In addition, 5G wireless networks may support network slicing, wherein a single physical network may be sliced into multiple virtual networks. Each network slice may include a set of logical network functions that may support the requirements of a particular use case.

SUMMARY

In a first aspect, the present disclosure provides a method comprising: receiving, by a user device, a non-access stratum message that comprises one or more operator specific access category filters, wherein each of the one or more operator specific access category filters is associated with an operator-specific access category and includes a slice/service type, and wherein the non-access stratum message additionally comprises at least one further operator-specific access category filter, wherein each of the at least one further operator-specific access category filter is associated with an operator-specific access category and includes an operating system application identifier,; detecting, by the user device, a network slice or an application with an access attempt by the user device to access a wireless network; determining, by the user device, an operator-specific access category based on the detected network slice or detected application; determining, by the user device, an access category based on the detected network slice and the one or more operator-specific access category filters or based on the detected application and the at least one further operator-specific access category filter; and making by the user device, a barring decision for the access attempt based on the determined operator-specific access category.

According to an example implementation, a method includes: detecting, by a user device, a network slice associated with an access attempt by the user device to access a wireless network; and, making, by the user device, a barring decision for the access attempt based on the network slice associated with the access attempt.

According to an example implementation, an apparatus includes at least one processor and at least one memory including computer instructions that, when executed by the at least one processor, cause the apparatus to: detect, by a user device, a network slice associated with an access attempt by the user device to access a wireless network; and, make, by the user device, a barring decision for the access attempt based on the network slice associated with the access attempt.

According to an example implementation, a computer program product includes a computer-readable storage medium and storing executable code that, when executed by at least one data processing apparatus, is configured to cause the at least one data processing apparatus to perform a method including: detecting, by a user device, a network slice associated with an access attempt by the user device to access a wireless network; and, making, by the user device, a barring decision for the access attempt based on the network slice associated with the access attempt.In a second aspect, the present disclosure provides a method comprising: receiving, by a base station from a core network entity within a wireless network, a non-access stratum message that comprises one or more operator-specific access category filters, wherein each of the one or more operator specific access category filters is associated with an operator-specific access category and a precedence value and includes a slice/service type, wherein the non-access stratum message additionally comprises at least one further operator-specific access category filter, wherein each of the at least one further operator-specific access category filter is associated with an operator-specific access category and includes an operating system application identifier;

sending, by the base station, the non-access stratum message to a user device;receiving, by the base station from the core network entities within a wireless network, network slice-specific load information that indicates a load for each of one or more network slices; determining, by the base station based on the received network slice-specific load information, a barring configuration that indicates a set of barring parameters for one or more operator-specific access categories; and sending, by the base station to the user device, the barring configuration to reduce a load on the wireless network.

According to an example implementation, an apparatus includes at least one processor and at

least one memory including computer instructions that, when executed by the at least one processor, cause the apparatus to: receive, by a base station from one or more core network entities within a wireless network, network slice-specific load information that indicates a load for each of one or more network slices; determine, by the base station based on the received network slice-specific load information, a barring configuration that indicates a set of barring parameters for one or more access categories; and send, by the base station to a user device, the barring configuration to reduce a load on the wireless network.

According to an example implementation, a computer program product includes a computer-readable storage medium and storing executable code that, when executed by at least one data processing apparatus, is configured to cause the at least one data processing apparatus to perform a method including: receiving, by a base station from one or more core network entities within a wireless network, network slice-specific load information that indicates a load for each of one or more network slices; determining, by the base station based on the received network slice-specific load information, a barring configuration that indicates a set of barring parameters for one or more access categories; and sending, by the base station to a user device, the barring configuration to reduce a load on the wireless network. In an embodiment, there is a method comprising:receiving, by a base station from a core network entities within a 5G wireless network, a non-access stratum message that comprises one or more operator specific access category filters, wherein each of the one or more operator specific access category filters is associated with an operator-specific access category and a precedence value and includes a slice/service type, and wherein the non-access stratum message is a 5G system mobility management message:sending, by the base station, the non-access stratum message that comprises one or more operator specific access category filters to a user device; receiving, by the base station from the core network entity within the wireless network, network slice-specific load information that indicates a load for each of one or more network slices;

determining, by the base station based on the received network slice-specific load information, a barring configuration that indicates a set of barring parameters for one or more access categories; and sending, by the base station to the user device, the barring configuration to reduce a load on the wireless network.

In a aspect, the present disclosure provides a method comprising: sending, by a core network entity of a wireless network, a non-access stratum message that comprises one or more operator-specific access category filters via a base station to a user device, wherein each of the one or more operator-specific access category filters is associated with an operator-specific access category and includes a slice/servicewherein the non-access stratum message additionally comprises at least one further operator-specific access category filter, wherein each of the at least one further operator-specific access category filter is associated with an operator-specific access category and includes an operating system application

identifier; determining, by the core network entity, network slice-specific load information that indicates a load for each of one or more network slices; and sending, by the core network entity to a base station, the network-slice specific load information.

According to an example implementation, an apparatus includes at least one processor and at least one memory including computer instructions that, when executed by the at least one processor, cause the apparatus to: determine, by a core network entity, network slice-specific load information that indicates a load for each of one or more network slices; and send, by the core network entity to a base station, the network-slice specific load information.

According to an example implementation, a computer program product includes a computer-readable storage medium and storing executable code that, when executed by at least one data processing apparatus, is configured to cause the at least one data processing apparatus to perform a method including: determining, by a core network entity, network slice-specific load information that indicates a load for each of one or more network slices; and sending, by the core network entity to a base station, the network-slice specific load information.

In a aspect, the present disclosure provides a user device, comprising: means for receiving a non-access stratum message that comprises one or more operator specific access category filters, wherein each of the one or more operator-specific access category filters is associated with an operator-specific access category and includes a slice/service type, wherein the non-access stratum message additionally comprises at least one further operator-specific access category filter, wherein each of the at least one further operator-specific access category filter is associated with an operator-specific access category and includes an operating system application identifier
means for detecting a network slice or an application associated with an access attempt by the user device to access a wireless network ; means for determining an operator-specific access category based on the detected network slice and the one or more operator-specific access category filters or based on the detected application and the at least one further operator-specific access category filter; and means for making a barring decision for the access attempt based on the determined operator-specific access category.

In a aspect, the present disclosure provides a base station, comprising: means for receiving from a core network entity within a wireless network, a non-access stratum message that comprises one or more operator specific access category filters, wherein each of the one or more operator-specific access category filters is associated with an operator-specific access category and includes a slice/service type

wherein the non-access stratum message additionally comprises at least one further operator-specific access category filter, wherein each of the at least one further operator-specific access category filter is associated with an operator-specific access category and includes an operating system application identifier;

means for sending to a user device, the non-access stratum message;

means for receiving from the core network entities within a wireless network, network slice-specific load information that indicates a load for each of one or more network slices; means for determining based on the received network slice-specific load information, a barring configuration that indicates a set of barring parameters for one or more operator-specific access categories; and means for sending to a user device, the barring configuration to reduce a load on the wireless network.

In an aspect, the present disclosure provides a core network entity of a wireless network, comprising: means for sending a non-access stratum message that comprises one or more operator-specific access category filters via a base station to a user device, wherein each of the one or more operator specific access category filters is associated with an operator-specific access category and includes a slice/service type, wherein the non-access stratum message additionally comprises at least one further operator-specific access category filter, wherein each of the at least one further operator-specific access category filter is associated with an operator-specific access category and includes an operating system application identifie; and means for determining network slice-specific load information that indicates a load for each of one or more network slices; and means for sending the network-slice specific load information to a base station.

In a aspect, the present disclosure provides an apparatus comprising at least one processor and at least one memory including computer instructions that, when executed by the at least one processor, cause the apparatus to perform a method according to one of the above aspects.

In an aspect, the present disclosure provides an apparatus comprising a computer program product including a non-transitory computer-readable storage medium and storing executable code that, when executed by at least one data processing apparatus, is configured to cause the at least one data processing apparatus to perform a method according to one of the above aspects.

CLAIMS

1. A method comprising:

receiving, by a user device, a non-access stratum message that comprises one or more operator-specific access category filters, wherein each of the one or more operator-specific access category filters is associated with an operator-specific access category and includes a slice/service type, and wherein the non-access stratum message additionally comprises at least one further operator-specific access category filter, wherein each of the at least one further operator-specific access category filter is associated with an operator-specific access category and includes an operating system application identifier;

detecting, by the user device, a network slice or an application associated with an access attempt by the user device to access a wireless network;

determining, by the user device, an operator-specific access category based on the detected network slice and the one or more operator-specific access category filters or based on the detected application and the at least one further operator-specific access category filter; and

making, by the user device, a barring decision for the access attempt based on the determined operator-specific access category.

2. A method of claim 1, wherein the making a barring decision comprises:

making, by the user device based on the determined operator-specific access category, a decision that the access attempt is not barred; and

the method further comprising performing, by the user device based on the decision, the detected access attempt to the wireless network.

3. The method of claim 2, wherein the performing the detected access attempt comprises:

sending, by the user device, a radio resource control (RRC) connection request message to request a connection to the wireless network.

4. The method of any of claims 1-3, further comprising:

receiving, by the user device, a barring configuration that indicates a set of barring parameters for one or more of the operator-specific access categories; and

wherein the making the barring decision for the access attempt includes making, by the user device, a barring decision for the access attempt based on the barring configuration and the operator-specific access category for the access attempt.

5. The method of claim 4, wherein said barring configuration indicates whether a particular operator-specific access category of the one or more of the operator-specific access categories should be barred with a certain barring factor and barring timer, and wherein said making a barring decision for the access attempt based on the barring configuration and the operator-specific access category for the access attempt comprises, when said barring configuration indicates that the determined operator-specific access category should be barred with a certain barring factor and barring time:

generating a random number; and

deciding that the access attempt is not barred when the random number is less than the certain barring factor, otherwise deciding that the access attempt is at least temporally barred.

6. The method of any of claims 4-5, wherein the set of barring parameters includes at least a barring rate and a barring timer.

7. The method of any of claims 4-5, wherein the barring configuration is based on a network slice-specific load information that indicates a network load for each of one or more network slices.

8. The method of any of claims 4-7, wherein the barring configuration that indicates a set of barring parameters for the one or more of the operator-specific access categories provides a different prioritization of one or more access attempts based on operator-specific access categories of the access attempts.

9. The method of any of claims 1-8, wherein the network slice associated with the

access attempt is identified by one or more of the following:

a slice/service type (SST); and

a slice/service type (SST) and slice differentiator (SD).

10. The method of any of claims 1-9, wherein the application associated with the access attempt is identified by one or more of the following:

operating system identity; and

operating system application identity.

11. The method of any of claims 1-10, and further comprising:

receiving a compensation parameter for a user device in Inactive mode;

determining, by the user device, that the user device is in Inactive mode; and

wherein the making a barring decision comprises:

applying, by the user device, the compensation parameter to the making a barring decision for the user device to adjust a barring rate of the access attempt of the user device that is in Inactive mode.

12. The method according to any of claims 1-11, wherein each operator-specific access category of at least one of the one or more operator-specific access category filters is further associated with a slice differentiator and/or wherein each operator-specific access category of at least one of the one or more operator-specific access category filters is associated with a precedence value and/or wherein each further operator-specific access category of at least one of the at least one further operator-specific access category filter is associated with a precedence value.

13. The method according to any of claims 1 to 12, wherein the non-access stratum message is a 5G system mobility management message, and wherein the wireless network is a 5G wireless network.

14. A method comprising: receiving, by a base station from a core network entity within a wireless network, a non-access stratum message that comprises one or more operator-specific access category filters, wherein each of the one or more operator-specific access category filters is associated with an operator-specific access category and includes a slice/service type, wherein the non-access stratum message additionally comprises at least one further operator-specific access category filter, wherein each of the at least one further operator-specific

access category filter is associated with an operator-specific access category and includes an operating system application identifier;

sending, by the base station, the non-access stratum message to a user device;

receiving, by the base station from the core network entity within the wireless network, network slice-specific load information that indicates a load for each of one or more network slices;

determining, by the base station based on the received network slice-specific load information, a barring configuration that indicates a set of barring parameters for one or more operator-specific access categories; and

sending, by the base station to the user device, the barring configuration to reduce a load on the wireless network.

15. The method of claim 14, wherein the barring configuration that indicates a set of barring parameters for the one or more operator-specific access categories indicates whether an access attempt with which a network slice is associated is triggered by radio access network (RAN)-level paging.

16. The method of claim 14, wherein the sending comprises sending, by the base station to a user device, the barring configuration, to allow the user device to make a barring decision for an access attempt based on a network slice associated with the access attempt by the user device.

17. The method of any of claims 14-16, wherein the set of barring parameters includes at least a barring rate and a barring timer.

18. The method of any of claims 14 to 17, wherein said barring configuration indicates whether a particular operator-specific access category should be barred with a certain barring factor and barring timer.

19. The method of any of claims 14-18, wherein the one or more network slices are identified by one or more of the following:

a slice/service type (SST); and

a slice/service type (SST) and slice differentiator (SD).

20. The method according to any of claims 14-19, wherein each operator-specific access category of at least one of the one or more operator-specific access category filters is further associated with a slice differentiator and/or wherein each operator-specific access category of at least one of the one or more operator-specific access category filters is associated with a precedence value and/or wherein each further operator-specific access category of at least one of the at least one further operator-specific access category filter is associated with a precedence value.

21. The method according to any of claims 14 to 20, wherein the non-access stratum message is a 5G system mobility management message, and wherein the wireless network is a 5G wireless network.

22. A method comprising:

sending, by a core network entity of a wireless network, a non-access stratum message that comprises one or more operator-specific access category filters via a base station to a user device, wherein each of the one or more operator-specific access category filters is associated with an operator-specific access category and includes a slice/service type, wherein the non-access stratum message additionally comprises at least one further operator-specific access category filter, wherein each of the at least one further operator-specific access category filter is associated with an operator-specific access category and includes an operating system application identifier;

determining, by the core network entity, network slice-specific load information that indicates a load for each of one or more network slices; and

sending, by the core network entity to the base station, the network-slice specific load information.

23. The method of claim 22, where the core network entity comprises a first core network entity, and wherein the network slice-specific load information is determined by the first core network entity from one or more of the following:

network slice-specific load information determined or gathered by the first core network entity; and

network slice-specific load information received from a second core network entity.

24. The method of any of claims 22-23, and further comprising:

sending, by the core network entity to a user device, one or more operator-specific access category filter definitions that indicate an operator-specific access category associated with one or more network slices.

25. The method of any of claims 22-24, wherein the one or more network slices are identified by or associated with one or more of the following:

a slice/service type (SST); and

a slice/service type (SST) and slice differentiator (SD).

26. The method according to any of claims 22-25, wherein each operator-specific access category of at least one of the one or more operator-specific access category filters is further associated with a slice differentiator and/or wherein each operator-specific access category of at least one of the one or more operator-specific access category filters is associated with a precedence value and/or wherein each further operator-specific access category of at least one of the at least one further operator-specific access category filter is associated with a precedence value.

27. The method according to any of claims 22 to 26, wherein the non-access stratum message is a 5G system mobility management message, and wherein the wireless network is a 5G wireless network.

28. A user device, comprising,

means for receiving a non-access stratum message that comprises one or more operator-specific access category filters, wherein each of the one or more operator-specific access category filters is associated with an operator-specific access category and includes a slice/service type, wherein the non-access stratum message additionally comprises at least one

further operator-specific access category filter, wherein each of the at least one further operator-specific access category filter is associated with an operator-specific access category and includes an operating system application identifier;

means for detecting a network slice or an application associated with an access attempt by the user device to access a wireless network;

means for determining an operator-specific access category based on the detected network slice and the one or more operator-specific access category filters or based on the detected application and the at least one further operator-specific access category filter; and

means for making a barring decision for the access attempt based on the determined operator-specific access category.

29. The user device of claim 28, wherein the means for making a barring decision are configured to make, based on the determined operator-specific access category, a decision that the access attempt is not barred; and wherein the user device comprises

means for performing, based on the decision, the detected access attempt to the wireless network.

30. The user device of claim 29, wherein the means for performing, based on the decision, the detected access attempt to the wireless network are configured to:

send a radio resource control (RRC) connection request message to request a connection to the wireless network.

31. The user device any of claims 29-30, further comprising:

means for receiving a barring configuration that indicates a set of barring parameters for one or more of the operator-specific access categories; and

wherein said means for making a barring decision for the access attempt based on the determined operator-specific access category is configured to make the barring decision based on the barring configuration and the operator-specific access category for the access attempt.

32. The user device of claim 31, wherein said barring configuration indicates whether a particular operator-specific access category should be barred with a certain barring factor and barring timer, and wherein said means for making a barring decision based on the determined operator-specific access category is configured to, when said barring configuration indicates that the determined operator-specific access category should be barred with a certain barring factor and barring time:

generate a random number; and

decide that the access attempt is not barred when the random number is less than the certain barring factor, otherwise decide that the access attempt is at least temporally barred.

33. The user device of any of claims 31-32, wherein the set of barring parameters includes at least a barring rate and a barring timer.

34. The user device of any of claims 31-33, wherein the barring configuration is based on a network slice-specific load information that indicates a network load for each of one or more network slices.

35. The user device of any of claims 32-34, wherein the barring configuration that indicates a set of barring parameters for the one or more of the operator-specific access categories provides a different prioritization of one or more access attempts based on operator-specific access categories of the access attempts.

36. The user device of any of claims 28-35, wherein the network slice associated with the access attempt is identified by one or more of the following:

a slice/service type (SST); and

a slice/service type (SST) and slice differentiator (SD).

37. The user device of any of claims 28-36, wherein the application associated with the access attempt is identified by one or more of the following:

operating system identity; and

operating system application identity.

38. The user device of any of claims 28-37, and further comprising:

means for receiving a compensation parameter in Inactive mode;

means for determining that the user device is in Inactive mode; and

wherein the means for making a barring decision for the access attempt based on the determined operator-specific access category are configured to:

apply the compensation parameter to the making a barring decision for the user device to adjust a barring rate of the access attempt of the user device that is in Inactive mode.

39. The user device according to any of claims 28-38, wherein each operator-specific access category of at least one of the one or more operator-specific access category filters is further associated with a slice differentiator and/or wherein each operator-specific access category of at least one of the one or more operator-specific access category filters is associated with a precedence value and/or wherein each further operator-specific access category of at least one of the at least one further operator-specific access category filter is associated with a precedence value.

40. The user device according to any of claims 28 to 39, wherein the non-access stratum message is a 5G system mobility management message, and wherein the wireless network is a 5G wireless network.

41. A base station, comprising:

means for receiving from a core network entity within a wireless network, a non-access stratum message that comprises one or more operator-specific access category filters, wherein each of the one or more operator-specific access category filters is associated with an operator-specific access category and includes a slice/service type, wherein the non-access stratum message additionally comprises at least one further operator-specific access category filter, wherein each of the at least one further operator-specific access category filter is associated with an operator-specific access category and includes an operating system application identifier;

means for sending to a user device, the non-access stratum message;

means for receiving from the core network entity within a wireless network, network slice-specific load information that indicates a load for each of one or more network slices;

means for determining based on the received network slice-specific load information, a barring configuration that indicates a set of barring parameters for one or more operator-specific access categories; and

means for sending to the user device, the barring configuration to reduce a load on the wireless network.

42. The base station of claim 41, wherein the barring configuration that indicates a set of barring parameters for the one or more operator-specific access categories indicates whether an access attempt with which a network slice is associated is triggered by radio access network (RAN)-level paging.

43. The base station of claim 42, wherein the means for sending are configured to send to a user device the barring configuration, to allow the user device to make a barring decision for an access attempt based on a network slice associated with the access attempt by the user device.

44. The base station of any of claims 41 to 43, wherein the set of barring parameters includes at least a barring rate and a barring timer.

45. The base station of any of claims 41 to 44, wherein said barring configuration indicates whether a particular operator-specific access category should be barred with a certain barring factor and barring timer.

46. The base station of any of claims 41-45, wherein the one or more network slices are identified by one or more of the following:

a slice/service type (SST); and

a slice/service type (SST) and slice differentiator (SD).

47. The base station according to any of claims 41-46, wherein each operator-specific access category of at least one of the one or more operator-specific access category filters is further associated with a slice differentiator and/or wherein each operator-specific access category of at least one of the one or more operator-specific access category filters is associated with a precedence value and/or wherein each further operator-specific access category of at least one of the at least one further operator-specific access category filter is associated with a precedence value.

48. The base station according to any of claims 39-45, wherein the non-access stratum message is a 5G system mobility management message, and wherein the wireless network is a 5G wireless network.

49. A core network entity of a wireless network, comprising:

means for sending a non-access stratum message that comprises one or more operator-specific access category filters via a base station to a user device, wherein each of the one or more operator-specific access category filters is associated with an operator-specific access category and includes a slice/service type, wherein the non-access stratum message additionally comprises at least one further operator-specific access category filter, wherein each of the at least one further operator-specific access category filter is associated with an operator-specific access category and includes an operating system application identifier;

means for determining network slice-specific load information that indicates a load for each of one or more network slices; and

means for sending the network-slice specific load information to a base station.

50. The core network entity of claim 49, wherein the core network entity comprises a first core network entity, and wherein the network slice-specific load information is determined by the first core network entity from one or more of the following:

network slice-specific load information determined or gathered by the first core network entity; and

network slice-specific load information received from a second core network entity.

51. The core network entity of any of claims 49-50, and further comprising:

means for sending one or more operator-specific access category filter definitions that indicate an operator-specific access category associated with one or more network slices to a user device.

52. The core network entity of any of claims 49-51, wherein the one or more network slices are identified by or associated with one or more of the following:

a slice/service type (SST); and

a slice/service type (SST) and slice differentiator (SD).

53. The core network entity of any of claims 49 to 52, wherein each operator-specific access category of at least one of the one or more operator-specific access category filters is further associated with a slice differentiator and/or wherein each operator-specific access category of at least one of the one or more operator-specific access category filters is associated with a precedence value and/or wherein each further operator-specific access category of at least one of the at least one further operator-specific access category filter is associated with a precedence value.

54. The core network entity of any of claims 49 to 53, wherein the non-access stratum message is a 5G system mobility management message, and wherein the wireless network is a 5G wireless network.

55. An apparatus comprising at least one processor and at least one memory including computer instructions that, when executed by the at least one processor, cause the apparatus to perform a method of any of claims 1-27.

56. An apparatus comprising a computer program product including a non-transitory computer-readable storage medium and storing executable code that, when executed by at least one data processing apparatus, is configured to cause the at least one data processing apparatus to perform a method of any of claims 1-27.