video which employs predictive encoding technique.

[0088] FIG. 3 shows a flowchart illustrating a second embodiment of a method for video streaming transmission according to the disclosure.

[0089] FIG. 4 illustrates the transmission of key frame packets and normal frame

packets over different channels in the second embodiment of the method for video streaming transmission.

[0090] FIG. 5 illustrates the transmission of a response signal in a fourth sub-frame after the sub-frame in which a video stream packet is transmitted according to an embodiment of a method for video streaming transmission.

[0091] FIG. 6 shows a flowchart illustrating a fourth embodiment of a method for video streaming transmission according to the disclosure.

[0092] FIG. 7 shows a flowchart illustrating the process of setting a timer according to the fourth embodiment of the method for video streaming transmission.

[0093] FIG. 8 shows a flowchart illustrating a fifth embodiment of a method for video streaming transmission according to the disclosure.

[0094] FIG. 9 shows a flowchart illustrating a sixth embodiment of a method for video streaming transmission according to the disclosure.

[0095] FIG. 10 shows a flowchart illustrating a seventh embodiment of a method for video streaming transmission according to the disclosure.

[0096] FIG. 11 shows a flowchart illustrating a ninth embodiment of a method for video streaming transmission according to the disclosure.

[0097] FIG. 12 shows a flowchart illustrating a tenth embodiment of a method for video streaming transmission according to the disclosure.

[0098] FIG. 13 illustrates a comparison of the relation of average Peak to Noise Ratio (PSNR) and distance from base station to UEs of existing eMBMS transmission protocol scheme as baseline versus such relation of the scheme proposed by the disclosure.

[0099] FIGS. 14 and 15 illustrate the PSNR gap between the baseline and the proposed scheme in each video frame at 4000m and 3500m distance.

[00100] FIG. 16 is a block diagram of a first embodiment of a base station according to the disclosure.

[00101] FIG. 17 shows a block diagram of a second embodiment of a base station according to the disclosure.

[00102] FIG. 18 shows a block diagram of a third embodiment of a base station

according to the disclosure.

[00103] FIG. 19 shows a block diagram of a fourth embodiment of a base station according to the disclosure.

[00104] FIG. 20 shows a block diagram of a first embodiment of a UE according to the disclosure.

[00105] FIG. 21 shows a block diagram of a second embodiment of a UE according to the disclosure.

[00106] FIG. 22 shows a block diagram of a third embodiment of a UE according to the disclosure.

[00107] FIG. 23 shows a block diagram of a fourth embodiment of a UE according to the disclosure.

[00108] This disclosure includes references to "one embodiment," "a particular embodiment," "some embodiments," "various embodiments," or "an embodiment." The appearances of the phrases "in one embodiment," "in a particular embodiment," "in some embodiments," "in various embodiments," or "in an embodiment," do not necessarily refer to the same embodiment. Particular features, structures, or characteristics may be combined in any suitable manner consistent with this disclosure.

[00109] Various modules, units, circuits, or other components may be described or claimed as "configured to" perform a task or tasks. In such contexts, "configured to" is used to connote structure by indicating that the modules/units/circuits/components include structure (e.g., circuitry) that performs those task or tasks during operation. As such, the modules/units/circuits/components can be said to be configured to perform the task even when the specified module/unit/circuit/component is not currently operational (e.g., is not on). The modules/units/circuits/components used with the "'configured to" language include hardware—for example, circuits, memory storing program instructions executable to implement the operation, etc. Reciting that a module/unit/circuit/component is "configured to" perform one or more tasks is expressly intended not to invoke 35 U.S.C. §112(f), for that module/unit/circuit/component. Additionally, "configured to" can include a generic

structure (e.g., generic circuitry) that is manipulated by software and/or firmware (e.g., an FPGA or a general-purpose processor executing software) to operate in a manner that is capable of performing the task(s) at issue. "Configured to" may also include adapting a manufacturing process (e.g., a semiconductor fabrication facility) to fabricate devices (e.g., integrated circuits) that are adapted to implement or perform one or more tasks.

[00110] As used herein, the term "based on" describes one or more factors that affect a determination. This term does not foreclose additional factors that may affect the determination. That is, a determination may be solely based on those factors or based, at least in part, on those factors. Consider the phrase "determine A based on B." While in this case, B is a factor affects the determination of A, such a phrase does not foreclose the determination of A from also being based on C. In other instances, A may be determined based solely on B.

DETAILED DESCRIPTION

[00111] Referring to FIG. 1, a flowchart of a first embodiment of a method for video streaming transmission is depicted. For purposes of illustration, the method is illustrated as being sequential. However, portions of the method may be performed in other orders or in parallel (e.g., simultaneously). The method can be implemented on a base station. The base station may be connected to a core network and may perform wireless communication with a plurality of user equipment (UE) to provide communications coverage for the associated geographical area. The base station may comprise, but not limited to, macro base stations, micro base stations, or pico base stations. In various embodiments, a base station can also be interchangeably referred to as a wireless base station, an access point, a Node B, an evolved Node B (eNodeB or eNB), and so forth. The method can comprise the following blocks.

[00112] At S11, the method includes receiving video stream data from a server.

[00113] The server may be a video content server. To satisfy the high real-time requirements of video streaming services and to adapt to complex network environment, video streamingmay typically adopt the predictive encoding technique

which can effect a high compression ratio. With predictive encoding, video frames can be divided into key frames and normal frames according to their importance. A key frame can also be called an I frame, i.e., an intra-encoded frame, or, more specifically, a full encoded frame. While a key frame may have a comparatively low compression ratio and thus large packets, it can be coded/decoded without referring to other frames, in other words, only the I frame itself would suffice to reconstruct a complete picture. In contrast, a normal frame may be represented merely by its difference from a reference frame, and thus cannot come to a complete picture without referring to the reference frame. While a normal frame may provide a comparatively high compression ratio and thus small packets, it may require the reference frame data outside of the normal frame to be coded/decoded. Depending on the number of reference frames used, normal frames can be divided into P frames and B frames. A P frame may be a forward-predicted frame--it may refer to the data of a previous I frame or P frame, while a B frame may be a bidirectional predicted frame--it may reference the data of a previous I or P frame and a following P frame. Therefore, a B frame may have a comparatively higher compression ratio and smaller packets in contrast with a P frame.

[00114] Frames of a video that employs such technology may typically be organized by arranging a group of pictures (GOP) into a unit. A group of pictures may comprise a set of consecutive frames, with the first frame being a key frame and the remaining being normal frames. Each group of pictures may comprise only one key frame. An example of a group of pictures is shown in FIG. 2, it can be concluded that decoding error of a B frame may not affect other frames, while decoding error of a P frame may affect following P frames and B frames and earlier B frames referring to this P frame, and decoding error of an I frame may affect all the normal frames in the whole group of pictures.

[00115] Typically, a base station may receive the video stream data from a video contents server via the core network. The video stream data can comprise only key frames, only normal frames, or both key frames and normal frames. The normal frames may comprise only P frames, only B frames, or both P frames and B frames.

[00116] At S12, the method includes transmitting the video stream data to at least one receiver.

[00117] Typically, the at least one receiver may comprisea plurality of user equipment (UE). A UE can be stationary at a fixed position or mobile from place to place, including, but not limited to, cellular phones, personal digital assistants (PDA), wireless modems, tablet computers, notebook computers, cordless phones, and so forth.

[00118] The base station can transmit the video stream data to the UEs by ways of unicast, multicast, or broadcast.

[00119] At S13, the method includes retransmitting the video stream data after confirming that the video stream data needs to be retransmitted.

[00120] Typically, the base station may confirm whether the video stream data needs to be retransmitted, depending on the response signal returned from thereceivers. The response signal may comprise a signal indicating that the video stream data needs to be retransmitted and/or a signal indicating that the video stream data needs not be retransmitted. In some embodiments, the signal indicating that the video stream data needs to be retransmitted may be a Non-acknowledgment (NACK) signal fed back from thereceivers with respect to the video stream data that is incorrectly received, while the signal indicating that the video stream data needs not be retransmitted may be an Acknowledgment (ACK) signal feedback with respect to the video stream data that is correctly received.

[00121] In some embodiments, the retransmission may adopt Hybrid Automatic Repeat Request (HARQ) mechanism. HARQ is a technique combining high-rate forward error correction (FEC) and automatic repeat request (ARQ) error-control, striding across the physical layer and the media access control (MAC) layer. Receivers can employ the FEC technique to correct a part of the errors to reduce the retransmission times. While for the errors that are uncorrectable with FEC, receivers may turn to the ARQ mechanism to request the sender for retransmission. Each time the sender transmits a packet, it may temporarily stop to wait for the corresponding response signal from the receiver. Once receiving the packet, the receiver may parse

it immediately, and reply with an Acknowledgment (ACK) signal if the packet is correctly received or a Non-Acknowledgment (NACK) signal if the packet is incorrectly received. When the sender receives the ACK signal, it may transmit out new data;otherwise it will retransmit the previous packet that is incorrectly received at the receiver side. Note, during the period of waiting for the response signal, the channel may be idle so that no data is transmitted.

[00122] Alternatively, in some embodiments, the retransmission can also adopt the ARQ mechanism living at radio link control (RLC) layer, or a combination of the ARQ mechanism living at RLC layer and the HARQ mechanism living at MAC and physical layers.

[00123] Therefore, according to the above embodiment, by retransmitting the video stream data that is incorrectly transmitted only when confirming that itrequires retransmission, the reliability of video streaming transmission can be greatly improved.

[00124] Referring now to FIG. 3, a second embodiment of a method for video streaming transmission is depicted, which is based on the first embodiment and further defines the video stream data to comprise a key frame packet. For purposes of illustration, the method is illustrated as being sequential. However, portions of the method may be performed in other orders or in parallel (e.g., simultaneously). The method may comprise the following blocks.

[00125] At S21, the method includes receiving key frame packets and normal frame packets from a server.

[00126] Normal frame packets may be received simultaneously during reception of key frame packets in S11. Key frames and normal frames ofa video may be arranged in a staggered or interweaved manner in the time domain. And the received key frame packets and normal frame packets may be in the original chronological order, or may be shuffled and thus out of order.

[00127] At S22, the method includes transmitting the key frame packets and normal frame packets to the at least one receiver.

[00128] In connection with the first embodiment, the normal frame packets can also

be transmitted during transmission of the key frame packets in block S12. The base station may rearrange the received key frame packets and normal frame packets according to the order of time and so transmit them to the receivers, or may transmit them directly as in the order they are received.

[00129] At S23, no normal frame packets would be retransmitted; instead, when it is confirmed that a key frame packet needs to be retransmitted, the key frame packet will be retransmitted.

[00130] The design of not retransmitting the normal frame packets maycomprise two types. First, even if a signal is received from receiversindicating that a normal frame packet needs to be retransmitted, the normal frame packetwouldstill not be retransmitted. Second, receivers may simply not return any response signal with respect to a normal frame packet; in this case, when executing block S22, the key frame packets and normal frame packets can be separately transmitted over different channels.

[00131] An example is shown in FIG. 4, in which the received key frame packets and normal frame packets may be separated at the packet data convergence protocol (PDCP) layer. In a particular embodiment, deep packet inspection (DPI) mechanism may be adopted for the separation. Then the separated key frame packets and normal frame packets may be independently transferred to RLC layer. The RLC layer may configure anUnacknowledgment Mode (UM) for both the key frame packets and the normal frame packets, that is, ARQ mechanism is not employed at the RLC layer.

[00132] The key frame packets may be transferred from RLC layer in RLC PDU (protocol data unit) format to MAC layer through a first logical channel, while the normal frame packets may be transferred from RLC layer to MAC layer through a second logical channel independent of the first logical channel. The key frame packets may be processed by the HARQ entity to form a transport block. The transport block may be transferred from MAC layer to physical layer through a first transport channel, then CRC insertion and Physical Layer-Hybrid ARQ functionality may both be implemented in the physical layer. By contrast, at MAC layer the

normal frame packets may not be processed by the HARQ entity, but may be simply conveyed from MAC layer to physical layer via a second transport channel independent of the first transport channel.

[00133] From the above example, it can be concluded that, after splitting the key frame packets and normal frame packets of the video, the key frame packets may be transferred using a first channel having retransmission function, while the normal frame packets may be transferred using a second channel without retransmission function. The first channel may comprise a first logical channel and a first transport channel, while the second channel may comprise a second logical channel and a second transport channel. The key frame packets and the normal frame packets can be transmitted using same or different physical channels.

[00134] If the retransmission mechanism is introduced to both the normal frames and key frames of the video, though the reliability can be ensured, the excessive uplink signaling and downlink retransmission may cause huge traffic burden and may probably affect the real-time performance. According to the present embodiment, though, the key frame packets may be retransmitted only when needed, thus the occurrence of retransmission can be tremendously reduced. In addition, because the importance of key frame packets is much higher than normal frame packets in decoding, the retransmission of only the key frame packets can in some degree improve the reliability and reduce the traffic overhead arising from retransmission, and may not make a perceptible impact on the real-time performance.

[00135] The third embodiment of a method for video streaming transmission is based on the first embodiment and further adopts an improved retransmission mechanism which is described as follows.

[00136] According to existing HARQ or ARQ mechanism, a current packet can be transmitted only after the ACK signal for the previous packet is received, implying that if a previous packet needs to be retransmitted, then the current packet will have to wait for the retransmission of the previous packet. According to the third embodiment, though, the action of transmitting the video stream data to the at least one receiver is continuous, and is independent of the action of retransmission. More

specifically, the operation by which the base station transmits the current video stream packet to the at least one receiver is independent of the operation of retransmitting the previous video stream packet, meaning the base station needs not to wait for the acknowledgment for the previous video stream packet before transmitting the current video stream packet.

[00137] In the prior art receivers may return an ACK signal or NACK signal, while in the present embodiment, receivers may return only the ACK signal or the NACK signal to further reduce the signaling overhead.

[00138] If receivers return only the ACK signal, and the base station doesn't receive the ACK signal within the predetermined period, then it may be confirmed that the video stream data needs to be retransmitted and so the video stream data would be retransmitted. If receivers return only the NACK signal and the base station receives the NACK signal, then, likewise, it would also be confirmed that the video stream data needs to be retransmitted and so the video stream data would be retransmitted.

[00139] In various embodiments, receivers may transmit a response signal through assigned physical uplink control channel (PUCCH). Alternatively, in some embodiments, receivers can transmit a response signal through physical uplink shared channel (PUSCH).

[00140] In order to further reduce the signaling overhead, the response signal can be uniformly scheduled to transmit in the fourth sub-frame after the Nth sub-frame in which the video stream data is transmitted. That is, the response signal may be transmitted by receivers in the (N+4)th sub-frame, as shown in FIG. 5. In the case the response signal being an NACK signal, if the base station receives the NACK signal in the (N+4)th sub-frame, it may be confirmed that the video stream data needs to be retransmitted. In the case that the response signal comprises only the ACK signal, if the base station does not receive the ACK signal in the (N+4)th sub-frame, it may be confirmed that the video stream data needs to be retransmitted.

[00141] Referring now to FIG. 6, a fourth embodiment of a method for video streaming transmission is depicted, which is based on the first embodiment and further comprises the following blocks. For purposes of illustration, the method is

illustrated as being sequential. However, portions of the method may be performed in other orders or in parallel (e.g., simultaneously).

[00142] At S14, the method includes saving the video stream data.

[00143] This block can be executed after S11 and before S13 so as to support retransmission, while it can be executed simultaneously with or independent of S12. If the retransmission adopts the HARQ mechanism, the video stream data may typically be stored in the base station MAC layer in transport block format.

[00144] At S15, if preservation time of the video stream data exceeds a preset threshold, the video stream data may be discarded.

[00145] The period from the point the video stream data is transmitted to the point hitherto the preservation time of the video stream data reaches the preset threshold can be defined as a maximum allowing retransmission time. Therefore, by discarding the video stream data whose preservation time has exceeded the preset threshold, buffer memory space of the base station can be effectively saved. Once the video stream data is discarded, it may not be able to be retransmitted, even if it is later confirmed that the video stream data needs to be retransmitted.

[00146] For example, referring now to FIG. 7, while transmitting the video stream data, the base station may simultaneously save the video stream data and start a timer to measure the time after transmission of the video stream data. If, before the timer approaches the maximum allowing retransmission time, an NACK signal feedback is received from receivers to indicate that the video stream data needs to be retransmitted, then this video stream data would be retransmitted. While retransmitting the video stream data, the timer can be reset to its initial value, or may remain unchanged. And when the timer reaches the maximum allowing retransmission time, the video stream data as saved may be discarded.

[00147] In various embodiments, the video stream data may comprise enhanced multimedia broadcast multicast service (eMBMS) data.

[00148] Multicasting enables the transmission of the same data to a group of receivers connected to a same access point (AP) or base station (BS), by transmitting only one packet to a group of users thereby improving the bandwidth consumption when

compared with unicasting techniques. 3GPP has first introduced Multimedia Broadcast Multicast Service (MBMS) standard in release 6 (Rel-6) for Universal Mobile Telecommunications System (UMTS) to provide broadcast service over cellular network. Since then, it has been evolved in subsequent releases and still in the state of standardization until now. From 3GPP specification Rel-9, together with the occurrence of Long Term Evolution (LTE), MBMS was included in Evolved Universal Terrestrial Radio Access Network (E-UTRAN) with the term of Evolved MBMS (eMBMS).

[00149] If the base station transmits the video stream data by way of multicast, the video stream data may be transmitted simultaneously to all receivers within the intended multicast group. If the base station confirms that the video stream data needs to be retransmitted to at least one receiver in the intended multicast group, it may still retransmit the video stream data to all of the receivers in the multicast group in the multicast manner. If the base station is to confirm that the video stream data needs to be retransmitted based on the returned NACK signal, it can be inferred that NACK signals fed back from different receivers in the same multicast group may be of the same significance, so the base station needs not to distinguish from which receiver or receivers the NACK signals are returned, this implies that different receivers in a same multicast group can be multiplexed in NACK signal transmission.

[00150] In particular, to further reduce the signaling overhead, when receivers transmit NACK signals using assigned PUCCH resources, the base station can multiplex the PUCCH resources of multiple receivers in the same multicast group. Specifically, the PUCCH resources assigned to receivers in the same multicast group may use same spreading sequence and/or correspond to same resource blocks.

[00151] The spreading sequence may comprise cyclic shift and/or orthogonal sequence. Specifically, for PUCCH format 1a/1b, the NACK acknowledgment information bits from receivers can be modulated by BPSK/QPSK into one complex-valued modulation symbol $d(0)$, which can be scrambled by $S(n_s)$, and block-wise spread with a cyclic shift in frequency domain, and an orthogonal

sequence in time domain; in this case, the spreading sequence may comprise both the cyclic shift and the orthogonal sequence. For PUCCH format 1a/1b, the NACK information bits from receivers can be modulated by BPSK/QPSK into one complex-valued modulation symbol $d(10)$, which can be block-wise spread with a cyclic shift in frequency domain, and then modulated to the second demodulation reference signal (DMRS) in each slot; in this case, the spreading sequence may comprise only the cyclic shift. For PUCCH format 3, the NACK information bits from receivers can be scrambled and then modulated by QPSK into complex-valued modulation symbols, which can be block-wise spread with an orthogonal sequence in time domain; in this case, the spreading sequence may comprise only the orthogonal sequence.

[00152] If PUCCH resources assigned to receivers in a same multicast group use same spreading sequence and correspond to the same resource block, and channel-state information (CSI) is not available at receiver side, the open-loop system transmit signal for the base station to receive is given by (1), where K denotes the total number of receivers who send the NACK signal for key frame packet transmission in the multicast service group, h_i is the i th receiver channel coefficient, n represents the received noise, and w denotes the spreading sequence used for mapping their NACK modulation symbol x to PUCCH channel.

$$y = \sum_{i=1}^{K} h_i w x + n \qquad (1)$$

[00153] If PUCCH resources assigned to receivers in a same multicast group use same spreading sequence and correspond to the same resource block, and CSI is available at both receiver side and base station side, multiuser diversity gain can be achieved to maximize the signal noise ratio (SNR) by maximum ratio transmission (MRT). The transmitted signal becomes a linear transformation of channel vector $\mathbf{g} = \frac{1}{a} x \mathbf{h}^H$, and the received signal is given by $y = \mathbf{h} w \mathbf{g} + n$. The corresponding close-loop system transmit signal for base station to receive after MRT transformation

can be finally given by formula (2), where factor $a=\sum_{i=1}^{K}|h_i|^2$ may denote the normalization factor, while definition of other parameters are the same as those in formula (1).

$$y=\frac{1}{a}\sum_{i=1}^{K}|h_i|^2 wx+n \qquad (2)$$

[00154] Referring now to FIG. 8, a flowchart of a fifth embodiment of a method for video streaming transmission is depicted. For purposes of illustration, the method is illustrated as being sequential. However, portions of the method may be performed in other orders or in parallel (e.g., simultaneously). The method can be implemented by any number of user equipment (UE). A UE can be stationary or mobile, including, but not limited to, cellular phones, personal digital assistants (PDA), wireless modems, tablet computers, notebook computers, cordless phones, and so forth. The method may comprise the following blocks.

[00155] At S31, the method includes receiving video stream data.

[00156] Typically, base station may be the sender of the video stream data.

[00157] The video stream data can comprise only key frames, only normal frames, or both key frames and normal frames. The normal frames may comprise only P frames, only B frames, or both P frames and B frames.

[00158] At S32, the method includes replying to the sender with a signal to indicate whether the video stream data needs to be retransmitted.

[00159] In general, the signal indicating whether the video stream data needs to be retransmitted may be a response signal, which may comprise a signal indicating that the video stream data needs to be retransmitted and/or a signal indicating that the video stream data needs not be retransmitted.

[00160] In one embodiment, the signal indicating that the video stream data needs to be retransmitted may be a Non-acknowledgment (NACK) signal fed back with respect to the video stream data that is incorrectly received, while the signal indicating that the video stream data needs not be retransmitted may be an Acknowledgment (ACK) signal feedback with respect to the video stream data that is correctly received.

[00161] In one embodiment, assigned physical uplink control channel (PUCCH) may be used to transmit to the sender the signal denoting whether the video stream data needs to be retransmitted, i.e., the response signal. Alternatively, in some embodiments, the UE also can transmit a response signal using physical uplink shared channel (PUSCH).

[00162] In order to further reduce the signaling overhead, the UE can receive the response signal in the fourth sub-frame after the Nth sub-frame in which the base station transmits the video stream data, that is, the UE may transmit the response signal in the (N+4)th sub-frame, as shown in FIG. 5. In the case the UE is to transmit an NACK signal, if the sender receives the NACK signal in the (N+4)th sub-frame, it may be confirmed that the video stream data needs to be retransmitted. In the case the UE is to transmit only an ACK signal, if the sender doesn't receive the ACK signal in the (N+4)th sub-frame, it may be confirmed that the video stream data needs to be retransmitted.

[00163] At S33, the method includes receiving the video stream data that needs to be retransmitted.

[00164] That is, receiving the video stream data that is retransmitted by the sender according to the response signal.

[00165] In some embodiments, the retransmission may adopt hybrid automatic repeat request (HARQ) mechanism. HARQ is a technique combining high-rate forward error correction (FEC) and automatic repeat request (ARQ) error-control, striding across the physical layer and the media access control (MAC) layer. Receivers can employ the FEC technique to correct a part of the errors to reduce the retransmission times. And for errors that are uncorrectable with FEC, receivers may turn to the ARQ mechanism to request the sender for retransmission. Each time the sender transmits a packet, it may temporarily stop to wait for the corresponding response signal from the receiver. Once receiving the packet, the receiver may parse it immediately, and reply with an Acknowledgment (ACK) signal if the packet is correctly received, or a Non-Acknowledgment (NACK) signal if the packet is incorrectly received. When the sender receives the ACK signal, it may transmit out

new data;otherwise it may retransmit the previous packet that is incorrectly received at the receiver side. Note, during the period of waiting for the response signal, the channel may be idle so that no data is transmitted.

[00166] Alternatively, in some embodiments, the retransmission also may adopt the ARQ mechanism living at the radio link control (RLC) layer, or a combination of the ARQ mechanism living at the RLC layer and the HARQ mechanism living at MAC and physical layers.

[00167] Therefore, according to the embodiment described above, by retransmitting the video stream data that is incorrectly transmitted only when confirming that it requires retransmission, the reliability of video streaming transmission can be greatly improved.

[00168] Referring now to FIG. 9, a sixth embodiment of a method for video streaming transmission is depicted, which is based on the fifth embodiment and further defines the video stream data to comprise a key frame packet. For purposes of illustration, the method is illustrated as being sequential. However, portions of the method may be performed in other orders or in parallel (e.g., simultaneously). The method according to this embodiment can comprise the following blocks.

[00169] At S41, the method includes receiving key frame packets and normal frame packets.

[00170] Normal frame packet may be simultaneously received during reception of key frame packets in S31. Key frames and normal frames of a video may be arranged in a staggered or interweaved manner in the time domain. While the received key frame packets and normal frame packets may be in the original chronological order, or may be shuffled and thus out of order.

[00171] The key frame packets and the normal frame packets can be transmitted using same or different channels. In one embodiment, the key frame packets may be transmitted over a first channel having retransmission function, while the normal frame packets may be transmitted through a second channel absent of retransmission function; see FIG. 4 and relevant description for details.

[00172] At S42, the method includes replying to the sender with a signal indicating

whether a key frame packet needs to be retransmitted, and not replying with a signal to indicate whether a normal frame packet needs to be retransmitted.

[00173] At S43, the method includes receiving the key frame packet that needs to be retransmitted.

[00174] If the retransmission mechanism is introduced to both the normal frames and key frames of the video, though the reliability can be ensured, the excessive uplink signaling and downlink retransmission may cause huge traffic burden and may probably affect the real-time performance. According to the present embodiment, though, the key frame packets may be retransmitted only when required, thus the occurrence of retransmission can be tremendously reduced. In addition, because the importance of key frame packets is much higher than normal frame packets in decoding, the retransmission of only the key frame packets can in some degree improve the reliability and reduce the traffic overhead arising from retransmission, and may not make a perceptible impact on the real-time performance.

[00175] Referring now to FIG. 10, a seventh embodiment of a method for video streaming transmission is depicted, which is based on the fifth embodiment and further comprises the following blocks.

[00176] At S34, the method includes resequencing and decoding the received key frame packets and normal frame packets.

[00177] The key frame packets and normal frame packets received at the UE may be out of order. So, in order to correctly play the video, the received key frame packets and normal frame packets may need to be rearranged according to the initial chronological order and thus decoded to play. The current embodiment can combine with the sixth embodiment of the method for video streaming transmission.

[00178] The eighth embodiment of a method for video streaming transmission is based on the fifth embodiment and further adopts an improved retransmission mechanism which is discussed in some depth as follows. This embodiment can combine with the sixth or seventh embodiment of the method for video streaming transmission.

[00179] Receivers in existing HARQ or ARQ mechanism, i.e., UEs in the present

embodiment, may return two types of signals including the signal denoting that the video stream data needs not be retransmitted (e.g., ACK) and the signal denoting that the video stream data needs to be retransmitted (e.g., NACK). However, in the present embodiment, UEs may return only one of the two types of signals, in order to further reduce the signaling overhead.

[00180] If UEs return only the ACK signal, and the sender doesn't receive the ACK signal from the UEs within the predetermined period, then it may be confirmed that the video stream data needs to be retransmitted and so the video stream data would be retransmitted. If UEs return only the NACK signal, and the sender receives the NACK signal, then it may be confirmed that the video stream data needs to be retransmitted and so the video stream data would be retransmitted.

[00181] Referring now to FIG. 11, a ninth embodiment of a method for video streaming transmission is depicted, which is based on the fifth embodiment and further comprises the following blocks.

[00182] At S35, the method includes: if a current video stream packet is correctly received before a previous video stream packet is correctly received, not replying the signal to the sender indicating that the previous video stream packet needs to be retransmitted, or replying the signal to the sender indicating that the previous video stream packet needs not be retransmitted.

[00183] If the UE receives and correctly parses the current video stream packet before correctly parsing the previous video stream packet, then it can inform the sender that the previous video stream data packet needs not be retransmitted in the manner, such as not replying to the sender with the signal indicating that the previous video stream packet needs to be retransmitted, or replying to the sender with a signal indicating that the previous video stream packet needs not be retransmitted. Thus, in this case, the previous video stream packet that is incorrectly received may be discarded or simply played as it is presented.

[00184] Typically, the present embodiment is suitable for the videos (e.g., live shows) which call for high real-time requirements, or which don't require replay and the current video stream packet doesn't need to refer to the previous video stream packet

to be correctly decoded when, for example, both the previous and current video stream packets belong to I or B frames, or the previous video stream packet belongs to a B frame, while the current belongs to a P or I frame, et cetera. The present embodiment can combine with any one of sixth to eighth embodiments of the method for video streaming transmission.

[00185] Referring now to FIG. 12, a tenth embodiment of a method for video streaming transmission is depicted, which is based on the fifth embodiment and further comprises the following blocks.

[00186] At S36, the method includes: if a current video stream packet is correctly received not later than a previous video stream packet, then discarding the previous video stream packet.

[00187] If the UE correctly parses the current video stream packet not later than correctly parsing the previous video stream packet, then the UE may simply discard the previous video stream data. That is, the current video stream packet may be directly played, thus the previous video stream packet may be simply skipped. Causes of the above scenario may include that the sender transmits the packets out of order, and/or that the previous video stream packet is incorrectly transmitted and so needs to be retransmitted leading to delay, et cetera.

[00188] Typically, the present embodiment is suitable for videos (e.g., live shows) which call for high real-time requirements, or which don't require replay and the current video stream packet doesn't need to refer to the previous video stream packetto be correctly decodedwhen, for example, both the previous and current video stream packets belong to I or B frames, or the previous video stream packet belongs to a B frame, while the current belongs to a P or I frame, et cetera. The present embodiment can combine with any one of sixth to ninth embodiments of the method for video streaming transmission.

[00189] In various embodiments, the video stream data may comprise enhanced multimedia broadcast multicast service (eMBMS) data.

[00190] To better illustrate the advantages of the disclosure, performance simulation of the scheme proposed by the disclosure is now given as follows using a combination

of the first to third embodiments of the method for video streaming transmission, in which the video stream data comprises eMBMS data and UEs return only NACK signal.

[00191] The performance metric used in video streaming simulation measurement is Peak Signal to Noise Ratio (PSNR) which is typically regarded as the most common method used to measure video quality. Herein the YUV format test video and transmitted video are used, because most information is stored in the luminance component, and little information would be lost if a thinning of the U and V components is done. The simulation configuration is shown as theTable 1 below, the existing eMBMS transmission protocol scheme is regarded as baseline. After decoded frames are transmitted to UE side, the H.264 parser is used to detect the different types of frame packets. Because packet loss may lead to impairment such as pixilation effects in the video, and to construct a more practical wireless transmission situation, we will compare the average PSNR vs Distance from base station to UEs between baseline and proposed structure scheme from 30 runs. We also compare the video quantitative impact of fixed Packet Loss rate in each frame between two schemes via simulation.

[00192] Table 1: Simulation Configuration

Video File	Foreman
Frame number	300
Format	MPEG-4
Codec	FFMPEG
Bit rate	224 kb/s
Frame frequency	40 fps
Resolution	176x144
GOP type	IBBPBBPBBP
Iteration times	30
Transmission Modulation Level	QPSK and 16QAM
System Bandwidth	20MHz
Noise Variance	-174dBm/Hz
Tx power	35dBm
NACK modulation	BPSK
Number of UEs in the group	20

[00193] The channel is generated according to the LTE channel model for Urban

MicroScenario in Section B.1.2.2 in 3GPP TR 36.814. The user device antenna patternis assumed omni directional with an antenna gain of 3 dBi. The path loss modelis given by PL(dB) = 40log10(d)-12.6, where d is distance in meter. The channelmodel parameters are chosen according to Table B.1.2.2.1-4 in 3GPP TR 36.814.

[00194] The simulation result is shown in FIG. 13, where we consider the average PSNR for the entire video clip as the performance metric, the PSNR results are thus generated by comparison of the original video file and transmitted video. FIG. 13 shows the video quality decreases drastically as the distance of the base station and UEs increases, this is due to the pathloss of the multicast transmission leading packet loss. Because the existing protocol cannot offer reliable transmission for all types of video frames, if an important frame is corrupted in wireless channel, the error will definitely propagated to the entire GOP and thus will affect the whole GOP quality.

[00195] FIGs. 14 and 15 illustrate the PSNR gap of two schemes in each video frame at 4000m and 3500m distance. Each video frame has same realization under two schemes except for key frame data, and it is well noted that the proposed scheme delivers better video quality than baseline for all video frames.

[00196] Referring now to FIG. 16, a block diagram of a first embodiment of a base station is depicted. The base station may comprise a receiving module 11, a transmission module 12, and a retransmission module 13.

[00197] Receiving module 11 may be configured to receive video stream data from a server.

[00198] Transmission module 12 may be configured to transmit the video stream data to at least one receiver.

[00199] And retransmission module 13 may be configured to retransmit the video stream data to the at least one receiver after confirming that the video stream data needs to be retransmitted.

[00200] Various modules of the base station may be configured to execute the corresponding steps of the first embodiment of the method for video streaming transmission as illustrated in FIG. 1; for greater details, see FIG. 1 and relevant

description.

[00201] In some embodiments, the video stream data may comprise a key frame packet.

[00202] In some embodiments, receiving module11 may further be configured to receive normal frame packets from the server during reception of the key frame packets, and transmission module12 may further be configured to transmit the normal frame packets to the at least one receiver during transmission of the key frame packets. Retransmission module 13 may be configured to not retransmit normal frame packets.

[00203] In some embodiments, transmission module12 may be configured to transmit key frame packets through a first channel having retransmission function, and transmit normal frame packets through a second channel absent of retransmission function.

[00204] Referring now to FIG. 17, a block diagram of a second embodiment of a base station is depicted. This embodiment is based on the first embodiment base station, and further comprises a detection module 14 configured to split the received key frame packets and normal frame packets using deep packet inspection (DPI).

[00205] Referring now to FIG. 18, a block diagram of a third embodiment of a base station is depicted. This embodiment is based on the first embodiment base station, and further comprises a storage module 15 and a discarding module 16.

[00206] Storage module 15 may be configured to save the video stream data.

[00207] And discarding module 16 may be configured to discard the video stream data when preservation time of the video stream data exceeds a preset threshold.

[00208] In some embodiments, retransmission module 13 may be configured to retransmit the video stream data to the at least one receiver upon receiving a signal indicating that the video stream data needs to retransmitted, or to retransmit the video stream data to the at least one receiver if not receiving a signal indicating that the video stream data needs not be transmitted within a preset period.

[00209] In some embodiments, the signal indicating that the video stream data needs to be retransmitted may comprise a Non-acknowledgment (NACK) signal fed back from receivers with respect to a key frame packet that is incorrectly received, while

the signal indicating that the video stream data needs not be retransmitted may comprise an Acknowledgment (ACK) signal fed back from receivers with respect to a key frame packet that is correctly received.

[00210] In some embodiments, the video stream data may comprise enhanced multimedia broadcast multicast service (eMBMS) data.

[00211] In some embodiments, PUCCH resources assigned to receivers in a same multicast group may use same cyclic shift and/or orthogonal sequence.

[00212] In some embodiments, PUCCH resources assigned to receivers in a same multicast group may correspond to same resource blocks (RBs).

[00213] In some embodiments, the retransmission may adopt hybrid automatic repeat request (HARQ) mechanism, and the at least one receiver may comprise a plurality of user equipment (UE).

[00214] Referring now to FIG. 19, a block diagram of a fourth embodiment of a base station is depicted. The base station may comprise a processor 210 and a transceiver 220 coupled to the processor 210 via a bus.

[00215] Transceiver 120 may be configured to transmit and receive data, serving as an interface through which the base station may communicate with other communication equipment.

[00216] Processor 110 may be configured to control operations of the base station; it may also be referred to as a central processing unit (CPU). Processor 110 may be an integrated circuit chip with signal processing capabilities. It may also be a general-purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), or other programmable logic devices, discrete gates, transistor logic devices, discrete hardware components. A general-purpose processor may be a microprocessor or any conventional processor.

[00217] The base station may further comprise a memory storage (not shown) used to store the commands and data necessary for operations of processor 110. The memory storage can also store the data received by transceiver 120.

[00218] Processor 110 may be configured to: receive via transceiver 120 the video

stream data from a server; transmit via transceiver 120 the video stream data to at least one receiver; and retransmit via transceiver 120 the video stream data to the at least one receiver after confirming that the video stream data needs to be retransmitted.

[00219] In some embodiments, the video stream data may comprise a key frame packet.

[00220] In some embodiments, processor 110 may further be configured to: receive via transceiver 120 normal frame packets during reception of the key frame packets; transmit to the at least one receiver via transceiver 120 the normal frame packets during transmission of the key frame packets; and not retransmit the normal frame packetsvia transceiver 120.

[00221] In some embodiments, processor 110 may be configured to transmit via transceiver 120 the key frame packets through a first channel having retransmission function, and transmit via transceiver 120 the normal frame packets through a second channel absent of retransmission function.

[00222] In some embodiments, processor 110 may further be configured to, after receiving from the server the key frame packets and normal frame packets, split the received key frame packets and normal frame packets using deep packet inspection (DPI).

[00223] In some embodiments, the action of transmitting via transceiver 120 the video stream data to the at least one receiver is continuous, and is independent of the action of retransmitting via transceiver 120 the video stream data to the at least one receiver.

[00224] In some embodiments, processor 110 may further be configured to: save the video stream data; and discard the video stream data when preservation time of the video stream data exceeds a preset threshold.

[00225] In some embodiments, processor 110 may be configured to retransmit via transceiver 120 the video stream data to the at least one receiver upon receiving a signal indicating that the video stream data needs to retransmitted, or to retransmit via transceiver 120 the video stream data to the at least one receiver if not receiving a

signal via transceiver 120 indicating that the video stream data needs not be transmitted within a preset period.

[00226] In some embodiments, the signal indicating that the video stream data needs to be retransmitted may comprise a Non-acknowledgment (NACK) signal fed back from receivers with respect to a key frame packet that is incorrectly received, while the signal indicating that the video stream data needs not be retransmitted may comprise an Acknowledgment (ACK) signal fed back from receivers with respect to a key frame packet that is correctly received.

[00227] In some embodiments, processor 110 may be configured to: receive from the at least one receiver via transceiver 120 the signal indicating the video stream data needs to be retransmitted over physical uplink control channel (PUCCH) assigned to the receivers; or receive from receivers via transceiver 120 the signal indicating the video stream data needs not be retransmitted over PUCCH assigned to the receivers.

[00228] In some embodiments, processor 110 may be configured to receive from receivers via transceiver 120 the signal indicating that the video stream data needs to be retransmitted in a fourth sub-frame after the sub-frame in which the video stream data is transmitted, or may not receive not from the receivers via transceiver 120 the signal indicating that the video stream data needs not be transmitted.

[00229] In some embodiments, the video stream data may comprise enhanced multimedia broadcast multicast service (eMBMS) data.

[00230] In some embodiments, PUCCH resources assigned to receivers in a same multicast group may use same cyclic shift and/or orthogonal sequence.

[00231] In some embodiments, PUCCH resources assigned to receivers in a same multicast group may correspond to same resource blocks (RBs).

[00232] In some embodiments, the retransmission may adopt hybrid automatic repeat request (HARQ) mechanism, and the at least one receiver may comprise a plurality of user equipment (UE).

[00233] For functions of various components of the base station according to the present embodiment, one may refer to the relevant description of corresponding embodiment of method for video streaming transmission.

[00234] Referring now to FIG. 20, a block diagram of a first embodiment of a user equipment (UE) is depicted. The UE may comprise a first receiving module 21, a response module 22, and a second receiving module 23.

[00235] First receiving module 21 may be configured to receive video stream data.

[00236] Response module 22 may be configured to reply to the sender with a signal to indicate whether the video stream data needs to be retransmitted.

[00237] And second receiving module 23 may be configured to receive the video stream data that needs to be retransmitted.

[00238] In some embodiments, the video stream data may comprise a key frame packet.

[00239] In some embodiments, first receiving module21 may further be configured to receive normal frame packets during reception of the key frame packets, and response module 22 may be configured to not reply the signal that indicates whether a normal frame packet needs to be retransmitted.

[00240] In some embodiments, first receiving module21 may be configured to receive key frame packets over a first channel having retransmission function, and normal frame packets through a second channel absent of retransmission function.

[00241] Referring now to FIG. 18, a block diagram of a second embodiment of a UE is depicted, which is based on the first embodiment UE, and further includes a decoding module 24 configured to resequence and decode the received key frame packets and normal frame packets.

[00242] In some embodiments, response module 22 may be configured to reply to the sender with only the signal indicating whether the video stream data needs to be retransmitted if the video stream data is incorrectly received, so that the sender may retransmit the video stream data upon receiving the signal, or reply to the sender with only the signal indicating that the video stream data needs not be retransmitted if the video stream data is correctly received, so that the sender may retransmit the video stream data if not receiving the signal within a preset period.

[00243] In some embodiments, the signal indicating that the video stream data needs to be retransmitted may comprise a Non-acknowledgment (NACK) signal feedback

with respect to the video stream data that is incorrectly received, while the signal indicating that the video stream data needs not be retransmitted may comprise an Acknowledgment (ACK) signal feedback with respect to the video stream data that is correctly received.

[00244] In some embodiments, response module 22 may be configured to, if a current video stream packet is correctly received before a previous video stream packet is correctly received, not reply the signal to the sender indicating that the previous video stream packet needs to retransmitted, or reply the signal to the sender indicating that the previous video stream packet needs not be retransmitted.

[00245] Referring now to FIG. 22, a block diagram of a third embodiment of a UE is depicted, which is based on the first embodiment UE, and further includesa discarding module 25 configured to, if a current video stream packet is correctly received not later than a previous video stream packet, discard the previous stream packet.

[00246] In some embodiments, the video stream data may comprise enhanced multimedia broadcast multicast service (eMBMS) data.

[00247] In some embodiments, the retransmission may adopt hybrid automatic repeat request (HARQ) mechanism, and the sender may be a base station.

[00248] Referring now to FIG. 23, a block diagram of a fourth embodiment of a UE according to the disclosure is depicted. The UE includes a processor 210 and a communications circuit 220 coupled to processor 210 via a bus.

[00249] Communications circuit 220 may be configured to transmit and receive data, serving as an interface through which the UE may communicate with other communication equipment.

[00250] Processor 210 may be configured to control operations of the UE; it may also be referred to as a central processing unit (CPU). Processor 210 may be an integrated circuit chip with signal processing capabilities. Processor 210 may also be a general-purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), or other programmable logic devices, discrete gates, transistor logic devices, discrete hardware components. A general purpose processor may be a microprocessor or any

conventional processor.

[00251] The UE may further include a memory storage (not shown) used to store the commands and data necessary for operations of processor 210. The memory storage may also store the data received by communications circuit 220.

[00252] Processor 210 may be configured to: receive video stream data via communications circuit 220; reply to the sender via communications circuit 220 with a signal indicating whether the video stream data needs to be retransmitted; and receive via communications circuit 220 the video stream data that needs to be retransmitted.

[00253] In some embodiments, the video stream data may comprise a key frame packet.

[00254] In some embodiments, processor 210 may further be configured to receive via communications circuit 220 normal frame packets during reception of the key frame packets, and not reply via communications circuit 220 the signal to indicate whether a normal frame packet needs to be retransmitted.

[00255] In some embodiments, processor 210 may be configured to receive via communications circuit 220 the key frame packets over a first channel having retransmission function, and the normal frame packets through a second channel absent of retransmission function.

[00256] In some embodiments, processor 210 may further be configured to resequence and decode the received key frame packets and normal frame packets.

[00257] In some embodiments, processor 210 may be configured to reply to the sender via communications circuit 220 with only the signal indicating whether the video stream data needs to be retransmitted when the video stream data is incorrectly received, so that the sender may retransmit the video stream data upon receiving the signal, or reply to the sender via communications circuit 220 with only the signal indicating that the video stream data needs not be retransmitted when the video stream data is correctly received, so that the sender may retransmit the video stream data if not receiving the signal within a preset period.

[00258] In some embodiments, the signal indicating that the video stream data needs

to be retransmitted may comprise a Non-acknowledgment (NACK) signal feedback with respect to the video stream data that is incorrectly received, while the signal indicating that the video stream data needs not be retransmitted may comprise an Acknowledgment (ACK) signal feedback with respect to the video stream data that is correctly received.

[00259] In some embodiments, processor 210 may further be configured to, if a current video stream packet is correctly received before a previous video stream packet is correctly received, not reply to the sender via communications circuit 220 the signal indicating that the previous video stream data needs to be retransmitted, or reply to the sender via communications circuit 220 the signal indicating that the previous video stream data needs not to be retransmitted.

[00260] In some embodiments, processor 210 may further be configured to, if a current video stream packet is correctly received not later than a previous video stream packet, discard the previous video stream packet.

[00261] In some embodiments, processor 210 may be configured to reply to the sender via communications circuit 220 the signal indicating whether the video stream data needs to be retransmitted through assigned physical uplink control channel (PUCCH).

[00262] In some embodiments, processor 210 may be configured to transmit via communications circuit 220 the signal indicating whether the video stream data needs to be retransmitted in a fourth sub-frame after the sub-frame in which the video stream data is received.

[00263] In some embodiments, the video stream data may comprise Enhanced Multimedia Broadcast Multicast Service (eMBMS) data.

[00264] In some embodiments, the retransmission may adopt hybrid automatic repeat request (HARQ) mechanism, and the sender may be a base station.

[00265] For functions of various components of the UE according to the present embodiment, one may refer to the relevant description of corresponding embodiment of method for video streaming transmission.

[00266] It should be appreciated that the UEs, base stations, and methods as disclosed

can also be implemented in other forms. Actually, the base stations and UEs as described are merely illustrative, for example, the division of modules or units is based solely on logic functions, thus in actual implementations there may be other division manners, e.g., multiple units or components may be combined or integrated onto another system, or some system features may be ignored or simply not executed. In addition, mutual couplings, direct couplings, or communication connections as displayed or discussed may be achieved through some interfaces, devices, or units, and may be achieved electrically, mechanically or in other forms.

[00267] Separated units as described may or may not be physically separated. Components displayed as units may or may not be physical units, and may reside at one location or may be distributed to multiple networked units. Part or all of the units may be selectively adopted according to actual requirements to achieve objectives of the disclosure.

[00268] Additionally, various function units in the disclosure may be integrated into one processing unit, or may be presented as various physically separated units, or two or more units may be integrated into one unit. The integrated units may be implemented by hardware, or may be implemented as software functional units.

[00269] If the integrated units are implemented as software function units and sold or used as standalone products, they can be stored in a computer readable storage medium. On the basis of such an understanding, the substantial technical solution, or the part which contributes to the prior art, or all or part of the technical solution, of the disclosure, may be embodied as software products. Computer software products can be stored in a storage medium and may include multiple instructions enabling a computing device (for example, a personal computer, a server, a network device, etc.) or a processor to execute all or part of the methods as described in various embodiments. The storage medium may include all kinds of media that can store program codes, such as a USB flash disk, a mobile hard drive, a read-only memory (ROM), a random access memory (RAM), a magnetic disk or an optical disk.

[00270] The above description merely depicts some exemplary embodiments of the disclosure, and is not meant to limit the scope of the disclosure. Any equivalent

structure or flow transformations made to the disclosure, or any direct or indirect applications of the disclosure on any other related fields, shall all be covered within the protection of the disclosure.

CLAIMS

1. A method for video streaming transmission, comprising:

receiving video stream data from a server;

transmitting the video stream data to at least one receiver; and

retransmitting the video stream data to the at least one receiver after confirming that the video stream data needs to be retransmitted.

2. The method according to claim 1, whereinthe video stream data comprises a key frame packet.

3. The method according to claim 2, wherein normal frame packets are simultaneously received from the server during reception of the key frame packets and simultaneously transmitted to the at least one receiver during transmission of the key frame packets, and the normal frame packets are not retransmitted.

4. The method according to claim 3, wherein the block of transmitting the key frame packets to the at least one receiver comprises:

transmitting the key frame packets through a first channel having retransmission function; and

the block of transmitting the normal frame packets to the at least one receiver comprises:

transmitting the normal frame packets through a second channel without retransmission function.

5. The method according to claim 3, further comprising, after the block of receiving the key frame packets and the normal frame packets from the server:

splitting the received key frame packets and normal frame packets using Deep Packet Inspection (DPI).

6. The method according to any one of claims 1-5, whereinaction of transmitting the video stream data to the at least one receiver is continuous, and is independent of action of retransmitting the video stream data to the at least one receiver.

7. The method according to any one of claims 1-5, further comprising:

saving the video stream data; and

discarding the video stream data when preservation time of the video stream data exceeds a preset threshold.

8. The method according to any one of claims 1-5, whereinthe block of retransmitting the video stream data to the at least one receiver after confirming that the video stream data needs to retransmitted comprises:

retransmitting the video stream data to the at least one receiver after receiving from the at least one receiver a signal indicating that the video stream data needs to retransmitted; or

retransmitting the video stream data to the at least one receiver when not receiving within a preset period from the at least one receiver a signal indicating that the video stream data needs not be retransmitted.

9. The method according to claim 8, whereinthe signal indicating that the video stream data needs to be retransmitted comprises a Non-acknowledgment (NACK) signal feedback from the at least one receiver with respect to the key frame packet that is incorrectly received;the signal indicating that the video stream data needs not be retransmitted comprises an Acknowledgment (ACK) signal feedback from the at least one receiver with respect to the key frame packet that is correctly received.

10. The method according to claim 8, whereinthe block of receiving from the at least one receiver the signal indicating that the video stream data needs to be retransmitted comprises:

receiving from the at least one receiver the signal indicating that the video stream data needs to be retransmitted through Physical Uplink Control Channel (PUCCH) assigned to the at least one receiver; and

the block of receiving from the at least one receiver the signal indicating that the video stream data needs not be retransmitted comprises:

receiving from the at least one receiver the signal indicating that the video stream data needs not be retransmitted throughPUCCH assigned to the at least one receiver.

11. The method according to claim 8, whereinthe block of receiving from the at least one receiver the signal indicating that the video stream data needs to be retransmitted comprises:

receiving from the at least one receiver the signal indicating that the video stream data needs to be retransmitted in a fourth sub-frame after the sub-frame in which the video stream data is transmitted; and

theblock of not receiving within the preset period from the at least one receiver the signal indicating that the video stream data needs not be retransmitted comprises:

not receiving,in the fourth sub-frame after the sub-frame in which the video stream data is transmitted, from the at least one receiver the signal indicating that the video stream data needs not be retransmitted.

12. The method according to any one of claims 1-5, whereinthe video stream data comprises Enhanced Multimedia Broadcast Multicast Service (eMBMS) data.

13. The method according to claim 12, whereinPUCCH resources assigned to receivers in a same multicast group use same cyclic shift and/or orthogonal sequence.

14. The method according to claim 12, whereinPUCCH resources assigned to receivers in a same multicast group correspond to same resource blocks (RBs).

15. The method according to any one of claims 1-5, whereinthe retransmission adopts Hybrid Automatic Repeat Request (HARQ) mechanism, and the at least one receiver comprises user equipment.

16. A method for video streaming transmission, comprising:

receiving video stream data;

replying to a sender with a signal to indicate whether the video stream data needs to be retransmitted; and

receiving the video stream data that needs to be retransmitted.

17. The method according to claim 16, wherein the video stream data comprises a key frame packet.

18. The method according to claim 17, whereinnormal frame packets are simultaneously received during reception of the key frame packets, and a signal is not replied to indicate whether the normal frame packet needs to be retransmitted.

19. The method according to claim 18, whereinthe block of receiving the key frame packets comprises:

receiving the key frame packets through a first channel having retransmission function; and

the block of receiving the normal frame packets comprises:

receiving the normal frame packets through a second channel without retransmission function.

20. The method according to claim 18, further comprising:

resequencing and decoding the received key frame packets and normal frame packets.

21. The method according to any one of claims 16-20, whereinthe block of replying to the sender with the signal to indicate whether the video stream data needs to be retransmitted comprises:

replying to the sender with only the signal indicating that the video stream data needs to be retransmitted when the video stream data is incorrectly received, so that the sender transmits the video stream data upon receiving the signal; or

replying to the sender with only the signal indicating that the video stream data needs not be retransmitted when the video stream data is correctly received, so that the sender transmits the video stream data when not receiving the signal within a predetermined period.

22. The method according to claim 21, whereinthe signal indicating that the video stream data needs to be retransmitted comprises a Non-acknowledgment (NACK) signal feedback with respect to the video stream data that is incorrectly received;the signal indicating that the video stream data needs not be retransmitted comprises an Acknowledgment (ACK) signal feedback with respect to the video stream data that is correctly received.

23. The method according to any one of claims 16-20, further comprising:

when a current video stream packet is correctly received before a previous video stream packet is correctly received, not replying to the sender with the signal indicating that the previous video stream packet needs to be retransmitted, or replying

to the sender with the signal indicating that the previous video stream packet needs not be retransmitted.

24. The method according to any one of claims 16-20, further comprising:

when a current video stream packet is correctly received not later than a previous video stream packet is received, discarding the previous video stream packet.

25. The method according to any one of claims 16-20, whereinthe block of replying to the sender with the signal to indicate whether the video stream data needs to be retransmitted comprises:

transmitting to the sender the signal indicating whether the video stream data needs to be retransmitted through assigned Physical Uplink Control Channel (PUCCH).

26. The method according to any one of claims 16-20, whereinthe block of replying to the sender with the signal to indicate whether the video stream data needs to be retransmitted comprises:

transmitting to the sender,in a fourth sub-frame after the sub-frame in which the video stream data is received, the signal indicating whether the video stream data needs to be retransmitted.

27. The method according to any one of claims 16-20, whereinthe video stream data comprises Enhanced Multimedia Broadcast Multicast Service (eMBMS) data.

28. The method according to any one of claims 16-20, whereinthe retransmission adopts Hybrid Automatic Repeat Request (HARQ) mechanism, and the sender is a base station.

29. A base station, comprising:

areceiving module configured to receive video stream data from a server;

atransmission module configured to transmit the video stream data to at least one receiver; and

a retransmission module configured to retransmit the video stream data to the at least one receiver when confirming that the video stream data needs to be retransmitted.

30. The base station according to claim 29, whereinthe video stream data comprises a key frame packet.

31. The base station according to claim 30, whereinthe receiving module is further configured to simultaneously receive normal frame packets from the server during reception of the key frame packets;

thetransmission module is further configured to simultaneously transmit the normal frame packets to the at least one receiver during transmission of the key frame packets; and

the retransmission module is configured to not retransmit the normal frame packets.

32. The base station according to claim 31, whereinthe transmission module is configured to transmit the key frame packets through a first channel having retransmission function, and the normal frame packets through a second channel without retransmission function.

33. The base station according to claim 31, further comprising:

a detection module configured to split the received key frame packets and normal frame packets using Deep Packet Inspection (DPI).

34. The base station according to any one of claims 29-33, whereinaction of transmitting the video stream data to the at least one receiver is continuous, and is independent of action of retransmitting the video stream data to the at least one receiver.

35. The base station according to any one of claims 29-33, further comprising:

a storage module configured to save the video stream data; and

a discarding module configured to discard the video stream data when preservation time of the video stream data exceeds a preset threshold.

36. The base station according to any one of claims 29-33, whereinthe retransmission module is configured to retransmit the video stream data to the at least one receiver upon receiving a signal from the at least one receiver indicating that the video stream data needs to retransmitted, or to retransmit the video stream data to the

at least one receiver when not receiving within a preset period a signal indicating that the video stream data needs not be transmitted.

37. The base station according to claim 36, whereinthe signal indicating that the video stream data needs to be retransmitted comprises a Non-acknowledgment (NACK) signal feedback from the at least one receiver with respect to the key frame packet that is incorrectly received;the signal indicating that the video stream data needs not be retransmitted comprises an Acknowledgment (ACK) signal feedback from the at least one receiver with respect to the key frame packet that is correctly received.

38. The base station according to any one of claims 29-33, whereinthe video stream data comprises Enhanced Multimedia Broadcast Multicast Service (eMBMS) data.

39. The base station according to claim 38, whereinPUCCH resources assigned to receivers in a same multicast group use same cyclic shift and/or orthogonal sequence.

40. The base station according to claim 38, whereinPUCCH resources assigned to receivers in a same multicast group correspond to same resource blocks (RBs).

41. The base station according to any one of claims 29-33, whereinthe retransmission adopts Hybrid Automatic Repeat Request (HARQ) mechanism, and the at least one receiver comprises user equipment.

42. A user equipment (UE), comprising:

a first receiving module configured to receive video stream data;

a response module configured to reply to a sender with a signal to indicate whether the video stream data needs to be retransmitted; and

a second receiving module configured to receive the video stream data that needs to be transmitted.

43. The UE according to claim 42, whereinthe video stream data comprises a key frame packet.

44. The UE according to claim 43, whereinthe first receiving module is further configured to simultaneously receive normal frame packets during reception of the

key frame packets; andthe response module is configured to not reply with a signal to indicate whether the normal frame packet needs to be retransmitted.

45. The UE according to claim 44, whereinthe first receiving module is configured to receive the key frame packets through a first channel having retransmission function, and the normal frame packets through a second channel without retransmission function.

46. The UE according to claim 44, further comprising:

a decoding module configured to resequence and decode the received key frame packets and normal frame packets.

47. The UE according to any one of claims 42-46, whereinthe response module is configured to reply to the sender with only the signal indicating that the video stream data needs to be retransmitted when the video stream data is incorrectly received, so that the sender transmits the video stream data upon receiving the signal, or reply to the sender with the signal indicating that the video stream data needs not be retransmitted when the video stream data is correctly received, so that the sender retransmits the video stream data when not receiving the signal within a preset period.

48. The UE according to claim 47, whereinthe signal indicating that the video stream data needs to be retransmitted comprises a Non-acknowledgment (NACK) signal feedback with respect to the video stream data that is incorrectly received;the signal indicating that the video stream data needs not be retransmitted comprises an Acknowledgment (ACK) signal feedback with respect to the video stream data that is correctly received.

49. The UE according to any one of claims 42-46, whereinthe response module is configured to, when a current video stream packet is correctly received before a previous video stream packet is correctly received, not reply to the sender with the signal to indicate that the previous video stream packet needs to be retransmitted, or reply to the sender with the signal indicating that the previous video stream packet needs not be retransmitted.

50. The UE according to any one of claims 42-46, further comprising:

a discarding module configured, when a current video stream data is correctly received not later than a previous video stream data, discard the previous stream packet.

51. The UE according to any one of claims 42-46, whereinthe video stream data comprises Enhanced Multimedia Broadcast Multicast Service (eMBMS) data.

52. The UE according to any one of claims 42-46, whereinthe retransmission adopts Hybrid Automatic Repeat Request (HARQ) mechanism, and the sender is a base station.

53. A base station comprising a processor and a transceiver coupled to the processor, the processor configured to:

receive, via the transceiver, video stream data from a server; transmit via the transceiver the video stream data to at least one receiver; and retransmit via the transceiver the video stream data to the at least one receiver when confirming that the video stream data needs to be retransmitted.

54. The base station according to claim 53, whereinthe video stream data comprises a key frame packet.

55. The base station according to claim 54, whereinthe processor is further configured to simultaneously receive, from the server via the transceiver, normal frame packets during reception of the key frame packets, transmit via the transceiver the normal frame packets to the at least one receiver during transmission of the key frame packets, and not retransmit the normal frame packets via the transceiver.

56. The base station according to claim 55, whereinthe processor is further configured to transmit via the transceiver the key frame packets through a first channel having retransmission function, and the normal frame packets through a second channel without retransmission function.

57. The base station according to claim 55, whereinthe processor is further configured to, after receiving via the transceiver the key frame packets and the normal frame packets from the server, split the received key frame packets and normal frame packets using Deep Packet Inspection (DPI).

58. The base station according to any one of claims 53-57, whereinaction of transmitting via the transceiver the video stream data to the at least one receiver is continuous, and is independent of action of retransmitting via the transceiver the video stream data to the at least one receiver.

59. The base station according to any one of claims 53-57, whereinthe processor is further configured to save the video stream data, and discard the video stream data when preservation time of the video stream data exceeds a preset threshold.

60. The base station according to any one of claims 53-57, whereinthe processor is configured to retransmit via the transceiver the video stream data to the at least one receiver upon receiving via the transceiver from the at least one receiver a signal indicating that the video stream data needs to be retransmitted, or to retransmit via the transceiver the video stream data to the at least one receiver when not receiving via the transceiver from the at least one receiver within a preset period a signal indicating that the video stream data needs not be retransmitted.

61. The base station according to claim 60, whereinthe signal indicating that the video stream data needs to be retransmitted comprises a Non-acknowledgment (NACK) signal feedback from the at least one receiver with respect to the key frame packet that is incorrectly received;the signal indicating that the video stream data needs not be retransmitted comprises an Acknowledgment (ACK) signal feedback from the at least one receiver with respect to the key frame packet that is correctly received.

62. The base station according to claim 60, whereinthe processor is configured to receive from the at least one receiver via the transceiver the signal indicating that the video stream data needs to be retransmitted through Physical Uplink Control Channel (PUCCH) assigned to the at least one receiver, or receive from the at least one receiver via the transceiver the signal indicating that the video stream data needs not be retransmitted through Physical Uplink Control Channel (PUCCH) assigned to the at least one receiver.

63. The base station according to claim 60, whereinthe processor is configured to receive from the at least one receiver via the transceiver the signal indicating that the video stream data needs to be retransmitted, in a fourth sub-frame after the sub-frame in which the video stream data is transmitted, or not receive from the at least one receiver via the transceiver the signal indicating that the video stream data needs not be transmitted, in the fourth sub-frame after the sub-frame in which the video stream data is transmitted via the transceiver.

64. The base station according to any one of claims 53-57, whereinthe video stream data comprises Enhanced Multimedia Broadcast Multicast Service (eMBMS) data.

65. The base station according to claim 64, whereinPUCCH resources assigned to receivers in a same multicast group use same cyclic shift and/or orthogonal sequence.

66. The base station according to claim 64, whereinPUCCH resources assigned to receivers in a same multicast group correspond to same resource blocks (RBs).

67. The base station according to any one of claims 53-57, whereinthe retransmission adopts Hybrid Automatic Repeat Request (HARQ) mechanism, and the at least one receiver comprises user equipment.

68. A user equipment (UE) comprising a processor and a communications circuit coupled to the processor, the processor configured to:

receive video stream data via the communications circuit; reply to a sender via the communications circuit with a signal to indicate whether the video stream data needs to be retransmitted; and receive via the communications circuit the video stream data that needs to be retransmitted.

69. The UE according to claim 68, whereinthe video stream data comprises a key frame packet.

70. The UE according to claim 69, whereinthe processor is further configured to simultaneously receive normal frame packets via the communications circuit during reception of the key frame packets, and not reply via the communications circuit a signal to indicate whether the normal frame packet needs to be retransmitted.

71. The UE according to claim 70, whereinthe processor is configured to receive via the communications circuit the key frame packets through a first channel having retransmission function, and the normal frame packets through a second channel without retransmission function.

72. The UE according to claim 70, whereinthe processor is further configured to resequence and decode the received key frame packets and normal frame packets.

73. The UE according to any one of claims 68-72, whereinthe processor is configured to reply to the sender via the communications circuit with only the signal indicating that the video stream data needs to be retransmitted when the video stream data is incorrectly received, so that the sender transmits the video stream data upon receiving the signal, or reply to the sender via the communications circuit with only the signal indicating that the video stream data needs not be retransmitted when the video stream data is correctly received, so that the sender retransmits the video stream data when not receiving the signal within a preset period.

74. The UE according to claim 73, whereinthe signal indicating that the video stream data needs to be retransmitted comprises a Non-acknowledgment (NACK) signal feedback with respect to the video stream data that is incorrectly received;the signal indicating that the video stream data needs not be retransmitted comprises an Acknowledgment (ACK) signal feedback with respect to the video stream data that is correctly received.

75. The UE according to any one of claims 68-72, whereinthe processor is further configured to, when a current video stream packet is correctly received before a previous video stream packet is correctly received, not reply to the sender via the communications circuit with the signal indicating that the previous video stream packet needs to be retransmitted, or reply to the sender via the communications circuit the signal indicating that the previous video stream packet needs not be retransmitted.

76. The UE according to any one of claims 68-72, whereinthe processor is further configured to, if a current video stream packet is correctly received not later than a previous video stream packet, discard the previous video stream packet.

77. The UE according to any one of claims 68-72, whereinthe processor is configured to reply to the sender via the communications circuit the signal indicating whether the video stream data needs to be retransmitted through assigned Physical Uplink Control Channel (PUCCH).

77. The UE according to any one of claims 68-72, whereinthe processor is configured to transmit via the communications circuit the signal indicating whether the video stream data needs to be retransmitted, in a fourth sub-frame after the sub-frame in which the video stream data is received.

78. The UE according to any one of claims 68-72, whereinthe video stream data comprises Enhanced Multimedia Broadcast Multicast Service (eMBMS) data.

79. The UE according to any one of claims 68-72, whereinthe retransmission adopts Hybrid Automatic Repeat Request (HARQ) mechanism, and the sender is a base station.

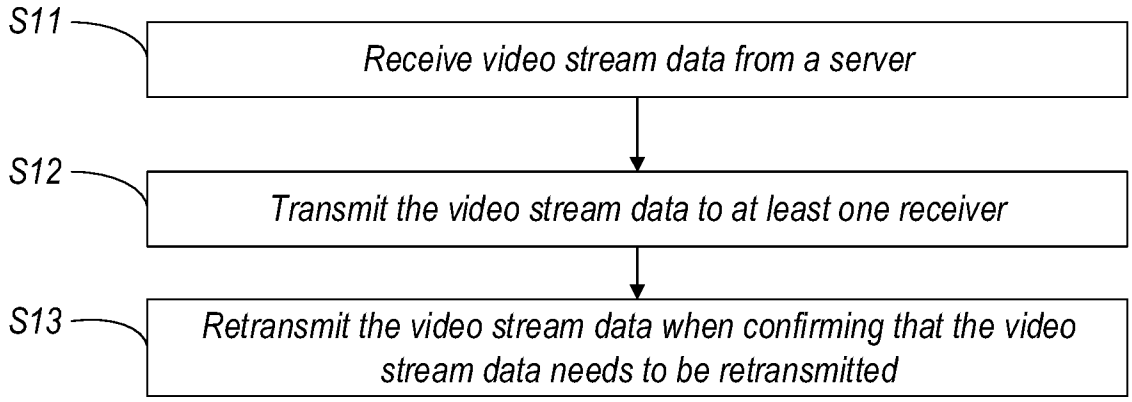


FIG. 1

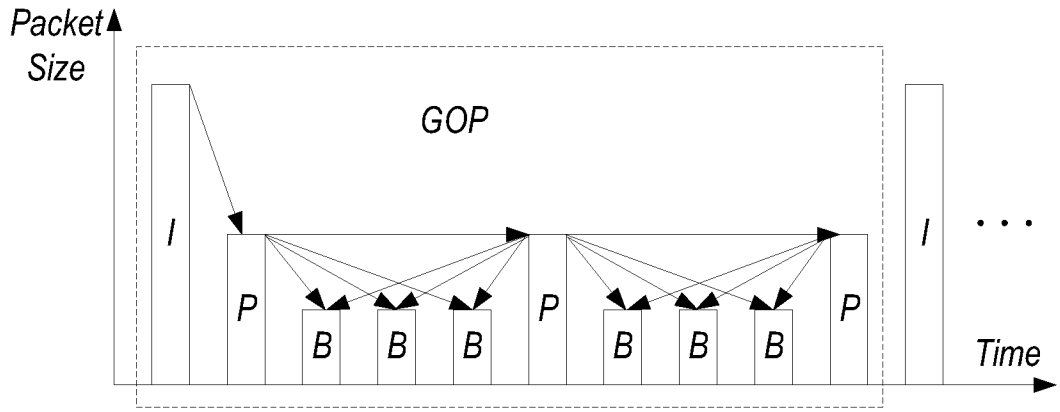


FIG. 2

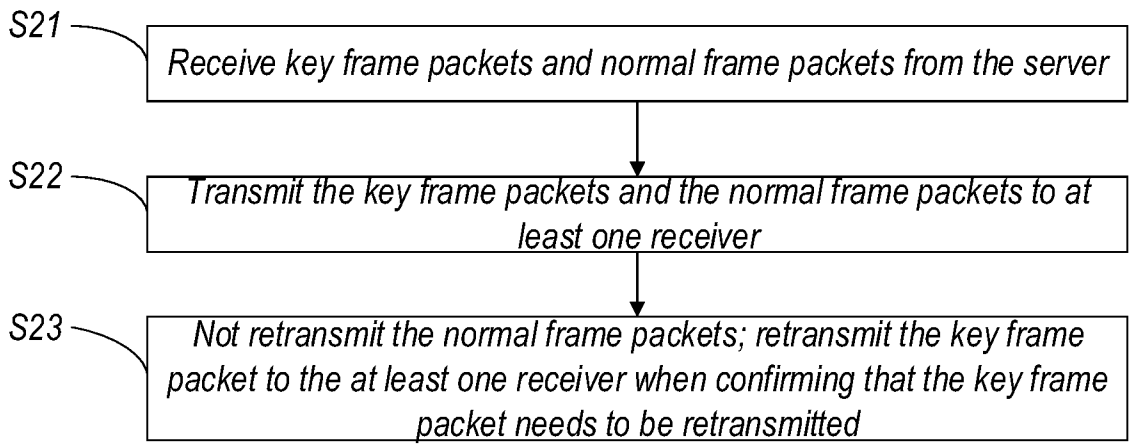


FIG. 3

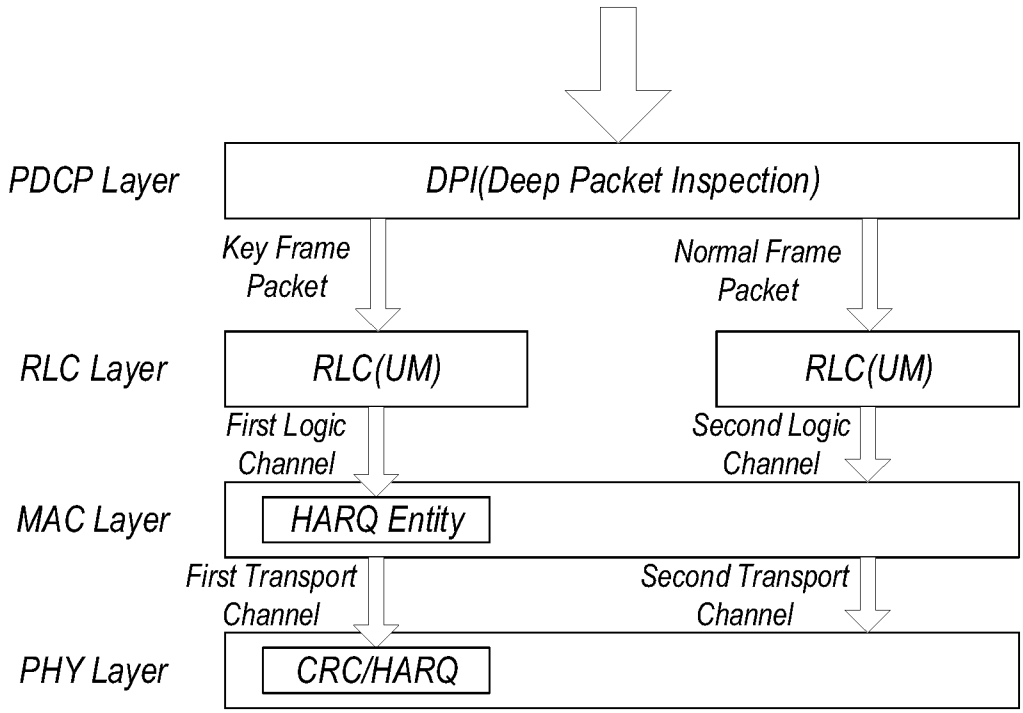


FIG. 4

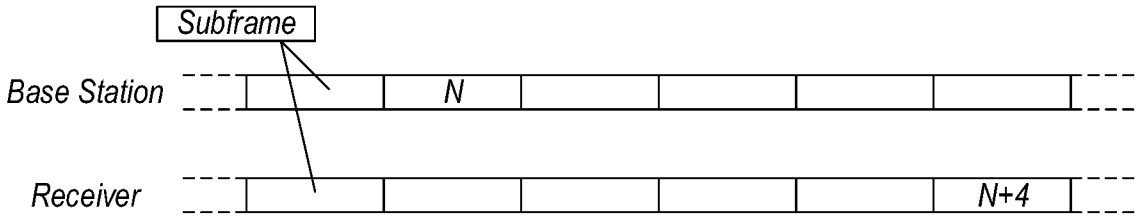


FIG. 5

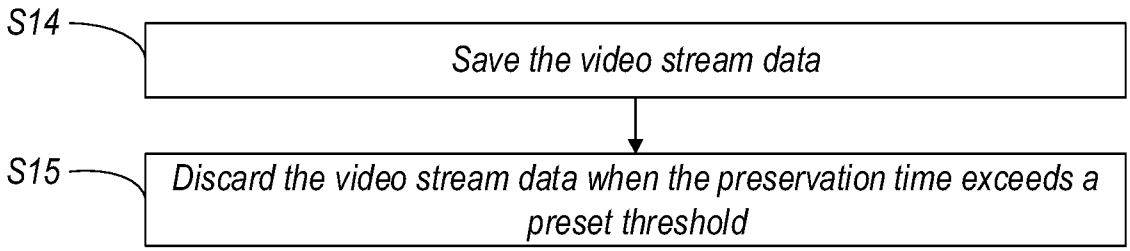


FIG. 6

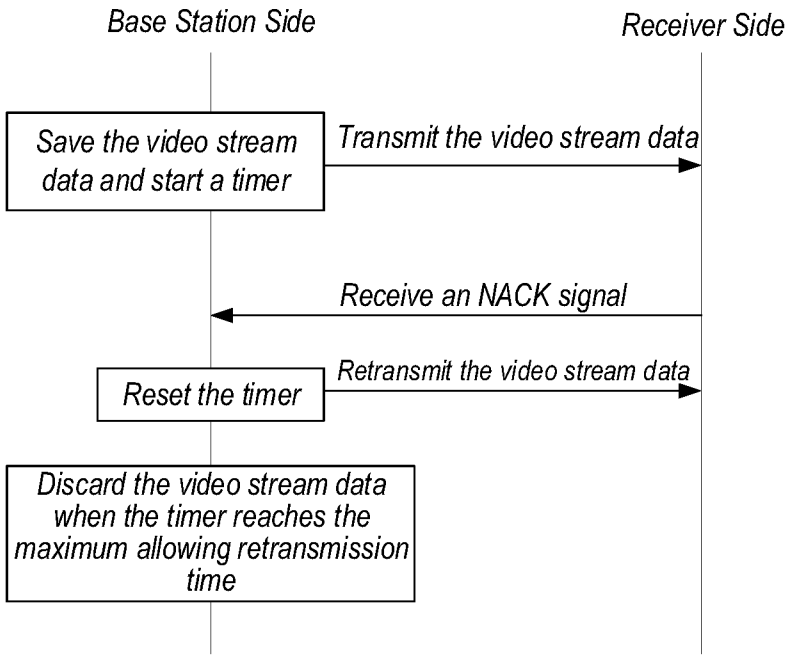

Base Station Side
Receiver Side
Save the video stream data and start a timer
Transmit the video stream data
Receive an NACK signal
Reset the timer
Retransmit the video stream data
Discard the video stream data when the timer reaches the maximum allowing retransmission time

FIG. 7

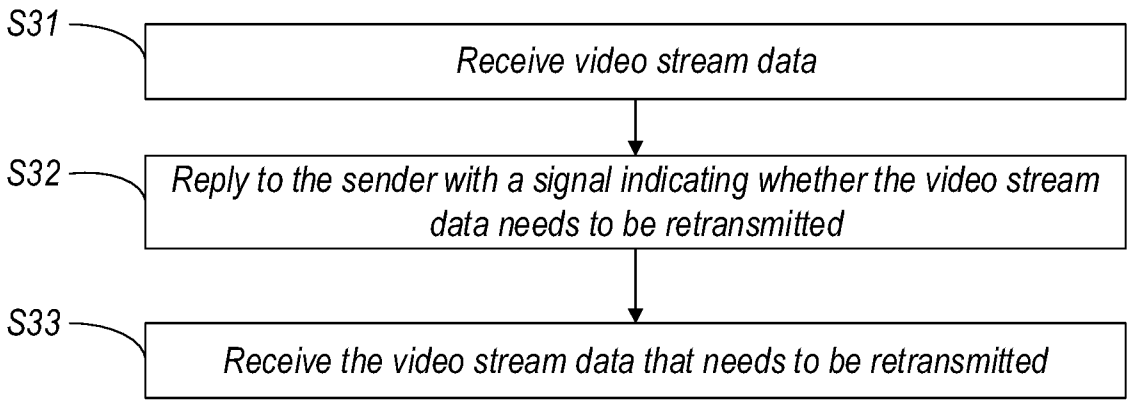

S31
Receive video stream data
S32
Reply to the sender with a signal indicating whether the video stream data needs to be retransmitted
S33
Receive the video stream data that needs to be retransmitted

FIG. 8

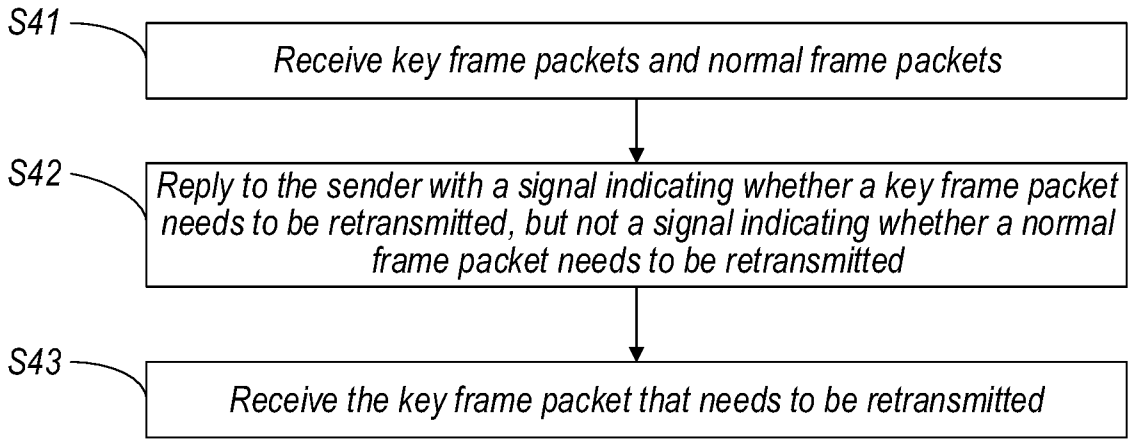


FIG. 9

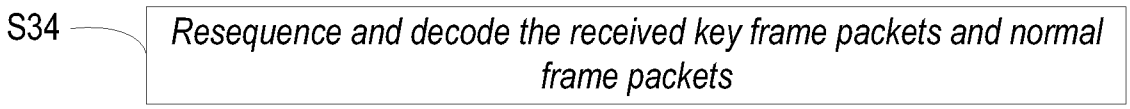


FIG. 10

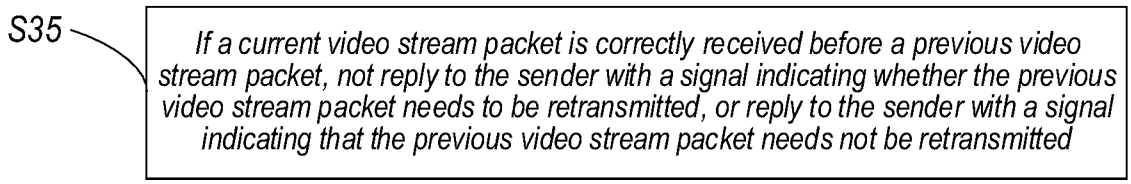


FIG. 11

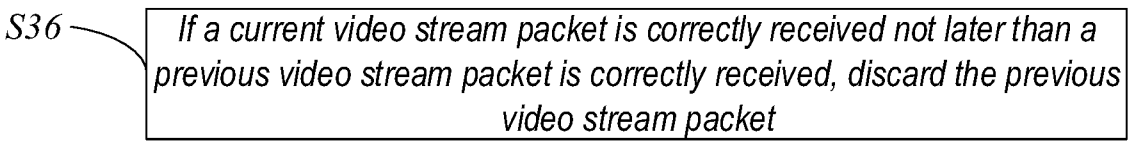


FIG. 12

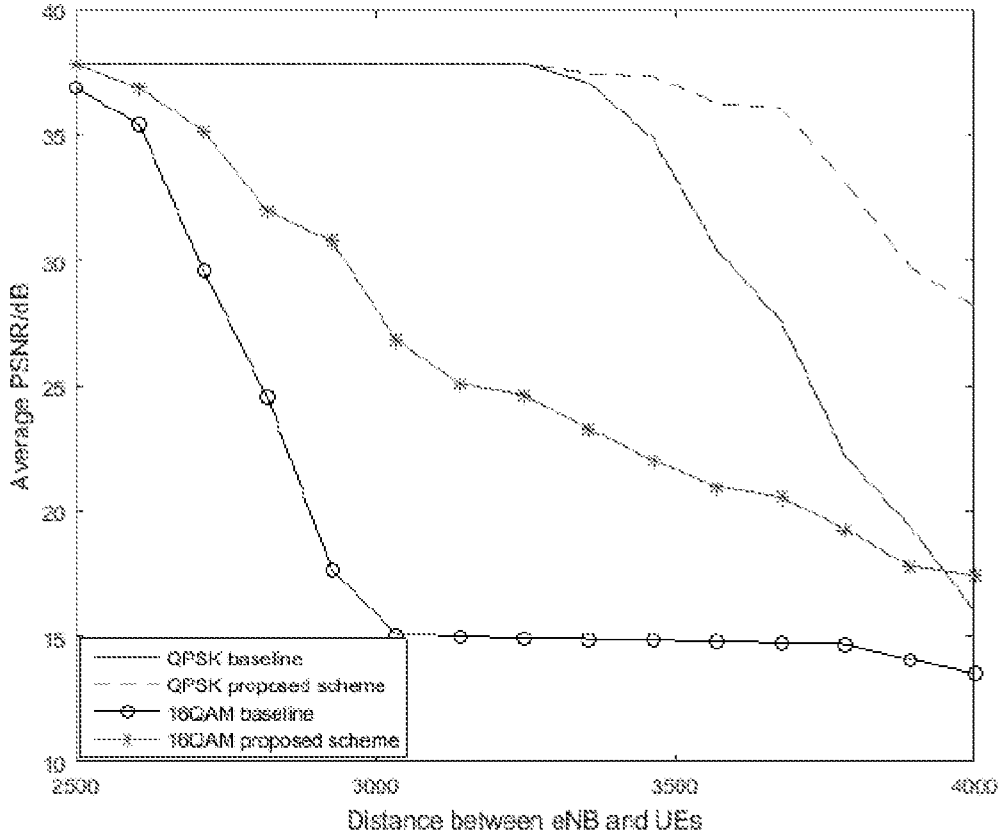

Average PSNR/dB
Distance between eNB and UEs
QPSK baseline
QPSK proposed scheme
16QAM baseline
16QAM proposed scheme

FIG. 13

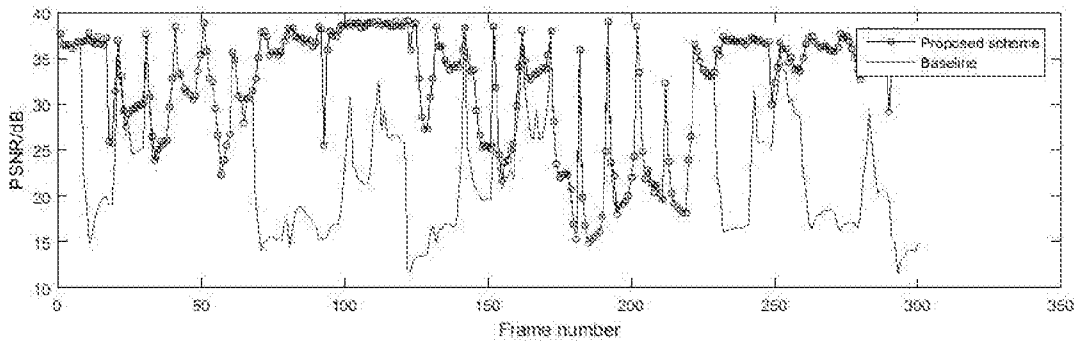

PSNR/dB
Frame number
Proposed scheme
Baseline

FIG. 14

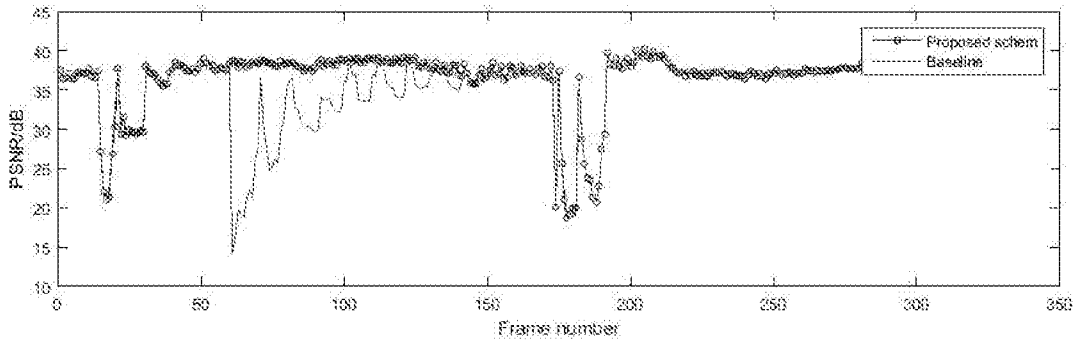


FIG. 15

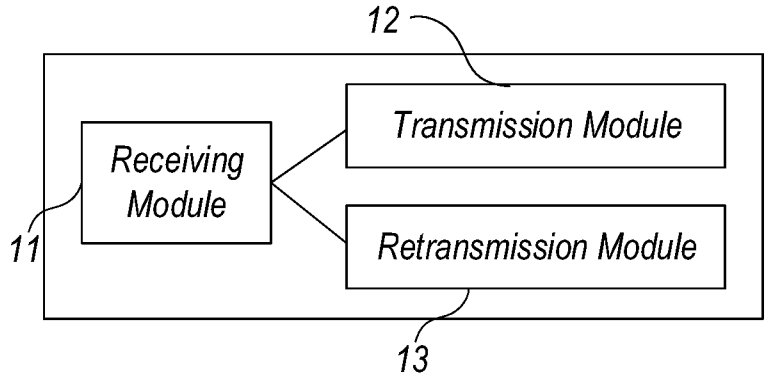


FIG. 16

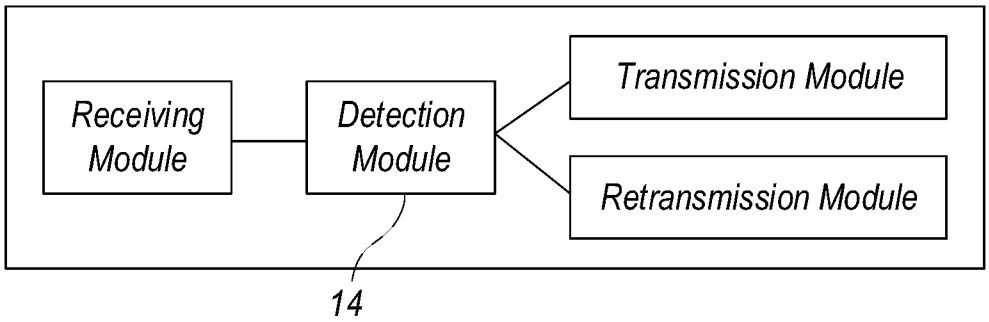


FIG. 17

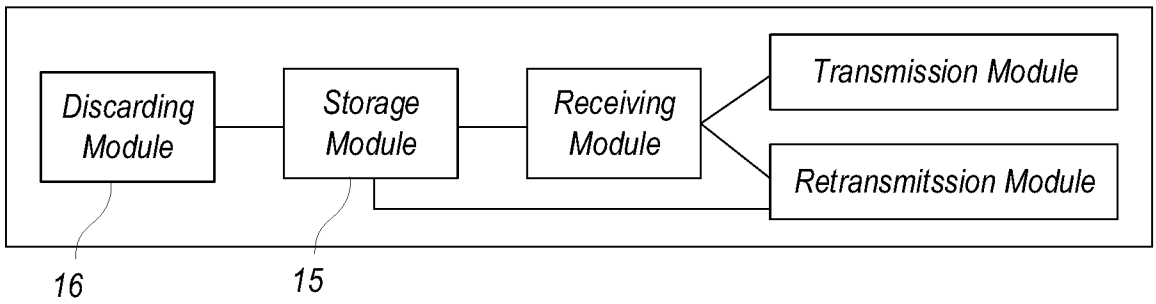


FIG. 18

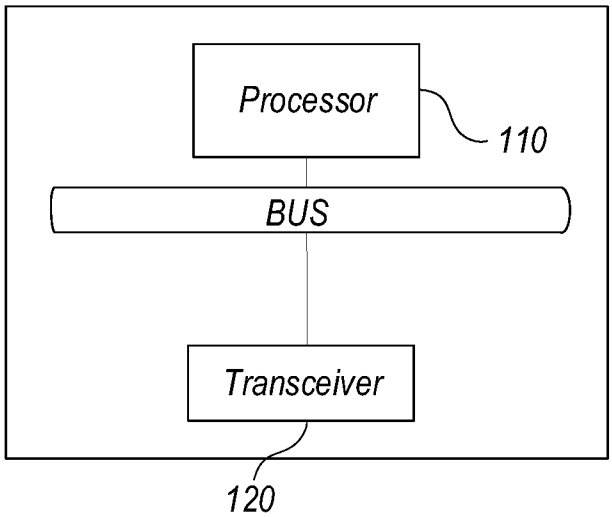


FIG. 19

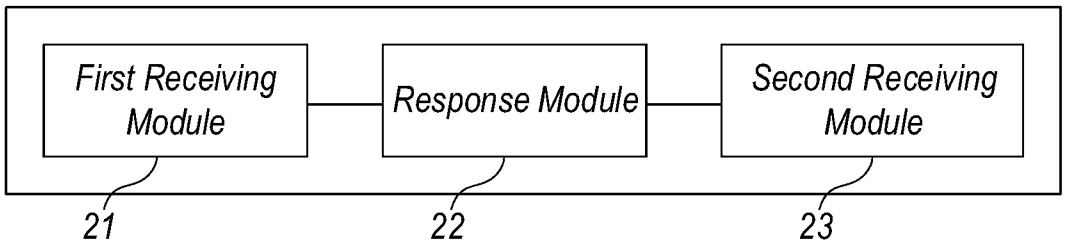


FIG. 20

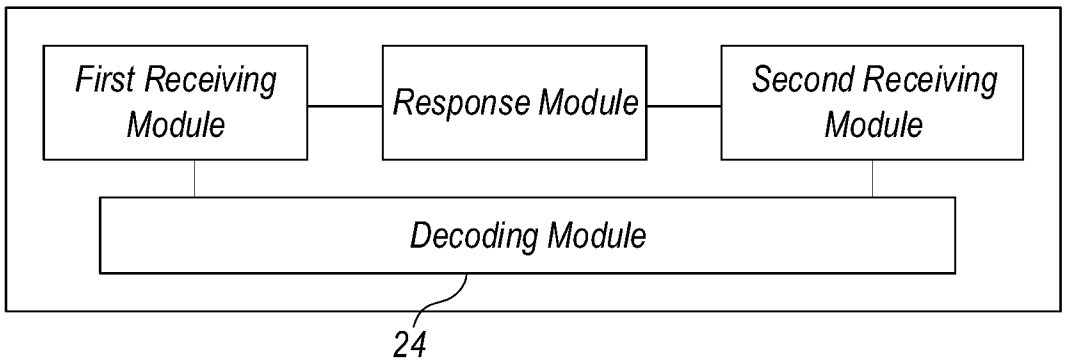


FIG. 21

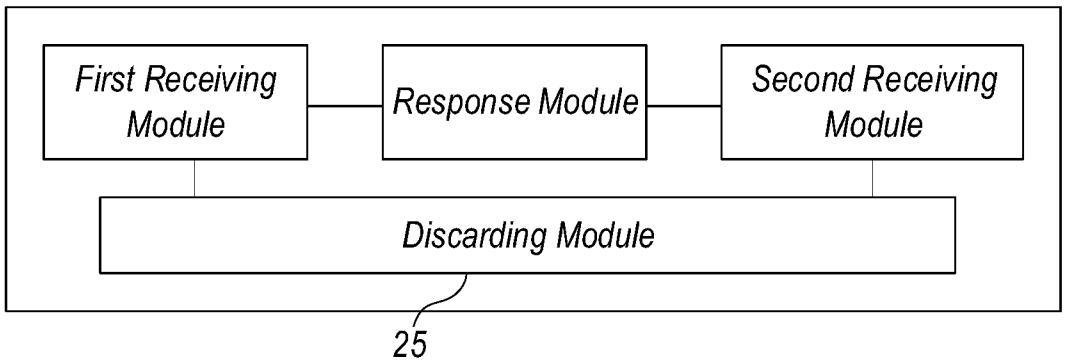


FIG. 22

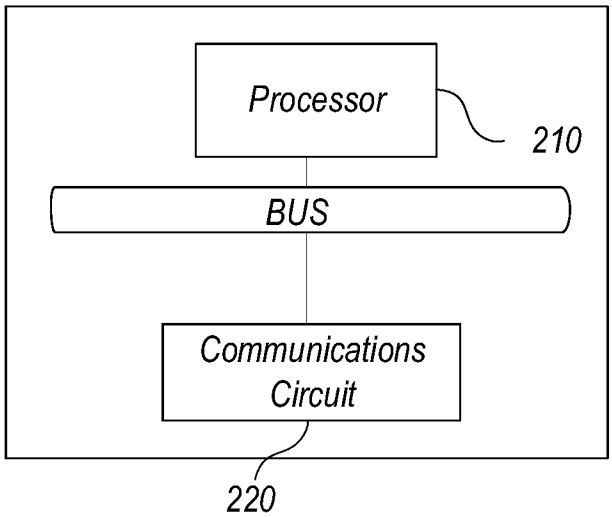


FIG. 23

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2016/095969

A. CLASSIFICATION OF SUBJECT MATTER

H04N 19/89(2014.01)i; H04L 1/08(2006.01)i; H04L 1/16(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04N; H04L; H04W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT,CNKI,WPI,EPODOC: video, stream, retransmission, retransmit, re-transmission, re-transmit, confirm, affirm, need, only, ACK, NACK, HARQ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 104780029 A (HUAWEI TECHNOLOGIES CO., LTD.) 15 July 2015 (2015-07-15) description, paragraphs [0053]-[0057], [0097]-[0119]	1-79
X	CN 105262746 A (STATE GRID CORP. CHINA ET AL.) 20 January 2016 (2016-01-20) description, paragraphs [0009]-[0017]	1-79
X	CN 102594534 A (SHENZHEN JIESHI FEITONG TECHNOLOGY CO., LTD.) 18 July 2012 (2012-07-18) description, paragraphs [0039]-[0055], [0063]-[0067], [0080]-[0097], fig.1	1-79
X	CN 101018108 A (HUAWEI TECHNOLOGIES CO., LTD.) 15 August 2007 (2007-08-15) description, page 8, lines 15-20, page 9, line 1 to page 10, line 15, page 13, lines 10-19	1-79
X	CN 101399651 A (DATANG MOBILE COMMUNICATION EQUIP. CO., LTD.) 01 April 2009 (2009-04-01) description, page 14, line 16 to page 15, line 24, page 16, line 7 to page 18, line 11, figures 3 and 8	1-5, 7-33, 35-57, 59-79

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 March 2017	**25 April 2017**

Name and mailing address of the ISA/CN	Authorized officer
STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088** **China**	**XU,Wei**
Facsimile No. **(86-10)62019451**	Telephone No. **(86-10)61648244**

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2016/095969

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2007086403 A1 (HATAKEYAMA, TAKESHI ET AL.) 19 April 2007 (2007-04-19) description, paragraphs [0047]-[0049], [0053]-[0072]	1-5, 7-33, 35-57, 59-79
X	CN 101370144 A (DATANG MOBILE COMMUNICATION EQUIP. CO., LTD. ET AL.) 18 February 2009 (2009-02-18) description, page 9, lines 9-21, fig. 4	1-2, 16-17, 29-30, 42-43, 53-54, 68-69
A	US 2015305015 A1 (VERIZON PATENT AND LICENSING INC.) 22 October 2015 (2015-10-22) the whole document	1-79

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2016/095969

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	104780029	A	15 July 2015	EP	3086500	A4	11 January 2017
				WO	2015106625	A1	23 July 2015
				EP	3086500	A1	26 October 2016
				US	2016323068	A1	03 November 2016
CN	105262746	A	20 January 2016		None		
CN	102594534	A	18 July 2012		None		
CN	101018108	A	15 August 2007		None		
CN	101399651	A	01 April 2009	CN	101399651	B	09 November 2011
US	2007086403	A1	19 April 2007	JP	2007143113	A	07 June 2007
CN	101370144	A	18 February 2009	CN	101370144	B	30 March 2011
US	2015305015	A1	22 October 2015	US	9438383	B2	06 September 2016