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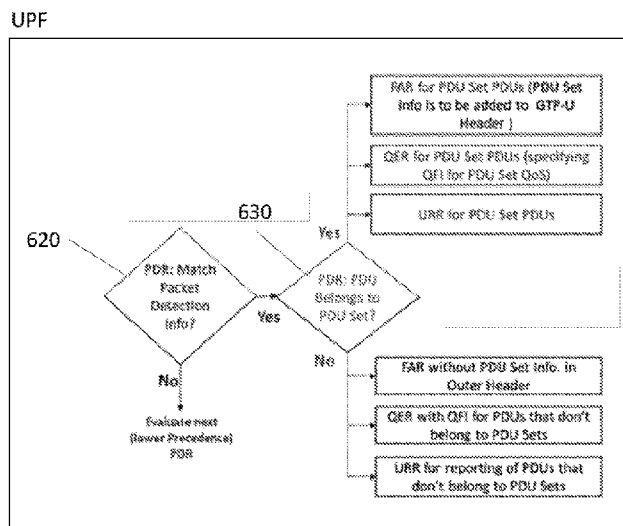


Figure 5

(57) Abstract: The present disclosure provides a method performed by a policy control function that comprises generating by a policy control function of a wireless communication network at least one first quality of service parameter for an application service flow based on at least one first quality of service requirement for protocol data units belonging to a protocol data unit set, and at least one second quality of service parameter for the application service flow based on at least one second quality of service requirement for protocol data units not belonging to a protocol data unit set, and sending information identifying the at least one first quality of service parameter and information identifying the at least one second quality of service parameter to a session management function of the wireless communications network.

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**METHOD AND APPARATUS RELATED TO APPLICATION SERVICE FLOWS
COMPRISING PROTOCOL DATA UNITS BELONGING TO PROTOCOL DATA
UNIT SETS AND PROTOCOL DATA UNITS NOT BELONGING TO PROTOCOL
DATA UNIT SETS**

RELATED APPLICATIONS

[0001] This application claims the benefit of priority of United States Provisional Patent Application No. 63/494,699 filed April 6, 2023, which is hereby incorporated by reference as if reproduced in its entirety.

TECHNICAL FIELD

[0002] Example embodiments of the subject matter described herein relate to apparatus, a method, and a computer program, for wireless communication networks and in particular, but not exclusively to apparatus, methods and computer programs for processing application service flows comprising protocol data units belonging to protocol data unit sets and protocol data units not belonging to protocol data unit sets.

BACKGROUND

[0003] The protocol data units of an application service flow may include a combination of protocol data units that belong to a protocol data unit set and protocol data units that do not belong to a protocol data unit set.

SUMMARY

[0004] A method, comprising: receiving by a user plane function of a core network of a wireless communication network information identifying at least one first protocol data unit processing rule and at least one second protocol data unit processing rule for protocol data units belonging to an application service flow, wherein the at least one first protocol data unit processing rule is for protocol data units determined by the user plane function to belong to a protocol data unit set; and the at least one second protocol data unit processing rule is for protocol data units determined by the user plane function to not belong to a protocol data unit set; and processing by the user plane function a protocol data unit belonging to the application service flow according to the at least one first protocol data unit processing rule or according to the at least one second protocol data unit processing rule depending on

whether or not the protocol data unit is determined by the user plane function to belong to a protocol data unit set.

[0005] The method may further comprise receiving from a session management function a first packet detection rule comprising information identifying the at least one first protocol data unit processing rule, and receiving from the session management function a second packet detection rule comprising information identifying the at least one second protocol data unit processing rule.

[0006] The first packet detection rule may comprise one or more of: information identifying a forwarding action rule specifying the addition of protocol data unit set information to a message header for sending a protocol data unit by the user plane function to a radio access network node of the communications system; information identifying a quality of service enforcement rule specifying a quality of service flow identifier; information identifying a usage reporting rule.

[0007] Application of the first packet detection rule and application of the second packet detection rule to a protocol data unit may both be dependent on user plane function determining that the protocol data unit belongs to the application service flow; wherein application of the first packet detection rule to a protocol data unit is additionally dependent on the user plane function determining that the protocol data unit belongs to a protocol data unit set; and application of the second packet detection rule to a protocol data unit is not additionally dependent on the user plane function determining that the protocol data unit belongs to a protocol data unit set; and wherein processing the protocol data unit may comprise checking whether the first packet detection rule is applicable to the protocol data unit, and only checking whether the second packet detection rule is applicable to the protocol data unit in the event that the first packet detection rule is not applicable to the protocol data unit.

[0008] The determination of whether a protocol data unit belongs to a protocol data unit set may be based on protocol description information received from the session management function as part of the first packet detection rule.

[0009] The method may further comprise receiving from a session management function a single packet detection rule comprising information identifying the at least one first protocol data unit processing rule and information identifying the at least one second protocol data unit processing rule

[0010] The method may comprise, based on determining by the user plane function that the single packet detection rule is applicable to a protocol data unit, determining, by the user

plane function, whether the protocol data unit belongs to a protocol data unit set; and based on determining by the user plane function that the protocol data unit belongs to a protocol data unit set, using the at least one first protocol data unit processing rule for processing the protocol data unit.

[0011] The at least one first protocol data unit processing rule may comprise at least one of: information identifying a forwarding action rule specifying the addition of protocol data unit set information to a message header for sending a protocol data unit by the user plane function to a radio access network of the communications system; information identifying a quality of service enforcement rule specifying a quality of service flow identifier; information identifying a usage report rule.

[0012] The method may comprise: based on determining by the user plane function that the single packet detection rule is applicable to a protocol data unit, determining whether the protocol data unit belongs to a protocol data unit set; and based on determining by the user plane function that the protocol data unit does not belong to a protocol data unit set, using the at least one second protocol data unit processing rule for processing the protocol data unit.

[0013] The determination of whether a protocol data unit belongs to a protocol data unit set may be based on protocol description information received from the session management function as part of the single packet detection rule.

[0014] A method comprising: receiving by a session management function information identifying at least one first quality of service parameter for protocol data units belonging to an application service flow and belonging to a protocol data unit set, and information identifying at least one second quality of service parameter for protocol data units belonging to the application service flow and not belonging to a protocol data unit set; generating by the session management function at least one first protocol data unit processing rule for a user plane function based on the at least one first quality of service parameter, and generating by the session management function at least one second protocol data unit processing rule for the user plane function based on the at least one second quality of service parameter; and sending by the session management function information identifying the at least one first protocol data unit processing rule and information identifying the at least one second protocol data unit processing rule to the user plane function.

[0015] The method may further comprise receiving by the session management function a first policy and charging control rule comprising information identifying at least one first quality of service parameter; and receiving by the session management function a second policy and charging control rule comprising information identifying the at least one second

quality of service parameter; and wherein the first and second policy and charging control rules share a service flow template.

[0016] The method may further comprise receiving by the session management function a single policy and charging control rule comprising information identifying the at least one first quality of service parameter and information identifying the at least one second quality of service parameter.

[0017] The method may comprise sending to the user plane function a first packet detection rule comprising information identifying the at least one first protocol data unit processing rule; and sending to the user plane function information identifying the at least one second protocol data unit processing rule.

[0018] The method may comprise sending to the user plane function a single packet detection rule comprising information identifying the at least one first protocol data unit processing rule and information identifying the at least one second protocol data unit processing rule.

[0019] The method may comprise: setting up a first quality of service flow based on the at least one first quality of service parameter, and a second quality of service flow based on the at least one second quality of service parameter; sending information identifying at least one first quality of service rule for the first quality of service flow to a user equipment associated with the application service flow, and sending information identifying at least one second quality of service rule for the second quality of service flow to the user equipment associated with the application service flow; and sending information identifying at least one first quality of service profile for the first quality of service flow to a radio access network serving the user equipment, and sending information identifying at least one second quality of service profile for the second quality of service flow to the radio access network serving the user equipment.

[0020] A method comprising: generating by a policy control function of a wireless communication network at least one first quality of service parameter for an application service flow based on at least one first quality of service requirement for protocol data units belonging to a protocol data unit set, and at least one second quality of service parameter for the application service flow based on at least one second quality of service requirement for protocol data units not belonging to a protocol data unit set; and sending by the policy control function information identifying the at least one first quality of service parameter and information identifying the at least one second quality of service parameter to a session management function of the wireless communications network.

[0021] The method may comprise receiving from an application function of the communications system by the policy control function quality of service requirement information for the application service flow; wherein the quality of service requirement information identifies the at least one first quality of service requirement and the least one second quality of service requirement.

[0022] A method comprising: generating by an application function quality of service requirement information for an application service flow; wherein the quality of service requirement information identifies at least one first quality of service requirement for protocol data units belonging to a protocol data unit set; and at least one second quality of service requirement for protocol data units not belonging to a protocol data unit set; and sending by the application function the quality of service requirement information to a session management function of a wireless communication network.

[0023] A method comprising: receiving by a user plane function of a wireless communication network a protocol data unit belonging to an application service flow; determining by the user plane function whether the protocol data unit belongs to a protocol data unit set; and based on determining that the protocol data unit is not identifiable by the user plane function as belonging to a protocol data unit set, sending the protocol data unit to a radio access network node of the wireless communication network with header information linking the protocol data unit to a quality of service flow also comprising a protocol data unit determined by the user plane function as belonging to a protocol data unit set.

[0024] The header information may indicate that the protocol data unit belongs to a protocol data unit set having a size of one protocol data unit.

[0025] Apparatus comprising: means for receiving information identifying at least one first protocol data unit processing rule and at least one second protocol data unit processing rule for protocol data units belonging to an application service flow, wherein the at least one first protocol data unit processing rule is for protocol data units determined to belong to a protocol data unit set; and the at least one second protocol data unit processing rule is for protocol data units determined to not belong to a protocol data unit set; and means for processing a protocol data unit belonging to the application service flow according to the at least one first protocol data unit processing rule or according to the at least one second protocol data unit processing rule depending on whether or not the protocol data unit is determined to belong to a protocol data unit set.

[0026] The apparatus may further comprise: means for receiving from a session management function a first packet detection rule comprising information identifying the at least one first

protocol data unit processing rule, and receiving from the session management function a second packet detection rule comprising information identifying the at least one second protocol data unit processing rule.

[0027] The first packet detection rule may comprise one or more of: information identifying a forwarding action rule specifying the addition of protocol data unit set information to a message header for sending a protocol data unit to a radio access network node of the communications system; information identifying a quality of service enforcement rule specifying a quality of service flow identifier; information identifying a usage reporting rule.

[0028] Application of the first packet detection rule and application of the second packet detection rule to a protocol data unit may both be dependent on determining that the protocol data unit belongs to the application service flow; wherein application of the first packet detection rule to a protocol data unit is additionally dependent on determining that the protocol data unit belongs to a protocol data unit set; and application of the second packet detection rule to a protocol data unit is not additionally dependent on determining that the protocol data unit belongs to a protocol data unit set; and wherein the means for processing the protocol data unit comprises means for checking whether the first packet detection rule is applicable to the protocol data unit, and only checking whether the second packet detection rule is applicable to the protocol data unit in the event that the first packet detection rule is not applicable to the protocol data unit.

[0029] The determination of whether a protocol data unit belongs to a protocol data unit set may be based on protocol description information received from the session management function as part of the first packet detection rule.

[0030] The apparatus may further comprise: means for receiving from a session management function a single packet detection rule comprising information identifying the at least one first protocol data unit processing rule and information identifying the at least one second protocol data unit processing rule

[0031] The apparatus may further comprise: means for, based on determining that the single packet detection rule is applicable to a protocol data unit, determining whether the protocol data unit belongs to a protocol data unit set; and means for, based on determining that the protocol data unit belongs to a protocol data unit set, using the at least one first protocol data unit processing rule for processing the protocol data unit.

[0032] The at least one first protocol data unit processing rule may comprise at least one of: information identifying a forwarding action rule specifying the addition of protocol data unit set information to a message header for sending a protocol data unit by the user plane

function to a radio access network of the communications system; information identifying a quality of service enforcement rule specifying a quality of service flow identifier; information identifying a usage report rule.

[0033] The apparatus may comprise: means for, based on determining that the single packet detection rule is applicable to a protocol data unit, determining whether the protocol data unit belongs to a protocol data unit set; and means for, based on determining that the protocol data unit does not belong to a protocol data unit set, using the at least one second protocol data unit processing rule for processing the protocol data unit.

[0034] The determination of whether a protocol data unit belongs to a protocol data unit set may be based on protocol description information received from the session management function as part of the single packet detection rule.

[0035] Apparatus comprising: means for receiving information identifying at least one first quality of service parameter for protocol data units belonging to an application service flow and belonging to a protocol data unit set, and information identifying at least one second quality of service parameter for protocol data units belonging to the application service flow and not belonging to a protocol data unit set; means for generating at least one first protocol data unit processing rule for a user plane function based on the at least one first quality of service parameter, and generating at least one second protocol data unit processing rule for the user plane function based on the at least one second quality of service parameter; and means for sending information identifying the at least one first protocol data unit processing rule and information identifying the at least one second protocol data unit processing rule to the user plane function.

[0036] The apparatus may comprise: means for receiving a first policy and charging control rule comprising information identifying at least one first quality of service parameter, and a second policy and charging control rule comprising information identifying the at least one second quality of service parameter; and wherein the first and second policy and charging control rules share a service flow template.

[0037] The apparatus may comprise: means for receiving a single policy and charging control rule comprising information identifying the at least one first quality of service parameter and information identifying the at least one second quality of service parameter.

[0038] The apparatus may comprise: means for sending to the user plane function a first packet detection rule comprising information identifying the at least one first protocol data unit processing rule, and sending to the user plane function a second packet detection rule comprising information identifying the at least one second protocol data unit processing rule.

[0039] The apparatus may comprise sending to the user plane function a single packet detection rule comprising information identifying the at least one first protocol data unit processing rule and information identifying the at least one second protocol data unit processing rule.

[0040] The apparatus may comprise: means for setting up a first quality of service flow based on the at least one first quality of service parameter, and a second quality of service flow based on the at least one second quality of service parameter; means for sending information identifying at least one first quality of service rule for the first quality of service flow to a user equipment associated with the application service flow, and sending information identifying at least one second quality of service rule for the second quality of service flow to the user equipment associated with the application service flow; and means for sending information identifying at least one first quality of service profile for the first quality of service flow to a radio access network serving the user equipment, and sending information identifying at least one second quality of service profile for the second quality of service flow to the radio access network serving the user equipment.

[0041] Apparatus comprising: means for generating at least one first quality of service parameter for an application service flow based on at least one first quality of service requirement for protocol data units belonging to a protocol data unit set, and at least one second quality of service parameter for the application service flow based on at least one second quality of service requirement for protocol data units not belonging to a protocol data unit set; and means for sending information identifying the at least one first quality of service parameter and information identifying the at least one second quality of service parameter to a session management function.

[0042] The apparatus may comprise: means for receiving from an application function quality of service requirement information for the application service flow; wherein the quality of service requirement information identifies the at least one first quality of service requirement and the least one second quality of service requirement.

[0043] Apparatus comprising: means for generating quality of service requirement information for an application service flow; wherein the quality of service requirement information identifies at least one first quality of service requirement for protocol data units belonging to a protocol data unit set; and at least one second quality of service requirement for protocol data units not belonging to a protocol data unit set; and means for sending the quality of service requirement information to a session management function.

[0044] Apparatus comprising: means for receiving a protocol data unit belonging to an application service flow; means for determining whether the protocol data unit belongs to a protocol data unit set; and means for, based on determining that the protocol data unit is not identifiable as belonging to a protocol data unit set, sending the protocol data unit to a radio access network node of the wireless communication network with header information linking the protocol data unit to a quality of service flow also comprising a protocol data unit determined as belonging to a protocol data unit set.

[0045] The header information may indicate that the protocol data unit belongs to a protocol data unit set having a size of one protocol data unit.

[0046] Apparatus comprising: at least one processor; and at least one memory including computer program code, the at least one memory and computer program code configured to, with the at least one processor, cause the apparatus to perform: receiving information identifying at least one first protocol data unit processing rule and at least one second protocol data unit processing rule for protocol data units belonging to an application service flow, wherein the at least one first protocol data unit processing rule is for protocol data units determined to belong to a protocol data unit set; and the at least one second protocol data unit processing rule is for protocol data units determined to not belong to a protocol data unit set; and processing a protocol data unit belonging to the application service flow according to the at least one first protocol data unit processing rule or according to the at least one second protocol data unit processing rule depending on whether or not the protocol data unit is determined to belong to a protocol data unit set.

[0047] The at least one memory and computer program code may be configured to, with the at least one processor, cause the apparatus to: receive from a session management function a first packet detection rule comprising information identifying the at least one first protocol data unit processing rule, and receive from the session management function a second packet detection rule comprising information identifying the at least one second protocol data unit processing rule.

[0048] The first packet detection rule may comprise one or more of: information identifying a forwarding action rule specifying the addition of protocol data unit set information to a message header for sending a protocol data unit to a radio access network node of the communications system; information identifying a quality of service enforcement rule specifying a quality of service flow identifier; information identifying a usage reporting rule.

[0049] Application of the first packet detection rule and application of the second packet detection rule to a protocol data unit may both be dependent on determining that the protocol

data unit belongs to the application service flow; wherein application of the first packet detection rule to a protocol data unit is additionally dependent on determining that the protocol data unit belongs to a protocol data unit set; and application of the second packet detection rule to a protocol data unit is not additionally dependent on determining that the protocol data unit belongs to a protocol data unit set; and wherein the at least one memory and computer program code are configured to, with the at least one processor, cause the apparatus to: check whether the first packet detection rule is applicable to the protocol data unit, and only check whether the second packet detection rule is applicable to the protocol data unit in the event that the first packet detection rule is not applicable to the protocol data unit.

[0050] The at least one memory and computer program code may be configured to, with the at least one processor, cause the apparatus to: determine whether a protocol data unit belongs to a protocol data unit set based on protocol description information received from the session management function as part of the first packet detection rule.

[0051] The at least one memory and computer program code may be configured to, with the at least one processor, cause the apparatus to: receive from a session management function a single packet detection rule comprising information identifying the at least one first protocol data unit processing rule and information identifying the at least one second protocol data unit processing rule.

[0052] The at least one memory and computer program code may be configured to, with the at least one processor, cause the apparatus to: based on determining that the single packet detection rule is applicable to a protocol data unit, determine whether the protocol data unit belongs to a protocol data unit set; and based on determining that the protocol data unit belongs to a protocol data unit set, use the at least one first protocol data unit processing rule for processing the protocol data unit.

[0053] The at least one first protocol data unit processing rule may comprise at least one of: information identifying a forwarding action rule specifying the addition of protocol data unit set information to a message header for sending a protocol data unit to a radio access network; information identifying a quality of service enforcement rule specifying a quality of service flow identifier; information identifying a usage report rule.

[0054] The at least one memory and computer program code may be configured to, with the at least one processor, cause the apparatus to: based on determining that the single packet detection rule is applicable to a protocol data unit, determine whether the protocol data unit belongs to a protocol data unit set; and based on determining that the protocol data unit does

not belong to a protocol data unit set, use the at least one second protocol data unit processing rule for processing the protocol data unit.

[0055] The at least one memory and computer program code may be configured to, with the at least one processor, cause the apparatus to: determine whether a protocol data unit belongs to a protocol data unit set based on protocol description information received from the session management function as part of the single packet detection rule.

[0056] Apparatus comprising: at least one processor; and at least one memory including computer program code, the at least one memory and computer program code configured to, with the at least one processor, cause the apparatus to perform: receiving information identifying at least one first quality of service parameter for protocol data units belonging to an application service flow and belonging to a protocol data unit set, and information identifying at least one second quality of service parameter for protocol data units belonging to the application service flow and not belonging to a protocol data unit set; generating at least one first protocol data unit processing rule for a user plane function based on the at least one first quality of service parameter, and generating at least one second protocol data unit processing rule for the user plane function based on the at least one second quality of service parameter; and sending information identifying the at least one first protocol data unit processing rule and information identifying the at least one second protocol data unit processing rule to the user plane function.

[0057] The at least one memory and computer program code may be configured to, with the at least one processor, cause the apparatus to: receive a first policy and charging control rule comprising information identifying at least one first quality of service parameter, and receive a second policy and charging control rule comprising information identifying the at least one second quality of service parameter; and wherein the first and second policy and charging control rules share a service flow template.

[0058] The at least one memory and computer program code may be configured to, with the at least one processor, cause the apparatus to: receive a single policy and charging control rule comprising information identifying the at least one first quality of service parameter and information identifying the at least one second quality of service parameter.

[0059] The at least one memory and computer program code may be configured to, with the at least one processor, cause the apparatus to: send to the user plane function a first packet detection rule comprising information identifying the at least one first protocol data unit processing rule; and send to the user plane function a second packet detection rule comprising information identifying the at least one second protocol data unit processing rule.

[0060] The at least one memory and computer program code may be configured to, with the at least one processor, cause the apparatus to: send to the user plane function a single packet detection rule comprising information identifying the at least one first protocol data unit processing rule and information identifying the at least one second protocol data unit processing rule.

[0061] The at least one memory and computer program code may be configured to, with the at least one processor, cause the apparatus to: set up a first quality of service flow based on the at least one first quality of service parameter, and a second quality of service flow based on the at least one second quality of service parameter; send information identifying at least one first quality of service rule for the first quality of service flow to a user equipment associated with the application service flow, and send information identifying at least one second quality of service rule for the second quality of service flow to the user equipment associated with the application service flow; and send information identifying at least one first quality of service profile for the first quality of service flow to a radio access network serving the user equipment, and send information identifying at least one second quality of service profile for the second quality of service flow to the radio access network serving the user equipment.

[0062] Apparatus comprising: at least one processor; and at least one memory including computer program code, the at least one memory and computer program code configured to, with the at least one processor, cause the apparatus to perform: generating at least one first quality of service parameter for an application service flow based on at least one first quality of service requirement for protocol data units belonging to a protocol data unit set, and at least one second quality of service parameter for the application service flow based on at least one second quality of service requirement for protocol data units not belonging to a protocol data unit set; and sending information identifying the at least one first quality of service parameter and information identifying the at least one second quality of service parameter to a session management function.

[0063] The at least one memory and computer program code may be configured to, with the at least one processor, cause the apparatus to: receive from an application function quality of service requirement information for the application service flow; wherein the quality of service requirement information identifies the at least one first quality of service requirement and the least one second quality of service requirement.

[0064] Apparatus comprising: at least one processor; and at least one memory including computer program code, the at least one memory and computer program code configured to,

with the at least one processor, cause the apparatus to perform: generating quality of service requirement information for an application service flow; wherein the quality of service requirement information identifies at least one first quality of service requirement for protocol data units belonging to a protocol data unit set; and at least one second quality of service requirement for protocol data units not belonging to a protocol data unit set; and sending the quality of service requirement information to a session management function.

[0065] Apparatus comprising: at least one processor; and at least one memory including computer program code, the at least one memory and computer program code configured to, with the at least one processor, cause the apparatus to perform: receiving a protocol data unit belonging to an application service flow; determining whether the protocol data unit belongs to a protocol data unit set; and based on determining that the protocol data unit is not identifiable as belonging to a protocol data unit set, sending the protocol data unit to a radio access network node of the wireless communication network with header information linking the protocol data unit to a quality of service flow also comprising a protocol data unit determined as belonging to a protocol data unit set.

[0066] The header information may indicate that the protocol data unit belongs to a protocol data unit set having a size of one protocol data unit.

[0067] Apparatus, comprising: receiving circuitry for receiving information identifying at least one first protocol data unit processing rule and at least one second protocol data unit processing rule for protocol data units belonging to an application service flow, wherein the at least one first protocol data unit processing rule is for protocol data units determined to belong to a protocol data unit set; and the at least one second protocol data unit processing rule is for protocol data units determined to not belong to a protocol data unit set; and processing circuitry for processing a protocol data unit belonging to the application service flow according to the at least one first protocol data unit processing rule or according to the at least one second protocol data unit processing rule depending on whether or not the protocol data unit is determined to belong to a protocol data unit set.

[0068] Apparatus comprising: receiving circuitry for receiving information identifying at least one first quality of service parameter for protocol data units belonging to an application service flow and belonging to a protocol data unit set, and information identifying at least one second quality of service parameter for protocol data units belonging to the application service flow and not belonging to a protocol data unit set; generating circuitry for generating at least one first protocol data unit processing rule for a user plane function based on the at least one first quality of service parameter, and generating at least one second protocol data

unit processing rule for the user plane function based on the at least one second quality of service parameter; and sending circuitry for sending information identifying the at least one first protocol data unit processing rule and information identifying the at least one second protocol data unit processing rule to the user plane function.

[0069] Apparatus comprising: generating circuitry for generating at least one first quality of service parameter for an application service flow based on at least one first quality of service requirement for protocol data units belonging to a protocol data unit set, and at least one second quality of service parameter for the application service flow based on at least one second quality of service requirement for protocol data units not belonging to a protocol data unit set; and sending circuitry for sending information identifying the at least one first quality of service parameter and information identifying the at least one second quality of service parameter to a session management function.

[0070] Apparatus comprising: generating circuitry for generating quality of service requirement information for an application service flow; wherein the quality of service requirement information identifies at least one first quality of service requirement for protocol data units belonging to a protocol data unit set; and at least one second quality of service requirement for protocol data units not belonging to a protocol data unit set; and sending circuitry for sending the quality of service requirement information to a session management function.

[0071] Apparatus comprising: receiving circuitry for receiving a protocol data unit belonging to an application service flow; determining circuitry for determining whether the protocol data unit belongs to a protocol data unit set; and sending circuitry for, based on determining that the protocol data unit is not identifiable as belonging to a protocol data unit set, sending the protocol data unit to a radio access network node with header information linking the protocol data unit to a quality of service flow also comprising a protocol data unit determined as belonging to a protocol data unit set.

[0072] A non-transitory computer readable medium comprising instructions stored thereon which, when executed by at least one processor cause the at least one processor to perform the operations comprising: receiving information identifying at least one first protocol data unit processing rule and at least one second protocol data unit processing rule for protocol data units belonging to an application service flow, wherein the at least one first protocol data unit processing rule is for protocol data units determined to belong to a protocol data unit set; and the at least one second protocol data unit processing rule is for protocol data units determined to not belong to a protocol data unit set; and processing a protocol data unit

belonging to the application service flow according to the at least one first protocol data unit processing rule or according to the at least one second protocol data unit processing rule depending on whether or not the protocol data unit is determined to belong to a protocol data unit set.

[0073] A non-transitory computer readable medium comprising instructions stored thereon which, when executed by at least one processor cause the at least one processor to perform the operations comprising: receiving information identifying at least one first quality of service parameter for protocol data units belonging to an application service flow and belonging to a protocol data unit set, and information identifying at least one second quality of service parameter for protocol data units belonging to the application service flow and not belonging to a protocol data unit set; generating at least one first protocol data unit processing rule for a user plane function based on the at least one first quality of service parameter, and generating at least one second protocol data unit processing rule for the user plane function based on the at least one second quality of service parameter; and sending information identifying the at least one first protocol data unit processing rule and information identifying the at least one second protocol data unit processing rule to the user plane function.

[0074] A non-transitory computer readable medium comprising instructions stored which, when executed by at least one processor cause the at least one processor to perform the operations comprising: generating at least one first quality of service parameter for an application service flow based on at least one first quality of service requirement for protocol data units belonging to a protocol data unit set, and at least one second quality of service parameter for the application service flow based on at least one second quality of service requirement for protocol data units not belonging to a protocol data unit set; and sending information identifying the at least one first quality of service parameter and information identifying the at least one second quality of service parameter to a session management function.

[0075] A non-transitory computer readable medium comprising instructions stored which, when executed by at least one processor cause the at least one processor to perform the operations comprising: generating quality of service requirement information for an application service flow; wherein the quality of service requirement information identifies at least one first quality of service requirement for protocol data units belonging to a protocol data unit set; and at least one second quality of service requirement for protocol data units not belonging to a protocol data unit set; and sending the quality of service requirement information to a session management function.

[0076] A computer readable medium comprising instructions stored thereon which, when executed by at least one processor cause the at least one processor to perform the operations comprising: receiving a protocol data unit belonging to an application service flow; determining whether the protocol data unit belongs to a protocol data unit set; and based on determining that the protocol data unit is not identifiable as belonging to a protocol data unit set, sending the protocol data unit to a radio access network node of the wireless communication network with header information linking the protocol data unit to a quality of service flow also comprising a protocol data unit determined as belonging to a protocol data unit set.

[0077] A non-transitory computer readable medium comprising instructions stored thereon which, when executed by at least one processor cause the at least one processor to perform the operations comprising: receiving information identifying at least one first protocol data unit processing rule and at least one second protocol data unit processing rule for protocol data units belonging to an application service flow, wherein the at least one first protocol data unit processing rule is for protocol data units determined to belong to a protocol data unit set; and the at least one second protocol data unit processing rule is for protocol data units determined to not belong to a protocol data unit set; and processing a protocol data unit belonging to the application service flow according to the at least one first protocol data unit processing rule or according to the at least one second protocol data unit processing rule depending on whether or not the protocol data unit is determined to belong to a protocol data unit set.

[0078] A non-transitory computer readable medium comprising instructions stored thereon which, when executed by at least one processor cause the at least one processor to perform the operations comprising: receiving information identifying at least one first quality of service parameter for protocol data units belonging to an application service flow and belonging to a protocol data unit set, and information identifying at least one second quality of service parameter for protocol data units belonging to the application service flow and not belonging to a protocol data unit set; generating at least one first protocol data unit processing rule for a user plane function based on the at least one first quality of service parameter, and generating at least one second protocol data unit processing rule for the user plane function based on the at least one second quality of service parameter; and sending information identifying the at least one first protocol data unit processing rule and information identifying the at least one second protocol data unit processing rule to the user plane function.

[0079] A non-transitory computer readable medium comprising program instructions stored thereon for performing: generating at least one first quality of service parameter for an application service flow based on at least one first quality of service requirement for protocol data units belonging to a protocol data unit set, and at least one second quality of service parameter for the application service flow based on at least one second quality of service requirement for protocol data units not belonging to a protocol data unit set; and sending information identifying the at least one first quality of service parameter and information identifying the at least one second quality of service parameter to a session management function.

[0080] A non-transitory computer readable medium comprising program instructions stored thereon for performing: generating quality of service requirement information for an application service flow; wherein the quality of service requirement information identifies at least one first quality of service requirement for protocol data units belonging to a protocol data unit set; and at least one second quality of service requirement for protocol data units not belonging to a protocol data unit set; and sending the quality of service requirement information to a session management function.

[0081] A non-transitory computer readable medium comprising program instructions stored thereon for performing: receiving a protocol data unit belonging to an application service flow; determining whether the protocol data unit belongs to a protocol data unit set; and based on determining that the protocol data unit is not identifiable as belonging to a protocol data unit set, sending the protocol data unit to a radio access network node of the wireless communication network with header information linking the protocol data unit to a quality of service flow also comprising a protocol data unit determined as belonging to a protocol data unit set.

[0082] A computer program comprising computer executable code which when run on at least one processor is configured to cause an apparatus to: receive information identifying at least one first protocol data unit processing rule and at least one second protocol data unit processing rule for protocol data units belonging to an application service flow, wherein the at least one first protocol data unit processing rule is for protocol data units determined to belong to a protocol data unit set; and the at least one second protocol data unit processing rule is for protocol data units determined to not belong to a protocol data unit set; and process a protocol data unit belonging to the application service flow according to the at least one first protocol data unit processing rule or according to the at least one second protocol data

unit processing rule depending on whether or not the protocol data unit is determined to belong to a protocol data unit set.

[0083] A computer program comprising computer executable code which when run on at least one processor is configured to cause an apparatus to: receive information identifying at least one first quality of service parameter for protocol data units belonging to an application service flow and belonging to a protocol data unit set, and information identifying at least one second quality of service parameter for protocol data units belonging to the application service flow and not belonging to a protocol data unit set; generate at least one first protocol data unit processing rule for a user plane function based on the at least one first quality of service parameter, and generate at least one second protocol data unit processing rule for the user plane function based on the at least one second quality of service parameter; and send information identifying the at least one first protocol data unit processing rule and information identifying the at least one second protocol data unit processing rule to the user plane function.

[0084] A computer program comprising computer executable code which when run on at least one processor is configured to cause an apparatus to: generate at least one first quality of service parameter for an application service flow based on at least one first quality of service requirement for protocol data units belonging to a protocol data unit set, and at least one second quality of service parameter for the application service flow based on at least one second quality of service requirement for protocol data units not belonging to a protocol data unit set; and send information identifying the at least one first quality of service parameter and information identifying the at least one second quality of service parameter to a session management function.

[0085] A computer program comprising computer executable code which when run on at least one processor is configured to cause an apparatus to: generate quality of service requirement information for an application service flow; wherein the quality of service requirement information identifies at least one first quality of service requirement for protocol data units belonging to a protocol data unit set; and at least one second quality of service requirement for protocol data units not belonging to a protocol data unit set; and send the quality of service requirement information to a session management function.

[0086] A computer program comprising computer executable code which when run on at least one processor is configured to cause an apparatus to: receive a protocol data unit belonging to an application service flow; determine whether the protocol data unit belongs to a protocol data unit set; and based on determining that the protocol data unit is not

identifiable as belonging to a protocol data unit set, send the protocol data unit to a radio access network node with header information linking the protocol data unit to a quality of service flow also comprising a protocol data unit determined as belonging to a protocol data unit set.

[0087] In the above, many different aspects have been described. It should be appreciated that further aspects may be provided by the combination of any two or more of the aspects described above.

[0088] Various other aspects are also described in the following detailed description and in the attached claims.

BRIEF DESCRIPTION OF THE FIGURES

[0089] Some example embodiments will now be described in further detail, by way of example only, with reference to the following examples and accompanying drawings, in which:

[0090] Figure 1 shows a representation of an example wireless communication network to which some example embodiments may be applied;

[0091] Figure 2 shows a representation of an example of control plane signalling (control plane messages) between the application function (AF), 5G core (5GC) network, Next Generation Radio Access Network (NG-RAN) and user equipment (UE) of Figure 1 according to some example embodiments;

[0092] Figure 3 shows a representation of operations performed by the user plane function of Figure 1 according to an example embodiment;

[0093] Figure 4 shows a representation of another example of control plane signalling (control plane messages) between the AF, 5GC, NG-RAN and UE of Figure 1 according to some example embodiments;

[0094] Figure 5 shows a representation of operations performed by the user plane function of Figure 1 according to some other example embodiments;

[0095] Figure 6 shows a representation of operations performed by the user plane function of Figure 1 according to some other example embodiments;

[0096] Figure 7 shows a representation of an example of apparatus for the network functions of the RAN or 5GC of Figure 1 according to some example embodiments;

[0097] Figure 8 shows a representation of an example of apparatus for the UE of Figure 1 according to some example embodiments; and

[0098] Figure 9 shows a representation of an example of non-volatile memory media.

DETAILED DESCRIPTION

[0099] By way of example, the following description focusses on the example of a wireless communications network operating according to a radio access technology, such as 5G or NR, but the underlying methods disclosed herein may also be applicable to wireless communication networks operating according to other radio access technologies, such as 6G or the like.

[0100] Fig. 1 shows a simple representation of one example of a wireless communication network comprising a 5G system. The 5G system (5GS) includes a user equipment (UE), a next generation radio access network (NG-RAN), and a 5G core network (5GC). Although the 5GS shown in Figure 1 only shows one UE and one RAN, in some implementations, the 5GS may include multiple UEs and multiple RANs. All the units shown in Figure 1 are logical units. The connections shown in Figure 1 are logical connections; the actual physical connections may be different.

[0101] A 5G core network (5GC) may comprise additional instances of the network functions shown in Figure 1.

[0102] The core network provides connections between the user equipment (UE)) and one or more data networks (DN) via a Next Generation Radio Access Network (NG-RAN) comprising radio access network nodes, such as a gNB (gNodeB) or eNB.

[0103] A radio access network node (e.g., gNB) is (i) connected to a user plane function (UPF) of the 5GC, for routing and forwarding data packets received from the UE and destined for the UE and for providing connectivity of the UE to the one or more data networks (DN). The one or more data networks may include a packet data network.

[0104] The term “user equipment” (UE) may refer to any type of wireless communication device.

[0105] The UE may be a mobile or static device (e.g. a portable or non-portable computing device) including, but not limited to, the following types of devices: mobile phone, smartphone, personal digital assistant (PDA), handset, device using a wireless modem (alarm or measurement device, etc.), laptop and/or touch screen computer, tablet, game console, notebook, Virtual Reality device, Augmented Reality device, Mixed Reality device, other Extended Reality device and multimedia device. It should be appreciated that a UE may also be a nearly exclusive uplink only device, of which an example is a camera or video camera loading images or video clips to a network. A UE may also be a wireless communication device having capability to operate in Internet of Things (IoT) network which is a scenario in

which objects are provided with the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction, e.g., to be used in smart power grids and connected vehicles. The UE may also utilise cloud. In some applications, a UE may comprise a user portable device with radio parts (such as a watch, earphones, extended reality headset or eyeglasses) and the computation is carried out in the cloud.

[0106] The NG-RAN may include one or more radio access nodes (e.g., gNB). A radio access node (e.g., gNB) may include multiple input – multiple output (MIMO) antennas, and the NG-RAN may include large numbers of RAN nodes (e.g., gNBs) including macro RAN nodes operating in co-operation with smaller RAN nodes and employing a variety of radio technologies depending on service needs, use cases and/or spectrum available. A 5GS may be used for communications including video streaming, augmented reality, different ways of data sharing and various forms of machine type applications (such as (massive) machine-type communications (mMTC), including vehicular safety, different sensors and real-time control). A 5GS may employ multiple frequency bands, e.g., below 6GHz or above 24 GHz, cmWave and mmWave, and may also be integrable with existing legacy radio access technologies, such as LTE. Integration with LTE may be implemented, as a system, where macro coverage is provided by LTE and 5G radio interface access comes from small cells by aggregation to the LTE. In other words, a 5GS may support both inter-RAT operability (such as LTE-5G) and inter-RI operability (inter-radio interface operability, such as below 6GHz – cmWave, 6 or above 24 GHz – cmWave and mmWave). 5G networks may employ network slicing, in which multiple independent and dedicated virtual sub-networks (network instances) may be created within the same infrastructure to run services that have different requirements on latency, reliability, throughput and mobility.

[0107] The 5GC has a service-based architecture (SBA) for the control plane as shown and described in Figure 4.2.3-1 of 3GPP TS 23.501 and communication between network functions in the control plane is performed using Service Based Interfaces (SBIs). Application Programming Interfaces (APIs) are used for the SBIs.

[0108] Some protocol data units of an application service flow may belong to a PDU set comprising one or more PDUs. For example, a PDU Set for an application service flow may comprise one or more PDUs carrying the payload of one unit of information generated at the application level (e.g., a video frame or video slice for eXtended Reality (XR) services). The same application service flow may also contain PDUs for which classification (i.e. categorisation or identification) as belonging to a PDU Set is not appropriate or not needed, such as real-time transport control protocol (RTCP) PDUs (to control real-time transport

protocol (RTP) flow(s)), or PDUs that represent additional media components such as an audio stream where a unit of information generated at the application level may always fit into a single PDU. More generally, the application service flow may contain a variety of PDUs that do not conform to a template, algorithm or other methodology used by the UPF to determine that a PDU belongs to a PDU Set. All these PDUs (PDU-set PDUs and non-PDU-set PDUs) may be multiplexed into one single application service flow, for instance using the various Internet Engineering Task Force (IETF) protocol multiplexing options that cover, e.g., RTP with multiple media streams; RTCP; Simple Traversal of User Datagram Protocol (UDP) Through Network Address Translators (NATs) (STUN); Datagram Transport Layer Security (DTLS) Extension to Establish Keys for the Secure Real-time Transport Protocol (SRTP) (DTLS-SRTP); and Web Real-Time Communication (WebRTC) data channel.

[0109] Figure 2 shows a representation of an example of control plane signalling (control plane messages) sent between the AF, 5GC, NG-RAN, UE of Figure 1 according to some example embodiments; and Figure 3 shows a representation of an example of operations performed by UPF of Figure 1 according to some example embodiments.

Referring to Figure 2, a policy control function (PCF) generates (or is configured to generate) at least first and second policy and charging control rules (PCC rules) for an application service flow between a data network (DN) and a user equipment (UE) via at least one UPF instance of the 5G core and a radio access network (RAN) node. The first PCC rule, denoted PCC-1, is for PDUs of the application service flow that belong to PDU Sets; and the second PCC rule, denoted PCC-2, is for PDUs of the application service flow that do not belong to a PDU Set. The first and second PCC rules contain or include the same Service Flow Template. The first and second PCC rules may be generated based on information, received from an application function (AF) (optionally via a network exposure function NEF), indicative of one or more quality of service (QoS) requirements (such as e.g. PDU Set delay budget, PDU Set error rate etc.) for PDUs of the application service flow that belong to PDU sets, and information indicative of one or more QoS requirements (such as e.g. packet delay budget, packet error rate etc.) for PDUs of the application service flow that do not belong to a PDU Set. According to one example variation, the AF sends (or is configured to send), at 100, a QoS request that includes information indicative of one or more quality of service (QoS) requirements (such as e.g. PDU Set delay budget, PDU Set error rate etc.) for PDUs of the application service flow that belong to PDU sets, and information indicative of one or more QoS requirements (such as e.g. packet delay budget, packet error rate etc.) for PDUs of

the application service flow that do not belong to a PDU Set. According to one example variation, the QoS requirements are determined by the PCF based on a local configuration of the PCF, where local configuration is performed by a network operator, for example via a management interface to the PCF. The configuration may be associated with Network Slice Selection Assistance Information (NSSAI), Data Network Name (DNN), UE or Subscriber ID, UE or Subscriber Group in which case it can be applied without explicit input from an Application Function.

[0110] The PCF sends at 200 the two PCC rules (e.g., the first PCC rule, PCC-1 and the second PCC rule, PCC-2) to the SMF instance associated with the application service flow.

[0111] The SMF receives the two PCC rules (e.g., the first PCC rule PCC-1 and the second PCC rule) PCC-2 and maps the two PCC rules to respective QoS flows (e.g., maps the first PCC rule PCC-1 to QoS flow 1 and maps the second PCC rule PCC-2 to QoS flow 2. Each QoS flow is characterized by a QoS Profile, UPF instructions for the UPF instance involved in the application service flow, and QoS Rules. SMF sends at 300 UPF instructions to UPF, sends at 400 QoS profiles for the QoS flows to the NG-RAN node (MESSAGING 400 of Figure 2); and sends at 500 the QoS rules for the QoS flows to the UE via the NG-RAN node. The UPF instructions, QoS profile for the QoS flows, and the QoS rules for the QoS flows sent by the SMF at 300, 400, 500 may be sent by the SMF in any order.

[0112] QoS flow 1 is used for PDUs belonging to PDU Sets; and RAN applies the PDU Set QoS Parameters (e.g., PDU Set Error Rate (PSER), PDU Set Delay Budget (PSDB) and PDU-Set Integrated Handing Indication (PSIHI) specified in the QoS profile 1 to PDUs classified by UPF as belonging to PDU sets. QoS Flow 2 is used for PDUs not belonging to a PDU Set; and the RAN applies QoS Parameters specified in the QoS Profile 2 (PDU Error Rate (PER) and PDU PDB) to PDUs classified by UPF as not belonging to a PDU Set. Additional QoS parameters and characteristics may be different between the two QoS flows.

[0113] SMF sends at 300 the UPF instructions to the UPF instance for the application service flow over the N4 interface. The UPF instructions comprise first and second packet detection rules PDR-1 and PDR-2 for the application service flow. In this example, a packet detection rule (PDR) has a format as set out at 3GPP 23.501 clause 5.8.2.11.3. The “Source interface”, “UE IP address”, “Network instance”, “CN tunnel info”, “Packet Filter Set”, “Application identifier”, “QoS Flow ID”, “Ethernet PDU Session Information” and “Framed Route Information” parts of the “Packet Detection Information” attribute have the same content for both PDR-1 and PDR-2. The PDR-1 for PDUs that belong to a set of PDUs additionally

includes an indicator that PDR-1 applies to PDUs that are classified by the UPF as belonging to a PDU set. The indicator may e.g., take the form of a flag indicating that PDU Set information is to be sent to the NG-RAN node, or the indicator may be the presence of (or inclusion of) information in PDR-1 used by the UPF to enable PDU Set processing, such as a “Protocol Description” providing information about protocol headers and payload formats containing the information based on which the UPF can identify and form the PDU Sets. Depending on the specificity of this information the UPF may treat it either as a mere hint or as a rule. One effect of this indicator is that the applicability of this PDR-1 to a PDU is dependent on the UPF classifying the PDU as belonging to a PDU set (i.e., the UPF identifying that the PDU belongs to a PDU set). The applicability of PDR-2 to a PDU is dependent on the UPF not classifying the PDU as belonging to a PDU set (i.e., the UPF not identifying that PDU belongs to a PDU set). PDR-1 is above PDR-2 in the precedence order in which the PDRs are to be checked against downlink PDUs by UPF. This precedence order may be implemented by SMF assigning to PDR-1 a higher PDR precedence value than SMF assigns to PDR-2. Alternatively, UPF may be configured with a rule according to which any PDR that is indicated to be applicable to PDU-set PDUs is treated by UPF as having a higher precedence than any PDR that is not indicated to be applicable to PDU-set PDUs. According to this alternative option, an explicit precedence value is not required to be provided by the SMF.

[0114] PDR-1 and PDR-2 each include information about at least one PDU processing rule. In this example, the PDU processing rules comprise information identifying: a forwarding action rule, a usage reporting rule, and a QoS enforcement rule.

[0115] Referring to the format set out at above-mentioned 3GPP 23.501 clause 5.8.2.11.3. one or more of the “Forwarding Action Rule ID”, “List of Usage Reporting Rule ID(s)” and “List of QoS Enforcement Rule ID(s)” may have different values between PDR-1 and PDR-2.

[0116] UPF receives PDR-1 and PDR-2 from SMF. UPF determines whether PDR-1 is applicable to a downlink PDU (OPERATION 600 of Figure 3). If the UPF determines that PDR-1 applies to the PDU (i.e., PDU meets all the conditions specified by the packet detection information attribute of PDR-1, and the PDU is classified by UPF (i.e., identified by the UPF) as belonging to a PDU set), UPF applies to the PDU the PDU processing rules identified in PDR-1. Determining by UPF whether a PDU belongs to a PDU set may be done by UPF by inspecting the content and pattern of the application traffic flow in an

implementation specific manner. For this the UPF may or may not utilize the “Protocol Description” or any other information provided by the SMF.

[0117] If UPF determines that PDR-1 does not apply to the PDU (i.e. the PDU does not meet all the conditions specified by the packet detection information attribute of PDR-1 and/or the PDU is not classified by UPF as belonging to a PDU set), UPF determines whether PDR-2 (next in the PDR precedence order after PDR-1) is applicable to the PDU (OPERATION 610 of Figure 3). If the PDU meets all the conditions specified by the packet detection information attribute of PDR-2, UPF applies to the PDU the PDU processing rules identified in PDR-2. On the other hand, if UPF determines that the PDU does not meet all the conditions specified by the packet detection information attribute of PDR-2, UPF moves onto the next PDR in the PDR precedence order. In this example, there are only two PDRs for this application service flow, and a determination that PDR-2 is not applicable to the PDU indicates that the PDU does not belong to this application service flow (and may belong to a different application service flow).

[0118] According to one variation of the example embodiment illustrated by Figures 2 and 3: instead of generating two PCC rules for the application service flow, PCF generates for the application service flow a single PCC rule that comprises information identifying (e.g., references via a 5G QoS Identifier (5QI)) both PDU Set QoS Parameters (e.g. PSER, PSDB) for PDUs belonging to a PDU set, and PDU QoS parameters (PDB, PER) for PDUs not belonging to any PDU set. SMF maps the single PCC Rule to two QoS Flows for the same application service flow, and sends two PDR rules to UPF for the same application service flow.

[0119] Figure 4 shows a representation of another example of control plane signalling (e.g., control plane messages) between the AF, 5GC, NG-RAN, UE of Figure 1 according to some example embodiments; and Figure 5 shows a representation of another example of operations by UPF of Figure 1 according to some example embodiments.

[0120] Referring to Figure 4, a policy control function (PCF) generates at least first and second policy and charging control rules (PCC rules) for an application service flow (traffic flow) between a data network (DN) and a user equipment (UE) via at least one UPF instance of the 5G core, and a radio access network (RAN). The first PCC rule PCC-1 is for PDUs of the application service flow that belong to PDU sets; and the second PCC rule is for PDUs of the application service flow that do not belong to a PDU set. The two PCC rules contain the same Service Flow Template. The two PCC rules may be generated based on information received from an application function (AF) (via network exposure function NEF) about one

or more quality of service (QoS) requirements (such as e.g. (PDU Set delay budget, PDU Set error rate etc.) for PDUs of the application service flow that belong to PDU sets, and about one or more QoS requirements (such as e.g. packet delay budget, packet error rate etc.) for PDUs of the application service flow that do not belong to a PDU Set. According to one example variation, the AF sends (or is configured to send), at 1000, a QoS request that includes information indicative of one or more quality of service (QoS) requirements (such as e.g. PDU Set delay budget, PDU Set error rate etc.) for PDUs of the application service flow that belong to PDU sets, and information indicative of one or more QoS requirements (such as e.g. packet delay budget, packet error rate etc.) for PDUs of the application service flow that do not belong to a PDU Set. According to one example variation, the QoS requirements are determined by the PCF based on a local configuration of the PCF.

[0121] The PCF sends at 2000 the two PCC rules to the SMF instance associated with the application service flow.

[0122] The SMF receives the two PCC rules PCC-1 and PCC-2 and maps them to respective QoS flows: QoS flow 1 and QoS flow 2. Each QoS flow is characterized by a QoS Profile, UPF instructions for the UPF instance involved in the application service flow, and QoS Rules.

[0123] SMF sends at 3100 the UPF instructions to UPF; sends at 4000 the QoS profiles for the QoS flows to a NG-RAN node; and sends at 5000 the QoS rules for the QoS flows to the UE via the NG-RAN node. The UPF instructions, QoS profile for the QoS flows, and the QoS rules for the QoS flows 3100, 4000 and 5000 may be sent by SMF in any order.

[0124] QoS flow 1 is used for PDUs classified (i.e., identified) by the UPF instance involved in the application service flow as belonging to PDU Sets; and the NG-RAN applies the PDU Set QoS Parameters (e.g., PSER, PSDB and PSIHI) specified in the QoS profile 1 to PDUs classified (i.e., identified) by UPF involved in the application service flow as belonging to PDU sets. QoS Flow 2 is used for PDUs classified (i.e., identified) by the UPF involved in the application service flow as not belonging to a PDU Set; and the NG-RAN node applies QoS Parameters specified in the QoS Profile 2 (PER and PDB) to PDUs classified (i.e., identified) by the UPF involved in the application service flow as not belonging to a PDU Set. Additional QoS parameters and characteristics may be different between the two QoS flows.

[0125] SMF sends the UPF instructions to the UPF instance for the application service flow over the N4 interface (OPERATION 300 of Figure 4). The UPF instructions comprise a

single PDR for the application service flow. In this example, the packet detection rule (PDR) comprises a format as set out at 3GPP TS 23.501 V17.6.0 clause 5.8.2.11.3.

[0126] The single PDR for an application service flow includes an identifier of a Forwarding Action Rule (referred to as the “Forwarding Action Rule ID”), identifiers of Usage Reporting Rules (referred to as a “List of Usage Reporting Rule ID(s)”) and identifiers of QoS Enforcement Rules (referred to as “List of QoS Enforcement Rule ID(s)”) of the structure set out at 3GPP TS 23.501 clause 5.8.2.11.3. The single PDR additionally includes (i) “Protocol Description” indicating the service protocol used in the application service flow e.g. H.264/RTP, SRTP; (ii) “FAR Rule ID for PDU Set PDUs” indicating an identifier of a forwarding action rule (referred to as forwarding action rule ID) that identifies a forwarding action; (iii) identifier(s) of URR(s) for PDU Set PDUs (referred to as “URR ID(s) for PDU Set PDUs”) that identify a measurement action; and (iv) identifiers of QER rules (referred to as QER Rule ID(s)) for PDU Set identifying a QoS enforcement action. These (i) to (iv) may be included in the single PDR as a single clustered “PDU Set Processing” attribute of the single PDR, or may be included in the single PDR in the form of a plurality of separate attributes.

[0127] The FAR (forwarding action rule), URR (usage reporting rule) and QER (QoS enforcement rule) of the PDU Set Processing attribute are PDU processing rules that are used (instead of the FAR, URR and QER identified elsewhere in the PDR) for processing PDUs that the UPF instance involved in the application service flow determines belong to a PDU Set.

[0128] One or more of the PDU processing rules for PDUs belonging to a PDU set (indicated by the “Forwarding Action Rule ID”, “List of Usage Reporting Rule ID(s)” and “List of QoS Enforcement Rule ID(s)” attributes) may be different to one or more of the PDU processing rules for PDUs not belonging to a PDU set (indicated by the “FAR Rule ID for PDU Set PDUs”, “URR ID(s) for PDU Set PDUs” and “QER Rule ID(s) for PDU Set” parts of the “PDU Set Processing” attribute). In some example embodiments, each PDR (e.g., PDR-1 and PDR-2) comprises one or more PDU processing rules. Examples of such PDU processing rules are a FAR, a QER, and a URR.

Shown below is an example of a structure for a single PDR for an application service flow. The structure of a single PDR for an application service flow includes attributes and a description of each respective attribute, including an additional clustered attribute comprised of the PDU processing rules for PDUs not belonging to a PDU set.

Attribute		Description
N4 Session ID		Identifies the N4 session associated to this PDR..
Rule ID		Unique identifier to identify this rule.
Precedence		Determines the order, in which the detection information of all rules is applied.
Packet Detection Information.	Source interface	Contains the values “access side”, “core side”, “SMF”, “N6-LAN”, “5G VN internal”.
	UE IP address	One IPv4 address and/or one Ipv6 prefix with prefix length
	Network instance	Identifies the Network instance associated with the incoming packet.
	CN tunnel info	CN tunnel info on N3, N9 interfaces, i.e. F-TEID.
	Packet Filter Set	Details see clause 5.7.6.
	Application identifier	
	QoS Flow ID	Contains the value of 5QI or non-standardized QFI.
	Ethernet PDU Session Information	Refers to all the (DL) Ethernet packets matching an Ethernet PDU session, as further described in clause 5.6.10.2 and in TS 29.244 [65].
	Framed Route Information	Refers to Framed Routes defined in clause 5.6.14.
Packet replication and detection carry on information	Packet replication skip information	Contains UE address indication or N19/N6 indication. If the packet matches the packet replication skip information, i.e. source address of the packet is the UE address or the packet has been received on the interface in the packet replication skip information, the UP function neither creates a copy of the packet nor applies the corresponding processing (i.e. FAR, QER, URR). Otherwise, the UPF performs a copy and applies the corresponding processing (i.e. FAR, QER, URR).
NOTE 6	Carry on indication	Instructs the UP function to continue the packet detection process, i.e. lookup of the other PDRs.
Outer header removal		Instructs the UP function to remove one or more outer header(s) (e.g., IP+UDP+GTP, IP + possibly UDP, VLAN tag), from the incoming packet.
Forwarding Action Rule ID		The Forwarding Action Rule ID identifies a forwarding action that has to be applied.
Multi-Access Rule ID		The Multi-Access Rule ID identifies an action to be applied for handling forwarding for a MA PDU Session.
List of Usage Reporting Rule ID(s)		Every Usage Reporting Rule ID identifies a measurement action that has to be applied.
List of QoS Enforcement Rule ID(s)		Every QoS Enforcement Rule ID identifies a QoS enforcement action that has to be applied.

PDU Set Processing	Protocol Description	Indicates service protocol used by the flow e.g., H.264/RTP, SRTP
	FAR Rule ID for PDU Set PDUs	The Forwarding Action Rule ID identifies a forwarding action that has to be applied for PDUs that are determined to belong to a PDU Set
	URR ID(s) for PDU Set PDUs	Every Usage Reporting Rule ID identifies a measurement action that has to be applied for PDUs that are determined to belong to a PDU Set
	QER Rule ID(s) for PDU Set	Every QoS Enforcement Rule ID identifies a QoS enforcement action that has to be applied for PDUs that are determined to belong to a PDU Set

[0129] The UPF instance for the application service flow receives this PDR from SMF. The UPF instance for the application service flow determines whether this PDR is applicable to a downlink PDU (OPERATION 620 of Figure 5). If the UPF instance for the application service flow determines that the PDU does not meet all the conditions specified by the packet detection information included in the PDR, the UPF instance for the application service flow moves onto the next PDR in the PDR precedence order. In this example, there is only one PDR for this application service flow; and a determination that the PDR does not apply to a PDU indicates that the PDU does not belong to this application service flow (and may belong to a different application service flow).

[0130] Otherwise, if UPF determines that the PDU meets all the conditions specified by the packet detection information included in the PDR, then the UPF instance for the application service flow determines if the PDU is classifiable (i.e., identifiable) as belonging to a PDU set (OPERATION 630 of Figure 5). Determining by the UPF instance for the application service flow whether a PDU belongs to a PDU set may be done, for example by detecting RTP/SRTP header or payload.

[0131] If the UPF instance for the for the application service flow determines that the PDU is classifiable (i.e., identifiable) as not belonging to a PDU set comprising one or more PDUs, the UPF instance for the for the application service flow processes the PDU according to at least one processing rule included in the single PDR. Examples of processing rules that may be included in the single PDR are the rules identified by the “Forwarding Action Rule ID”, “List of Usage Reporting Rule ID(s)” and “List of QoS Enforcement Rule ID(s)”,.

Otherwise, if the UPF instance for the for the application service flow determines that the PDU is classifiable (i.e., identifiable) as belonging to a PDU set comprising one or more PDUs, the UPF instance for the application service flow processes the PDU according to at least one processing rule included in the single PDR. Example of processing rules that may

be included in the single PDR are the rules identified by the "FAR Rule ID for PDU Set PDUs", "URR ID(s) for PDU Set PDUs" and "QER Rule ID(s) for PDU Set".

[0132] According to one variation of the example embodiment illustrated by Figures 4 and 5: instead of generating two PCC rules for the application service flow, the PCF generates for the application service flow a single PCC rule that comprises information identifying (e.g., references via 5QI) both PDU Set QoS Parameters (e.g., PSER, PSDB) for PDUs belonging to a PDU set, and PDU QoS parameters (PDB, PER) for PDUs not belonging to any PDU set. SMF maps the single PCC Rule to two QoS Flows for the same application service flow, and sends the single PDR rule to the UPF instance for the application service flow. In some example variations, the PCF generates for the application service flow a single PCC rule that comprises a 5QI which references or is associated with information identifying both PDU Set QoS Parameters (e.g., PSER, PSDB) for PDUs belonging to a PDU set, and PDU QoS parameters (PDB, PER) for PDUs not belonging to any PDU set.

[0133] Figure 6 shows operations performed by UPF according to further example embodiments.

[0134] In this example, the SMF sets up only one QoS flow when a (one) PCC rule is received from the PCF indicating that PDU Set processing is enabled. The UPF instance for the application service flow receives from SMF a PDR that activates PDU Set processing. The PDR contains, comprises, or includes packet detection information that allows the UPF instance for the application service flow to determine whether a PDU belongs to the application service flow for which the PDR is created. The PDR may contain, comprise, or includes "Protocol Description" information that informs the UPF of the service protocol (e.g., RTP header or payload) used by the application of the application service data flow. The PDR also identifies a rule (e.g., a parameter in a FAR, which is contained, comprised, or included in the PDR), according to which the UPF instance for the application service flow sends a PDU-set PDU (PDU classified (i.e., identified) by UPF as belonging to a PDU set) to NG-RAN with PDU Set Information in the GTP-U header of the packet by which UPF sends the PDU to NG-RAN node. In this example, the PDU Set Information has the format described at 3GPP TS 23.501 clause 5.37. Determining by UPF whether a PDU belongs to a PDU set may, for example, be done by the UPF by inspecting the content and pattern of the application service flow. For this the UPF instance for the application service flow may or may not utilize the "Protocol Description" or any other information provided by the SMF.

[0135] In this example, the PDU Set information sent to the NG-RAN node in the GTP-U header comprises the following: PDU Set Sequence Number; Indication of End PDU of the

PDU Set; PDU Sequence Number within a PDU Set; PDU Set Size in bytes; PDU Set Importance, which identifies the importance of a PDU Set within a QoS Flow. PDU Set Importance is the only one of these that differentiates PDU Sets according to the type of application/media layer attributes represented (e.g., a different importance value can be given to a PDU carrying an I-Frame versus a P-Frame). The NG-RAN node may use the PDU Set Importance for PDU Set level packet discarding in presence of congestion.

[0136] Based on the Packet Detection Information of the PDR, UPF determines that a PDR (received from SMF) is applicable to a downlink PDU (OPERATION 700). For example, the Packet Detection Information contains a packet filter set that is matched against the packet header of a received PDU.

[0137] UPF then determines whether the PDU belongs to a PDU set (OPERATION 710).

[0138] If the UPF determines that the PDU belongs to a PDU set (i.e. the PDU matches both the Packet Detection Information of the PDR and the UPF determines that the PDU belongs to a PDU Set based on the Protocol Description provided in the PDR and/or implementation specific means used by the UPF to classify (i.e., identify) a PDU as belonging to a PDU set), UPF sends the PDU to NG-RAN node in a GTP-U packet with GTP-U header including PDU set information (OPERATION 720). In some implementations, a classifier may be used to classify a PDU as belonging to a PDU set.

[0139] Otherwise, if the UPF determines that the PDU matches the Packet Detection Information attribute of the PDR and does not belong to a PDU set (i.e. the PDU matches both the Packet Detection Information of the PDR and the UPF determines that the PDU belongs to a PDU Set based on the Protocol Description provided in the PDR and/or implementation specific means used by the UPF to classify a PDU as belonging to a PDU set) the UPF sends the PDU (having unknown application-level attributes) to NG-RAN node in a GTP-U packet with a GTP-U header including default PDU set information determined by the UPF; and the NG-RAN node processes the PDU as a PDU-set PDU based on the PDU default set information (OPERATION 730). The UPF instance for the application service flow thus treats any such PDU as belonging to a (default) set comprising only a single PDU. As mentioned above PDU set information included in the GTP-U header may include the size of the PDU set; and in the case of the default set, the PDU set information indicates that the size of the PDU set (referred to herein as PDU set size) is one PDU.

[0140] PDUs of the default PDU Set are mapped to the same QoS flow as PDUs that are determined to belong to a PDU Set (i.e. PDUs that match both the Packet Detection Information of the PDR from SMF and for which the UPF determines that the PDU belongs

to a PDU Set based on the Protocol Description provided in the PDR from SMF and/or implementation specific means used by the UPF to classify a PDU as belonging to a PDU set).

[0141] With the operations by the UPF illustrated in Figure 6, all PDUs of an application service flow received at NG-RAN node from UPF have a GTP-U header with PDU Set information. The NG-RAN node can thus apply PDU Set QoS using PDU Set attributes (e.g., PSDB and PSER) to all the PDUs of the application service flow (including PDUs that UPF does not classify as belonging to a PDU set).

[0142] Figure 7 illustrates an example of an apparatus 1200 comprising or implementing a network function of the 5GC as illustrated on Figure 1. The apparatus 1200 may comprise at least one random access memory (RAM) 1211a, at least one read only memory (ROM) 1211b, at least one processor 1212, 1213 and an input/output interface 1214. The at least one processor 1212, 1213 may be coupled to the RAM 1211a and the ROM 1211b. The at least one processor 1212, 1213 may be configured to execute appropriate instructions of software code 1215. The software code 1215 may for example be software code of a network function of the 5GC, for example, software code of the PCF, SMF, UPF described herein. The software code 1215 of a network function comprises executable instructions, which when executed by the at least one processor 1212, 1213, causes the apparatus to perform one or more operations of the network function, for example, one or more of the operations of the PCF, SMF, or UPF described herein. The software code 1215 may for example be software code of the application function described herein, and the software of the application function comprises executable instructions, which when executed by the at least one processor 1212, 1213, causes the apparatus to perform the one or more operations of the application function described herein. The software code 1215 may be stored in the ROM 1211b. The apparatus 200 may be interconnected with another control apparatus 1200 controlling another function of the 5GC or an apparatus of the NG-RAN. In some embodiments, each network function of the 5GC is comprised or implemented in an apparatus 1200. In alternative embodiments, two or more network functions of the 5GC may be comprised or implemented in an apparatus 1200.

[0143] Figure 8 illustrates an example of the UE illustrated in Figure 1. The UE may receive signals over an air or radio interface 1307 via appropriate apparatus for receiving and may transmit signals via appropriate apparatus for transmitting radio signals. In Figure 8, transceiver apparatus is designated schematically by block 1306. The transceiver apparatus 1306 may be provided for example by means of a radio part and associated antenna

arrangement. The antenna arrangement may be arranged internally or externally to the mobile device. The UE may be provided with at least one processor 1301, at least one memory ROM 1302a, at least one RAM 1302b and other possible components 1303 for use in software and hardware aided execution of tasks it is designed to perform, including control of access to and communications with access systems and other communication devices. The at least one processor 1301 is coupled to the RAM 1302b and the ROM 1302a. The at least one processor 1301 may be configured to execute instructions of software code 1308. The execution of the instructions of the software code 1308 may for example allow the UE to perform one or more operations, including operations of the UE described herein. The software code 1308 may be stored in the ROM 1302a.

[0144] The processor, storage and other relevant control apparatus can be provided on an appropriate circuit board and/or in chipsets. This feature is denoted by reference 1304. The device may optionally have a user interface such as key pad 1305, touch sensitive screen or pad, combinations thereof or the like. Optionally one or more of a display, a speaker and a microphone may be provided depending on the type of the device.

[0145] Figure 9 shows a schematic representation of non-volatile memory media 1100a (e.g. computer disc (CD) or digital versatile disc (DVD)) and 1100b (e.g. universal serial bus (USB) memory stick) storing instructions and/or parameters 1102 which when executed by a processor allows the processor to perform one or more of the steps of the methods described previously.

[0146] It is to be noted that example embodiments may be implemented as circuitry, in software, hardware, application logic or a combination of software, hardware and application logic. In an example embodiment, the application logic, software or an instruction set is maintained on any computer-readable media. In the context of this document, a "computer-readable medium" may be any media or means that can contain, store, communicate, propagate or transport the instructions for use by or in connection with an instruction execution system, apparatus, or device, such as the base stations or user equipment of the above-described example embodiments.

[0147] As used in this application, the term "circuitry" refers to all of the following: (a) hardware- only circuit implementations (such as implementations in only analog and/or digital circuitry) and (b) to combinations of circuits and software (and/or firmware), such as (as applicable): (i) to a combination of processor(s) or (ii) to portions of processor(s)/software (including digital signal processor(s)), software, and memory(ies) that work together to cause an apparatus, such as the user equipment or base stations of the above-described

embodiments, to perform various functions) and (c) to circuits, such as a microprocessor(s) or a portion of a microprocessor(s), that require software or firmware for operation, even if the software or firmware is not physically present. This definition of 'circuitry' applies to all uses of this term in this application, including in any claims. As a further example, as used in this application, the term "circuitry" would also cover an implementation of merely a processor (or multiple processors) or portion of a processor and its (or their) accompanying software and/or firmware. The term "circuitry" would also cover, for example and if applicable to the particular claim element, a baseband integrated circuit or applications processor integrated circuit for a mobile phone or a similar integrated circuit in server, a cellular network device, or other network device.

[0148] The features, advantages, and characteristics described herein can be combined in any suitable manner in one or more example embodiments. One skilled in the relevant art will recognize that such example embodiments can be practiced without one or more of the specific features or advantages of a particular embodiment. In other instances, additional features and advantages can be recognized in certain embodiments that may not be present in all example embodiments. One having ordinary skill in the art will readily understand that the example embodiments as discussed above may be practiced with steps in a different order, and/or with hardware elements in configurations which are different than those which are disclosed. Therefore, although some embodiments have been described based upon these example embodiments, it would be apparent to those of skill in the art that certain modifications, variations, and alternative constructions would be apparent, while remaining within the spirit and scope of example embodiments.

Claims:

1. A method for a user plane function of a wireless communication network, the method comprising:

receiving information identifying at least one first protocol data unit processing rule and at least one second protocol data unit processing rule for protocol data units belonging to an application service flow, wherein the at least one first protocol data unit processing rule is for protocol data units determined by the user plane function to belong to a protocol data unit set; and the at least one second protocol data unit processing rule is for protocol data units determined by the user plane function to not belong to a protocol data unit set; and

processing a protocol data unit belonging to the application service flow according to the at least one first protocol data unit processing rule or according to the at least one second protocol data unit processing rule depending on whether or not the protocol data unit is determined by the user plane function to belong to a protocol data unit set.

2. The method according to claim 1, further comprising receiving from a session management function a first packet detection rule comprising information identifying the at least one first protocol data unit processing rule and receiving from the session management function a second packet detection rule comprising information identifying the at least one second protocol data unit processing rule.

3. The method according to claim 2, wherein the first packet detection rule comprises one or more of: information identifying a forwarding action rule specifying the addition of protocol data unit set information to a message header for sending a protocol data unit by the user plane function to a radio access network node of the communications system; information identifying a quality of service enforcement rule specifying a quality of service flow identifier; information identifying a usage reporting rule.

4. The method according to claim 2 or claim 3, wherein application of the first packet detection rule and application of the second packet detection rule to a protocol data unit are both dependent on user plane function determining that the protocol data unit belongs to the application service flow; wherein application of the first packet detection rule to a protocol data unit is additionally dependent on the user plane function determining that the protocol data unit belongs to a protocol data unit set; and application of the second packet detection

rule to a protocol data unit is not additionally dependent on the user plane function determining that the protocol data unit belongs to a protocol data unit set; and wherein processing the protocol data unit comprises checking whether the first packet detection rule is applicable to the protocol data unit, and only checking whether the second packet detection rule is applicable to the protocol data unit in the event that the first packet detection rule is not applicable to the protocol data unit.

5. The method according to any of claims 2 to 4, wherein the determination of whether a protocol data unit belongs to a protocol data unit set is based on protocol description information received from the session management function as part of the first packet detection rule.

6. The method according to claim 1, comprising receiving from a session management function a single packet detection rule comprising information identifying the at least one first protocol data unit processing rule and information identifying the at least one second protocol data unit processing rule.

7. The method according to claim 6, comprising: based on determining by the user plane function that the single packet detection rule is applicable to a protocol data unit, determining, by the user plane function, whether the protocol data unit belongs to a protocol data unit set; and based on determining by the user plane function that the protocol data unit belongs to a protocol data unit set, using the at least one first protocol data unit processing rule for processing the protocol data unit.

8. The method according to claim 7, wherein the at least one first protocol data unit processing rule comprises at least one of: information identifying a forwarding action rule specifying the addition of protocol data unit set information to a message header for sending a protocol data unit by the user plane function to a radio access network of the communications system; information identifying a quality of service enforcement rule specifying a quality of service flow identifier; information identifying a usage report rule.

9. The method according to claim 6, comprising: based on determining by the user plane function that the single packet detection rule is applicable to a protocol data unit, determining whether the protocol data unit belongs to a protocol data unit set; and based on determining

by the user plane function that the protocol data unit does not belong to a protocol data unit set, using the at least one second protocol data unit processing rule for processing the protocol data unit.

10. The method according to any of claims 6 to 9, wherein the determination of whether a protocol data unit belongs to a protocol data unit set is based on protocol description information received from the session management function as part of the single packet detection rule.

11. A method for a session management function of a wireless communication network, the method comprising:

receiving by a information identifying at least one first quality of service parameter for protocol data units belonging to an application service flow and belonging to a protocol data unit set, and information identifying at least one second quality of service parameter for protocol data units belonging to the application service flow and not belonging to a protocol data unit set;

generating by the session management function at least one first protocol data unit processing rule for a user plane function based on the at least one first quality of service parameter, and generating by the session management function at least one second protocol data unit processing rule for the user plane function based on the at least one second quality of service parameter; and

sending by the session management function information identifying the at least one first protocol data unit processing rule and information identifying the at least one second protocol data unit processing rule to the user plane function.

12. The method according to claim 11, comprising receiving by the session management function a first policy and charging control rule comprising information identifying at least one first quality of service parameter; and receiving by the session management function a second policy and charging control rule comprising information identifying the at least one second quality of service parameter; and wherein the first and second policy and charging control rules share a service flow template.

13. The method according to claim 11, comprising receiving by the session management function a single policy and charging control rule comprising information identifying the at

least one first quality of service parameter and information identifying the at least one second quality of service parameter.

14. The method according to any of claims 11 to 13, comprising sending to the user plane function a first packet detection rule comprising information identifying the at least one first protocol data unit processing rule; and sending to the user plane function a second packet detection rule comprising information identifying the at least one second protocol data unit processing rule.

15. The method according to any of claims 11 to 14, comprising sending to the user plane function a single packet detection rule comprising information identifying the at least one first protocol data unit processing rule and information identifying the at least one second protocol data unit processing rule.

16. The method according to any of claims 11 to 15, comprising:

setting up a first quality of service flow based on the at least one first quality of service parameter, and a second quality of service flow based on the at least one second quality of service parameter;

sending information identifying at least one first quality of service rule for the first quality of service flow to a user equipment associated with the application service flow, and sending information identifying at least one second quality of service rule for the second quality of service flow to the user equipment associated with the application service flow; and

sending information identifying at least one first quality of service profile for the first quality of service flow to a radio access network serving the user equipment, and sending information identifying at least one second quality of service profile for the second quality of service flow to the radio access network serving the user equipment.

17. A method for a policy control function of a wireless communication network comprising:

generating at least one first quality of service parameter for an application service flow based on at least one first quality of service requirement for protocol data units belonging to a protocol data unit set, and at least one second quality of service parameter for the application service flow based on at least one second quality of service requirement for protocol data units not belonging to a protocol data unit set; and

sending information identifying the at least one first quality of service parameter and information identifying the at least one second quality of service parameter to a session management function of the wireless communications network.

18. The method according to claim 17, receiving from an application function of the communications system by the policy control function quality of service requirement information for the application service flow; wherein the quality of service requirement information identifies the at least one first quality of service requirement and the least one second quality of service requirement.

19. A method for an application function comprising:

generating quality of service requirement information for an application service flow; wherein the quality of service requirement information identifies at least one first quality of service requirement for protocol data units belonging to a protocol data unit set; and at least one second quality of service requirement for protocol data units not belonging to a protocol data unit set; and

sending by the application function the quality of service requirement information to a session management function of a wireless communication network.

20. A method for a user plane function of a wireless communication network, the method comprising:

receiving a protocol data unit belonging to an application service flow;

determining whether the protocol data unit is identifiable as belonging to a protocol data unit set; and

based on determining that the protocol data unit is not identifiable as belonging to a protocol data unit set, sending the protocol data unit to a radio access network node of the wireless communication network with header information linking the protocol data unit to a quality of service flow also comprising a protocol data unit determined by the user plane function as belonging to a protocol data unit set wherein the header information indicates that the protocol data unit belongs to a protocol data unit set having a size of one protocol data unit.

21. An apparatus comprising:

means for performing the method according to any of claims 1 to 20.

22. A computer-readable medium comprising instructions which, when executed by at least one processor of an apparatus cause the apparatus to perform the method according to any of claims 1 to 20.
23. A computer program comprising instructions which, when the program is executed by an apparatus, cause the apparatus to perform the method according to any of claims 1 to 20.
24. An apparatus comprising:
a user plane function configured to perform the method according to any of claims 1 to 10 and 20.
25. An apparatus comprising:
at least one processor;
at least one memory comprising instructions of a user plane function, wherein execution of instructions by the at least one processor causes the apparatus to perform the method of any of claims 1 to 10 and 20.
26. An apparatus comprising:
a session management function configured to perform the method according to any of claims 11 to 16.
27. An apparatus comprising:
at least one processor;
at least one memory comprising instructions of a session management function, wherein execution of instructions by the at least one processor causes the apparatus to perform the method of any of claims 11 to 16.
28. An apparatus comprising:
a policy control function configured to perform the method according to any of claims 17 to 18.
29. An apparatus comprising:
at least one processor;

at least one memory comprising instructions of a policy control function, wherein execution of instructions by the at least one processor causes the apparatus to perform the method of claim 19.

30. An apparatus comprising:
an application function configured to perform the method according to claim 19.
31. An apparatus comprising:
at least one processor;
at least one memory comprising instructions of an application function, wherein execution of instructions by the at least one processor causes the apparatus to perform the method of claim 19.
32. A core network comprising:
a user plane function configured to perform the method according to any of claims 1 to 10 and 20;
a session management function configured to perform the method according to any of claims 11 to 16; and
a policy control function configured to perform the method according to any of claims 17 to 18.

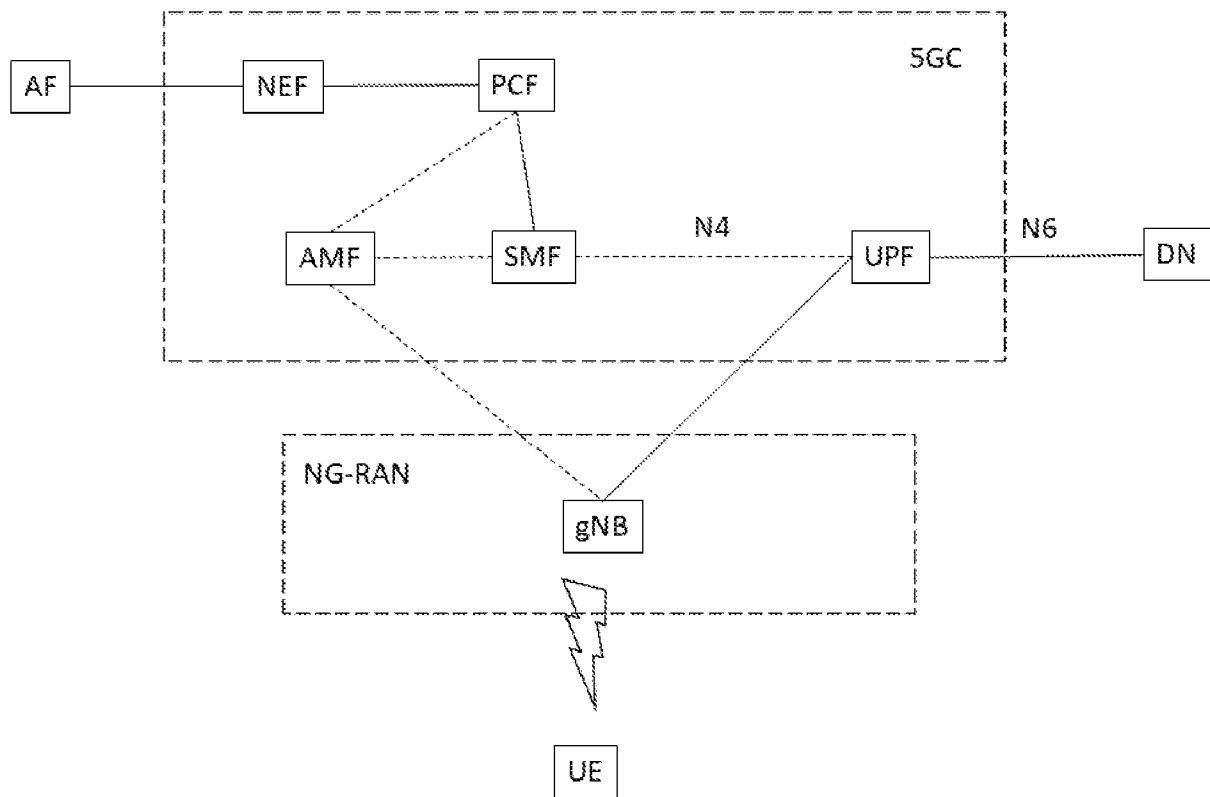


Figure 1

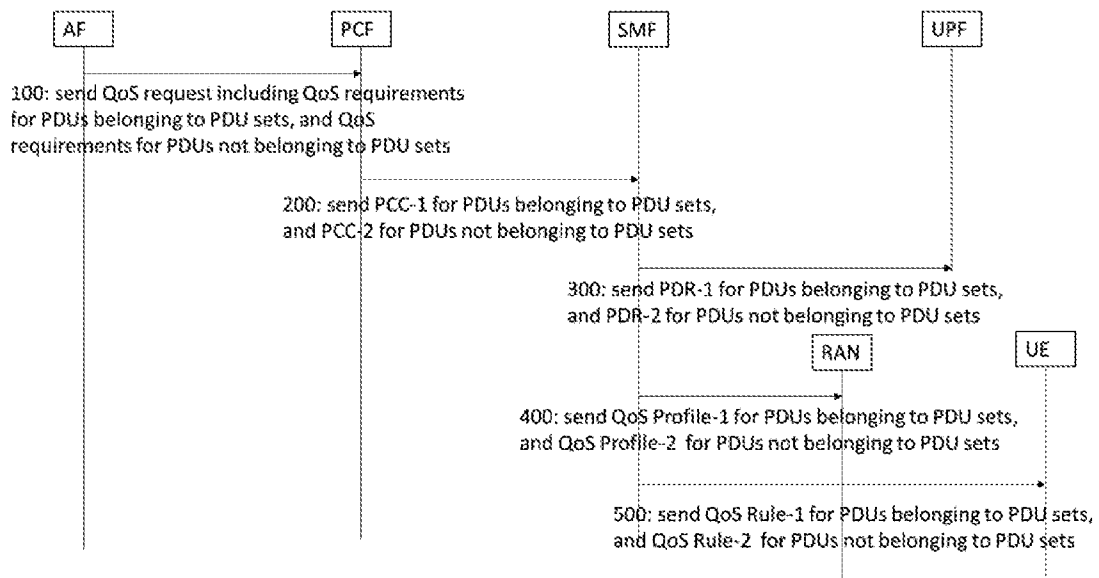


Figure 2

UPF

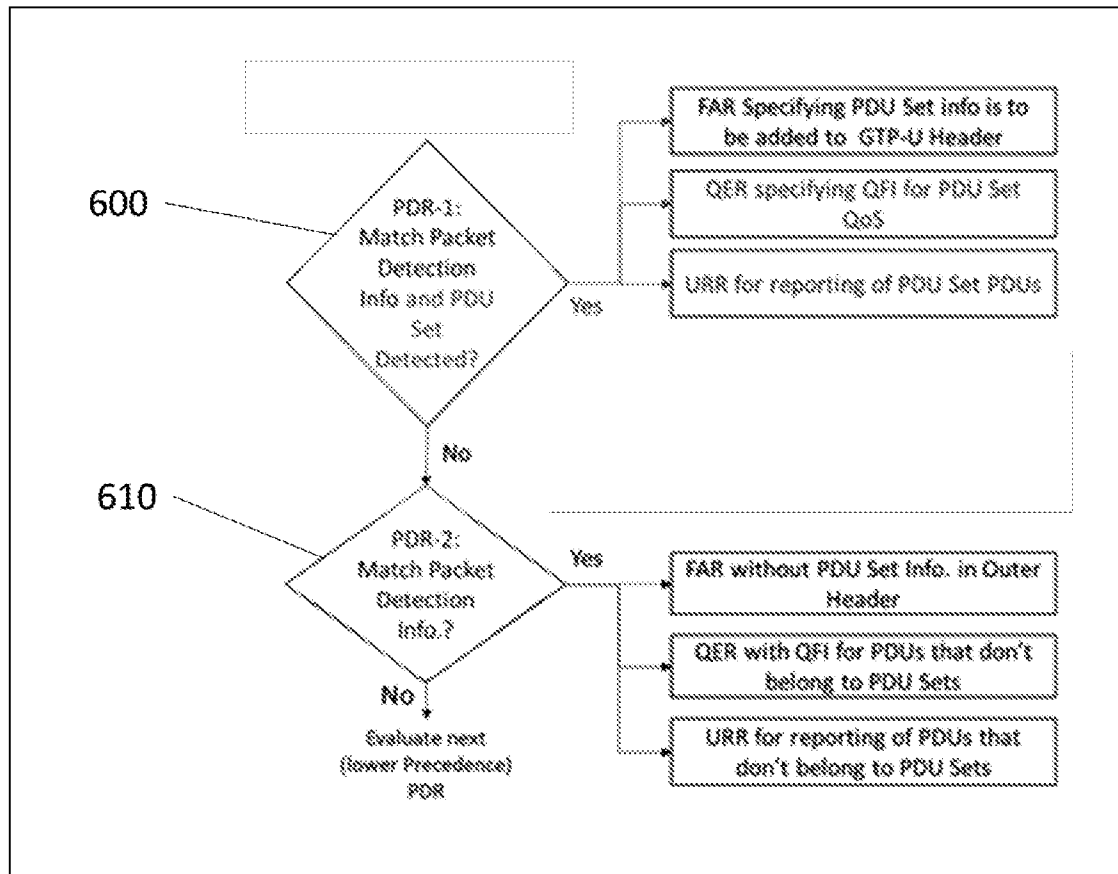


Figure 3

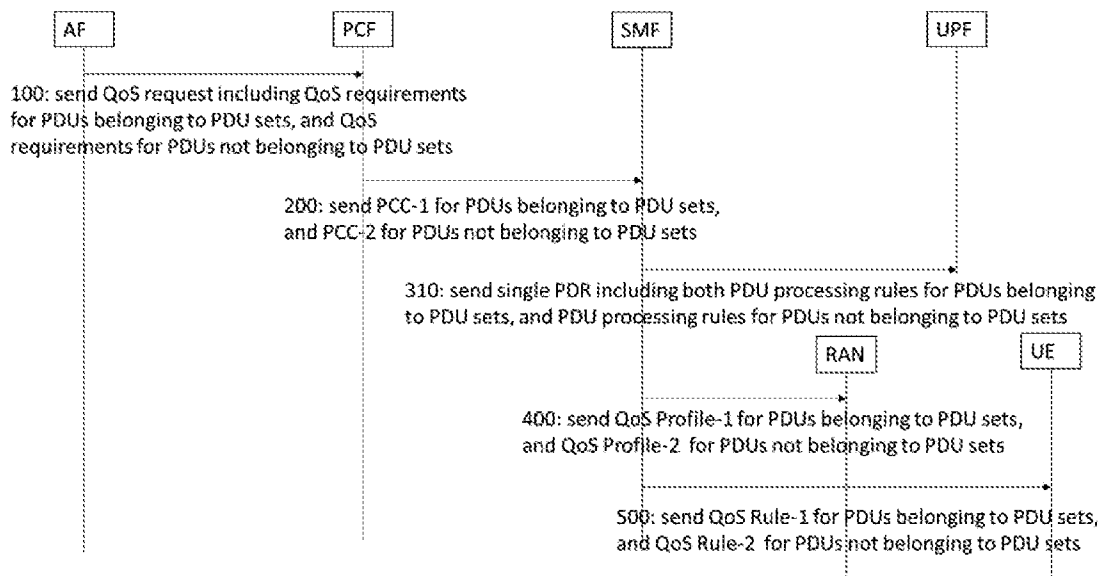


Figure 4

UPF

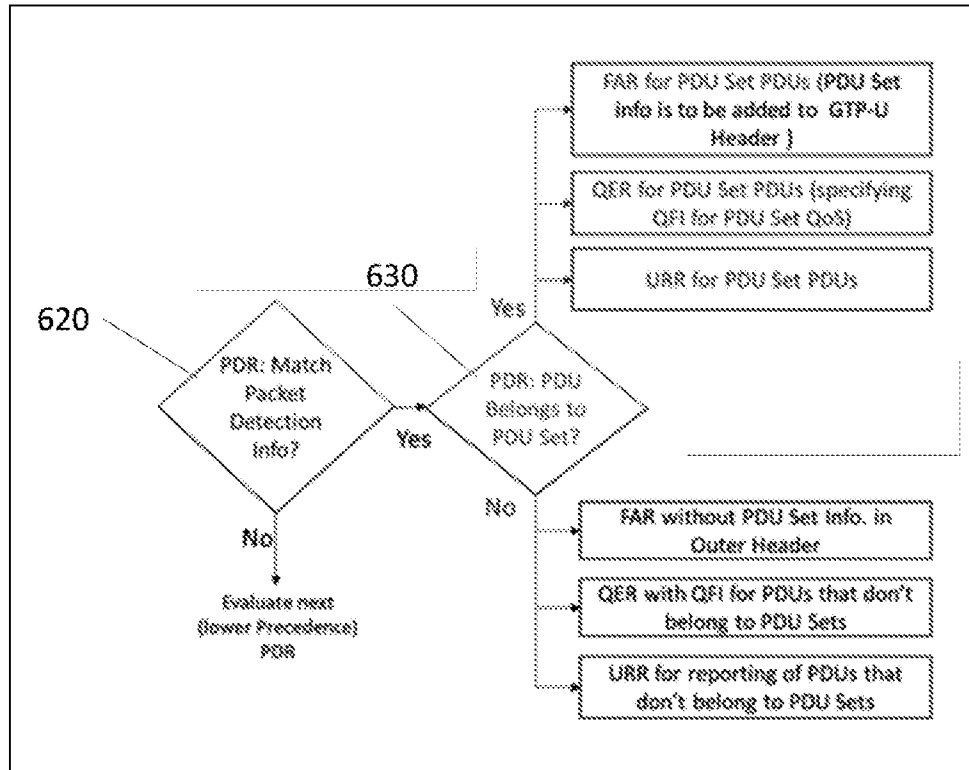


Figure 5

UPF

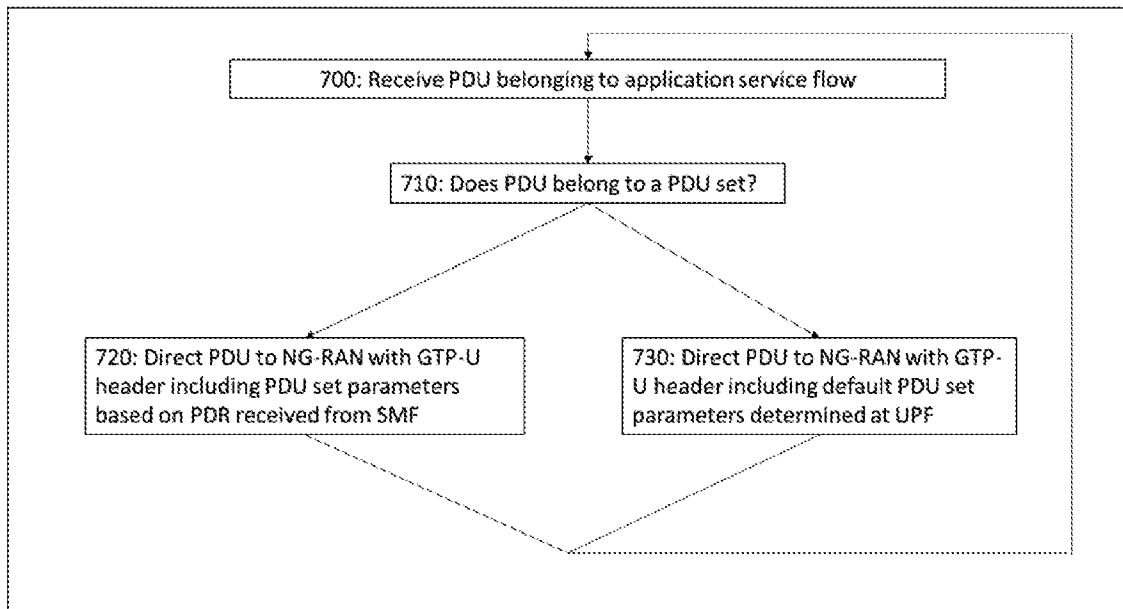


Figure 6

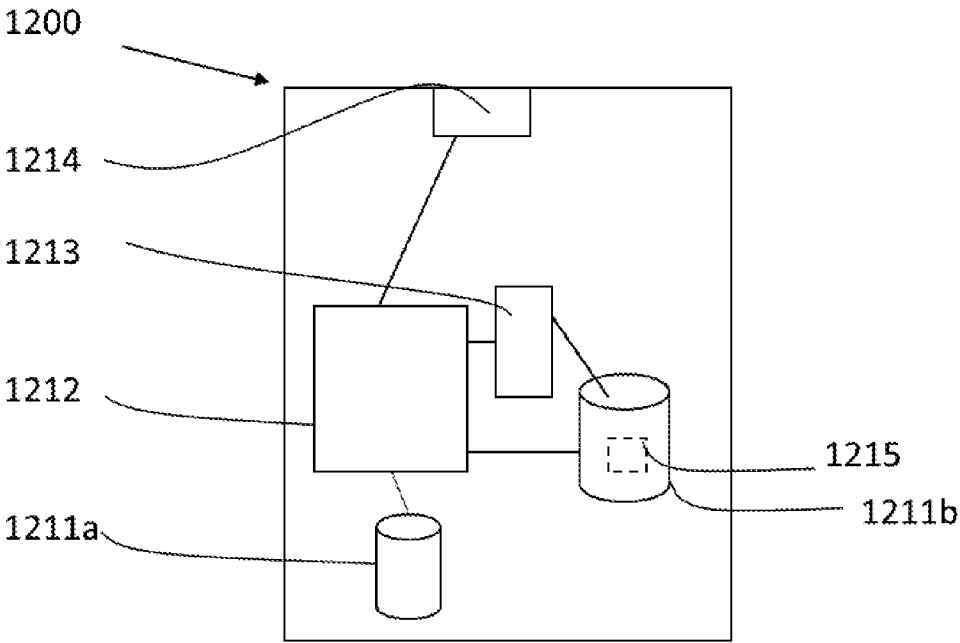


Figure 7

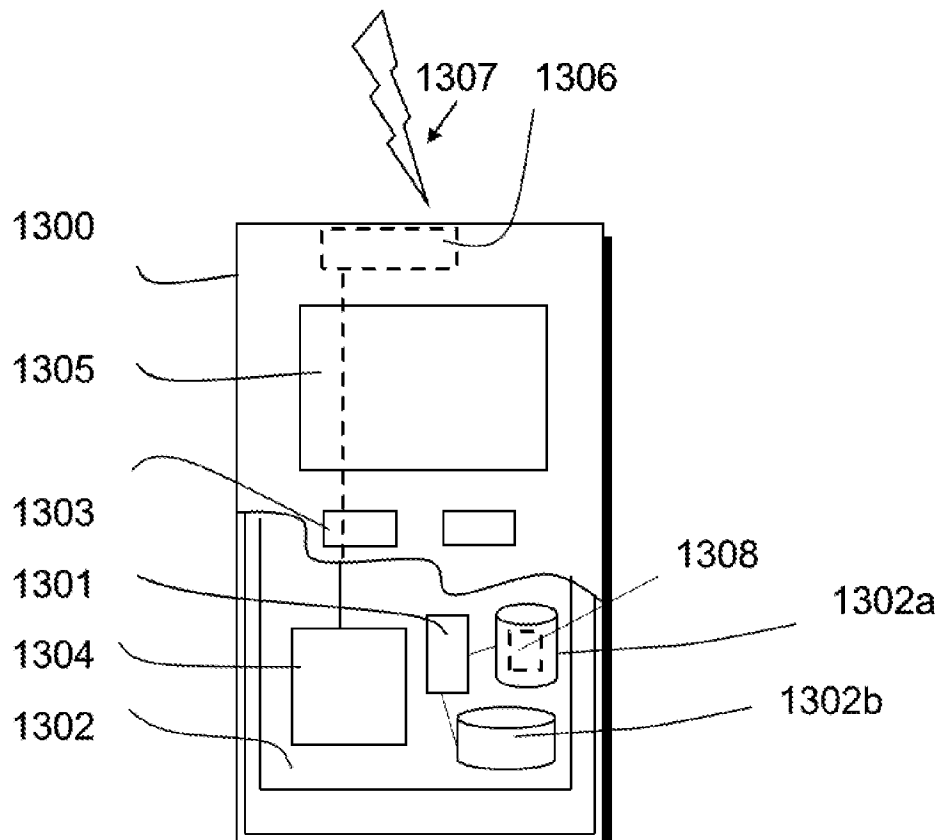


Figure 8

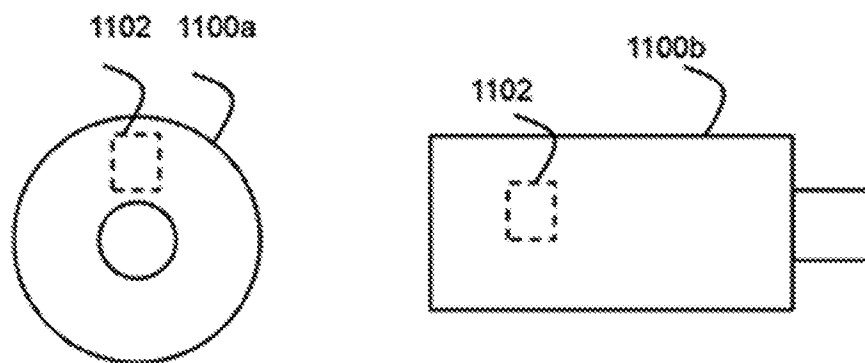


Figure 9

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2024/053245

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04W28/02

ADD. H04L47/20

H04L47/24

H04L47/31

H04L47/2425

H04L47/2483

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)

H04W H04L

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)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	YOUNGKYO BAEK ET AL: "(KI #4&5) modification on QoS description for PDU set based mechanism", 3GPP DRAFT; S2-2300758; TYPE CR; CR 3978; XRM, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. 3GPP SA 2, no. Online; 20230116 - 20230120 9 January 2023 (2023-01-09), XP052232226, Retrieved from the Internet: URL:https://www.3gpp.org/ftp/tsg_sa/WG2_Arch/TSGS2_154AHE_Electronic_2023-01/Docs/S2-2300758.zip S2-2300758-KI4&5-501 CR-PDUSetbasedhandling-samsung.docx [retrieved on 2023-01-09] paragraph [5.7.1.1] - / - -	1 - 32

☒ Further documents are listed in the continuation of Box C.

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Date of the actual completion of the international search

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	paragraph [5.7.1.2] paragraph [5.7.1.5] paragraph [5.7.2.1] paragraph [5.8.2.1] paragraph [5.37] ----- SHABNAM SULTANA ET AL: "Introduction of support for PDU Set handling", 3GPP DRAFT; S2-2300336; TYPE CR; CR 3876; XRM, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. 3GPP SA 2, no. Online; 20230116 - 20230120 9 January 2023 (2023-01-09), XP052231812, Retrieved from the Internet: URL:https://www.3gpp.org/ftp/tsg_sa/WG2_Arch/TSGS2_154AHE_Electronic_2023-01/Docs/S2-2300336.zip S2-2300336 23.501_XRM_KI4-5v2.docx [retrieved on 2023-01-09] paragraph [5.8.2.4.2] paragraph [5.8.2.11.3] paragraph [5.37.X.1] paragraph [5.37.X.2] paragraphs [5.37.X.3.1] - [0003] paragraph [6.2.2] paragraph [6.2.5.0] -----	1-32
X	US 2020/145876 A1 (DAO NGOC DUNG [CA] ET AL) 7 May 2020 (2020-05-07) abstract paragraphs [0269] - [0295] -----	1-32

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2024/053245

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		CN 114845258 A	02-08-2022
		EP 3864822 A1	18-08-2021
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