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Zhang

(54) **SERVICE PREFERENCES FOR MULTIPLE-CARRIER-ENABLED DEVICES**

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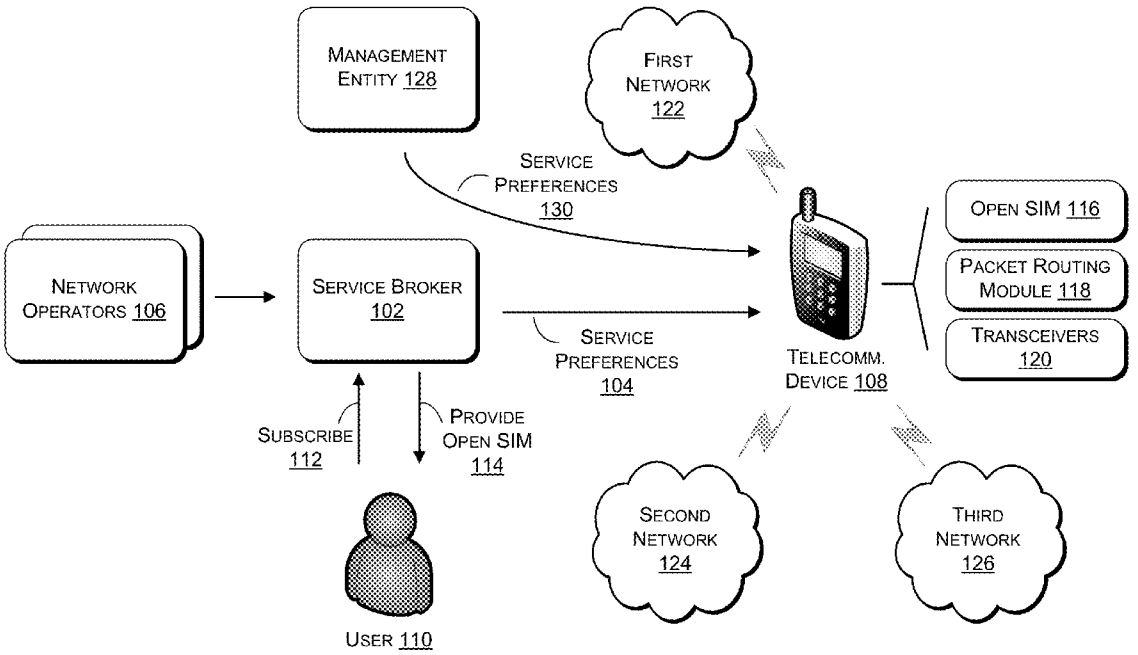
(57) **ABSTRACT**

Techniques are described herein for generating service preferences for a telecommunication device. Those service preferences are then provided to the telecommunication device to enable the telecommunication device to select a network connectivity from a plurality of network connectivities based at least in part on the service preferences. The network connectivities are respectively associated with a plurality of network operators. The service preferences may be generated and provided by any of a network operator, a service broker, or a management service.



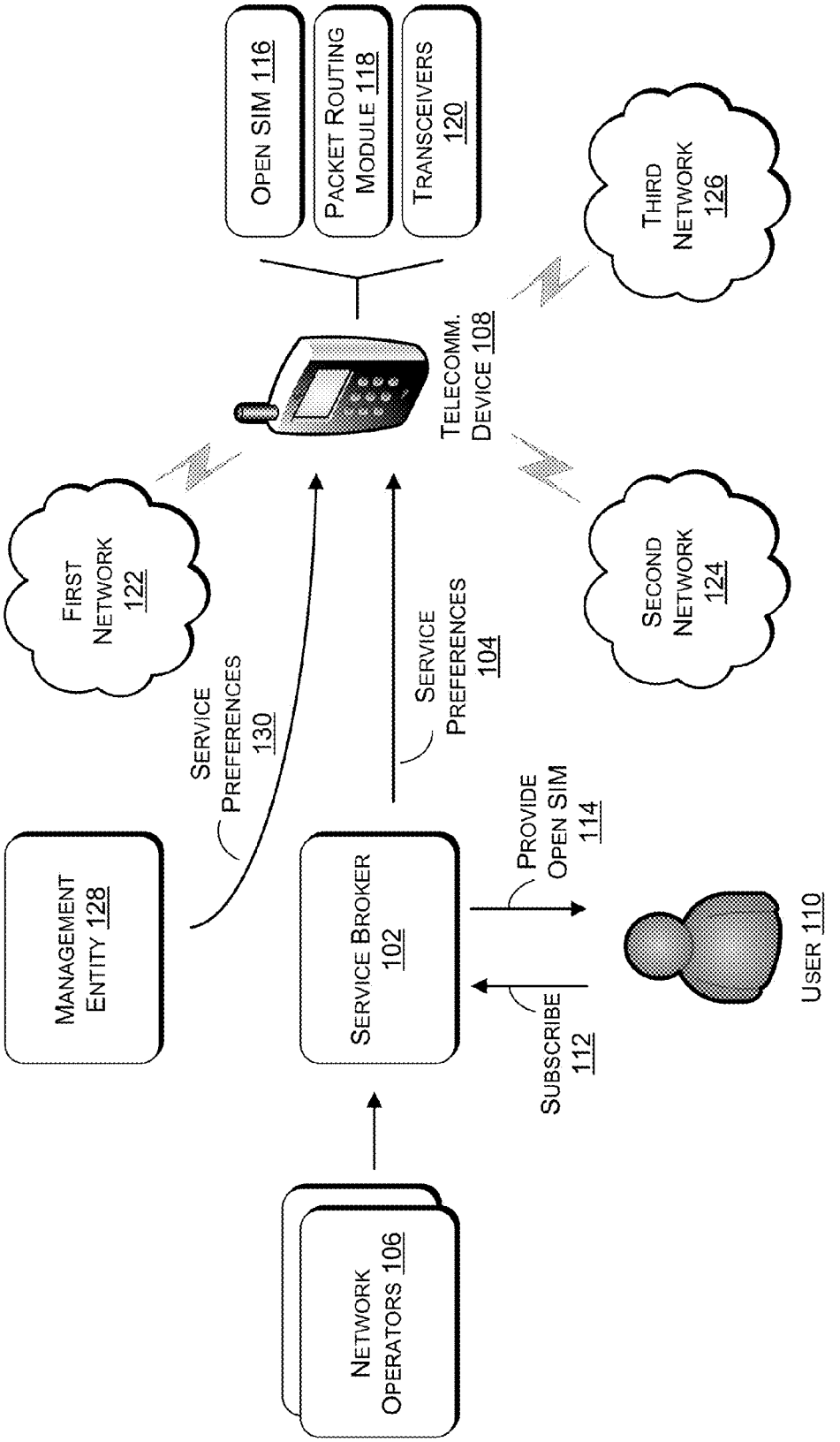

Open SIM 116
Packet Routing Module 118
Transceivers 120
Third Network 126
Telecomm. Device 108
First Network 122
Second Network 124
Service Preferences 130
Service Preferences 104
Management Entity 128
Service Broker 102
Provide Open SIM 114
Subscribe 112
User 110
Network Operators 106

FIG. 1

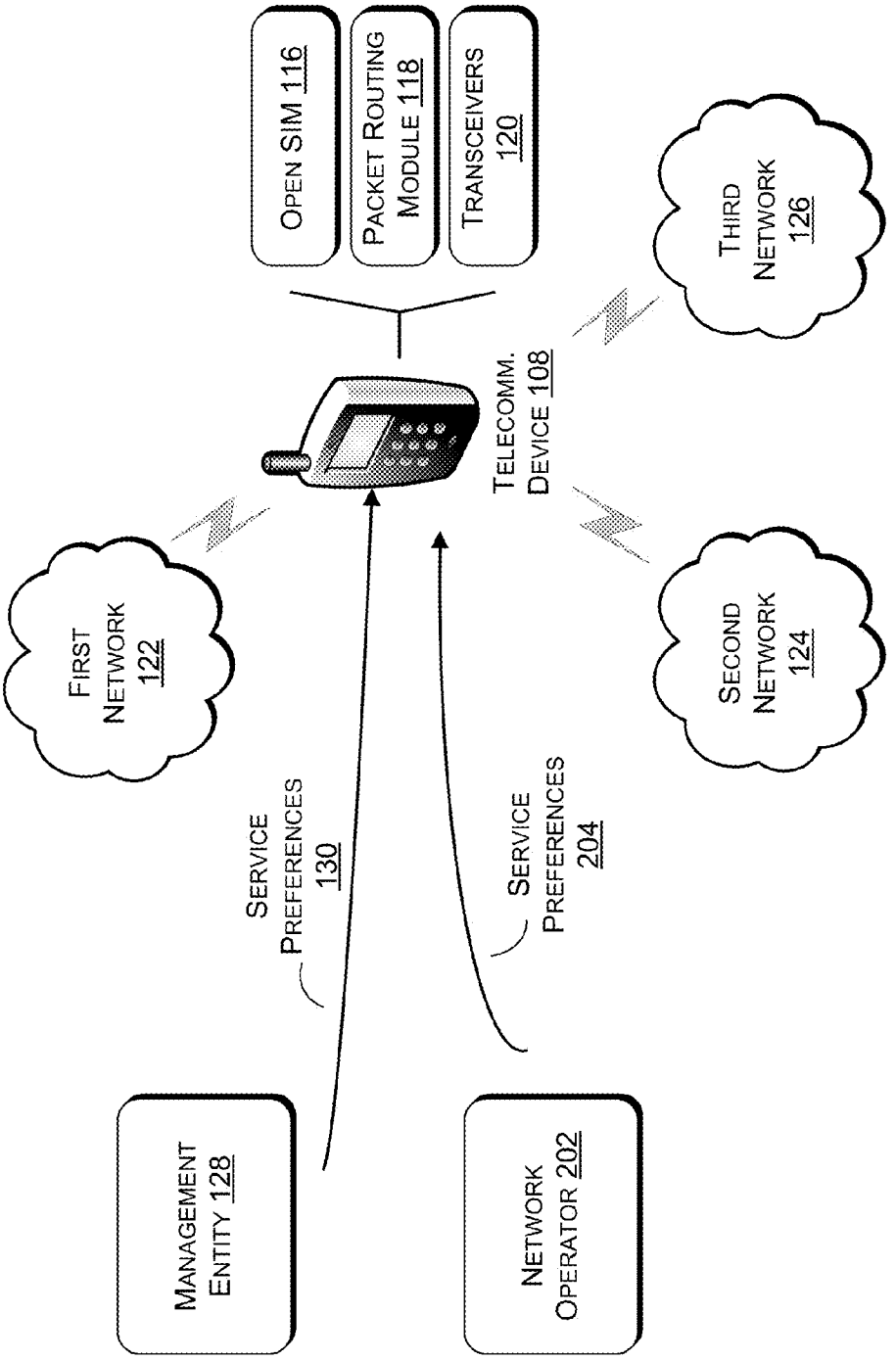

OPEN SIM 116
PACKET ROUTING MODULE 118
TRANSCEIVERS 120
THIRD NETWORK 126
TELECOMM. DEVICE 108
FIRST NETWORK 122
SECOND NETWORK 124
SERVICE PREFERENCES 130
SERVICE PREFERENCES 204
MANAGEMENT ENTITY 128
NETWORK OPERATOR 202

FIG. 2

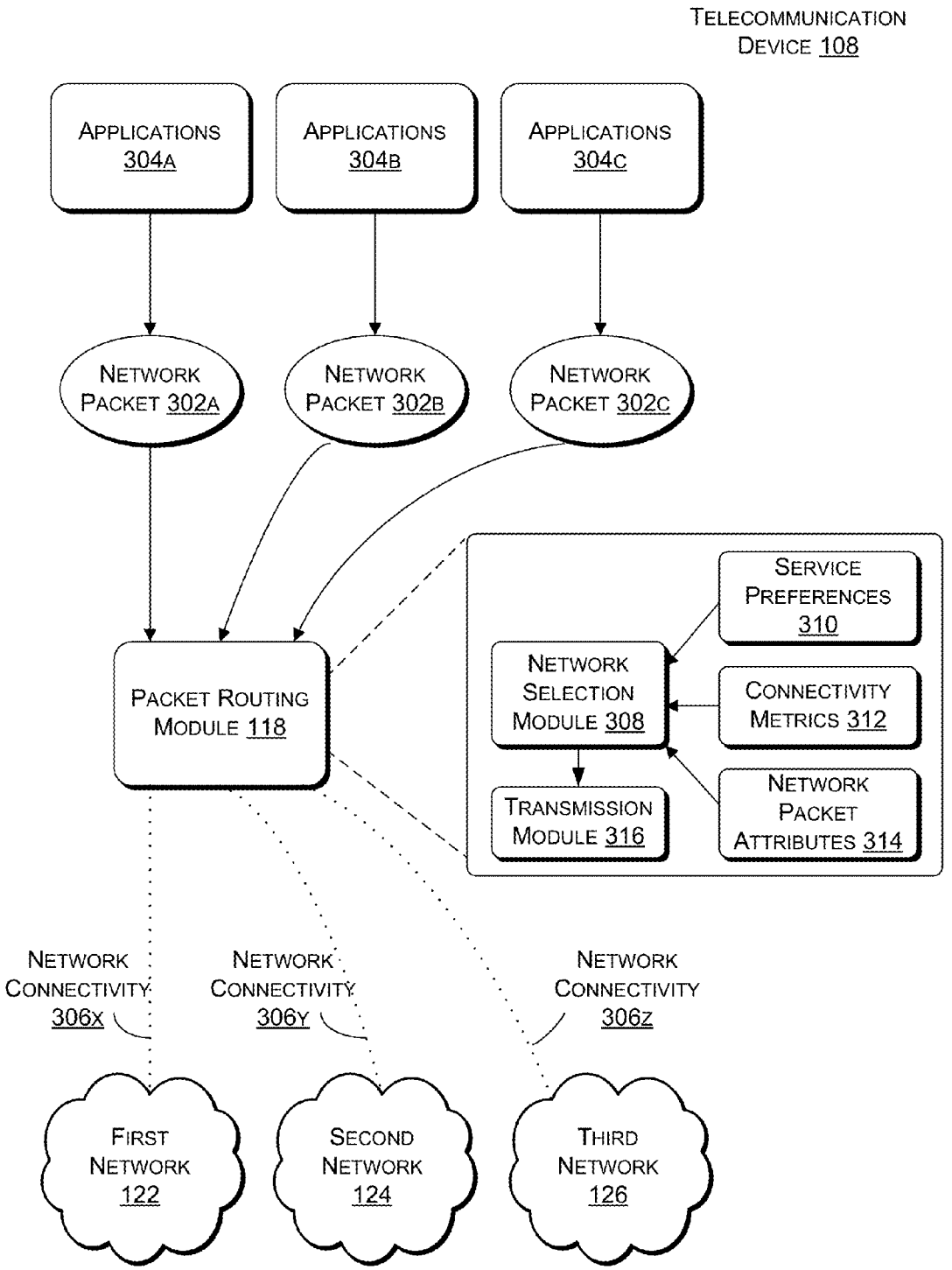

TELECOMMUNICATION DEVICE 108
APPLICATIONS 304A
APPLICATIONS 304B
APPLICATIONS 304C
NETWORK PACKET 302A
NETWORK PACKET 302B
NETWORK PACKET 302C
PACKET ROUTING MODULE 118
SERVICE PREFERENCES 310
NETWORK SELECTION MODULE 308
CONNECTIVITY METRICS 312
TRANSMISSION MODULE 316
NETWORK PACKET ATTRIBUTES 314
NETWORK CONNECTIVITY 306X
NETWORK CONNECTIVITY 306Y
NETWORK CONNECTIVITY 306Z
FIRST NETWORK 122
SECOND NETWORK 124
THIRD NETWORK 126

FIG. 3

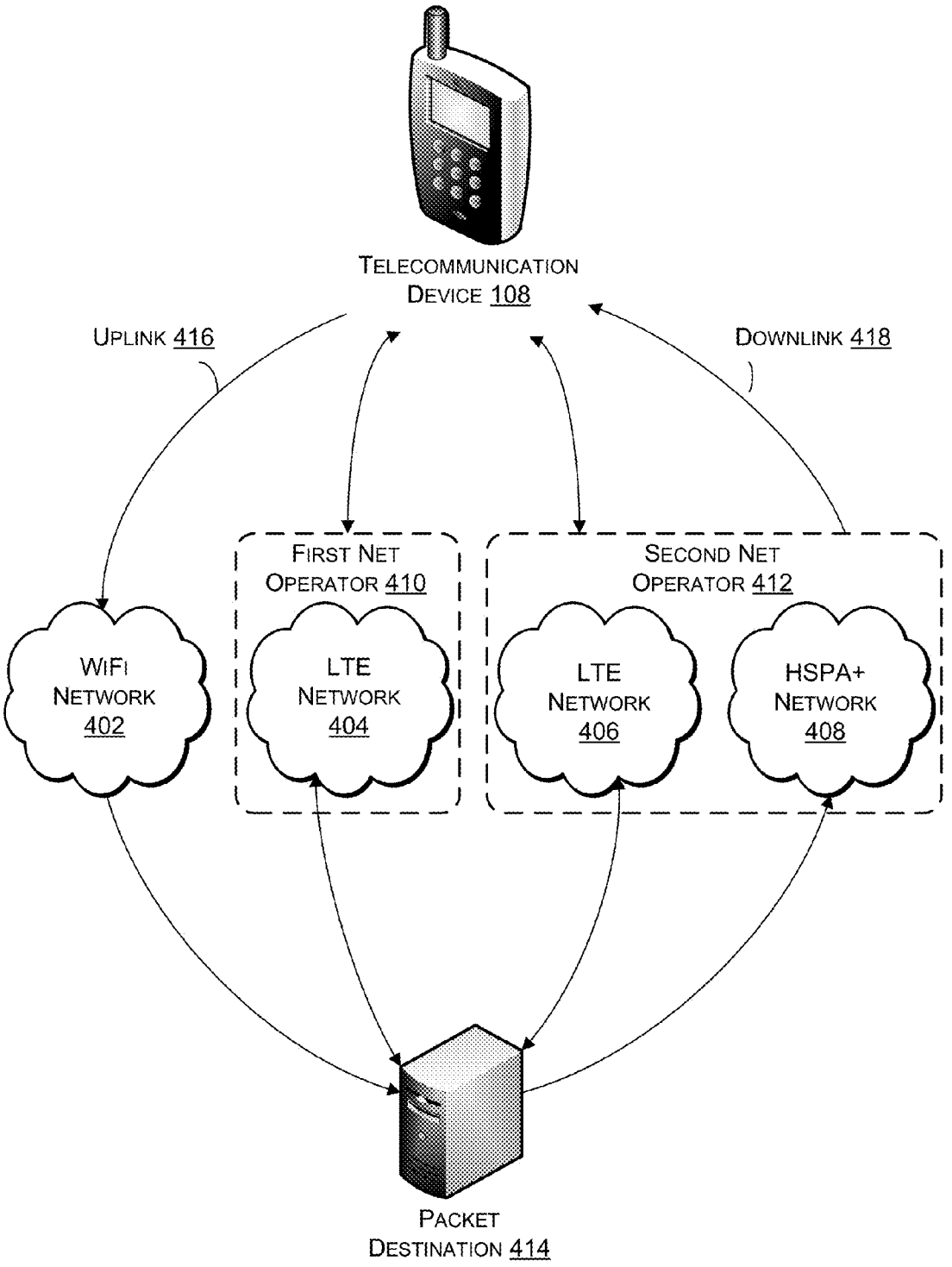

TELECOMMUNICATION DEVICE 108
UPLINK 416
DOWNLINK 418
FIRST NET OPERATOR 410
SECOND NET OPERATOR 412
WIFI NETWORK 402
LTE NETWORK 404
LTE NETWORK 406
HSPA+ NETWORK 408
PACKET DESTINATION 414

FIG. 4

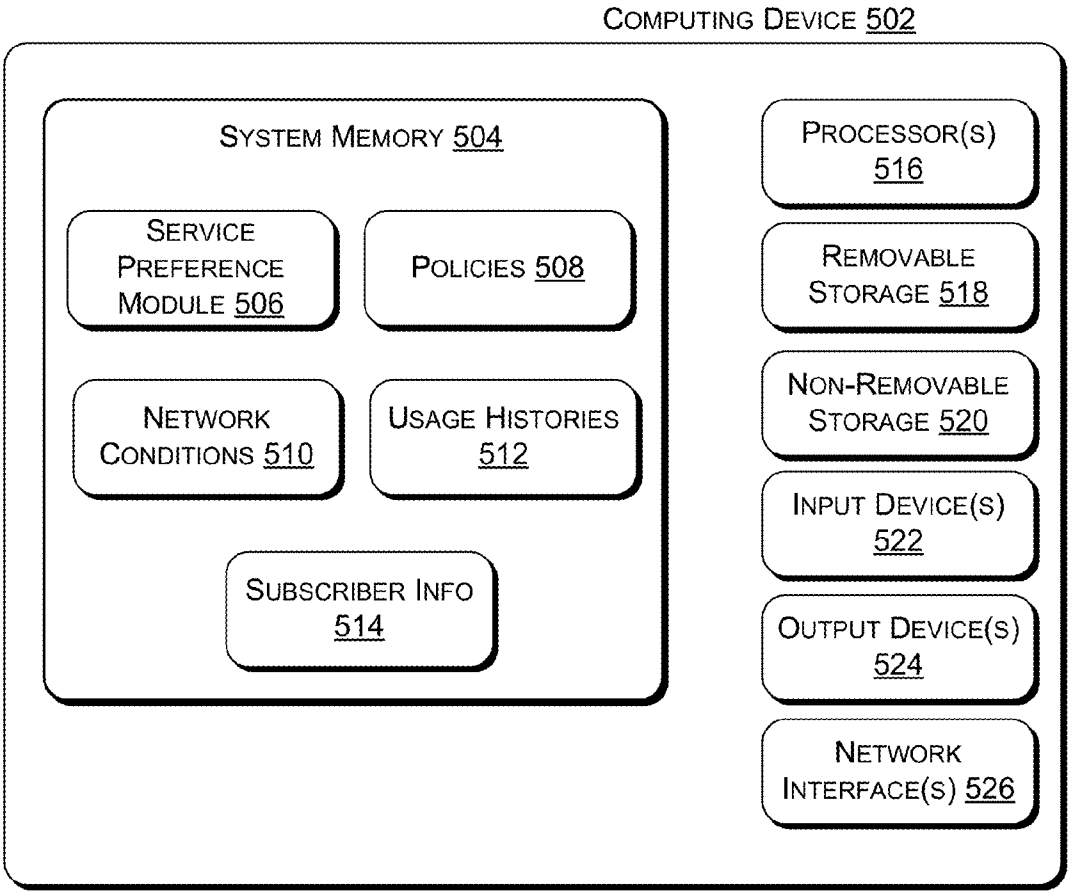
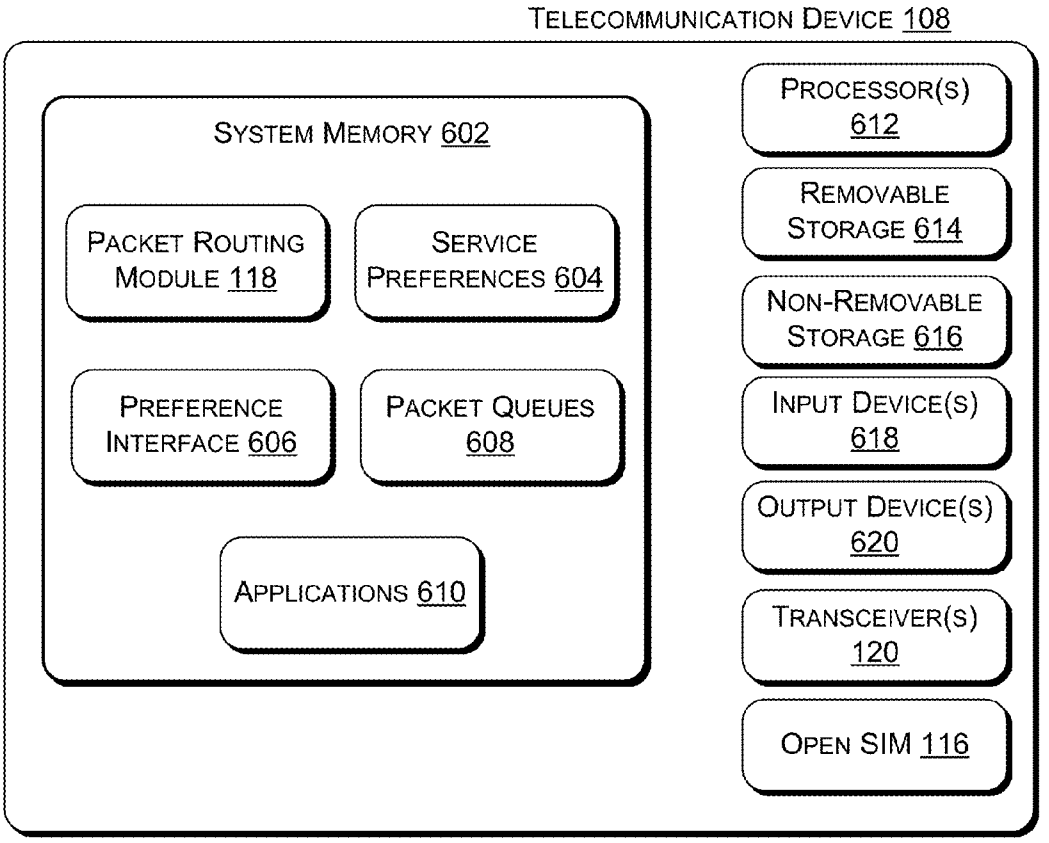

COMPUTING DEVICE 502
SYSTEM MEMORY 504
SERVICE PREFERENCE MODULE 506
POLICIES 508
NETWORK CONDITIONS 510
USAGE HISTORIES 512
SUBSCRIBER INFO 514
PROCESSOR(S) 516
REMOVABLE STORAGE 518
NON-REMOVABLE STORAGE 520
INPUT DEVICE(S) 522
OUTPUT DEVICE(S) 524
NETWORK INTERFACE(S) 526

FIG. 5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PACKET ROUTING MODULE 118
SERVICE PREFERENCES 604
PREFERENCE INTERFACE 606
PACKET QUEUES 608
APPLICATIONS 610
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REMOVABLE STORAGE 614
NON-REMOVABLE STORAGE 616
INPUT DEVICE(S) 618
OUTPUT DEVICE(S) 620
TRANSCEIVER(S) 120
OPEN SIM 116

FIG. 6

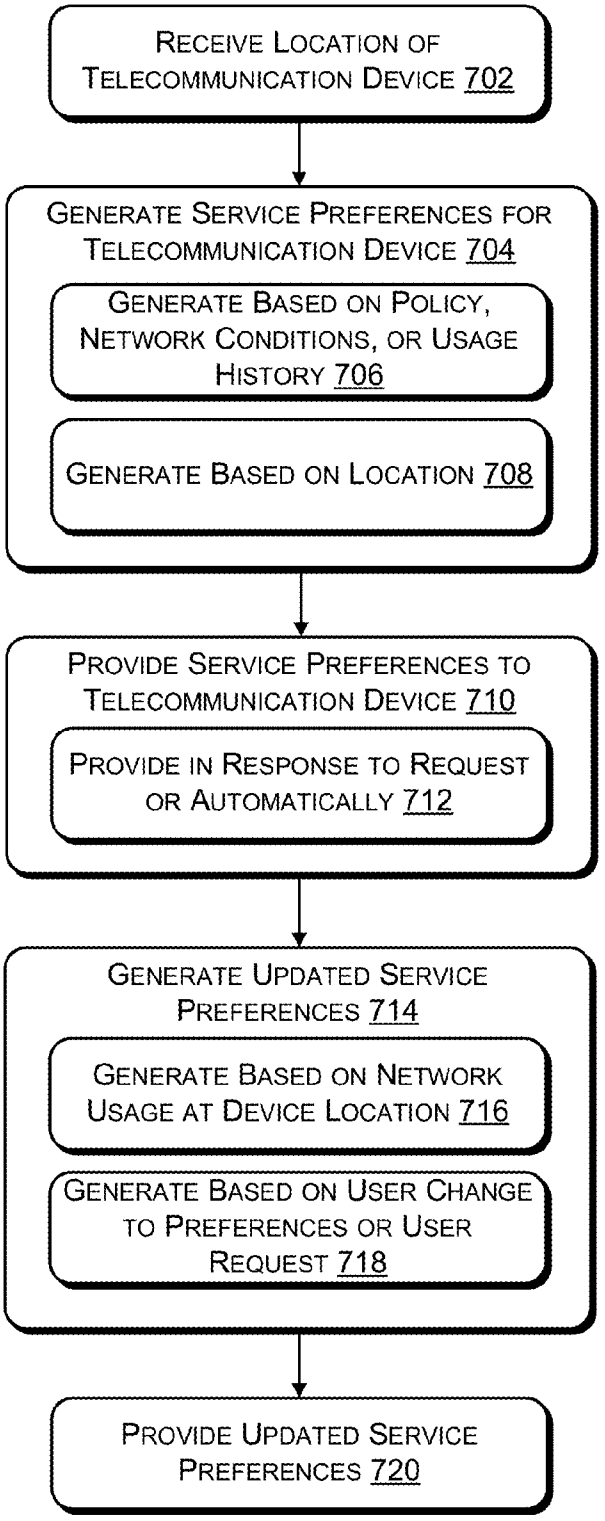
RECEIVE LOCATION OF TELECOMMUNICATION DEVICE 702
GENERATE SERVICE PREFERENCES FOR TELECOMMUNICATION DEVICE 704
GENERATE BASED ON POLICY, NETWORK CONDITIONS, OR USAGE HISTORY 706
GENERATE BASED ON LOCATION 708
PROVIDE SERVICE PREFERENCES TO TELECOMMUNICATION DEVICE 710
PROVIDE IN RESPONSE TO REQUEST OR AUTOMATICALLY 712
GENERATE UPDATED SERVICE PREFERENCES 714
GENERATE BASED ON NETWORK USAGE AT DEVICE LOCATION 716
GENERATE BASED ON USER CHANGE TO PREFERENCES OR USER REQUEST 718
PROVIDE UPDATED SERVICE PREFERENCES 720

FIG. 7

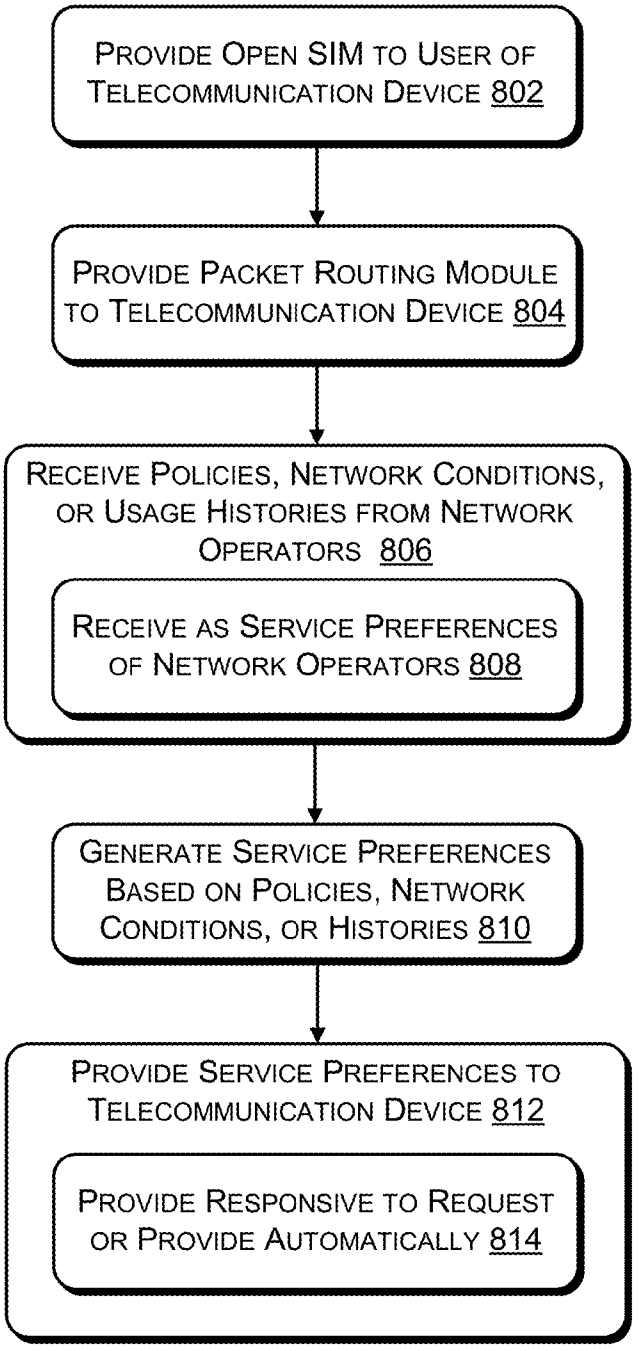
PROVIDE OPEN SIM TO USER OF TELECOMMUNICATION DEVICE 802
PROVIDE PACKET ROUTING MODULE TO TELECOMMUNICATION DEVICE 804
RECEIVE POLICIES, NETWORK CONDITIONS, OR USAGE HISTORIES FROM NETWORK OPERATORS 806
RECEIVE AS SERVICE PREFERENCES OF NETWORK OPERATORS 808
GENERATE SERVICE PREFERENCES BASED ON POLICIES, NETWORK CONDITIONS, OR HISTORIES 810
PROVIDE SERVICE PREFERENCES TO TELECOMMUNICATION DEVICE 812
PROVIDE RESPONSIVE TO REQUEST OR PROVIDE AUTOMATICALLY 814

FIG. 8

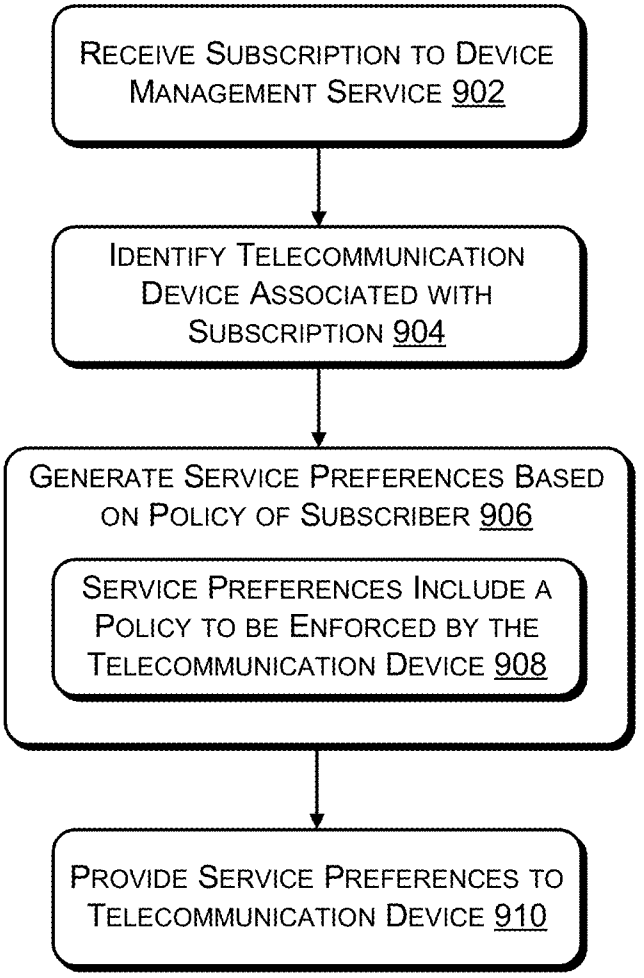
RECEIVE SUBSCRIPTION TO DEVICE MANAGEMENT SERVICE 902
IDENTIFY TELECOMMUNICATION DEVICE ASSOCIATED WITH SUBSCRIPTION 904
GENERATE SERVICE PREFERENCES BASED ON POLICY OF SUBSCRIBER 906
SERVICE PREFERENCES INCLUDE A POLICY TO BE ENFORCED BY THE TELECOMMUNICATION DEVICE 908
PROVIDE SERVICE PREFERENCES TO TELECOMMUNICATION DEVICE 910

FIG. 9

SERVICE PREFERENCES FOR MULTIPLE-CARRIER-ENABLED DEVICES

RELATED APPLICATIONS

[0001] This patent application is a continuation-in-part application of and claims priority to the U.S. patent application entitled "Intelligent Routing of Network Packets on Telecommunication Devices" with Ser. No. 13/732,111 filed on Dec. 31, 2012, which is fully incorporated herein by reference.

[0002] This patent application also claims priority to the U.S. provisional patent application entitled "Service Preferences for Multiple-Carrier-Enabled Devices" with Ser. No. 61/911,047 filed on Dec. 3, 2013, which is fully incorporated herein by reference.

BACKGROUND

[0003] Telecommunication devices have evolved from mobile replacements for the telephone to all-in-one communication, media, and productivity solutions. In addition to voice calling, telecommunication devices now support video and song playback, calendaring, and a variety of features requiring communication over a packet-based network. Such features include web browsing, video streaming, video chat, and many others. To support such packet-based communications, network operators have enhanced their circuit-based telecommunication network offerings by building and offering packet-based telecommunication networks, such as Long Term Evolution (LTE) and Evolved High-Speed Packet Access (HSPA+) networks. In addition to packet-based telecommunication network services, telecommunication devices are now also typically equipped to engage in packet-based communications through wireless data networks, such as WiFi networks, WiMax networks, or Bluetooth networks, or through infrared technology.

[0004] With the rapid spread of wireless data networks and packet-based telecommunication networks, telecommunication devices typically have multiple network connectivities to select from. For example, a telecommunication device could download an audio file via a packet-based telecommunication network offered by the network operator tethered to that telecommunication device or via a WiFi network. Typically, selection of a network connectivity is made based on a universal preference (e.g., always use WiFi when available). Such selection techniques often provide suboptimal results, however, and do not take full advantage of the continuously improving packet-based communication infrastructure available to telecommunication devices. Further, each network operator has advantages and disadvantages; some may offer great coverage, but at a high price, while others may offer suboptimal coverage at a lower price. Also, a given network operator may have better coverage in some locations than in others. Telecommunication devices may not be able to take advantage of these varying benefits, however, as they are often tethered to a single network operator.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] The detailed description is set forth with reference to the accompanying figures. In the figures, the left-most digit(s) of a reference number identifies the figure in which the reference number first appears. The use of the same reference numbers in different figures indicates similar or identical items or features.

[0006] FIG. **1** illustrates an example environment in which a service broker generates service preferences based on input from network operators and provides the service preferences to a telecommunication device to enable the telecommunication device to intelligently select network connectivities to use for transmission of network packets.

[0007] FIG. **2** illustrates an example environment in which a network operator generates service preferences and provides the service preferences to a telecommunication device to enable the telecommunication device to intelligently select network connectivities to use for transmission of network packets.

[0008] FIG. **3** illustrates an example telecommunication device packet routing module for intelligently selecting network connectivities to use for transmission of network packets.

[0009] FIG. **4** illustrates a plurality of packet-based networks supporting various packet routing scenarios.

[0010] FIG. **5** illustrates an example computing device configured with a service preference module for generating service preferences and providing the service preferences to a telecommunication device.

[0011] FIG. **6** illustrates an example telecommunication device configured with a packet routing module and service preferences for selecting network connectivities to use for transmission of network packets.

[0012] FIG. **7** illustrates an example process of a network operator for generating service preferences for a telecommunication device and providing the service preferences to the telecommunication device to enable the telecommunication device to intelligently select network connectivities to use for transmission of network packets.

[0013] FIG. **8** illustrates an example process of a service broker for generating service preferences for a telecommunication device based on input from network operators and providing the service preferences to the telecommunication device to enable the telecommunication device to intelligently select network connectivities to use for transmission of network packets.

[0014] FIG. **9** illustrates an example process of a management service for generating service preferences for a telecommunication device and providing the service preferences to the telecommunication device to manage intelligent selection by the telecommunication device of network connectivities to use for transmission of network packets.

DETAILED DESCRIPTION

[0015] This disclosure describes, in part, techniques for generating service preferences for a telecommunication device. Those service preferences are then provided to the telecommunication device to enable the telecommunication device to select a network connectivity from a plurality of network connectivities based at least in part on the service preferences. The network connectivities are respectively associated with a plurality of network operators. The service preferences may be generated and provided by any of a network operator, a service broker, or a management service.

[0016] To intelligently select among a plurality of available network connectivities, a telecommunication device may be equipped with a packet routing module to select a connectivity and route network packets via that connectivity. The telecommunication device may also be equipped with an open subscriber identity module (SIM) which includes authentication information for a plurality of network operators and thus

enables selection of available network connectivities associated with those network operators. The user of the telecommunication device may receive the open SIM from a service broker in exchange for subscribing to services of that service broker. Alternatively, the user may receive the open SIM from a network operator, from a management service, or the telecommunication device may be built to include an open SIM. The packet routing module may be part of a platform of the telecommunication device or may be received from the service broker, network operator, or management service.

[0017] In various embodiments, the telecommunication device intelligently selects among the available network connectivities based on service preferences. Service preferences may prioritize at least one of connection performance, cost, power consumption, bandwidth, packet delivery efficiency, security level, coverage, and user experience. Service preferences may also prioritize between different network operators associated with the available network connectivities. In some embodiments, the service preferences may be an aggregation of service preferences of the different network operators that is generated by a service broker or may be service preferences received from a single network operator. Further, the service preferences may include different fees respectively associated with different levels of usage of a specific network connectivity associated with a specific network operator. The service preferences may also be associated with a location of the telecommunication device and may be updated as that location changes. The telecommunication device may utilize the service preferences alone or in conjunction with network connectivity metrics or packet attributes in selecting a network connectivity.

[0018] In some embodiments, the service preferences may be received from a management service and may include a policy which is enforced by the telecommunication device. The policy may dictate which network connectivity is selected and may prevent the user of the telecommunication device from providing input which changes the network connectivity selected by the telecommunication device. For example, the telecommunication device may be provided to the user by the user's employer, and the employer may subscribe to the management service to manage network usage on its telecommunication devices.

[0019] In further embodiments, as mentioned above, the service preferences may be generated by a service broker. The service broker may receive service policies, indications of network conditions, usage histories, or service fees from a plurality of network operators and may generate service preferences based on those service policies, indications of network conditions, usage histories, or service fees. In some embodiments, the service policies, indications of network conditions, usage histories, or service fees may be provided as service preferences of the network operators and the service broker may aggregate those service preferences. The user of the telecommunication device may subscribe to services of the service broker, and in return the service broker may provide service preferences to the telecommunication device. The service broker may also provide either or both of the open SIM or the packet routing module, as mentioned above. The service preferences may be provided automatically or responsive to a user request.

[0020] In various embodiments, the service preferences may be generated by a network operator and provided by that network operator to the telecommunication device. The user of the telecommunication device may have a non-exclusive service contract or a service contract without a set-term with the network operator. The network operator may prioritize network connectivities associated with its network, may offer different fees depending on the usage by the telecommunication device of that network, etc. The service preferences may be provided automatically or responsive to a user request.

[0021] The telecommunication device may further enable the user of the telecommunication device to update service preferences through a preferences user interface. Alternatively or additionally, the user may update the service preferences through a website. In some embodiments, the changes may trigger an update to service preferences by a service broker or network operator, which may then provide updated service preferences to the telecommunication device. In further embodiments, the service broker or network operator may monitor network usage at the location of the telecommunication device and provide updated service preferences based on that network usage.

Example Environments

[0022] FIG. **1** illustrates an example environment in which a service broker generates service preferences based on input from network operators and provides the service preferences to a telecommunication device to enable the telecommunication device to intelligently select network connectivities to use for transmission of network packets. As illustrated, a service broker **102** may generate service preferences **104** based on input from a plurality of network operators **106** and may provide the service preferences **104** to a telecommunication device **108**. The telecommunication device **108** may be associated with a user **110** who has subscribed **112** to services of the service broker **102**. The service broker **102** may provide **114** an open SIM **116** to the user **110**, unless the telecommunication device **108** is already provisioned with an open SIM **116**. The telecommunication device **108** may also be provisioned with a packet routing module **118** and transceivers **120**. The telecommunication device **108** may utilize the service preferences **104**, open SIM **116**, packet routing module **118**, and transceivers **120** to select among connectivities for a first network **122**, a second network **124**, and a third network **126**. In some embodiments, the user **110** or an entity associated with the user **110** may subscribe to services of a management entity **128**, which may provide service preferences **130** in addition to or in place of the service preferences **104**.

[0023] In various embodiments, each of the service broker **102**, the network operators **106**, and the management entity **128** may be associated with one or more computing devices. Such computing devices may each be any of a server or server farm, multiple, distributed server farms, a mainframe, a work station, a personal computer (PC), a laptop computer, a tablet computer, an embedded system, or any other sort of device or devices. In some embodiments, the computing devices may form a cloud computing device. In further embodiments, the computing devices may include one or more virtual machines. An example computing device is illustrated in FIG. **5** and described below with reference to that figure.

[0024] In various embodiments, the telecommunications device **108** may be any sort of device capable of engaging in packet-based connections and of having multiple wireless network connectivities. For example the telecommunications device **108** may be any of a smart phone, a tablet computer, a personal digital assistant (PDA), a personal computer (PC), a laptop computer, a media center, a work station, etc. An

example telecommunications device **108** is illustrated in FIG. **6** and described below with reference to that figure.

[0025] In some embodiments, the service broker **102** may be an entity which provides service preferences **104** to telecommunication devices **108** of users **110** who are subscribed **112** to services of the service broker **102**. If the telecommunication device **108** is not provisioned with either or both of an open SIM **116** or a packet routing module **118**, the service broker **102** may provide the open SIM **116** to the user **110** to install in the telecommunication device **108** or may provide the packet routing module **118** to the telecommunication device **108**. Also, if the user **110** does not have a telecommunication device **108** when subscribing **112**, the service broker **102** may provide the user **110** with the telecommunication device **108** (e.g., either through lease or sale). The service broker **102** may also receive input from a plurality of network operators **106**, such as service policies, indications of network conditions, usage histories, or service fees from the network operators **106**. The service broker **102** then generates the service preferences **104** based at least in part on that network operator input. The service broker **102** may have contractual arrangements with some or all of the network operators **106**. Also or instead, the service broker **102** may be an affiliated entity (e.g., a subsidiary) of a network operator **106**. The service broker **102** may deal with network operators **106** on charging, policy, and billing and remotely update charging policy for telecommunication device **108**.

[0026] In various embodiments, the network operators **106** may each be any sort of network operators, such as telecommunication service providers that operate a telecommunication infrastructure, including access networks and a core network, to provide telecommunication services such as voice calling, video calling, messaging, email, and data (e.g., streaming video and audio or web browsing). The network operators **106** may offer these services as part of service plans subscribed to by telecommunication device users or may allow the services to be purchased incrementally (e.g., per packet, per communication session, per connection, etc.).

[0027] For example, each of the first network **122**, the second network **124**, and the third network **126** may be associated with a different network operator **106**. Alternatively, two of the first network **122**, the second network **124**, and the third network **126** may be associated with a single network operator **106**, and the other with another network operator **106**. Each network operator **106** may charge different fees for usage of its network **122**, **124**, or **126**, which may vary based on the user **110**, the telecommunication device **108**, the location of service, the utilization of services at that location, or the type of service (e.g., voice, video, data, etc.). Each network operator **106** may provide information to a service broker **102**, such as service policies, indications of network conditions, usage histories, or service fees. In some embodiments, each network operator **106** generates service preferences to be suggested to a telecommunication device **108**, and may provide the service preferences to the service broker **102**. Such service preferences, may, in embodiments, convey the service policies, indications of network conditions, usage histories, or service fees to the service broker **102**.

[0028] Upon receiving service preferences or service policies, indications of network conditions, usage histories, or service fees from a plurality of network operators **106**, the service broker **102** generates the service preferences **104**. Additionally or instead, the service broker **102** may generate the service preferences **104** based input received from the user **110** or based on observation of behavior or preferences of the user **110**. For instance, as part of the subscription **112** or later, the user **110** may indicate that she prefers to use the "lowest cost" network, and the service broker **102** may generate the service preferences **104** based at least in part on those user preferences. In some embodiments, the service broker **102** may generate the service preferences **104** for the telecommunication device **108** when it first registers. In other embodiments, the service broker **102** may generate and provide the service preferences **104** periodically. In embodiments in which the service broker **102** received service preferences from network operators **106**, generating the service preferences **104** may comprise aggregating the service preferences of the network operators.

[0029] In various embodiments, the service preferences **104** may prioritize at least one of connection performance, cost, power consumption, bandwidth, packet delivery efficiency, security level, coverage, and user experience. Service preferences **104** may also prioritize between different network operators **106** associated with the available network connectivities. Further, the service preferences **104** may include different fees respectively associated with different levels of usage of a specific network connectivity associated with a specific network operator **106**. The service preferences **104** may also be associated with a location of the telecommunication device **108** and may be updated as that location changes. The telecommunication device **108** may utilize the service preferences **104** alone or in conjunction with network connectivity metrics or packet attributes in selecting a network connectivity.

[0030] In some embodiments, the service preferences **104** may be any of "best network performance" (which may be a function of factors such as packet delay, packet loss, and jitter), a specific QoS, "lowest cost", "lowest power consumption with the minimum bandwidth", "largest available bandwidth" given specific performance requirements, "best packet delivering efficiency" (e.g., by grouping/sorting network packets), "best overall metrics", "most secure connection", or some combination of these criteria.

[0031] As mentioned, a user **110** may subscribe **112** to services of the service broker **102** and may receive, in return, a telecommunication device **108** or, if the user **110** has a telecommunication device **108**, the service broker **102** may provide **114** the user **110** with an open SIM **116**. In yet other embodiments, the user **110** may have a telecommunication device **108** provisioned with an open SIM **116**, and the service broker **102** may simply active service in response to the subscription **112**. In further embodiments, subscribing **112** to the service may include indicating preferences or limitations, such as "best performance" or "do not spend more than $100 per month" which may be used by the service broker **102** in generating service preferences **104**.

[0032] In various embodiments, an open SIM **116** is a SIM that is not tethered to any specific network operator **106**. Typically, a SIM is tethered to a specific network operator, providing information (e.g., authentication information) to its network operator that utilizes in enabling services and connectivity for the telecommunication device that includes the SIM. The open SIM **116** provides authentication information to each or any of a plurality of network operators **106** or to a specific subset of network operators **106**, enabling the telecommunication device **108** to switch between different network connectivities of different network operators **106**. An open SIM **116** may be implemented with multiple SIMs com-

bined, each from one network operator. It may also be implemented as virtual SIM or soft SIM.

[0033] The packet routing module **118** is described below in detail with respect to FIG. **3**. The packet routing module **118** may form part of the platform of the telecommunication device **108** or may be an application downloaded from the service broker **102** or another source.

[0034] In some embodiments, the telecommunication device **108** includes one or more wireless transceivers **120**, such as a wireless transceiver for each network connectivity or a wireless transceiver capable of communicating with multiple networks. The telecommunication device **108** may also have a single wireless transceiver **120** with multiple soft radios, such as a soft radio for each network connectivity. To increase throughput, the wireless transceivers **120** may utilize multiple-input/multiple-output (MIMO) technology. The wireless transceivers **120** may be any sort of wireless transceivers capable of engaging in wireless, radio frequency (RF) communication. The wireless transceivers **120** may also include other wireless modems, such as a modem for engaging in WiFi, WiMax, Bluetooth, or infrared communication.

[0035] Once the telecommunication device **108** is associated with a subscription **112**, has an open SIM **116**, packet routing module **118**, wireless transceivers **120**, and has received service preferences **104**, the telecommunication device **108** may select among available network connectivities associated with one or more of the first network **122**, the second network **124**, and the third network **126**. The packet routing module **118** of the telecommunication device **108** utilizes at least the service preferences **104** and, optionally, connectivity metrics or packet attributes in selecting a network connectivity for a packet or flow of packets. Such use of the service preferences **104** in selecting network connectivities is described in greater detail further herein.

[0036] In various embodiments, the networks **122-126** may represent one packet-based access network, such as a WiFi network, an LTE network, an HSPA+ network, a Bluetooth network, or a network associated with infrared technology. If one of the networks **122-126** is a packet-based cellular network, such as a LTE network or an HSPA+ network, that network **122**, **124**, or **126** may include a base station transceiver, base station controller, a node B, or an eNode B. Such a network **122**, **124**, or **126** may provide connectivity to a core network of a network operator **106**. In some embodiments, each of the networks **122-126** that is a packet-based cellular network may be associated with a network operator **106**. Multiple ones of the networks **122-126** may be associated with a same network operator **106**, or each of the networks **122-126** may be associated with a different network operator **106**. Networks **122-126** that are non-cellular data networks, such as WiFi networks, may include an access point device for sending and receiving wireless transmissions. These access devices may in turn be associated with an Internet service provider that provides connectivity to the Internet. For example, the first network **122** may be a WiFi network, the second network **124** may be an LTE network, and the third network **126** may be an HSPA+ network.

[0037] In some embodiments, a user **110** may wish to update the received service preferences **104**. For example, the service preferences **104** may prioritize "best QoS" over "lowest cost," and the user may wish to alter the order of those preferences. The user **110** may enter or update service preferences **104** through some sort of user interface, such as a graphic user interface (GUI), physical input control, or voice input control. The telecommunication device **108** may then translate the user-provided or user-updated preferences to service preferences **104** based on some rules or models. In some embodiments, rather than entering the user-provided or user-updated preferences through an interface or control of the telecommunication device **108**, the user **110** of the telecommunication device **108** may enter the preferences through a web site. Also, in further embodiments, the telecommunication device **108** may provide a GUI that shows costs and performance associated with different service preferences **104** (e.g. decrease in cost per increase in delay measured in milliseconds, or increase in throughput per increase in power consumption). Such a GUI may enable a user **110** to express preferences that result in more satisfactory service preferences. Also, if the user-provided or user-updated preferences will result in changes service fees or other service parameters from a network operator **106**, the GUI may warn the user **110** of this and ask the user **110** to confirm that he or she wishes to proceed.

[0038] The service preferences **104** may be dynamically updated at any time. For example, a user **110** may be unhappy with the quality of the video played on the telecommunication devices **108** and may actuate a soft key or physical button, or may provide a spoken command (e.g., "increase quality"). This new user-provided preference may be translated into an updated service preference **104** (e.g., better performance or improved QoS) that is used going forward in selecting network connectivities for network packets.

[0039] In some embodiments, the telecommunication device **108** may monitor the usage by the user **110** of voice, video, and data services provided via networks **122-126** and update the service preferences **104** based on the monitoring. Such monitoring and updating may involve machine learning techniques which may progressively improve the service preferences **104** to match preferences of the user **110**.

[0040] In various embodiments, the service broker **102** may update the service preferences **104**, either periodically or in response to an event, such as updated input from a network operator **106** or service preference updates made by the user **110**. As mentioned above, a user **110** may specify a new service preference **104** or modify one or more of the service preferences **104** provided by the service broker **102**. The service broker **102** may be notified of the new or modified service preferences **104** by the telecommunication device **108** and may, in response, update the service preferences **104**. For example, the service preferences **104** provided to the telecommunication device **108** may have prioritized one network operator **106** over another, and the user **110** may have modified the service preferences **104** to reverse that priority. In response to the user modification, the service broker **102** may generate updated service preferences **104** that reflect different service fees for the network operators **106**. The service broker **102** may then provide the updated service preferences **104** to the telecommunication device **102**.

[0041] The service broker may also receive new input from one or more of the network operators **106** from time to time. For example, a network operator **106** may update its service fees based on the network usage at a specific location and may provide indicia of that update to the service broker **102**. The service broker **102** may then generate updated service preferences **104** and provide those updated service preferences **104** to the telecommunication device **102**.

[0042] In some embodiments, the service broker **102** or a network operator **106** may monitor the usage by the user **110**

of voice, video, and data services provided via one or more of the networks **122-126** and update the service preferences **104** based on the monitoring. Such monitoring and updating may involve machine learning techniques which may progressively improve the service preferences **104** to match preferences of the user **110**.

[0043] In various embodiments, the management entity **128** may provide remote device management services, controlling which network connectivity that the telecommunication device **108** selects. In such embodiments, the user **110** may be an employee of an entity that subscribes to the management services offered by the management entity **128**. The management entity **128** may control the network connectivity selection so that the selection is in line with preferences of the employer/service subscriber rather than the user **110**. To control the network connectivity selection, the management entity **128** generates and provides service preferences **130** which include a policy that determines which network connectivity is selected. The management entity **128** may generate service preferences **130** in a manner similar to that described above for the service broker **102**, taking into account input from the network operators **106**. The user **110** may also not be able to modify the service preferences **130**, and if the telecommunication device **104** receives both service preferences **104** and service preferences **130**, the service preferences **130** may override the service preferences **104**. In other embodiments, the telecommunication device **108** may only receive service preferences **130**, not service preferences **104**, and the user **110** may not have a subscription with the service broker **102**.

[0044] FIG. **2** illustrates an example environment in which a network operator generates service preferences and provides the service preferences to a telecommunication device to enable the telecommunication device to intelligently select network connectivities to use for transmission of network packets. As illustrated, a network operator **202** may generate service preferences **204** and provide those service preferences **204** directly to the telecommunication device **108**, without any service broker **102** being involved.

[0045] In various embodiments, the network operator **202** may be one of the network operators **106** described above, but may generate, update, and provide its own service preferences **204** to the telecommunication device **108**. The user **110** may have a service arrangement with the network operator **202**. For example, the user **110** may have purchased the telecommunication device **108** from the network operator **202**, subscribed to a non-exclusive or non-set-term service contract with the network operator **202**, etc. The network operator **202** may also provide the open SIM **116** to the user **110**, if the telecommunication device **108** is not provisioned with an open SIM **116**, and may provide the packet routing module **118**.

[0046] The service preferences **204** may be the same as the service preferences **104**, except that service preferences **204** are generated by a network operator **202** rather than a service broker **102**. Also, the service preferences **204** may reward the user **110** for utilizing the network **122**, **124**, or **126** of the network operator **202**, providing differing service fees based on different levels of usage of the network **122**, **124**, or **126** of the network operator **202**.

Example Routing Module

[0047] FIG. **3** illustrates an example telecommunication device packet routing module for intelligently selecting network connectivities to use for transmission of network packets. As illustrated, a telecommunications device **108** may be configured with a packet routing module **118** to route network packets **302***a*-**302***c* from telecommunication device applications **304***a*-**304***c*. To transmit at least one of the network packets **302***a*-**302***c*, the packet routing module **118** selects a network connectivity **306** of a plurality of network connectivities **306***x*-**306***z* respectively associated with a plurality of networks **122-126**. A network selection module **308** of the packet routing module **118** selects the network connectivity **306** based on an evaluation of service preferences **310**, connectivity metrics **312** associated with the network connectivities **306***x*-**306***z*, and network packet attributes **314** associated with the network packet(s) **302** that is/are to be transmitted. After selecting the network connectivity **306**, a transmission module **316** of the packet routing module **118** then utilizes the selected network connectivity **306** to transmit the network packet(s) **302**.

[0048] In some embodiments, the packet routing module **118** receives the network packets **302***a*-**302***c* from the applications **304***a*-**304***c* and stores the network packets **302***a*-**302***c* in a queue or stack associated with the packet routing module **118**. The network packets **302***a*-**302***c* may be any sort of Internet Protocol (IP) packets or other sort of network packets. The applications **304***a*-**304***c* may be any sort of telecommunication device applications which send and receive network packets. For example, the application **304***a* may be a web browser and network packet **302***a* may be a request for web content. Application **304***b* may be a video call client and network packet **302***b* may be a packet associated with a video call. Application **304***c* may be client for a multi-player online game and network packet **302***c* may be a packet associated with a game-play session. These examples are provided only for the sake of illustration; applications **304***a*-**304***c* may be or include many other different types of applications.

[0049] Upon storing the network packets **302***a*-**302***c* in the queue or stack (or as they are stored), the packet routing module **118** may collect network packet attributes **314** of the network packets **302***a*-**302***c* and perform quality of service (QoS) marking of the network packets **302***a*-**302***c*. The collected network packet attributes **314** may include any of the network protocols of the network packets **302***a*-**302***c*, such as the transmission control protocol (TCP), the user datagram protocol (UDP), or the real-time transport protocol (RTP), QoS profiles, packet size, destination address, bandwidth demand, class of services, or security level.

[0050] In various embodiments, before, during, and after receiving the network packets **302***a*-**302***c* (e.g., on a substantially continuous basis), the packet routing module **118** determines the network connectivities **306***x*-**306***z* available to the telecommunication device **108** as well as connectivity metrics **312** for those network connectivities **306***x*-**306***z*. The network connectivities **306***x*-**306***z* may be connectivities to a variety of different packet-based networks **122-126**, such as WiFi networks, LTE network, or HSPA+ networks. The available network connectivities **306***x*-**306***z* may change based on movement of the telecommunication device **108** to a different location or may even change at a given location based on factors such as signal strength or congestion of a network **122-126**. The connectivity metrics **312** collected for each network connectivity **306***x*-**306***z* may include:

[0051] a network protocol used for the associated network **122-126**, such as TCP, UDP, or RTP,

[0052] the availability of the associated network **122-126** at the current location and time,

[0053] performance of a transmission across the associated network **122-126** (delay, jitter, packet-loss rate),

[0054] power consumption associated with use of the associated network **122-126**,

[0055] a bandwidth profile for the associated network **122-126**,

[0056] connection cost for use of the associated network **122-126**, or

[0057] security level.

[0058] The networks **122-126** are described in detail with respect to FIGS. **1** and **2**. As shown in FIG. **3**, the network connectivity **306***x* may be a network connectivity associated with the first network **122**, the network connectivity **306***y* may be a network connectivity associated with the second network **124**, and the network connectivity **306***z* may be a network connectivity associated with the third network **126**.

[0059] In various embodiments, the packet routing module **118** may include both a network selection module **308** and transmission module **316** to select a network connectivity **306** and to transmit network packet(s) **302** using the network connectivity **306**. The network selection module **308** selects a network connectivity **306** for each received network packet **302** and may do so substantially when that network packet **302** is received or at a later time. Each selection is based at least on service preferences **310**, and possibly also on connectivity metrics **312**, and attributes **314** of the network packet **302** for which the network connectivity **306** is being selected. The connectivity metrics **312** may vary from moment to moment and from location to location, and the attributes **314** may be different for each network packet **302**. Even when there is no substantial change in connectivity metrics **312** or attributes **314** between the receiving of two network packets **302**, the service preferences **310** may result in the network selection module **308** selecting different network connectivities **306**.

[0060] In some embodiments, the service preferences **310** may include any one or more of service preferences **104**, service preferences **130**, service preferences **204**, or user-specified service preferences or service preference updates. Such service preferences **310** are described in greater detail above.

[0061] In various embodiments, the network selection module **308** determines a score for each network connectivity **306**. The score may reflect the degree to which the connectivity metrics **312** for the network connectivity **306** meet the service preferences **310** given the attributes **314** of the network packet **302** to be transmitted. The network selection module **308** may then select the network connectivity **306** with the highest score to use in transmitting the network packet **302**. In some embodiments, the network selection module **308** may select a specific network connectivity **306** as a default routing path based on the service preferences **310**.

[0062] Once the network selection module **308** has selected the network connectivity **306** to use for transmitting the network packet **302**, the network selection module **308** invokes the transmission module **316**. The transmission module **316** may establish a connection with the network **122**, **124**, or **126** associated with the selected network connectivity **306**, unless one is already established, and transmit the network packet **302** to the network **122**, **124**, or **126** over the connection.

Example Routing Scenarios

[0063] FIG. **4** illustrates a plurality of packet-based networks supporting various packet routing scenarios. As illustrated, the telecommunication device **108** has network connectivities associated with a WiFi network **402**, an LTE network **404**, an LTE network **406**, and an HSPA+ network **408**. The LTE network **404** is operated by a first network operator **410**, and the LTE network **406** and HSPA+ network **408** are operated by a second network operator **412**. The telecommunication device **108** may transmit one or more network packets to the packet destination **414** over one or more of the networks **402-408**. Also, as illustrated, the telecommunication device **108** may select one network connectivity, such as the network connectivity associated with the HSPA+ network **408**, for downlink communications **416** and another network connectivity, such as the network connectivity associated with the WiFi network **402**, for uplink communications **418**.

[0064] In various embodiments, the networks **402-408** may be examples of the networks **122-126** illustrated in FIGS. **1-3** and described herein with reference to those figures. The first network operator **410** and second network operator **412** may be examples of network operators **106** or the network operator **202**, which are described above in greater detail.

[0065] The packet destination **414** may be any sort of device or devices identifiable by a network address. Such a device or devices may include another telecommunication device, a server, a network or cloud, or any sort of computing device. The network address of the packet destination **414** is specified by the network packet that is to be transmitted to the packet destination **414**.

[0066] In a first routing scenario, the telecommunication device **108** has multiple network connectivities respectively associated with multiple, different network operators, including the first network operator **410** and the second network operator **412**. In such a scenario, the user of the telecommunication device **108** may not be tethered to a service plan of any specific network operator, or may be subject to a non-exclusive service plan. The telecommunication device **108** may utilize service preferences, such as service preferences **104**, **130**, or **310**, and, optionally, evaluate the connectivity metrics associated with the network connectivities in selecting a network connectivity. For example, a first network connectivity associated with an LTE network **404** operated by the first network operator **410** may have a lower cost than a second network connectivity associated with an LTE network **406** operated by the second network operator **412**. If the service preferences specify "use lowest cost," the telecommunication device **108** may select the first network connectivity associated with the LTE network **404**, establish a connection to the LTE network **404** (or use an established connection) and transmit a network packet to the packet destination **414** over the LTE network **404**. After transmitting the network packet, there may be a change to the service preferences, connectivity metrics, or packet attributes. For example, the second network operator **412** may lower its cost, and that lower cost may be reflected in updated service preferences or connectivity metrics. If the service preferences still specify "use lowest cost," the telecommunication device **108** may then select the second network connectivity associated with the LTE network **406** for transmission of further network packets.

[0067] In a second scenario, network packets associated with a single logical connection (e.g., a video call) may be

transmitted first over one network (e.g., LTE network **406**) and then another (e.g., HSPA+ network **408**) based on updated service preferences or varying metrics/attributes, without interruption to the logical connection. For example, the attributes of the network packets and connectivity metrics may stay largely the same, but the telecommunication device **108** may receive updated service preferences, or the user may modify the service preferences. The user may modify the service preferences, for instance, because of suboptimal quality of experience. In this example, the update may result in service preferences that require a higher quality of service (QoS). This higher QoS may, in turn, result in the telecommunication device **108** selecting a second network (e.g., HSPA+ network **408**) in place of a previously used, first network (e.g., LTE network **406**).

[0068] In a third routing scenario, different networks **402-408** may be associated with different network topologies. These different network topologies may result in significantly different network latencies. For example, a telecommunication device **108** may have a first network connectivity associated with a WiFi network **402** and a second network connectivity associated with an LTE network **404**. The packet destination **414** may be geographically proximate to the telecommunication device **108**, and the network topology of the LTE network **404** may require all network traffic to be sent to a node of the first network operator **410** a significant distance from the telecommunication device **108**. When using the LTE network **404**, then, this far distance must be traversed twice to send the network packet to its destination **414**. When using the WiFi network **402**, only a short distance need be traversed. To detect such differences in network topologies, the telecommunication device **108** may send messages to the destination **414** using each of the networks **402** and **404**, receive responses, and calculate round trip times. This may be performed by the telecommunication device **108**, for example, using a ping utility. These round trip times may then be evaluated in light of the service preferences to select a network connectivity. If the service preferences specify "select lowest network latency," the telecommunication device **108** may select the WiFi network **402**.

[0069] In some embodiments, the calculation of network latencies need not be repeated for each packet; rather, the telecommunication device **108** need only calculate the network latencies once for a logical connection, a session, a flow, or for packets associated with a same destination **414** that are transmitted within a time window of each other.

[0070] In a fourth scenario, the telecommunication device **108** may select different network connectivities for uplink communications **418** and downlink communications **416**. For example the telecommunication device **108** may select a network connectivity associated with the HSPA+ network **408** for downlink communications **416** and a network connectivity associated with the WiFi network **402** for uplink communications **418**. The telecommunication device **108** may then transmit network packets using the WiFi network **402** and receive network packets using the HSPA+ network **408**.

[0071] In a fifth routing scenario, telecommunication device **108** may sort or combine for transmission multiple network packets to better achieve the service preferences. This may involve grouping network packets by size, destination, or QoS profile and transmitting the grouped networked packets using a same one of the networks **402-408** or concurrently over multiple ones of the networks **402-408**. Also or instead, the sorting may involve prioritizing some network packets and delaying others.

[0072] In a sixth routing scenario, the service preferences may specify "maximum throughput" and the telecommunication device **108** may, as a result, select all available network connectivities for transmission of packets to the packet destination **414**. In such a scenario, the telecommunication device **108** may connect to each of the networks **402-408** and may simultaneously transmit packets over all of the networks **402-408**.

[0073] The above scenarios are described for the sake of illustration and do not limit the routing scenarios possible given the packet routing techniques described herein.

Example Devices

[0074] FIG. **5** illustrates an example computing device configured with a service preference module for generating service preferences and providing the service preferences to a telecommunication device. As illustrated, a computing device **502** comprises a system memory **504** storing service preferences module **506**, policies **508**, network conditions **510**, usage histories **512**, and subscriber information **514**. Also, the computing device **502** includes processor(s) **516**, a removable storage **518** and non-removable storage **520**, input device(s) **522**, output device(s) **524**, and network interface(s) **526**. The computing device **502** may be associated with any of the service broker **102**, the management entity **128**, or the network operator **202**.

[0075] In various embodiments, system memory **504** is volatile (such as RAM), non-volatile (such as ROM, flash memory, etc.) or some combination of the two. The service preferences module **506**, policies **508**, network conditions **510**, usage histories **512**, and subscriber information **514** stored in the system memory **504** may comprise methods, threads, processes, applications or any other sort of executable instructions. The service preferences module **506**, policies **508**, network conditions **510**, usage histories **512**, and subscriber information **514** may also include files and databases.

[0076] The service preferences module **506** comprises any logic capable of generating, updating, and providing service preferences in the manner described in greater detail further herein. Also, further description of the policies **508**, network conditions **510**, usage histories **512**, and subscriber information **514** is provided above.

[0077] In some embodiments, the processor(s) **516** is a central processing unit (CPU), a graphics processing unit (GPU), or both CPU and GPU, or other processing unit or component known in the art.

[0078] Computing device **502** also includes additional data storage devices (removable and/or non-removable) such as, for example, magnetic disks, optical disks, or tape. Such additional storage is illustrated in FIG. **5** by removable storage **518** and non-removable storage **520**. Tangible computer-readable media may include volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information, such as computer readable instructions, data structures, program modules, or other data. System memory **504**, removable storage **518** and non-removable storage **520** are all examples of computer-readable storage media. Computer-readable storage media include, but are not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital ver-

satile disks (DVD) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can be accessed by the computing device **502**. Any such tangible computer-readable media may be part of the computing device **502**.

[0079] Computing device **502** also has input device(s) **522**, such as a keypad, a cursor control, a touch-sensitive display, voice input device, etc., and output device(s) **524** such as a display, speakers, etc. These devices are well known in the art and need not be discussed at length here.

[0080] Computing device **502** further includes network interface(s) **526** for wired and/or wireless communication with other computing devices over one or more networks, such as any of networks **122-124**, public networks, private networks, or the Internet. Such network interfaces are well known in the art and need not be discussed at length here.

[0081] FIG. **6** illustrates an example telecommunication device configured with a packet routing module and service preferences for selecting network connectivities to use for transmission of network packets. As illustrated, telecommunication device **108** comprises a system memory **602** storing a packet routing module **118**, service preferences **604**, a preference interface **606**, packet queues **608**, and applications **610**. Also, the telecommunication device **108** includes processor(s) **612**, a removable storage **614** and non-removable storage **616**, input device(s) **618**, output device(s) **620**, transceivers **120**, and an open SIM **116**.

[0082] In various embodiments, system memory **602** is volatile (such as RAM), non-volatile (such as ROM, flash memory, etc.) or some combination of the two. The packet routing module **118**, service preferences **604**, preference interface **606**, packet queues **608**, and applications **610** stored in the system memory **602** may comprise methods, threads, processes, applications or any other sort of executable instructions. The packet routing module **118**, service preferences **604**, preference interface **606**, packet queues **608**, and applications **610** may also include files and databases. Further description of the packet routing module **118**, examples of service preferences **604** (e.g., service preferences **104**, service preferences **130**, service preferences **204**, and service preferences **310**), and applications **610** is provided above.

[0083] In further embodiments, the preference interface **606** may be any sort of GUI, physical control, or voice control through which a user may enter preferences used to modify or request an update to the service preferences **604**. Such preference interfaces **606** are described in further detail herein when describing examples of service preferences **604** (e.g., service preferences **104**, service preferences **130**, service preferences **204**, and service preferences **310**).

[0084] In various embodiments, the packet queues **608** may include one or more queues or stacks associated with the packet routing module **118**. Such packet queues **608** may be used to store the network packets **302** pending selection of a network connectivity **306** for each network packet **302**. Packet queues **608** may also include queues or stacks associated with wireless transceivers **120** or with network protocols used in transmitting the network packets **302** any one or more of network(s) **122-126**.

[0085] In some embodiments, the processor(s) **612** is a central processing unit (CPU), a graphics processing unit (GPU), or both CPU and GPU, or other processing unit or component known in the art.

[0086] Telecommunication device **108** also includes additional data storage devices (removable and/or non-removable) such as, for example, magnetic disks, optical disks, or tape. Such additional storage is illustrated in FIG. **6** by removable storage **614** and non-removable storage **616**. Tangible computer-readable media may include volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information, such as computer readable instructions, data structures, program modules, or other data. System memory **602**, removable storage **614** and non-removable storage **616** are all examples of computer-readable storage media. Computer-readable storage media include, but are not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVD) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can be accessed by the telecommunication device **108**. Any such tangible computer-readable media may be part of the telecommunication device **108**.

[0087] Telecommunication device **108** also has input device(s) **618**, such as a keypad, a cursor control, a touch-sensitive display, voice input device, etc., and output device (s) **620** such as a display, speakers, etc. These devices are well known in the art and need not be discussed at length here.

[0088] Wireless transceivers **120** and open SIM **116** are described above in detail with respect to FIG. **1**.

Example Processes

[0089] FIGS. **7-9** illustrate example processes. These processes are illustrated as logical flow graphs, each operation of which represents a sequence of operations that can be implemented in hardware, software, or a combination thereof. In the context of software, the operations represent computer-executable instructions stored on one or more computer-readable storage media that, when executed by one or more processors, perform the recited operations. Generally, computer-executable instructions include routines, programs, objects, components, data structures, and the like that perform particular functions or implement particular abstract data types. The order in which the operations are described is not intended to be construed as a limitation, and any number of the described operations can be combined in any order and/or in parallel to implement the processes.

[0090] FIG. **7** illustrates an example process of a network operator for generating service preferences for a telecommunication device and providing the service preferences to the telecommunication device to enable the telecommunication device to intelligently select network connectivities to use for transmission of network packets. The process includes, at **702**, receiving, by a network operator, a location of a telecommunication device. The telecommunication device may be associated with a user who does not have a set-term service contract with the network operator.

[0091] At **704**, the network operator generates service preferences for the telecommunication device. At **706**, the generating is based at least in part on one or more network conditions, a network operator policy, or a network usage history. At **708**, the generating is based at least in part on the received location of the telecommunication device. The service preferences may include different fees respectively associated with different levels of usage of a network connectivity associated with the network operator. Also or instead, the service

preferences may include preferences between the network operator and one of the other network operators or preferences between at least two of the other network operators. Further, the service preferences may prioritize at least one of connection performance, cost, power consumption, bandwidth, packet delivery efficiency, security level, coverage, and user experience.

[0092] At **710**, the network operator provides the service preferences to the telecommunication device to enable the telecommunication device to select a network connectivity from a plurality of network connectivities based at least in part on the service preferences. The plurality of network connectivities may be respectively associated with the network operator and one or more other network operators. At **712**, the service preferences are provided responsive to request from the telecommunication device or are provided automatically.

[0093] At **714**, the network operator, generates updated service preferences. At **716**, generating the updated service preferences comprises generating the updated service preferences based at least in part on network usage at a location of the telecommunication device. At **718**, generating the updated service preferences comprises generating the updated service preferences based at least in part on a user request or a user change to the provided service preferences.

[0094] At **720**, the network operator provides the updated service preferences to the telecommunication device.

[0095] FIG. **8** illustrates an example process of a service broker for generating service preferences for a telecommunication device based on input from network operators and providing the service preferences to the telecommunication device to enable the telecommunication device to intelligently select network connectivities to use for transmission of network packets. The process includes, at **802**, providing, by a service broker, an open SIM to a user of a telecommunication device. At **804**, the service broker may also provide a packet routing module to the telecommunication device. The service broker enables access to the network connectivities of a plurality of network operators.

[0096] At **806**, the service broker receives at least one of service policies, indications of network conditions, usage histories, or service fees from the plurality of network operators. At **808**, the service broker receives the service policies, the indications of network conditions, the usage histories, or the service fees as service preferences specified by each of the plurality of network operators.

[0097] At **810**, the service broker generates service preferences for the telecommunication device based at least in part on the service policies, the indications of network conditions, the usage histories, or the service fees. The generating may comprise aggregating the service preferences of the network operators. The service preferences may include preferences between at least two of the network operators. Also, the service preferences may prioritize at least one of connection performance, cost, power consumption, bandwidth, packet delivery efficiency, security level, coverage, and user experience.

[0098] At **812**, the service broker provides the service preferences to the telecommunication device to enable the telecommunication device to select a network connectivity from a plurality of network connectivities based at least in part on the service preferences. The plurality of network connectivities may be respectively associated with the plurality of network operators. At **814**, the service preferences are provided responsive to a request from the telecommunication device or are provided automatically.

[0099] FIG. **9** illustrates an example process of a management service for generating service preferences for a telecommunication device and providing the service preferences to the telecommunication device to manage intelligent selection by the telecommunication device of network connectivities to use for transmission of network packets. The process includes, at **902**, receiving from a subscriber, by a management service, a subscription for management of the telecommunication device through service preferences. At **904**, the management service identifies a telecommunication device associated with the subscriber.

[0100] At **906**, the management service generates service preferences for the telecommunication device based at least in part on a policy of the subscriber. At **908**, the service preferences include a policy to be enforced by a packet routing module of the telecommunication device.

[0101] At **910**, the management service provides the service preferences to the telecommunication device to enable the telecommunication device to select a network connectivity from a plurality of network connectivities based at least in part on the service preferences. The plurality of network connectivities may be respectively associated with a plurality of network operators.

CONCLUSION

[0102] Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described. Rather, the specific features and acts are disclosed as exemplary forms of implementing the claims.

What is claimed is:

1. A computer-implemented method comprising:

generating, by a network operator, service preferences for a telecommunication device; and

providing, by the network operator, the service preferences to the telecommunication device to enable the telecommunication device to select a network connectivity from a plurality of network connectivities based at least in part on the service preferences, the plurality of network connectivities being respectively associated with the network operator and one or more other network operators.

2. The method of claim **1**, wherein the generating is based at least in part on one or more network conditions, a network operator policy, or a network usage history.

3. The method of claim **1**, wherein the service preferences include different fees respectively associated with different levels of usage of the network connectivity associated with the network operator.

4. The method of claim **1**, further comprising generating updated service preferences and providing the updated service preferences to the telecommunication device.

5. The method of claim **4**, wherein generating the updated service preferences comprises generating the updated service preferences based at least in part on network usage at a location of the telecommunication device.

6. The method of claim **4**, wherein generating the updated service preferences comprises generating the updated service preferences based at least in part on a user request or a user change to the provided service preferences.

7. The method of claim 1, further comprising receiving a location of the telecommunication device and performing the generating of the service preferences based at least in part on the location.

8. The method of claim 1, wherein the service preferences include preferences between the network operator and one of the other network operators or preferences between at least two of the other network operators.

9. The method of claim 1, wherein the service preferences prioritize at least one of connection performance, cost, power consumption, bandwidth, packet delivery efficiency, security level, coverage, and user experience.

10. The method of claim 1, wherein a user of the telecommunication device does not have a set-term service contract with the network operator.

11. The method of claim 1, wherein the service preferences are provided responsive to request from the telecommunication device or are provided automatically.

12. One or more non-transitory computer-readable media having stored thereon a plurality of programming instructions which, when executed by one or more computing devices, perform operations comprising:

receiving at least one of service policies, indications of network conditions, usage histories, or service fees from a plurality of network operators;

generating service preferences for a telecommunication device based at least in part on the service policies, the indications of network conditions, the usage histories, or the service fees; and

providing, by the network operator, the service preferences to the telecommunication device to enable the telecommunication device to select a network connectivity from a plurality of network connectivities based at least in part on the service preferences, the plurality of network connectivities being respectively associated with the plurality of network operators.

13. The one or more non-transitory computer-readable media of claim 12, wherein the service policies, the indications of network conditions, the usage histories, or the service fees are provided as service preferences specified by each of the plurality of network operators, and the generating comprises aggregating the service preferences.

14. The one or more non-transitory computer-readable media of claim 12, wherein the one or more computing devices are associated with a service broker that enables access to the network connectivities of the plurality of network operators.

15. The one or more non-transitory computer-readable media of claim 12, wherein the operations further comprise providing an open subscriber identity module (SIM) to a user of the telecommunication device.

16. The one or more non-transitory computer-readable media of claim 12, wherein the operations further comprise providing a packet routing module to the telecommunication device.

17. The one or more non-transitory computer-readable media of claim 12, wherein the service preferences include preferences between at least two of the network operators.

18. The one or more non-transitory computer-readable media of claim 12, wherein the service preferences prioritize at least one of connection performance, cost, power consumption, bandwidth, packet delivery efficiency, security level, coverage, and user experience.

19. The one or more non-transitory computer-readable media of claim 12, wherein the service preferences are provided responsive to a request from the telecommunication device or are provided automatically.

20. A computing device comprising:

one or more processors; and

a service preference management module configured to be operated by the one or more processors to:

generate service preferences for a telecommunication device based at least in part on a policy of a subscriber associated with the telecommunication device, and

provide the service preferences to the telecommunication device to enable the telecommunication device to select a network connectivity from a plurality of network connectivities based at least in part on the service preferences, the plurality of network connectivities being respectively associated with a plurality of network operators.

21. The computing device of claim 20, wherein the service preferences include a policy to be enforced by a packet routing module of the telecommunication device.

22. The computing device of claim 20, wherein the subscriber subscribes to a service associated with computing device for managing the telecommunication device through the service preferences.

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