Node B) in an LTE network. The access point (e.g., gNB/eNB) is illustratively part of an access network of the communication system. For example, in a 5G network, the access network is referred to as a 5G System and is described in 5G Technical Specification (TS) 23.501, V0.4.0, entitled "Technical Specification Group Services and System Aspects; System Architecture for the 5G System," the disclosure of which is incorporated by reference herein in its entirety. In an LTE network, the access network is an Evolved Universal Terrestrial Radio Access Network (E-UTRAN). In general, the access point (e.g., gNB/eNB) provides access for the UE to a core network (CN), which then provides access for the UE to other UEs and/or a data network such as a packet data network (e.g., Internet).

Privacy is an important consideration in any communication system. Privacy is broadly addressed in 5G Technical Report (TR) 33.899, V1.1.0, entitled "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Study on the security aspects of the next generation system (Release 14)," the disclosure of which is incorporated by reference herein in its entirety. In particular, TR 33.899 identifies subscription (UE) privacy as one of the most important security areas to be addressed in 5G networks.

Summary

Illustrative embodiments provide one or more privacy indicators for controlling authentication requests in communication systems.

In a first aspect, the present disclosure provides a method comprising: receiving, at an element or function in a communication network, from user equipment of the communication network, a message comprising one or more privacy indicators, wherein the message comprises a registration request comprising a subscription identifier for a subscriber of the communication network associated with the user equipment, the one or more privacy indicators comprising a field indicating whether the subscription identifier in the registration request is privacy-protected; and in an instance in which the field indicates that the subscription identifier in the registration request is privacy-protected, processing the registration request in the message to remove privacy protection from the subscription identifier in the registration request.

In a second aspect, the present disclosure provides an apparatus comprising: at least one

processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the apparatus to perform at least: receiving, from user equipment, in a communication network, a message comprising one or more privacy indicators, wherein the message comprises a registration request comprising a subscription identifier for a subscriber of the communication network associated with the user equipment, the one or more privacy indicators comprising a field indicating whether the subscription identifier in the registration request is privacy-protected; and in an instance in which the field indicates that the subscription identifier in the registration request is privacy-protected, processing the registration request in the message to remove privacy protection from the subscription identifier in the registration request.

In a third aspect, the present disclosure provides an apparatus comprising: at least one processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the apparatus to perform at least: generating a message comprising a registration request, the message comprising a subscription identifier for a subscriber associated with the apparatus; determining whether the subscription identifier in the message is to be privacy protected; in an instance in which the subscription identifier in the message is to be privacy protected, privacy protecting the subscription identifier in the message, wherein the message comprises two or more privacy indicators that indicates whether the subscription identifier in the message is privacy protected, wherein at least one of the two or more privacy indicators resides in the algorithm scheme used, and wherein a first value of the privacy indicator indicates that the subscription identifier in the message is privacy protected; in an instance in which the subscription identifier in the message is not to be privacy protected, refraining from privacy protecting the subscription identifier in the message, wherein the message comprises two or more privacy indicators that indicates whether the subscription identifier in the message in the registration request is privacy protected, wherein at least one of the privacy indicators resides in the algorithm scheme used, wherein, a second value of the privacy indicator indicating that the subscription identifier in the message is not privacy protected; and wherein the second value is different from the first value, and sending the message comprising the registration request to a network entity in a communication network.

In a fourth aspect, the present disclosure provides a method comprising: generating, at a user equipment, a message comprising a registration request, the message comprising a subscription identifier for a subscriber associated with the user equipment; determining whether the subscription identifier in the message is to be privacy protected; in an instance in which the subscription identifier in the message is to be privacy protected, privacy protecting the subscription identifier in the message, wherein the message comprises two or more privacy indicators that indicates whether the subscription identifier in the message is privacy protected, wherein at least one of the two or more privacy indicators resides in the algorithm scheme used, and wherein a first value of the privacy indicator indicates that the subscription identifier in the message is privacy protected; in an instance in which the subscription identifier in the message is not to be privacy protected, refraining from privacy protecting the subscription identifier in the message, wherein the message comprises two or more privacy indicators that indicates whether the subscription identifier in the message in the registration request is privacy protected, wherein at least one of the privacy indicators resides in the algorithm scheme used, wherein, a second value of the privacy indicator indicating that the subscription identifier in the message is not privacy protected; and wherein the second value is different from the first value, and sending the message comprising the registration request from the user equipment to a network entity in a communication network.

In a fifth aspect, the present disclosure provides a method comprising: determining, at a user equipment, based on a first message received at the user equipment from a network entity of a communication network, whether the network entity is configured to handle privacy-protected subscription identifiers in registration request messages; generating, at the user equipment, a second message comprising a registration request, the second message comprising a subscription identifier for a subscriber of the communication network associated with the user equipment; determining, based on the first message, whether the subscription identifier in the second message is to be privacy protected; in an instance in which the subscription identifier in the second message is to be privacy protected, privacy protecting the subscription identifier in the second message, adding, to the second message, two or more privacy indicators comprising a field that indicates whether the subscription identifier in the second message is privacy protected, and adding a first value to the field in the second message,

the first value indicating that the subscription identifier in the second message is privacy protected; in an instance in which the subscription identifier in the second message is not to be privacy protected, refraining from privacy protecting the subscription identifier in the second message, adding, to the second message, the two or more privacy indicators comprising the field that indicates whether the subscription identifier in the second message in the registration request is privacy protected, and adding a second value to the field in the second message, the second value indicating that the subscription identifier in the second message is not privacy protected; and sending the second message comprising the registration request from the user equipment to the network entity in the communication network.

In a sixth aspect, the present disclosure provides an apparatus comprising: at least one processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the apparatus to perform at least: determining, based on a first message received at the apparatus from a network entity of a communication network, whether the network entity is configured to handle privacy-protected subscription identifiers in registration request messages; generating a second message comprising a registration request, the second message comprising a subscription identifier for a subscriber of the communication network associated with the apparatus; determining, based on the first message, whether the subscription identifier in the second message is to be privacy protected; in an instance in which the subscription identifier in the second message is to be privacy protected, privacy protecting the subscription identifier in the second message, adding, to the second message, two or more privacy indicators comprising a field that indicates whether the subscription identifier in the second message is privacy protected, and adding a first value to the field in the second message, the first value indicating that the subscription identifier in the second message is privacy protected; in an instance in which the subscription identifier in the second message is not to be privacy protected, refraining from privacy protecting the subscription identifier in the second message, adding, to the second message, the two or more privacy indicators comprising the field that indicates whether the subscription identifier in the second message in the registration request is privacy protected, and adding a second value to the field in the second message, the second value indicating that the subscription identifier in the second message is not privacy protected; and sending the second message comprising the registration request to the network

entity in the communication network.

In a seventh aspect, the present disclosure provides a method comprising: receiving, at a user equipment, from a network entity of a new radio standalone network, a system information message, the system information message indicating whether the network entity is configured to handle privacy-protected subscription identifiers in registration request messages; determining, at the user equipment, based on the system information message received from the network entity, whether the network entity is configured to handle privacy-protected subscription identifiers in registration request messages; generating, at the user equipment, a registration request message comprising a registration request and a subscription identifier for a subscriber of the new radio standalone network associated with the user equipment; determining whether the subscription identifier in the registration request message is to be privacy protected; in an instance in which the subscription identifier in the registration request message is to be privacy protected: privacy protecting the subscription identifier in the registration request message, adding a privacy indicator field to the registration request message that indicates whether the subscription identifier in the registration request message is privacy protected, and setting the privacy indicator field to a first value that indicates that the subscription identifier in the registration request message is privacy protected in the registration request message; in an instance in which the subscription identifier in the registration request message is not to be privacy protected: refraining from privacy protecting the subscription identifier in the registration request message, adding the privacy indicator field to the registration request message that indicates whether the subscription identifier in the registration request message is privacy protected, and setting the privacy indicator field to a second value that indicates that the subscription identifier in the registration request message is not privacy protected; and sending, from the user equipment, to the network entity in the new radio standalone network, the registration request message comprising the registration request, the subscription identifier, and the privacy indicator field indicating whether the subscription identifier in the registration request message is privacy protected.

In an eighth aspect, the present disclosure provides an apparatus comprising: at least one processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the apparatus to perform at least: receiving, from a network entity of a

new radio standalone network, a system information message, the system information message indicating whether the network entity is configured to handle privacy-protected subscription identifiers in registration request messages; determining, based on the system information message received from the network entity, whether the network entity is configured to handle privacy-protected subscription identifiers in registration request messages; generating a registration request message comprising a registration request and a subscription identifier for a subscriber of the new radio standalone network associated with the apparatus; determining whether the subscription identifier in the registration request message is to be privacy protected; in an instance in which the subscription identifier in the registration request message is to be privacy protected: privacy protecting the subscription identifier in the registration request message, adding a privacy indicator field to the registration request message that indicates whether the subscription identifier in the registration request message is privacy protected, and setting the privacy indicator field to a first value that indicates that the subscription identifier in the registration request message is privacy protected in the registration request message; in an instance in which the subscription identifier in the registration request message is not to be privacy protected: refraining from privacy protecting the subscription identifier in the registration request message, adding the privacy indicator field to the registration request message that indicates whether the subscription identifier in the registration request message is privacy protected, and setting the privacy indicator field to a second value that indicates that the subscription identifier in the registration request message is not privacy protected; and sending, to the network entity in the new radio standalone network, the registration request message comprising the registration request, the subscription identifier, and the privacy indicator field indicating whether the subscription identifier in the registration request message is privacy protected.

In a ninth aspect, the present disclosure provides a method comprising: determining, at a user equipment, based on a first message received at the user equipment from a network entity of a communication network, whether the communication network is configured to handle concealed subscription identifiers in registration request messages; generating, at the user equipment, a second message comprising a registration request, the second message comprising a subscription identifier for a subscriber of the communication network associated

with the user equipment; determining, at the user equipment, based on the first message received from the network entity, whether the subscription identifier in the second message is to be a concealed subscription identifier; in an instance in which the subscription identifier in the second message is to be a concealed subscription identifier, encrypting the subscription identifier in the second message, adding, to the second message, two or more privacy indicators comprising a field, the field indicating whether the subscription identifier in the second message is a concealed subscription identifier, and adding a first value to the field in the second message, the first value indicating that the subscription identifier in the second message is a concealed subscription identifier; in an instance in which the subscription identifier in the second message is not to be a concealed subscription identifier, refraining from encrypting the subscription identifier in the second message, adding, to the second message, the two or more privacy indicators comprising the field that indicates whether the subscription identifier in the second message in the registration request is a concealed subscription identifier, and adding a second value to the field in the second message, the second value indicating that the subscription identifier in the second message is not a concealed subscription identifier; and sending the second message comprising the registration request to the network entity in the communication network.

In a tenth aspect, the present disclosure provides an apparatus comprising: at least one processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the apparatus to perform at least: determining, based on a first message received at the apparatus from a network entity of a communication network, whether the network entity is configured to handle concealed subscription identifiers in registration request messages; generating a second message comprising a registration request, the second message comprising a subscription identifier for a subscriber of the communication network associated with the apparatus; determining, based on the first message, whether the subscription identifier in the second message is to be a concealed subscription identifier; in an instance in which the subscription identifier in the second message is to be a concealed subscription identifier, encrypting the subscription identifier in the second message, adding, to the second message, two or more privacy indicators comprising a field, the field indicating whether the subscription identifier in the second message is a concealed subscription identifier, and adding a first value

to the field in the second message, the first value indicating that the subscription identifier in the second message is a concealed subscription identifier; in an instance in which the subscription identifier in the second message is not to be a concealed subscription identifier, refraining from encrypting the subscription identifier in the second message, adding, to the second message, the two or more privacy indicators comprising the field that indicates whether the subscription identifier in the second message in the registration request is a concealed subscription identifier, and adding a second value to the field in the second message, the second value indicating that the subscription identifier in the second message is not a concealed subscription identifier; and sending the second message comprising the registration request to the network entity in the communication network.

In an eleventh aspect, the present disclosure provides a method comprising: determining, at a network entity in a communication network, one or more privacy features supported by the communication network, the one or more privacy features comprising an indication of whether the communication network is configured to handle privacy-protected subscription identifiers; generating, at the network entity in the communication network, a System Information Message comprising a Master Information Block or a System Information Block, the System Information Message further comprising one or more privacy indicators selected based on the determined one or more privacy features, the one or more privacy indicators comprising a field indicating whether the communication network is configured to handle the privacy-protected subscription identifiers; sending, from the network entity, to the plurality of user equipment, the System Information Message comprising the one or more privacy indicators; receiving, in response to the System Information Message, at the network entity, from at least a portion of the plurality of user equipment, one or more registration requests comprising respective privacy-protected subscription identifiers; processing the one or more registration requests to determine respective subscription identifiers; and identifying one or more Home Subscriber Servers (HSS) or one or more User Data Management (UDM) functions to which to provide the one or more registration requests.

In a twelfth aspect, the present disclosure provides an apparatus comprising: at least one processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the apparatus to perform at least: determining one or more privacy features

supported by a communication network in which the apparatus operates, the one or more privacy features comprising an indication of whether the communication network is configured to handle privacy-protected subscription identifiers; generating a System Information Message comprising a Master Information Block or a System Information Block, the System Information Message further comprising one or more privacy indicators selected based on the determined one or more privacy features, the one or more privacy indicators comprising a field indicating whether the communication network is configured to handle the privacy-protected subscription identifiers; sending, to user equipment of the communication network, the System Information Message comprising the one or more privacy indicators; receiving, in response to the System Information Message, from at least a portion of the user equipment, one or more registration requests comprising respective privacy-protected subscription identifiers; processing the one or more registration requests to determine respective subscription identifiers of the user equipment; and identifying one or more Home Subscriber Servers (HSS) or one or more User Data Management (UDM) functions to which to provide the one or more registration requests.

In a thirteenth aspect, the present disclosure provides a non-transitory processor-readable storage medium having embodied therein executable program code that when executed by a processor causes the processor to at least: determine, at a network entity in a communication network, one or more privacy features supported by the communication network, the one or more privacy features comprising an indication of whether the network entity is configured to handle privacy-protected subscription identifiers; generate, at the network entity in the communication network, a System Information Message comprising a Master Information Block or a System Information Block, the System Information Message further comprising one or more privacy indicators selected based on the determined one or more privacy features, the one or more privacy indicators comprising a field indicating whether the communication network is configured to handle the privacy-protected subscription identifiers; send, from the network entity in the communication network to the plurality of user equipment of the communication network, the System Information Message comprising the one or more privacy indicators; receive, in response to the System Information Message, at the network entity, from at least a portion of the plurality of user equipment, one or more

registration requests comprising respective privacy-protected subscription identifiers; process the one or more registration requests to determine respective subscription identifiers; and identify one or more Home Subscriber Servers (HSS) or one or more User Data Management (UDM) functions to which to provide the one or more registration requests.

In a fourteenth aspect, the present disclosure provides a method comprising: receiving, from a network entity in a communication network, at user equipment of the communication network, a first message comprising an indication of one or more privacy features of the communication network, wherein the indication of one or more privacy features of the communication network comprises a first field indicating whether the communication network is configured to handle privacy-protected subscription identifiers; determining, at the user equipment of the communication network, based at least on the indication comprising the first field, the one or more privacy features of the communication network for processing a second message, the second message comprising a registration request and a subscription identifier for a subscriber of the communication network associated with the user equipment; in an instance in which the first field in the first message indicates that the communication network is not configured to handle privacy-protected subscription identifiers, refraining from privacy protecting the subscription identifier in the second message; in an instance in which the first field in the first message indicates that the communication network is configured to handle privacy-protected subscription identifiers, privacy-protecting the subscription identifier in the second message; adding one or more privacy indicators to the second message based on the determined one or more privacy features of the communication network, the one or more privacy indicators comprising a second field indicating whether the subscription identifier in the registration request is privacy-protected, wherein, in an instance in which the second field comprises a first value, the second field indicates that the subscription identifier in the registration request is not privacy-protected, and, in an instance in which the second field comprises a second value, the second field indicates that the subscription identifier in the registration request is privacy-protected; and sending the second message from the user equipment to the network entity in the communication network.

In a fifteenth aspect, the present disclosure provides an apparatus comprising: at least one processor; and at least one memory storing instructions that, when executed by the at least

one processor, cause the apparatus to perform at least: receiving, from a network entity in a communication network, a first message comprising an indication of one or more privacy features of the communication network, wherein the indication of one or more privacy features of the communication network comprises a first field indicating whether the communication network is configured to handle privacy-protected subscription identifiers; determining, based at least on the indication comprising the first field, the one or more privacy features of the communication network for processing a second message, the second message comprising a registration request and a subscription identifier for a subscriber of the communication network associated with the user equipment; in an instance in which the first field in the first message indicates that the communication network is not configured to handle privacy-protected subscription identifiers, refraining from privacy protecting the subscription identifier in the second message; in an instance in which the first field in the first message indicates that the communication network is configured to handle privacy-protected subscription identifiers, privacy-protecting the subscription identifier in the second message; adding one or more privacy indicators to the second message based on the determined one or more privacy features of the communication network, the one or more privacy indicators comprising a second field indicating whether the subscription identifier in the registration request is privacy-protected, wherein, in an instance in which the second field comprises a first value, the second field indicates that the subscription identifier in the registration request is not privacy-protected, and, in an instance in which the second field comprises a second value, the second field indicates that the subscription identifier in the registration request is privacy-protected; and sending the second message from the user equipment to the network entity in the communication network.

In a sixteenth aspect, the present disclosure provides a non-transitory processor-readable storage medium having embodied therein executable program code that when executed by a processor causes the processor to at least: receiving, from a network entity in a communication network, at user equipment of the communication network, a first message comprising an indication of one or more privacy features of the communication network, wherein the indication of one or more privacy features of the communication network comprises a first field indicating whether the communication network is configured to handle privacy-protected subscription identifiers; determining, at the user equipment of the

communication network, based at least on the indication comprising the first field, the one or more privacy features of the communication network for processing a second message, the second message comprising a registration request and a subscription identifier for a subscriber of the communication network associated with the user equipment; in an instance in which the first field in the first message indicates that the communication network is not configured to handle privacy-protected subscription identifiers, refraining from privacy protecting the subscription identifier in the second message; in an instance in which the first field in the first message indicates that the communication network is configured to handle privacy-protected subscription identifiers, privacy-protecting the subscription identifier in the second message; adding one or more privacy indicators to the second message based on the determined one or more privacy features of the communication network, the one or more privacy indicators comprising a second field indicating whether the subscription identifier in the registration request is privacy-protected, wherein, in an instance in which the second field comprises a first value, the second field indicates that the subscription identifier in the registration request is not privacy-protected, and, in an instance in which the second field comprises a second value, the second field indicates that the subscription identifier in the registration request is privacy-protected; and sending the second message from the user equipment to the network entity in the communication network.

In a seventeenth aspect, the present disclosure provides a method comprising: receiving, at user equipment of a communication network, from a network entity in the communication network, a System Information Message comprising a Master Information Block or a System Information Block, the System Information Message further comprising an indication of whether the network entity requests or requires that subscription identifiers be privacy-protected in registration request messages transmitted to the network entity;

generating, at the user equipment, a registration request message comprising a registration request and a subscription identifier for a subscriber of the communication network associated with the user equipment; in an instance in which the indication in the System Information Message is that the network entity requests or requires that subscription identifiers be privacy-protected in registration request messages to the network entity, privacy protecting the subscription identifier in the registration request message; or in an instance in which the

indication in the System Information Message is that subscription identifiers in registration request messages to the network entity need not be privacy-protected, refraining from privacy protecting the subscription identifier in the registration request message; and transmitting the registration request message towards the network entity in the communication network.

In an eighteenth aspect, the present disclosure provides an apparatus comprising: at least one processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the apparatus to perform at least: receiving, from a network entity in a communication network, a System Information Message comprising a Master Information Block or a System Information Block, the System Information Message further comprising an indication of whether the network entity requests or requires that subscription identifiers in registration request messages to the network entity be privacy-protected; generating a registration request message comprising a registration request and a subscription identifier for a subscriber of the communication network associated with the apparatus; in an instance in which the indication in the System Information Message is that the network entity requests or requires that subscription identifiers be privacy-protected in registration request messages to the network entity, privacy protecting the subscription identifier in the registration request message; or in an instance in which the System Information Message comprises an indication that subscription identifiers in registration request messages to the network entity need not be privacy-protected, refraining from privacy protecting the subscription identifier in the registration request message; and transmitting the registration request message towards the network entity in the communication network.

In a ninth aspect, the present disclosure provides a non-transitory processor-readable storage medium having embodied therein executable program code that, when executed by a processor, causes the processor to perform at least: receiving, at user equipment of a communication network, from a network entity in the communication network, a System Information Message comprising a Master Information Block or a System Information Block, the System Information Message further comprising an indication of whether the network entity requests or requires that subscription identifiers in registration request messages to the network entity be privacy-protected; generating, at the user equipment, a registration request message comprising a registration request and a subscription identifier for a subscriber of the

communication network associated with the user equipment; in an instance in which the System Information Message comprises an indication that the network entity requests or requires that subscription identifiers in registration request messages to the network entity be privacy-protected, privacy protecting the subscription identifier in the registration request message; or in an instance in which the System Information Message comprises an indication that subscription identifiers in registration request messages to the network entity need not be privacy-protected, refraining from privacy protecting the subscription identifier in the registration request message; and transmitting the registration request message towards the network entity in the communication network.

In a twentieth aspect, the present disclosure provides a method comprising: receiving, at user equipment, from a network entity in a communication network, a first message comprising one or more privacy indicators, the one or more privacy indicators comprising a first field, the first field indicating whether the network entity is configured to handle privacy-protected subscription identifiers; determining, in an instance in which the first field in the first message comprises a first value, that the network entity is configured to handle privacy-protected subscription identifiers; or determining, in an instance in which the first field in the first message comprises a second value, that the network entity is not configured to handle privacy-protected subscription identifiers; generating a second message comprising a registration request and one or more subscription identifiers; in an instance in which the first field in the first message comprises the first value and indicates that the network entity is configured to handle privacy-protected subscription identifiers, privacy protecting the one or more subscription identifiers in the second message; or in an instance in which the first field in the first message comprises the second value and indicates that the network entity is not configured to handle privacy-protected subscription identifiers, refraining from privacy protecting the one or more subscription identifiers in the second message; adding, to the second message, a second field, the second field indicating whether the one or more subscription identifiers in the second message are privacy protected; and transmitting, from the user equipment, towards the network entity, the second message comprising the registration request, the one or more subscription identifiers, and the second field indicating whether the one or more subscription identifiers are privacy protected.

In a twenty-first aspect, the present disclosure provides an apparatus comprising: a processor; and a memory, the processor being operatively coupled to the memory and configured to at least: receive, from a network entity in a communication network, a first message comprising one or more privacy indicators, the one or more privacy indicators comprising a first field, the first field indicating whether the network entity is configured to handle privacy-protected subscription identifiers; determine, in an instance in which the first field in the first message comprises a first value, that the network entity is configured to handle privacy-protected subscription identifiers; or determine, in an instance in which the first field in the first message comprises a second value, that the network entity is not configured to handle privacy-protected subscription identifiers; generate a second message comprising a registration request and one or more subscription identifiers; in an instance in which the first field in the first message indicates that the network entity is configured to handle privacy-protected subscription identifiers, privacy protect the one or more subscription identifiers in the second message; or in an instance in which the first field in the first message indicates that the network entity is not configured to handle privacy-protected subscription identifiers, refrain from privacy protecting the one or more subscription identifiers in the second message; add, to the second message, a second field that indicates whether the one or more subscription identifiers in the second message are privacy protected; and transmit, towards the network entity, the second message comprising the registration request, the one or more subscription identifiers, and the second field indicating whether the one or more subscription identifiers are privacy protected.

In a twenty-second aspect, the present disclosure provides a non-transitory processor-readable storage medium having embodied therein executable program code that, when executed by a processor, causes the processor to at least: receive, at user equipment, from a network entity in a communication network, a first message comprising one or more privacy indicators, the one or more privacy indicators comprising a first field, the first field indicating whether the network entity is configured to handle privacy-protected subscription identifiers; determine, in an instance in which the first field in the first message comprises a first value, that the network entity is configured to handle privacy-protected subscription identifiers; or determine, in an instance in which the first field in the first message comprises a second value,

that the network entity is not configured to handle privacy-protected subscription identifiers; generate a second message comprising a registration request and one or more subscription identifiers; in an instance in which the first field in the first message indicates that the network entity is configured to handle privacy-protected subscription identifiers, privacy protect the one or more subscription identifiers in the second message; or in an instance in which the first field in the first message indicates that the network entity is not configured to handle privacy-protected subscription identifiers, refrain from privacy protecting the one or more subscription identifiers in the second message; and transmit, from the user equipment, towards the network entity, the second message comprising the registration request, the one or more subscription identifiers, and the second field indicating whether the one or more subscription identifiers are privacy protected.

In a twenty-third aspect, the present disclosure provides a method comprising: determining, at a network entity in a communication network, whether the network entity is configured to handle privacy-protected subscription identifiers; generating, at the network entity, a System Information Message comprising one or more privacy indicators, the one or more privacy indicators comprising a field, the field comprising a first value if the network entity is configured to handle privacy-protected subscription identifiers or a second value if the network entity is not configured to handle privacy-protected subscription identifiers; sending, from the network entity, towards user equipment in the communication network, the System Information Message comprising the one or more privacy indicators; receiving, at the network entity, from a particular user equipment, a registration request comprising a subscription identifier for a subscriber associated with the particular user equipment; in an instance in which the field in the System Information Message comprises the first value and the subscription identifier in the registration request is privacy-protected, processing the registration request to determine the subscription identifier; and identifying one or more Home Subscriber Servers (HSS) or one or more User Data Management (UDM) functions to which to provide the registration request; or in an instance in which the field in the System Information Message comprises the second value and the subscription identifier in the registration request is privacy-protected, providing a registration reject message to the particular user equipment.

In a twenty-fourth aspect, the present disclosure provides an apparatus comprising: at

least one processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the apparatus to perform at least: determining whether a communication network in which the apparatus operates is configured to handle privacy-protected subscription identifiers from user equipment; generating a System Information Message comprising one or more privacy indicators, the one or more privacy indicators comprising a field, the field comprising a first value if the communication network is configured to handle privacy-protected subscription identifiers or a second value if the communication network is not configured to handle privacy-protected subscription identifiers; sending, to the user equipment in the communication network, the System Information Message comprising the one or more privacy indicators; receiving, from a particular user equipment, a registration request comprising a subscription identifier for a subscriber associated with the particular user equipment; in an instance in which the field in the System Information Message comprises the first value and the subscription identifier in the registration request is privacy-protected, processing the registration request to determine the subscription identifier for the subscriber associated with the particular user equipment; and identifying one or more Home Subscriber Servers (HSS) or one or more User Data Management (UDM) functions to which to provide the registration request; or in an instance in which the field in the System Information Message comprises the second value and the subscription identifier in the registration request is privacy-protected, providing a registration reject message to the particular user equipment.

In a twenty-fifth aspect, the present disclosure provides a non-transitory processor-readable storage medium having embodied therein executable program code that when executed by a processor causes the processor to perform at least: determining whether a communication network is configured to handle privacy-protected subscription identifiers; generating a System Information Message comprising one or more privacy indicators, the one or more privacy indicators comprising a field, the field comprising a first value if the communication network is configured to handle privacy-protected subscription identifiers or a second value if the communication network is not configured to handle privacy-protected subscription identifiers; transmitting, towards user equipment in the communication network, the System Information Message comprising the one or more privacy indicators; receiving,

from a particular user equipment, a registration request comprising a subscription identifier for a subscriber associated with the particular user equipment; in an instance in which the field in the System Information Message comprises the first value and the subscription identifier in the registration request from the particular user equipment is privacy-protected, processing the registration request to determine the subscription identifier; and identifying one or more Home Subscriber Servers (HSS) or one or more User Data Management (UDM) functions to which to provide the registration request; or in an instance in which the field in the System Information Message comprises the second value and the subscription identifier in the registration request is privacy-protected, provide a registration reject message to the particular user equipment.

In a twenty-sixth aspect, the present disclosure provides a method comprising: generating, at a user equipment, a message comprising a registration request and one or more subscription identifiers associated with the user equipment; adding, to the message, two or more privacy indicators, the two or more privacy indicators comprising a field that indicates whether subscription identifiers in the message are privacy protected; in an instance in which the user equipment determines that the one or more subscription identifiers should be privacy protected in the message, privacy protecting the one or more subscription identifiers in the message and setting a value of the field to a first value indicating that the one or more subscription identifiers in the message are privacy protected; or in an instance in which the user equipment determines that the one or more subscription identifiers should not be privacy protected in the message, refraining from privacy protecting the one or more subscription identifiers in the message and setting the value of the field to a second value indicating that the one or more subscription identifiers in the message are not privacy protected; and transmitting, from the user equipment, towards a network entity of the communication system, the message comprising the registration request, the one or more subscription identifiers, and the two or more privacy indicators comprising the field indicating whether the one or more subscription identifiers in the message are privacy protected.

In a twenty-seventh aspect, the present disclosure provides an apparatus comprising: at least one processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the apparatus to perform at least: generating a message comprising a registration request and one or more subscription identifiers associated with the apparatus;

adding, to the message, two or more privacy indicators, the two or more privacy indicators comprising a field that indicates whether subscription identifiers in the message are privacy protected; in an instance in which the apparatus determines that the one or more subscription identifiers should be privacy protected in the message, privacy protecting the one or more subscription identifiers in the message and setting a value of the field to a first value indicating that the one or more subscription identifiers in the message are privacy protected; or in an instance in which the apparatus determines that the one or more subscription identifiers should not be privacy protected in the message, refraining from privacy protecting the one or more subscription identifiers in the message and setting the value of the field to a second value indicating that the one or more subscription identifiers in the message are not privacy protected; and transmitting, towards a network entity of the communication system, the message comprising the registration request, the one or more subscription identifiers, and the two or more privacy indicators comprising the field indicating whether the one or more subscription identifiers in the message are privacy protected.

In a twenty-eighth aspect, the present disclosure provides a non-transitory processor-readable storage medium having embodied therein executable program code that, when executed by a processor, causes the processor to at least: generating, at a user equipment, a message comprising a registration request and one or more subscription identifiers associated with the user equipment; adding, to the message, two or more privacy indicators, the two or more privacy indicators comprising a field that indicates whether subscription identifiers in the message are privacy protected; in an instance in which the user equipment determines that the one or more subscription identifiers should be privacy protected in the message, privacy protecting the one or more subscription identifiers in the message and setting a value of the field to a first value indicating that the one or more subscription identifiers in the message are privacy protected; or in an instance in which the user equipment determines that the one or more subscription identifiers should not be privacy protected in the message, refraining from privacy protecting the one or more subscription identifiers in the message and setting the value of the field to a second value indicating that the one or more subscription identifiers in the message are not privacy protected; and transmitting, from the user equipment, towards a network entity of the communication system, the message comprising the registration request,

the one or more subscription identifiers, and the two or more privacy indicators comprising the field indicating whether the one or more subscription identifiers in the message are privacy protected.

In a twenty-ninth aspect, the present disclosure provides an apparatus comprising: at least one processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the apparatus to perform at least: generating a message comprising a registration request, the message comprising a subscription identifier for a subscriber associated with the apparatus; determining whether the subscription identifier in the message is to be privacy protected; in an instance in which the subscription identifier in the message is to be privacy protected, privacy protecting the subscription identifier in the message, wherein the message comprises two or more privacy indicators that indicates whether the subscription identifier in the message is privacy protected, wherein at least one of the two or more privacy indicators resides in the algorithm scheme used, and wherein a first value of the privacy indicator indicates that the subscription identifier in the message is privacy protected; in an instance in which the subscription identifier in the message is not to be privacy protected, refraining from privacy protecting the subscription identifier in the message, wherein the message comprises two or more privacy indicators that indicates whether the subscription identifier in the message in the registration request is privacy protected, wherein at least one of the privacy indicators resides in the algorithm scheme used, wherein, a second value of the privacy indicator indicating that the subscription identifier in the message is not privacy protected; and wherein the second value is different from the first value, and sending the message comprising the registration request to a network entity in a communication network.

In a thirtieth aspect, the present disclosure provides a method comprising: generating, at a user equipment, a message comprising a registration request, the message comprising a subscription identifier for a subscriber associated with the user equipment; determining whether the subscription identifier in the message is to be privacy protected; in an instance in which the subscription identifier in the message is to be privacy protected, privacy protecting the subscription identifier in the message, wherein the message comprises two or more privacy indicators that indicates whether the subscription identifier in the message is privacy protected, wherein at least one of the two or more privacy indicators resides in the algorithm scheme used,

and wherein a first value of the privacy indicator indicates that the subscription identifier in the message is privacy protected; in an instance in which the subscription identifier in the message is not to be privacy protected, refraining from privacy protecting the subscription identifier in the message, wherein the message comprises two or more privacy indicators that indicates whether the subscription identifier in the message in the registration request is privacy protected, wherein at least one of the privacy indicators resides in the algorithm scheme used, wherein, a second value of the privacy indicator indicating that the subscription identifier in the message is not privacy protected; and wherein the second value is different from the first value, and sending the message comprising the registration request from the user equipment to a network entity in a communication network.

For example, in one embodiment, a method comprises receiving, at an element or function in a communication network from user equipment of the communication network, a message comprising one or more privacy indicators and determining one or more privacy features for processing the message based on the one or more privacy indicators.

The message may comprise an attach request comprising a subscription identifier for a subscriber of the communication network associated with the user equipment, the one or more privacy indicators comprising a flag indicating whether the subscription identifier in the attach request is privacy-protected. The privacy-protected subscription identifier may comprise at least a portion of a permanent subscription identifier of the subscriber.

In another embodiment, a method comprises determining, at an element or function in a communication network, one or more privacy features supported by the communication