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(54) **APPARATUSES AND METHODS FOR ENHANCING MULTI-OPERATOR/MULTI-VENDOR RADIO ACCESS NETWORK RESOURCE POOLING AND SLICING**

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**H04W 28/18** (2009.01)

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USPC ..... 370/310; 455/450–452.2  
See application file for complete search history.

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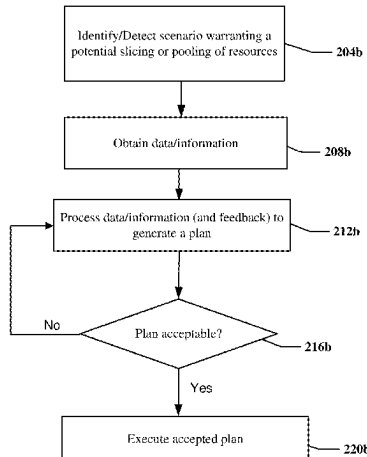
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(57) **ABSTRACT**

Aspects of the subject disclosure may include, for example, detecting a scenario that warrants a pooling of first resources associated with a first network operator with second resources associated with at least a second network operator that is different from the first network operator, based on the detecting, obtaining first data indicating an availability of a first portion of the first resources and second data indicating an availability of a first portion of the second resources, processing at least the first data and the second data to generate a plan for facilitating a communication service involving the first portion of the first resources and the first portion of the second resources, and facilitating the communication service based on the plan. Other embodiments are disclosed.

**20 Claims, 7 Drawing Sheets**



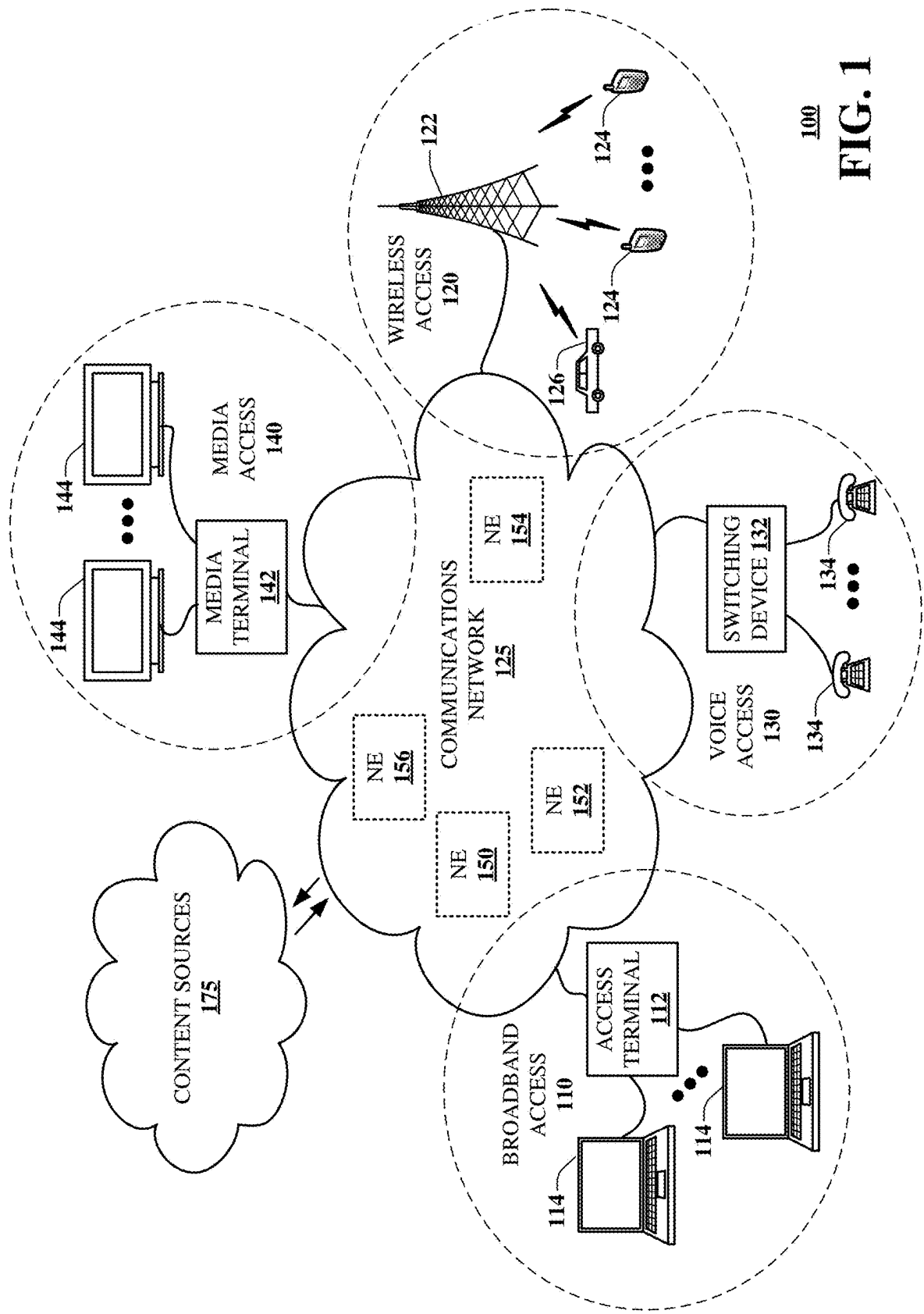
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100  
FIG. 1

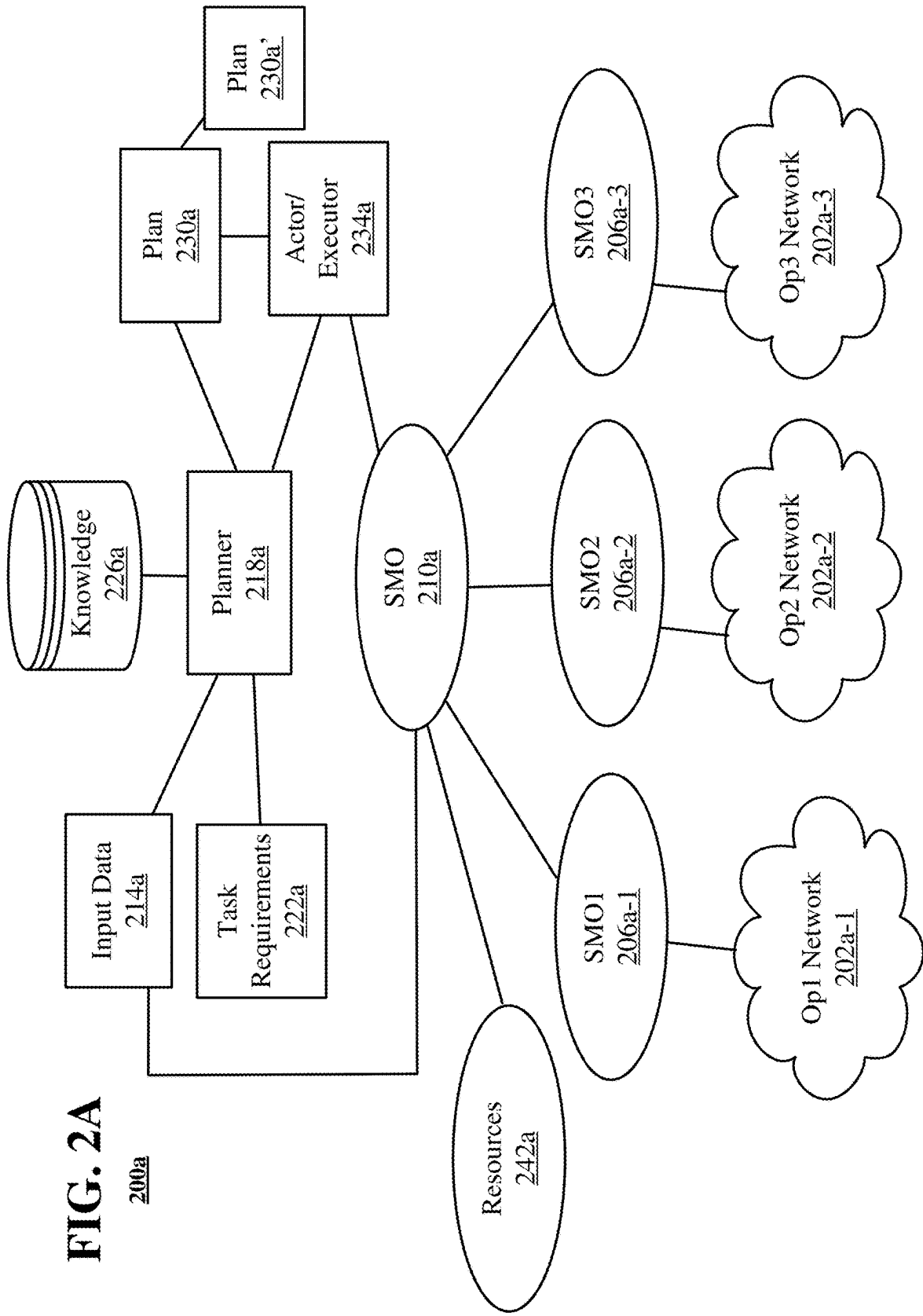
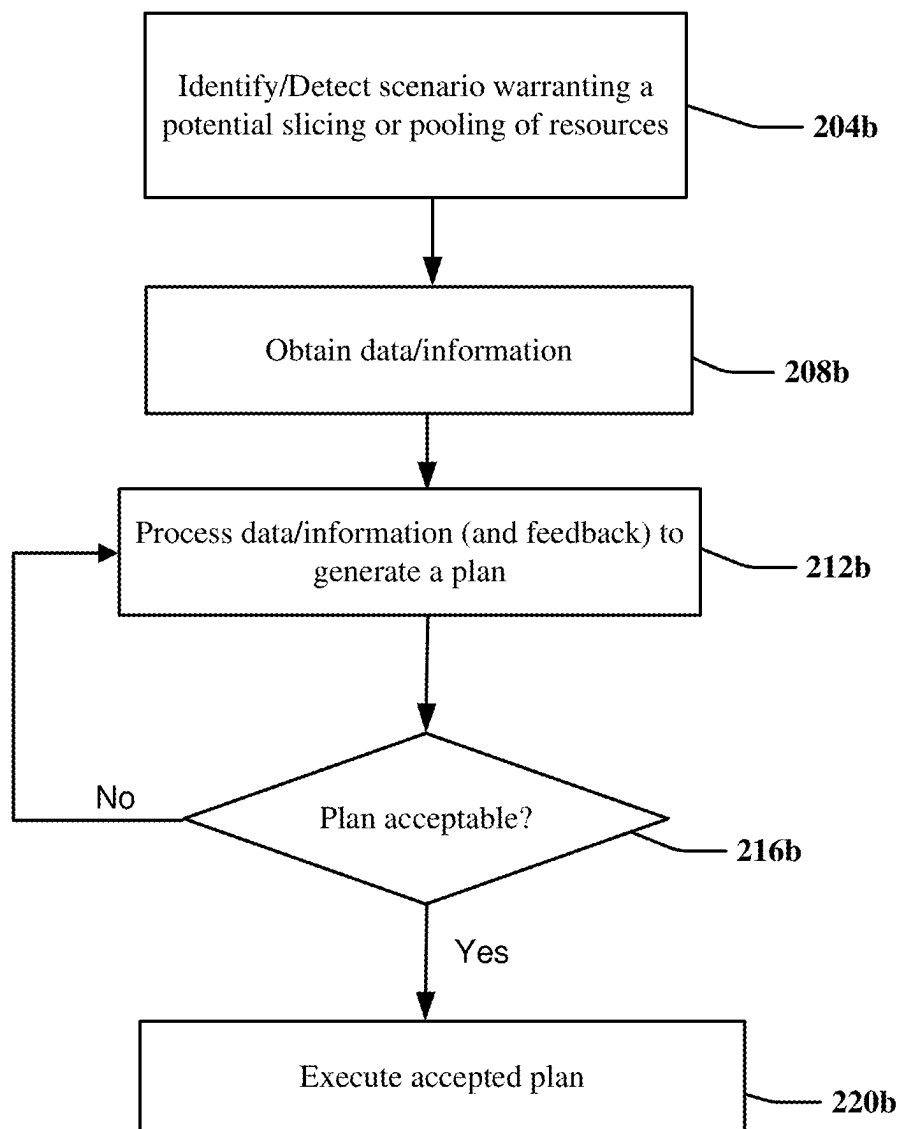
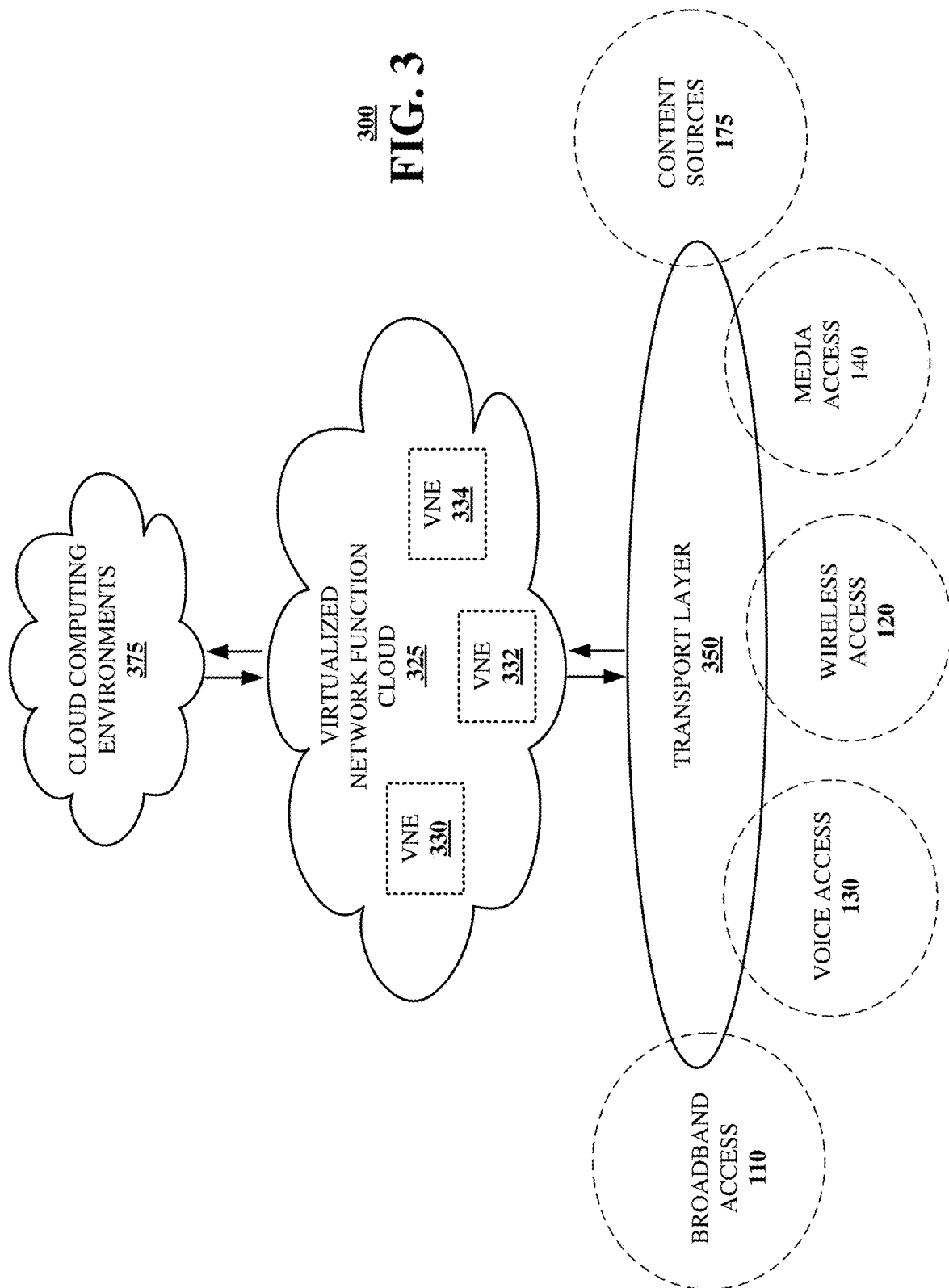


FIG. 2A  
200a



200b

**FIG. 2B**



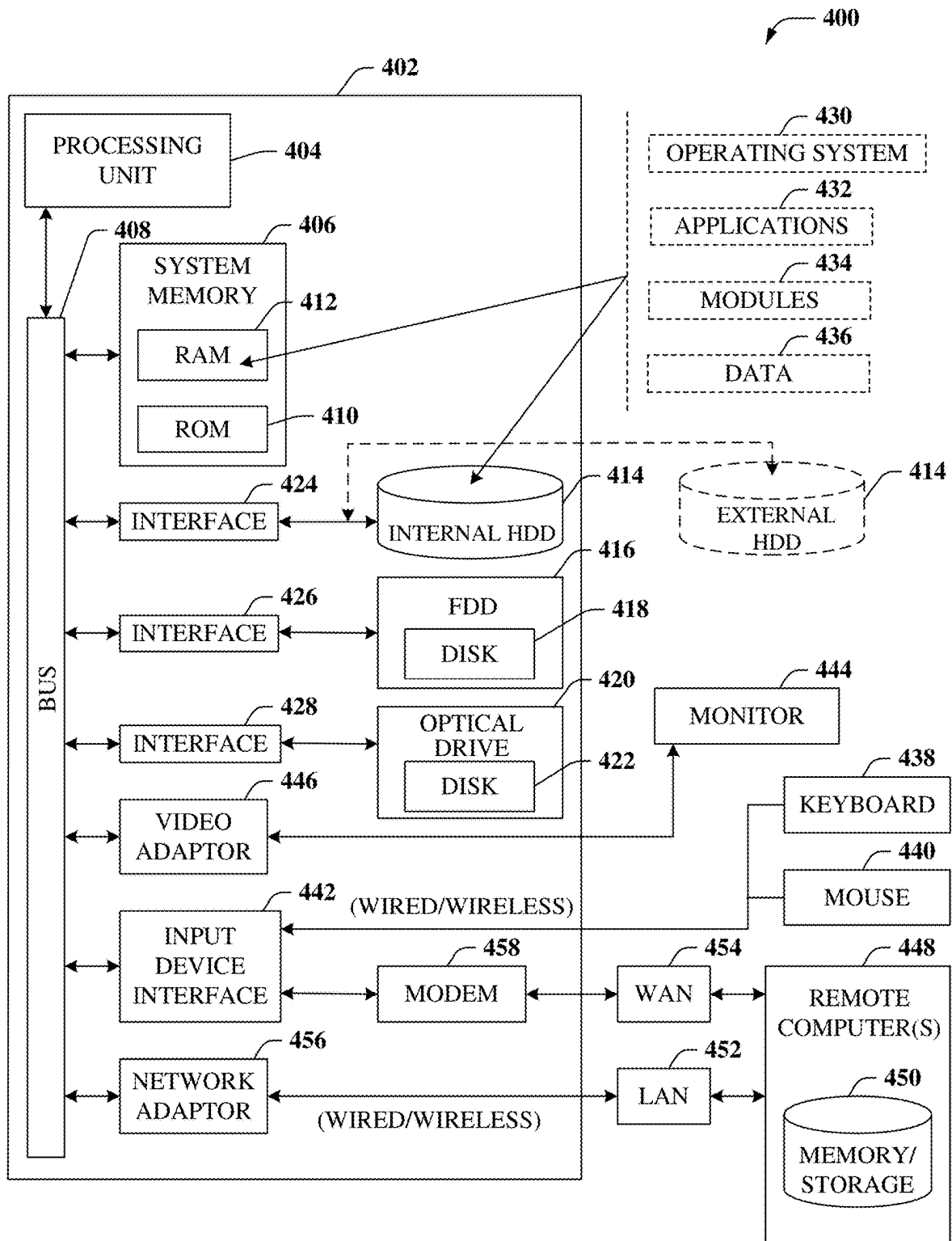


FIG. 4

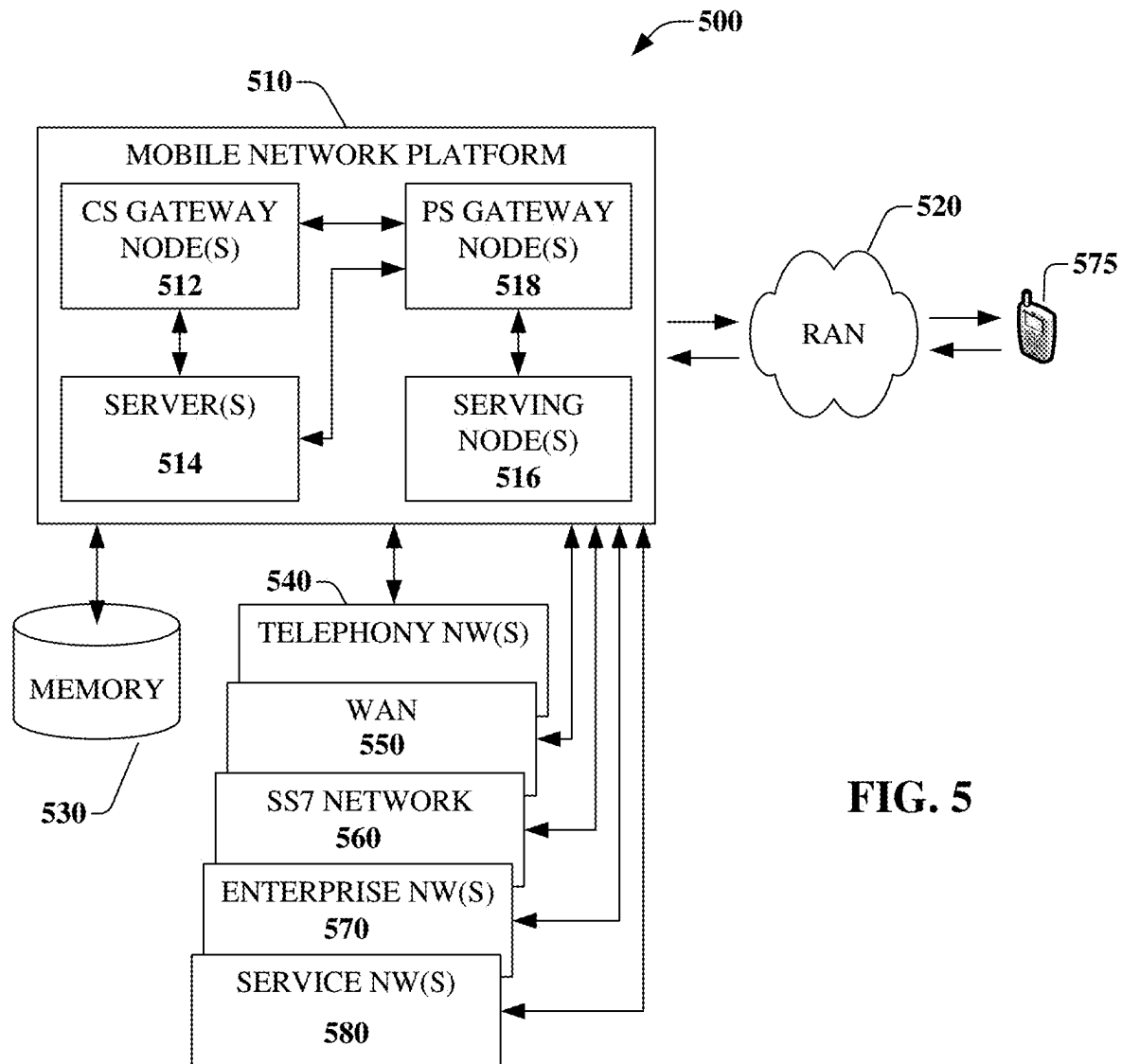
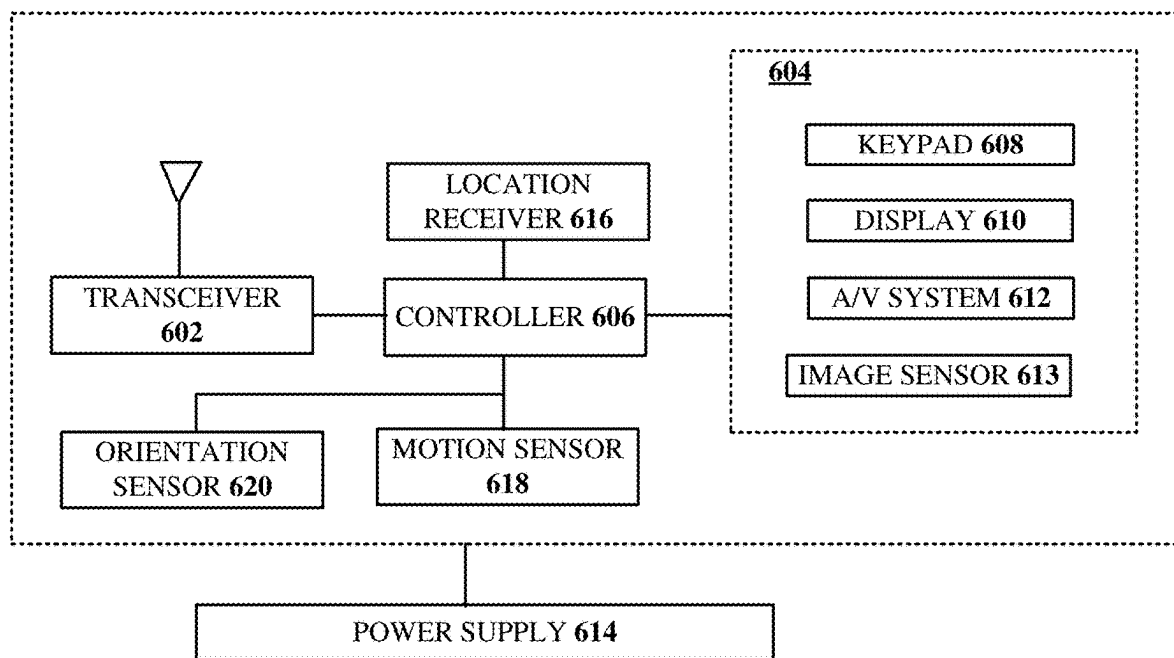


FIG. 5





600  
**FIG. 6**

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# APPARATUSES AND METHODS FOR ENHANCING MULTI-OPERATOR/MULTI-VENDOR RADIO ACCESS NETWORK RESOURCE POOLING AND SLICING

## FIELD OF THE DISCLOSURE

The subject disclosure relates to apparatuses and methods for enhancing multi-operator/multi-vendor radio access network resource pooling and slicing.

## BACKGROUND

As the world increasingly becomes connected via vast communication networks and via various types of communication devices, the world is increasingly becoming dependent on communication services. For example, and in relation to natural or man-made disasters or emergencies, human experts (such as first responders, network operators/managers, government officials, etc.), make critical decisions as conditions or circumstances evolve. Ad hoc decision-making introduces significant delays—upwards of hours or days—during situations when time is of the essence to save lives and reduce devastation. A degradation of communication services or resources during disaster scenarios or emergencies exacerbates the delay.

Conventionally, requests for communication services to be restored are conveyed to individual service providers (e.g., mobile network operators). Typically, such service providers are in competition with one another; thus, their normal (e.g., non-disaster) mode of operation does not include cooperating and collaborating with each other to pool resources. Different operators fulfill requests independently that are then implemented by vendor proprietary systems (also independently) in monolithic networks, i.e., it is not possible to salvage all viable network functions and then optimize via a “mix-&-match” process because of the lack of disaggregation and the lack of some degree of compliance with open industry standards.

## BRIEF DESCRIPTION OF THE DRAWINGS

Reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

FIG. 1 is a block diagram illustrating an exemplary, non-limiting embodiment of a communications network in accordance with various aspects described herein.

FIG. 2A is a block diagram illustrating an example, non-limiting embodiment of a system in accordance with various aspects described herein.

FIG. 2B depicts an illustrative embodiment of a method in accordance with various aspects described herein.

FIG. 3 is a block diagram illustrating an example, non-limiting embodiment of a virtualized communication network in accordance with various aspects described herein.

FIG. 4 is a block diagram of an example, non-limiting embodiment of a computing environment in accordance with various aspects described herein.

FIG. 5 is a block diagram of an example, non-limiting embodiment of a mobile network platform in accordance with various aspects described herein.

FIG. 6 is a block diagram of an example, non-limiting embodiment of a communication device in accordance with various aspects described herein.

## DETAILED DESCRIPTION

The subject disclosure describes, among other things, illustrative embodiments for facilitating communication ser-

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vices utilizing various resources, inclusive of resources associated with multiple radio access network operators or service providers. Other embodiments are described in the subject disclosure.

One or more aspects of the subject disclosure include, in whole or in part, detecting a scenario that warrants a pooling of first resources associated with a first network operator with second resources associated with at least a second network operator that is different from the first network operator; based on the detecting, obtaining first data indicating an availability of a first portion of the first resources and second data indicating an availability of a first portion of the second resources; processing at least the first data and the second data to generate a plan for facilitating a communication service involving the first portion of the first resources and the first portion of the second resources; and facilitating the communication service based on the plan.

One or more aspects of the subject disclosure include, in whole or in part, determining that a first quality of a communication service facilitated by a first resource of a first communication network is less than a first threshold; based on the determining, identifying a second resource of a second communication network that is available to facilitate at least a portion of the communication service, wherein the first communication network is operated by a first network operator and the second communication network is operated by a second network operator that is different from the first network operator; and adapting a parameter of the second resource to provide the at least a portion of the communication service with a second quality that exceeds a second threshold.

One or more aspects of the subject disclosure include, in whole or in part, obtaining, by a processing system including a processor, a requirement associated with a communication service that is provided to a first responder; based on the obtaining of the requirement, identifying, by the processing system, a first resource of a first communication network managed by a first network operator and a second resource of a second communication network managed by a second network operator that is different from the first network operator; transmitting, by the processing system, a first command to a first controller of the first communication network to configure the first resource to facilitate a first portion of the communication service; and transmitting, by the processing system, a second command to a second controller of the second communication network to configure the second resource to facilitate a second portion of the communication service.

Referring now to FIG. 1, a block diagram is shown illustrating an example, non-limiting embodiment of a system 100 in accordance with various aspects described herein. For example, system 100 can facilitate in whole or in part detecting a scenario that warrants a pooling of first resources associated with a first network operator with second resources associated with at least a second network operator that is different from the first network operator, based on the detecting, obtaining first data indicating an availability of a first portion of the first resources and second data indicating an availability of a first portion of the second resources, processing at least the first data and the second data to generate a plan for facilitating a communication service involving the first portion of the first resources and the first portion of the second resources, and facilitating the communication service based on the plan. System 100 can facilitate in whole or in part determining that a first quality of a communication service facilitated by a first resource of a first communication network is less than a first threshold,

based on the determining, identifying a second resource of a second communication network that is available to facilitate at least a portion of the communication service, wherein the first communication network is operated by a first network operator and the second communication network is operated by a second network operator that is different from the first network operator, and adapting a parameter of the second resource to provide the at least a portion of the communication service with a second quality that exceeds a second threshold. System 100 can facilitate in whole or in part obtaining, by a processing system including a processor, a requirement associated with a communication service that is provided to a first responder, based on the obtaining of the requirement, identifying, by the processing system, a first resource of a first communication network managed by a first network operator and a second resource of a second communication network managed by a second network operator that is different from the first network operator, transmitting, by the processing system, a first command to a first controller of the first communication network to configure the first resource to facilitate a first portion of the communication service, and transmitting, by the processing system, a second command to a second controller of the second communication network to configure the second resource to facilitate a second portion of the communication service.

In particular, in FIG. 1 a communications network 125 is presented for providing broadband access 110 to a plurality of data terminals 114 via access terminal 112, wireless access 120 to a plurality of mobile devices 124 and vehicle 126 via base station or access point 122, voice access 130 to a plurality of telephony devices 134, via switching device 132 and/or media access 140 to a plurality of audio/video display devices 144 via media terminal 142. In addition, communication network 125 is coupled to one or more content sources 175 of audio, video, graphics, text and/or other media. While broadband access 110, wireless access 120, voice access 130 and media access 140 are shown separately, one or more of these forms of access can be combined to provide multiple access services to a single client device (e.g., mobile devices 124 can receive media content via media terminal 142, data terminal 114 can be provided voice access via switching device 132, and so on).

The communications network 125 includes a plurality of network elements (NE) 150, 152, 154, 156, etc. for facilitating the broadband access 110, wireless access 120, voice access 130, media access 140 and/or the distribution of content from content sources 175. The communications network 125 can include a circuit switched or packet switched network, a voice over Internet protocol (VoIP) network, Internet protocol (IP) network, a cable network, a passive or active optical network, a 4G, 5G, or higher generation wireless access network, WIMAX network, UltraWideband network, personal area network or other wireless access network, a broadcast satellite network and/or other communications network.

In various embodiments, the access terminal 112 can include a digital subscriber line access multiplexer (DSLAM), cable modem termination system (CMTS), optical line terminal (OLT) and/or other access terminal. The data terminals 114 can include personal computers, laptop computers, netbook computers, tablets or other computing devices along with digital subscriber line (DSL) modems, data over coax service interface specification (DOCSIS) modems or other cable modems, a wireless modem such as a 4G, 5G, or higher generation modem, an optical modem and/or other access devices.

In various embodiments, the base station or access point 122 can include a 4G, 5G, or higher generation base station, an access point that operates via an 802.11 standard such as 802.11n, 802.11ac or other wireless access terminal. The mobile devices 124 can include mobile phones, e-readers, tablets, phablets, wireless modems, and/or other mobile computing devices.

In various embodiments, the switching device 132 can include a private branch exchange or central office switch, a media services gateway, VoIP gateway or other gateway device and/or other switching device. The telephony devices 134 can include traditional telephones (with or without a terminal adapter), VoIP telephones and/or other telephony devices.

In various embodiments, the media terminal 142 can include a cable head-end or other TV head-end, a satellite receiver, gateway or other media terminal 142. The display devices 144 can include televisions with or without a set top box, personal computers and/or other display devices.

In various embodiments, the content sources 175 include broadcast television and radio sources, video on demand platforms and streaming video and audio services platforms, one or more content data networks, data servers, web servers and other content servers, and/or other sources of media.

In various embodiments, the communications network 125 can include wired, optical and/or wireless links and the network elements 150, 152, 154, 156, etc. can include service switching points, signal transfer points, service control points, network gateways, media distribution hubs, servers, firewalls, routers, edge devices, switches and other network nodes for routing and controlling communications traffic over wired, optical and wireless links as part of the Internet and other public networks as well as one or more private networks, for managing subscriber access, for billing and network management and for supporting other network functions.

FIG. 2A is a block diagram illustrating an example, non-limiting embodiment of a system 200a in accordance with various aspects described herein. In some embodiments, one or more portions of the system 200a may function within, or may be operatively overlaid upon, one or more portions of the system 100 (such as, for example, one or more portions of the network 125) of FIG. 1.

The system 200a may include one or more networks operated or managed by one or more operators. For example, the system 200a may include a first operator (Op1) network 202a-1, a second operator (Op2) network 202a-2, and a third operator (Op3) network 202a-3. Each of the networks 202a-1 through 202a-3 may be associated with a respective, different operator. Each of the networks 202a-1 through 202a-3 may be associated with a controller or service management and orchestration (SMO) entity, such as a combination of the first Op1 network 202a-1 and a first SMO (SMO1) 206a-1, a combination of the second Op2 network 202a-2 and a second SMO (SMO2) 206a-2, and a combination of the third Op3 network 202a-3 and a third SMO (SMO3) 206a-3. The use of three operator networks 202a-1 through 202a-3 (and corresponding SMOs 206a-1 through 206a-3) in FIG. 2A is illustrative, which is to say that more or fewer than three operator networks may be utilized or included in some embodiments.

Each of the SMOs 206a-1 through 206a-3 may be capable or responsible of coordinating resources for the respective operator network (e.g., the respective operator network 202a-1 through 202a-3) within the SMO's purview. For example, in relation to communication services facilitated by a given operator network (e.g., the network 202a-1), the

respective SMO (e.g., the SMO **206a-1**) may generally manage communication resources associated with, e.g., a utilization of frequencies or frequency bands, transmission power levels, receiver sensitivity levels, modulation/demodulation schemes, security (e.g., encryption/decryption) schemes, encoding/decoding schemes, etc.

Generally, during normal (e.g., non-disaster and non-emergency) scenarios, the coordination/management provided by the SMOs **206a-1** through **206a-3** may be sufficient to enable communication services to be administered reliably and efficiently in each of the respective networks **202a-1** through **202a-3**, and each of the SMOs **206a-1** through **206a-3** (and associated networks **202a-1** through **202a-3**) may operate independently of one another (perhaps, in part, to foster a competitive marketplace for users/subscribers in relation to obtaining communication services). In other scenarios (such as, for example, in relation to disaster or emergency scenarios), communication services associated with any given network (e.g., the first network **202a-1**) may be rendered unavailable or unreliable; in extreme scenarios, communication services may be unavailable (or may be degraded) in each of the three networks **202a-1** through **202a-3** when taken individually/independently. However, in such (e.g., disaster or emergency) scenarios, it may be possible to provide at least some appreciable level of service (and maybe even a full level of customary/typical service) if, for example, (portions of) resources of the networks **202a-1** through **202a-3** could be pooled or combined. In this respect, each of the SMOs **206a-1** through **206a-3** may have at least some of the resource coordination/utilization decisions facilitated by the respective SMO managed by a master or primary controller or SMO **210a**. Stated differently, during certain scenarios (e.g., disaster or emergency scenarios), each of the SMOs **206a-1** through **206a-3** may be treated as, or relegated to a status of, a secondary/slave SMO relative to the primary/master SMO **210a**, and each of the secondary SMOs may be responsible for coordinating resources within the purview of the secondary SMO based on instructions/directives/commands from the primary SMO **210a**.

In operation, during certain scenarios (e.g., disaster or emergency scenarios), each of the secondary SMOs **206a-1** through **206a-3** may report to the primary SMO **210a** information pertaining to the status of resources of the network that are within the purview of the secondary SMO. The reports/information from the secondary SMOs may be processed (e.g., filtered) by the primary SMO **210a**, and the (processed) reports/information may be provided as a portion of input data **214a** to a planner **218a**. Another portion of the input data **214a** may include, or be based on, user-generated inputs, such as for example reports or information generated by emergency services personnel, government officials, end-users (e.g., social media platform users or eyewitnesses to a disaster or emergency), and the like.

In addition to the input data **214a**, the planner **218a** may obtain other inputs, such as for example task requirements **222a**. The task requirements **222a** may be defined, in whole or in part, in accordance with one or more specifications. The task requirements **222a** may be based on parameters associated with the given scenario at hand. For example, in relation to a scenario involving a partial collapse of a building, the requirements **222a** may stipulate that a first or main priority is to ensure that a chief of the local fire department is to have an ability to communicate with a head of an ambulance or EMT corps; secondary priorities may include ensuring communication services for end-users/subscribers that were detected as being proximal to the

partial building collapse at the time of the collapse relative to other end-user/subscribers that were detected as being further away from the partial building collapse at the time of the collapse.

The planner **218a** may process the input data **214a**, potentially in combination with the task requirements **222a** and/or knowledge obtained from a knowledge (data)base **226a**, to generate a plan **230a**. The knowledge of the knowledge base **226a** may be representative of inputs and/or outputs associated with past scenarios (e.g., past disaster or emergency scenarios), best-practices promulgated by emergency services personnel/groups, government officials, etc., or other information as appropriate. The plan **230a** may be provided to one or more actors/executors **234a** that may bear responsibility for mitigating an emergency, managing communications, etc. In some embodiments, the plan **230a** may include a number of suggested or recommend options, and the actor/executor **234a** may choose/select one or more of the options for execution. In some embodiments, the actor/executor **234a** may provide feedback to the planner **218a** based on a review of the plan **230a**, and the planner **218a** may, in turn, generate one or more other plans (represented in FIG. 2A as a plan **230a'**) that may be based on (e.g., may be derivatives of) the (initial) plan **230a** and the feedback. The actor/executor **234a** may approve the plan **230a** (or a modified version thereof, such as the plan **230a'**), and the approved plan may be provided to the (primary) SMO **210a** for execution. For example, the (primary) SMO **210a** may generate instructions/commands/directives in accordance with the approved plan, and may provide the instructions/commands/directives to the (secondary) SMOs **206a-1** through **206a-3** to implement aspects of the approved plan.

In some embodiments or scenarios, the (primary) SMO **210a** may oversee/manage resources **242a** beyond the resources associated with the (secondary) SMOs **206a-1** through **206a-3** (or, analogously, networks **202a-1** through **202a-3**). For example, if in a particular scenario (e.g., a particular disaster scenario) a first transmitter (conventionally with a first power level capability) within the network **202a-1** is rendered inoperative, but a second transmitter within the network **202a-1** is available with a second power level capability this is less than the first power level capability, a drone of the resources **242a** may be dispatched to extend a geographical range/reach of coverage associated with the second transmitter (or associated antenna). Still further, the drone may operate on communications (e.g., messages) originating within the first network **202a-1** and may provide (processed versions of) the communications to the second network **202a-2** and/or the third network **202a-3** for consumption/use within the second network **202a-2** and/or the third network **202a-3**. In general, a drone may bridge what might otherwise be a gap in communications or services. It should be borne in mind that a drone is one example of a resource that may be included within the resources **242a**; other types/kinds of resources (such as, for example, satellites, automobile, marine vessels, etc.) may be utilized in some embodiments.

Referring now to FIG. 2B, an illustrative embodiment of a method **200b** in accordance with various aspects described herein is shown. The method **200b** may be implemented or executed, in whole or in part, in conjunction with one or more systems, devices, and/or components, such as for example the systems, devices, and components set forth herein. The method **200b** may facilitate communication services via a utilization of resources across/amongst a plurality of network operators or service providers.

In block **204b**, a scenario that may warrant a sharing/slicing or pooling of resources across/amongst multiple operators or service providers may be identified/detected. For example, the identification/detection of the scenario in block **204b** may be based on information from (secondary) SMOs indicating, individually or in some combination with one another, that a quality of communication services is less than a threshold amount/figure. In some embodiments, the identification/detection in block **204b** may be based on a monitoring of user-generated inputs, such as inputs from an (emergency services or government-based) command and control center, demand for communication services from a pool/group of end-users/subscribers exceeds a threshold (potentially as a function of time), etc. Criteria for determining whether a particular scenario qualifies for sharing/slicing or pooling of resources may be based on one or more specifications, agreements, or the like.

Assuming a scenario that qualifies for sharing/slicing or pooling of resources as identified/detected in block **204b**, data or information may be obtained as part of block **208b**. The data/information of block **208b** may include an identification of a state of one or more resources (e.g., whether the resources are operative, whether they are operative at full capacity/capability or a degraded level of capacity/capability, etc.) associated with multiple networks. The data/information of block **208b** may include an identification of conditions associated with the scenario (e.g., active-shooter, extent or degree of property damage, a number of expected or anticipated casualties or injuries, whether a use of biological, chemical, or nuclear weapons is involved, involvement of a vehicle (e.g., automobile, marine, aerospace, etc.) in a crash, etc.). The data/information of block **208b** may include an identification of requirements associated with communication services that are needed or desired, an identification of requirements for mitigating damages to (the well-being of) persons or property associated with the scenario, etc.

In block **212b**, the data/information obtained as part of block **208b** may be processed to generate a plan. The processing of block **212b** may be performed in conjunction with one or more algorithms. The algorithm(s) may be operative in accordance with artificial intelligence (AI) and/or machine learning (ML) based technologies. In this regard, domain knowledge that is learned or developed over time may be consulted or incorporated as part of the processing of block **212b** (where such knowledge may correspond to the knowledge contained in the base **226a** of FIG. 2A, for example). In some embodiments, the processing performed as part of block **212b** may be based on feedback that may be obtained as part of, e.g., block **216b** described below.

In block **216b**, a determination may be made regarding whether the plan generated as part of block **212b** is acceptable. For example, in some embodiments block **216b** may include a user and/or a machine reviewing a proposal included in the plan, and potentially selecting one or more options included in the plan. If the plan is acceptable, flow may proceed from block **216b** to block **220b**; otherwise, flow may proceed from block **216b** to block **212b**.

As part of the flow from block **216b** to block **212b**, feedback may be included that may explain why the plan that was generated in block **212b** and that was reviewed as part of block **216b** was deemed to be insufficient or deficient. In this manner, a loop may be established between block **212b** and block **216b**, whereby the plan that is generated may more closely conform to expectations or objectives/goals.

In block **220b**, the plan that was approved/accepted as part of block **216b** may be executed. For example, an execution of the plan may include modifying or reallocating resources associated with one or more networks for other uses, such as for example for use by another network. Block **220b** may include a generation and issuance of instructions/commands/directives for use by one or more networks (or associated SMOs) to facilitate a modification or (re)allocation of resources of the network(s). Block **220b** may include generating and issuing instructions/commands/directives for consumption or execution by personnel (e.g., emergency services personnel, government officials or employees, etc.). Such instructions/commands/directives may command the personnel to perform one or more actions.

While not shown in FIG. 2B, in some embodiments flow may proceed from block **220b** to, e.g., block **208b**. As one skilled in the art would appreciate, such a flow may enable the method **200b** (e.g., the plan that is to be executed) to be adapted in response to changing circumstances or conditions. Stated differently, as events associated with a particular scenario (e.g., a particular disaster or emergency scenario) unfold in a dynamic manner or fashion, outputs of decision-making processes or logic may need to be updated or modified to obtain desired or needed results.

While for purposes of simplicity of explanation, the respective processes are shown and described as a series of blocks in FIG. 2B, it is to be understood and appreciated that the claimed subject matter is not limited by the order of the blocks, as some blocks may occur in different orders and/or concurrently with other blocks from what is depicted and described herein. Moreover, not all illustrated blocks may be required to implement the methods described herein.

Aspects of this disclosure may include/incorporate natural language processing (NLP) technologies to translate from user-entered inputs to a form/version of the inputs that are capable of being acted on or processed by one or more machines or processing systems. In this manner, user interfaces may be simplified; ease of user-interaction may be especially important in particular scenarios (such as disaster or emergency scenarios).

Aspects of this disclosure provide for an integration of resources typically managed by various independent networks and operators under one platform or umbrella. In this regard, a system-of-systems (or, analogously, a network-of-networks) may be established or generated, with a confederated collection of capabilities that may be realized/obtained. To demonstrate, in some embodiments a first responder may be able to arrive at a scene of a disaster and immediately requisition telecommunication services with a given quality of service (QoS) (or, analogously, a requisite quality of experience (QoE)), potentially irrespective of predefined or traditional boundaries associated with particular network operators or vendor-proprietary network functions.

Aspects of this disclosure may be applied in respect of multi-vendor and multi-tenant networks. Aspects (e.g., portions of resources) of such networks may be sliced/spliced and combined in various ways under the umbrella/framework of a common network, platform, or architecture. In some embodiments, such slicing/splicing may be performed dynamically, and may be used to scale-up (or, analogously, scale-down) the resources included under the common network, platform, or architecture in response to changes in conditions, circumstances, or events. Stated differently, aspects of this disclosure may include or incorporate an intelligent pooling or sharing of resources across multiple operator radio access networks (MORANs). Such pooling/

sharing may be supplemented by additional resources that are not traditionally maintained/managed by network operators or service providers.

Aspects of this disclosure may include an AI-based planner that incorporates knowledge from human experts at design time, i.e., well in advance of an actual disaster scenario or emergency situation. An agent (such as an actor/executor) may be operative on a set of data inputs that can make near-instantaneous decisions as needed as conditions evolve across multiple sub-domains, e.g., physical transportation infrastructure, communications networks (or associated network infrastructure), trauma centers, etc. In this respect, it may be said that aspects of this disclosure may be “sub-network” aware.

In some embodiments, controllers or SMOs may be configured to coordinate and combine resources across multiple paradigms or platforms in a way that is truly hybrid—e.g., entities or functions from open-source platforms may be combined with proprietary entities or functions to achieve never-before-seen results. In some embodiments, a controller or SMO may be configured to control and manage multiple vendors’ disaggregated physical or virtual network functions and then enhance (e.g., optimize) via a “mix-and-match” approach, e.g., pairing a first disaggregated network function from vendor A with a second disaggregated network function from vendor B. In some embodiments, adapters, sockets, porting devices, or the like may be combined with physical or virtual network functions from various vendors resulting in true/actual multi-vendor interoperability, regardless of an actual degree of compliance with open industry standards or protocols.

In accordance with aspects of this disclosure, resources may be configured with given states (or reconfigured amongst different states) based on changes in conditions or circumstances. In some embodiments, such configurations or reconfigurations may be undertaken to ensure continuity in service or quality in service.

Aspects of this disclosure may be included or integrated as part of one or more practical applications. For example, and as demonstrated herein, aspects of this disclosure may be integrated as part of a common framework for coordinating resource allocations amongst a plurality of network operators or service providers. By virtue of such coordination, enhanced communication capabilities may be obtained, even in times of disaster or emergency. Furthermore, the quality or accuracy of decision-making processes or logic may be enhanced, while at the same time reducing an amount of time it takes to formulate and execute a plan of operations. Practically speaking, the enhancement in quality or accuracy, along with the reduction in time, may serve to mitigate damages to people or property, by drawing an emergency situation/scenario to (as near) a close as soon as possible. Thus, aspects of this disclosure, inclusive of the coordination of various resources, represent substantial improvements relative to conventional techniques/technologies. In brief, aspects of this disclosure may serve to save lives and limbs and may ensure an availability of communications during emergencies or disasters with at least some (minimum) quality. Even in scenarios involving near-complete devastation, aspects of this disclosure may serve to ensure that any remaining, available resources are allocated to their highest-priority uses/ends, while at the same time respecting a need to foster a competitive marketplace for communication services; appropriate trade-offs may be made by one of skill in the art.

Referring now to FIG. 3, a block diagram 300 is shown illustrating an example, non-limiting embodiment of a vir-

tualized communication network in accordance with various aspects described herein. In particular a virtualized communication network is presented that can be used to implement some or all of the subsystems and functions of system 100, the subsystems and functions of system 200a, and method 200b presented in FIGS. 1, 2A, and 2B. For example, virtualized communication network 300 can facilitate in whole or in part detecting a scenario that warrants a pooling of first resources associated with a first network operator with second resources associated with at least a second network operator that is different from the first network operator, based on the detecting, obtaining first data indicating an availability of a first portion of the first resources and second data indicating an availability of a first portion of the second resources, processing at least the first data and the second data to generate a plan for facilitating a communication service involving the first portion of the first resources and the first portion of the second resources, and facilitating the communication service based on the plan. Virtualized communication network 300 can facilitate in whole or in part determining that a first quality of a communication service facilitated by a first resource of a first communication network is less than a first threshold, based on the determining, identifying a second resource of a second communication network that is available to facilitate at least a portion of the communication service, wherein the first communication network is operated by a first network operator and the second communication network is operated by a second network operator that is different from the first network operator, and adapting a parameter of the second resource to provide the at least a portion of the communication service with a second quality that exceeds a second threshold. Virtualized communication network 300 can facilitate in whole or in part obtaining, by a processing system including a processor, a requirement associated with a communication service that is provided to a first responder, based on the obtaining of the requirement, identifying, by the processing system, a first resource of a first communication network managed by a first network operator and a second resource of a second communication network managed by a second network operator that is different from the first network operator, transmitting, by the processing system, a first command to a first controller of the first communication network to configure the first resource to facilitate a first portion of the communication service, and transmitting, by the processing system, a second command to a second controller of the second communication network to configure the second resource to facilitate a second portion of the communication service.

In particular, a cloud networking architecture is shown that leverages cloud technologies and supports rapid innovation and scalability via a transport layer 350, a virtualized network function cloud 325 and/or one or more cloud computing environments 375. In various embodiments, this cloud networking architecture is an open architecture that leverages application programming interfaces (APIs); reduces complexity from services and operations; supports more nimble business models; and rapidly and seamlessly scales to meet evolving customer requirements including traffic growth, diversity of traffic types, and diversity of performance and reliability expectations.

In contrast to traditional network elements—which are typically integrated to perform a single function, the virtualized communication network employs virtual network elements (VNEs) 330, 332, 334, etc. that perform some or all of the functions of network elements 150, 152, 154, 156, etc. For example, the network architecture can provide a sub-

strate of networking capability, often called Network Function Virtualization Infrastructure (NFVI) or simply infrastructure that is capable of being directed with software and Software Defined Networking (SDN) protocols to perform a broad variety of network functions and services. This infrastructure can include several types of substrates. The most typical type of substrate being servers that support Network Function Virtualization (NFV), followed by packet forwarding capabilities based on generic computing resources, with specialized network technologies brought to bear when general purpose processors or general purpose integrated circuit devices offered by merchants (referred to herein as merchant silicon) are not appropriate. In this case, communication services can be implemented as cloud-centric workloads.

As an example, a traditional network element **150** (shown in FIG. 1), such as an edge router can be implemented via a VNE **330** composed of NFV software modules, merchant silicon, and associated controllers. The software can be written so that increasing workload consumes incremental resources from a common resource pool, and moreover so that it's elastic: so the resources are only consumed when needed. In a similar fashion, other network elements such as other routers, switches, edge caches, and middle-boxes are instantiated from the common resource pool. Such sharing of infrastructure across a broad set of uses makes planning and growing infrastructure easier to manage.

In an embodiment, the transport layer **350** includes fiber, cable, wired and/or wireless transport elements, network elements and interfaces to provide broadband access **110**, wireless access **120**, voice access **130**, media access **140** and/or access to content sources **175** for distribution of content to any or all of the access technologies. In particular, in some cases a network element needs to be positioned at a specific place, and this allows for less sharing of common infrastructure. Other times, the network elements have specific physical layer adapters that cannot be abstracted or virtualized, and might require special DSP code and analog front-ends (AFEs) that do not lend themselves to implementation as VNEs **330**, **332** or **334**. These network elements can be included in transport layer **350**.

The virtualized network function cloud **325** interfaces with the transport layer **350** to provide the VNEs **330**, **332**, **334**, etc. to provide specific NFVs. In particular, the virtualized network function cloud **325** leverages cloud operations, applications, and architectures to support networking workloads. The virtualized network elements **330**, **332** and **334** can employ network function software that provides either a one-for-one mapping of traditional network element function or alternately some combination of network functions designed for cloud computing. For example, VNEs **330**, **332** and **334** can include route reflectors, domain name system (DNS) servers, and dynamic host configuration protocol (DHCP) servers, system architecture evolution (SAE) and/or mobility management entity (MME) gateways, broadband network gateways, IP edge routers for IP-VPN, Ethernet and other services, load balancers, distributors and other network elements. Because these elements don't typically need to forward large amounts of traffic, their workload can be distributed across a number of servers—each of which adds a portion of the capability, and overall which creates an elastic function with higher availability than its former monolithic version. These virtual network elements **330**, **332**, **334**, etc. can be instantiated and managed using an orchestration approach similar to those used in cloud compute services.

The cloud computing environments **375** can interface with the virtualized network function cloud **325** via APIs that expose functional capabilities of the VNEs **330**, **332**, **334**, etc. to provide the flexible and expanded capabilities to the virtualized network function cloud **325**. In particular, network workloads may have applications distributed across the virtualized network function cloud **325** and cloud computing environment **375** and in the commercial cloud, or might simply orchestrate workloads supported entirely in NFV infrastructure from these third party locations.

Turning now to FIG. 4, there is illustrated a block diagram of a computing environment in accordance with various aspects described herein. In order to provide additional context for various embodiments of the embodiments described herein, FIG. 4 and the following discussion are intended to provide a brief, general description of a suitable computing environment **400** in which the various embodiments of the subject disclosure can be implemented. In particular, computing environment **400** can be used in the implementation of network elements **150**, **152**, **154**, **156**, access terminal **112**, base station or access point **122**, switching device **132**, media terminal **142**, and/or VNEs **330**, **332**, **334**, etc. Each of these devices can be implemented via computer-executable instructions that can run on one or more computers, and/or in combination with other program modules and/or as a combination of hardware and software. For example, computing environment **400** can facilitate in whole or in part detecting a scenario that warrants a pooling of first resources associated with a first network operator with second resources associated with at least a second network operator that is different from the first network operator, based on the detecting, obtaining first data indicating an availability of a first portion of the first resources and second data indicating an availability of a first portion of the second resources, processing at least the first data and the second data to generate a plan for facilitating a communication service involving the first portion of the first resources and the first portion of the second resources, and facilitating the communication service based on the plan. Computing environment **400** can facilitate in whole or in part determining that a first quality of a communication service facilitated by a first resource of a first communication network is less than a first threshold, based on the determining, identifying a second resource of a second communication network that is available to facilitate at least a portion of the communication service, wherein the first communication network is operated by a first network operator and the second communication network is operated by a second network operator that is different from the first network operator, and adapting a parameter of the second resource to provide the at least a portion of the communication service with a second quality that exceeds a second threshold. Computing environment **400** can facilitate in whole or in part obtaining, by a processing system including a processor, a requirement associated with a communication service that is provided to a first responder, based on the obtaining of the requirement, identifying, by the processing system, a first resource of a first communication network managed by a first network operator and a second resource of a second communication network managed by a second network operator that is different from the first network operator, transmitting, by the processing system, a first command to a first controller of the first communication network to configure the first resource to facilitate a first portion of the communication service, and transmitting, by the processing system, a second command to a second

controller of the second communication network to configure the second resource to facilitate a second portion of the communication service.

Generally, program modules comprise routines, programs, components, data structures, etc., that perform particular tasks or implement particular abstract data types. Moreover, those skilled in the art will appreciate that the methods can be practiced with other computer system configurations, comprising single-processor or multiprocessor computer systems, minicomputers, mainframe computers, as well as personal computers, hand-held computing devices, microprocessor-based or programmable consumer electronics, and the like, each of which can be operatively coupled to one or more associated devices.

As used herein, a processing circuit includes one or more processors as well as other application specific circuits such as an application specific integrated circuit, digital logic circuit, state machine, programmable gate array or other circuit that processes input signals or data and that produces output signals or data in response thereto. It should be noted that while any functions and features described herein in association with the operation of a processor could likewise be performed by a processing circuit.

The illustrated embodiments of the embodiments herein can be also practiced in distributed computing environments where certain tasks are performed by remote processing devices that are linked through a communications network. In a distributed computing environment, program modules can be located in both local and remote memory storage devices.

Computing devices typically comprise a variety of media, which can comprise computer-readable storage media and/or communications media, which two terms are used herein differently from one another as follows. Computer-readable storage media can be any available storage media that can be accessed by the computer and comprises both volatile and nonvolatile media, removable and non-removable media. By way of example, and not limitation, computer-readable storage media can be implemented in connection with any method or technology for storage of information such as computer-readable instructions, program modules, structured data or unstructured data.

Computer-readable storage media can comprise, but are not limited to, random access memory (RAM), read only memory (ROM), electrically erasable programmable read only memory (EEPROM), flash memory or other memory technology, compact disk read only memory (CD-ROM), digital versatile disk (DVD) or other optical disk storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices or other tangible and/or non-transitory media which can be used to store desired information. In this regard, the terms “tangible” or “non-transitory” herein as applied to storage, memory or computer-readable media, are to be understood to exclude only propagating transitory signals per se as modifiers and do not relinquish rights to all standard storage, memory or computer-readable media that are not only propagating transitory signals per se.

Computer-readable storage media can be accessed by one or more local or remote computing devices, e.g., via access requests, queries or other data retrieval protocols, for a variety of operations with respect to the information stored by the medium.

Communications media typically embody computer-readable instructions, data structures, program modules or other structured or unstructured data in a data signal such as a modulated data signal, e.g., a carrier wave or other transport

mechanism, and comprises any information delivery or transport media. The term “modulated data signal” or signals refers to a signal that has one or more of its characteristics set or changed in such a manner as to encode information in one or more signals. By way of example, and not limitation, communication media comprise wired media, such as a wired network or direct-wired connection, and wireless media such as acoustic, RF, infrared and other wireless media.

With reference again to FIG. 4, the example environment can comprise a computer 402, the computer 402 comprising a processing unit 404, a system memory 406 and a system bus 408. The system bus 408 couples system components including, but not limited to, the system memory 406 to the processing unit 404. The processing unit 404 can be any of various commercially available processors. Dual microprocessors and other multiprocessor architectures can also be employed as the processing unit 404.

The system bus 408 can be any of several types of bus structure that can further interconnect to a memory bus (with or without a memory controller), a peripheral bus, and a local bus using any of a variety of commercially available bus architectures. The system memory 406 comprises ROM 410 and RAM 412. A basic input/output system (BIOS) can be stored in a non-volatile memory such as ROM, erasable programmable read only memory (EPROM), EEPROM, which BIOS contains the basic routines that help to transfer information between elements within the computer 402, such as during startup. The RAM 412 can also comprise a high-speed RAM such as static RAM for caching data.

The computer 402 further comprises an internal hard disk drive (HDD) 414 (e.g., EIDE, SATA), which internal HDD 414 can also be configured for external use in a suitable chassis (not shown), a magnetic floppy disk drive (FDD) 416, (e.g., to read from or write to a removable diskette 418) and an optical disk drive 420, (e.g., reading a CD-ROM disk 422 or, to read from or write to other high capacity optical media such as the DVD). The HDD 414, magnetic FDD 416 and optical disk drive 420 can be connected to the system bus 408 by a hard disk drive interface 424, a magnetic disk drive interface 426 and an optical drive interface 428, respectively. The hard disk drive interface 424 for external drive implementations comprises at least one or both of Universal Serial Bus (USB) and Institute of Electrical and Electronics Engineers (IEEE) 1394 interface technologies. Other external drive connection technologies are within contemplation of the embodiments described herein.

The drives and their associated computer-readable storage media provide nonvolatile storage of data, data structures, computer-executable instructions, and so forth. For the computer 402, the drives and storage media accommodate the storage of any data in a suitable digital format. Although the description of computer-readable storage media above refers to a hard disk drive (HDD), a removable magnetic diskette, and a removable optical media such as a CD or DVD, it should be appreciated by those skilled in the art that other types of storage media which are readable by a computer, such as zip drives, magnetic cassettes, flash memory cards, cartridges, and the like, can also be used in the example operating environment, and further, that any such storage media can contain computer-executable instructions for performing the methods described herein.

A number of program modules can be stored in the drives and RAM 412, comprising an operating system 430, one or more application programs 432, other program modules 434 and program data 436. All or portions of the operating system, applications, modules, and/or data can also be



cached in the RAM 412. The systems and methods described herein can be implemented utilizing various commercially available operating systems or combinations of operating systems.

A user can enter commands and information into the computer 402 through one or more wired/wireless input devices, e.g., a keyboard 438 and a pointing device, such as a mouse 440. Other input devices (not shown) can comprise a microphone, an infrared (IR) remote control, a joystick, a game pad, a stylus pen, touch screen or the like. These and other input devices are often connected to the processing unit 404 through an input device interface 442 that can be coupled to the system bus 408, but can be connected by other interfaces, such as a parallel port, an IEEE 1394 serial port, a game port, a universal serial bus (USB) port, an IR interface, etc.

A monitor 444 or other type of display device can be also connected to the system bus 408 via an interface, such as a video adapter 446. It will also be appreciated that in alternative embodiments, a monitor 444 can also be any display device (e.g., another computer having a display, a smart phone, a tablet computer, etc.) for receiving display information associated with computer 402 via any communication means, including via the Internet and cloud-based networks. In addition to the monitor 444, a computer typically comprises other peripheral output devices (not shown), such as speakers, printers, etc.

The computer 402 can operate in a networked environment using logical connections via wired and/or wireless communications to one or more remote computers, such as a remote computer(s) 448. The remote computer(s) 448 can be a workstation, a server computer, a router, a personal computer, portable computer, microprocessor-based entertainment appliance, a peer device or other common network node, and typically comprises many or all of the elements described relative to the computer 402, although, for purposes of brevity, only a remote memory/storage device 450 is illustrated. The logical connections depicted comprise wired/wireless connectivity to a local area network (LAN) 452 and/or larger networks, e.g., a wide area network (WAN) 454. Such LAN and WAN networking environments are commonplace in offices and companies, and facilitate enterprise-wide computer networks, such as intranets, all of which can connect to a global communications network, e.g., the Internet.

When used in a LAN networking environment, the computer 402 can be connected to the LAN 452 through a wired and/or wireless communication network interface or adapter 456. The adapter 456 can facilitate wired or wireless communication to the LAN 452, which can also comprise a wireless AP disposed thereon for communicating with the adapter 456.

When used in a WAN networking environment, the computer 402 can comprise a modem 458 or can be connected to a communications server on the WAN 454 or has other means for establishing communications over the WAN 454, such as by way of the Internet. The modem 458, which can be internal or external and a wired or wireless device, can be connected to the system bus 408 via the input device interface 442. In a networked environment, program modules depicted relative to the computer 402 or portions thereof, can be stored in the remote memory/storage device 450. It will be appreciated that the network connections shown are example and other means of establishing a communications link between the computers can be used.

The computer 402 can be operable to communicate with any wireless devices or entities operatively disposed in

wireless communication, e.g., a printer, scanner, desktop and/or portable computer, portable data assistant, communications satellite, any piece of equipment or location associated with a wirelessly detectable tag (e.g., a kiosk, news stand, restroom), and telephone. This can comprise Wireless Fidelity (Wi-Fi) and BLUETOOTH® wireless technologies. Thus, the communication can be a predefined structure as with a conventional network or simply an ad hoc communication between at least two devices.

Wi-Fi can allow connection to the Internet from a couch at home, a bed in a hotel room or a conference room at work, without wires. Wi-Fi is a wireless technology similar to that used in a cell phone that enables such devices, e.g., computers, to send and receive data indoors and out; anywhere within the range of a base station. Wi-Fi networks use radio technologies called IEEE 802.11 (a, b, g, n, ac, ag, etc.) to provide secure, reliable, fast wireless connectivity. A Wi-Fi network can be used to connect computers to each other, to the Internet, and to wired networks (which can use IEEE 802.3 or Ethernet). Wi-Fi networks operate in the unlicensed 2.4 and 5 GHz radio bands for example or with products that contain both bands (dual band), so the networks can provide real-world performance similar to the basic 10BaseT wired Ethernet networks used in many offices.

Turning now to FIG. 5, an embodiment 500 of a mobile network platform 510 is shown that is an example of network elements 150, 152, 154, 156, and/or VNEs 330, 332, 334, etc. For example, platform 510 can facilitate in whole or in part detecting a scenario that warrants a pooling of first resources associated with a first network operator with second resources associated with at least a second network operator that is different from the first network operator, based on the detecting, obtaining first data indicating an availability of a first portion of the first resources and second data indicating an availability of a first portion of the second resources, processing at least the first data and the second data to generate a plan for facilitating a communication service involving the first portion of the first resources and the first portion of the second resources, and facilitating the communication service based on the plan. Platform 510 can facilitate in whole or in part determining that a first quality of a communication service facilitated by a first resource of a first communication network is less than a first threshold, based on the determining, identifying a second resource of a second communication network that is available to facilitate at least a portion of the communication service, wherein the first communication network is operated by a first network operator and the second communication network is operated by a second network operator that is different from the first network operator, and adapting a parameter of the second resource to provide the at least a portion of the communication service with a second quality that exceeds a second threshold. Platform 510 can facilitate in whole or in part obtaining, by a processing system including a processor, a requirement associated with a communication service that is provided to a first responder, based on the obtaining of the requirement, identifying, by the processing system, a first resource of a first communication network managed by a first network operator and a second resource of a second communication network managed by a second network operator that is different from the first network operator, transmitting, by the processing system, a first command to a first controller of the first communication network to configure the first resource to facilitate a first portion of the communication service, and transmitting, by the processing system, a second command to a second controller of the second communication network

to configure the second resource to facilitate a second portion of the communication service.

In one or more embodiments, the mobile network platform **510** can generate and receive signals transmitted and received by base stations or access points such as base station or access point **122**. Generally, mobile network platform **510** can comprise components, e.g., nodes, gateways, interfaces, servers, or disparate platforms, that facilitate both packet-switched (PS) (e.g., internet protocol (IP), frame relay, asynchronous transfer mode (ATM)) and circuit-switched (CS) traffic (e.g., voice and data), as well as control generation for networked wireless telecommunication. As a non-limiting example, mobile network platform **510** can be included in telecommunications carrier networks, and can be considered carrier-side components as discussed elsewhere herein. Mobile network platform **510** comprises CS gateway node(s) **512** which can interface CS traffic received from legacy networks like telephony network(s) **540** (e.g., public switched telephone network (PSTN), or public land mobile network (PLMN)) or a signaling system #7 (SS7) network **560**. CS gateway node(s) **512** can authorize and authenticate traffic (e.g., voice) arising from such networks. Additionally, CS gateway node(s) **512** can access mobility, or roaming, data generated through SS7 network **560**; for instance, mobility data stored in a visited location register (VLR), which can reside in memory **530**. Moreover, CS gateway node(s) **512** interfaces CS-based traffic and signaling and PS gateway node(s) **518**. As an example, in a 3GPP UMTS network, CS gateway node(s) **512** can be realized at least in part in gateway GPRS support node(s) (GGSN). It should be appreciated that functionality and specific operation of CS gateway node(s) **512**, PS gateway node(s) **518**, and serving node(s) **516**, is provided and dictated by radio technology(ies) utilized by mobile network platform **510** for telecommunication over a radio access network **520** with other devices, such as a radiotelephone **575**.

In addition to receiving and processing CS-switched traffic and signaling, PS gateway node(s) **518** can authorize and authenticate PS-based data sessions with served mobile devices. Data sessions can comprise traffic, or content(s), exchanged with networks external to the mobile network platform **510**, like wide area network(s) (WANs) **550**, enterprise network(s) **570**, and service network(s) **580**, which can be embodied in local area network(s) (LANs), can also be interfaced with mobile network platform **510** through PS gateway node(s) **518**. It is to be noted that WANs **550** and enterprise network(s) **570** can embody, at least in part, a service network(s) like IP multimedia subsystem (IMS). Based on radio technology layer(s) available in technology resource(s) or radio access network **520**, PS gateway node(s) **518** can generate packet data protocol contexts when a data session is established; other data structures that facilitate routing of packetized data also can be generated. To that end, in an aspect, PS gateway node(s) **518** can comprise a tunnel interface (e.g., tunnel termination gateway (TTG) in 3GPP UMTS network(s) (not shown)) which can facilitate packetized communication with disparate wireless network(s), such as Wi-Fi networks.

In embodiment **500**, mobile network platform **510** also comprises serving node(s) **516** that, based upon available radio technology layer(s) within technology resource(s) in the radio access network **520**, convey the various packetized flows of data streams received through PS gateway node(s) **518**. It is to be noted that for technology resource(s) that rely primarily on CS communication, server node(s) can deliver traffic without reliance on PS gateway node(s) **518**; for

example, server node(s) can embody at least in part a mobile switching center. As an example, in a 3GPP UMTS network, serving node(s) **516** can be embodied in serving GPRS support node(s) (SGSN).

For radio technologies that exploit packetized communication, server(s) **514** in mobile network platform **510** can execute numerous applications that can generate multiple disparate packetized data streams or flows, and manage (e.g., schedule, queue, format . . . ) such flows. Such application(s) can comprise add-on features to standard services (for example, provisioning, billing, customer support . . . ) provided by mobile network platform **510**. Data streams (e.g., content(s) that are part of a voice call or data session) can be conveyed to PS gateway node(s) **518** for authorization/authentication and initiation of a data session, and to serving node(s) **516** for communication thereafter. In addition to application server, server(s) **514** can comprise utility server(s), a utility server can comprise a provisioning server, an operations and maintenance server, a security server that can implement at least in part a certificate authority and firewalls as well as other security mechanisms, and the like. In an aspect, security server(s) secure communication served through mobile network platform **510** to ensure network's operation and data integrity in addition to authorization and authentication procedures that CS gateway node(s) **512** and PS gateway node(s) **518** can enact. Moreover, provisioning server(s) can provision services from external network(s) like networks operated by a disparate service provider; for instance, WAN **550** or Global Positioning System (GPS) network(s) (not shown). Provisioning server(s) can also provision coverage through networks associated to mobile network platform **510** (e.g., deployed and operated by the same service provider), such as the distributed antennas networks shown in FIG. 1(s) that enhance wireless service coverage by providing more network coverage.

It is to be noted that server(s) **514** can comprise one or more processors configured to confer at least in part the functionality of mobile network platform **510**. To that end, the one or more processor can execute code instructions stored in memory **530**, for example. It is should be appreciated that server(s) **514** can comprise a content manager, which operates in substantially the same manner as described hereinbefore.

In example embodiment **500**, memory **530** can store information related to operation of mobile network platform **510**. Other operational information can comprise provisioning information of mobile devices served through mobile network platform **510**, subscriber databases; application intelligence, pricing schemes, e.g., promotional rates, flat-rate programs, couponing campaigns; technical specification(s) consistent with telecommunication protocols for operation of disparate radio, or wireless, technology layers; and so forth. Memory **530** can also store information from at least one of telephony network(s) **540**, WAN **550**, SS7 network **560**, or enterprise network(s) **570**. In an aspect, memory **530** can be, for example, accessed as part of a data store component or as a remotely connected memory store.

In order to provide a context for the various aspects of the disclosed subject matter, FIG. 5, and the following discussion, are intended to provide a brief, general description of a suitable environment in which the various aspects of the disclosed subject matter can be implemented. While the subject matter has been described above in the general context of computer-executable instructions of a computer program that runs on a computer and/or computers, those skilled in the art will recognize that the disclosed subject

matter also can be implemented in combination with other program modules. Generally, program modules comprise routines, programs, components, data structures, etc. that perform particular tasks and/or implement particular abstract data types.

Turning now to FIG. 6, an illustrative embodiment of a communication device 600 is shown. The communication device 600 can serve as an illustrative embodiment of devices such as data terminals 114, mobile devices 124, vehicle 126, display devices 144 or other client devices for communication via either communications network 125. For example, computing device 600 can facilitate in whole or in part detecting a scenario that warrants a pooling of first resources associated with a first network operator with second resources associated with at least a second network operator that is different from the first network operator, based on the detecting, obtaining first data indicating an availability of a first portion of the first resources and second data indicating an availability of a first portion of the second resources, processing at least the first data and the second data to generate a plan for facilitating a communication service involving the first portion of the first resources and the first portion of the second resources, and facilitating the communication service based on the plan. Computing device 600 can facilitate in whole or in part determining that a first quality of a communication service facilitated by a first resource of a first communication network is less than a first threshold, based on the determining, identifying a second resource of a second communication network that is available to facilitate at least a portion of the communication service, wherein the first communication network is operated by a first network operator and the second communication network is operated by a second network operator that is different from the first network operator, and adapting a parameter of the second resource to provide the at least a portion of the communication service with a second quality that exceeds a second threshold. Computing device 600 can facilitate in whole or in part obtaining, by a processing system including a processor, a requirement associated with a communication service that is provided to a first responder, based on the obtaining of the requirement, identifying, by the processing system, a first resource of a first communication network managed by a first network operator and a second resource of a second communication network managed by a second network operator that is different from the first network operator, transmitting, by the processing system, a first command to a first controller of the first communication network to configure the first resource to facilitate a first portion of the communication service, and transmitting, by the processing system, a second command to a second controller of the second communication network to configure the second resource to facilitate a second portion of the communication service.

The communication device 600 can comprise a wireline and/or wireless transceiver 602 (herein transceiver 602), a user interface (UI) 604, a power supply 614, a location receiver 616, a motion sensor 618, an orientation sensor 620, and a controller 606 for managing operations thereof. The transceiver 602 can support short-range or long-range wireless access technologies such as Bluetooth®, ZigBee®, WiFi, DECT, or cellular communication technologies, just to mention a few (Bluetooth® and ZigBee® are trademarks registered by the Bluetooth® Special Interest Group and the ZigBee® Alliance, respectively). Cellular technologies can include, for example, CDMA-1X, UMTS/HSDPA, GSM/GPRS, TDMA/EDGE, EV/DO, WiMAX, SDR, LTE, as well as other next generation wireless communication tech-

nologies as they arise. The transceiver 602 can also be adapted to support circuit-switched wireline access technologies (such as PSTN), packet-switched wireline access technologies (such as TCP/IP, VoIP, etc.), and combinations thereof.

The UI 604 can include a depressible or touch-sensitive keypad 608 with a navigation mechanism such as a roller ball, a joystick, a mouse, or a navigation disk for manipulating operations of the communication device 600. The keypad 608 can be an integral part of a housing assembly of the communication device 600 or an independent device operably coupled thereto by a tethered wireline interface (such as a USB cable) or a wireless interface supporting for example Bluetooth®. The keypad 608 can represent a numeric keypad commonly used by phones, and/or a QWERTY keypad with alphanumeric keys. The UI 604 can further include a display 610 such as monochrome or color LCD (Liquid Crystal Display), OLED (Organic Light Emitting Diode) or other suitable display technology for conveying images to an end user of the communication device 600. In an embodiment where the display 610 is touch-sensitive, a portion or all of the keypad 608 can be presented by way of the display 610 with navigation features.

The display 610 can use touch screen technology to also serve as a user interface for detecting user input. As a touch screen display, the communication device 600 can be adapted to present a user interface having graphical user interface (GUI) elements that can be selected by a user with a touch of a finger. The display 610 can be equipped with capacitive, resistive or other forms of sensing technology to detect how much surface area of a user's finger has been placed on a portion of the touch screen display. This sensing information can be used to control the manipulation of the GUI elements or other functions of the user interface. The display 610 can be an integral part of the housing assembly of the communication device 600 or an independent device communicatively coupled thereto by a tethered wireline interface (such as a cable) or a wireless interface.

The UI 604 can also include an audio system 612 that utilizes audio technology for conveying low volume audio (such as audio heard in proximity of a human ear) and high volume audio (such as speakerphone for hands free operation). The audio system 612 can further include a microphone for receiving audible signals of an end user. The audio system 612 can also be used for voice recognition applications. The UI 604 can further include an image sensor 613 such as a charged coupled device (CCD) camera for capturing still or moving images.

The power supply 614 can utilize common power management technologies such as replaceable and rechargeable batteries, supply regulation technologies, and/or charging system technologies for supplying energy to the components of the communication device 600 to facilitate long-range or short-range portable communications. Alternatively, or in combination, the charging system can utilize external power sources such as DC power supplied over a physical interface such as a USB port or other suitable tethering technologies.

The location receiver 616 can utilize location technology such as a global positioning system (GPS) receiver capable of assisted GPS for identifying a location of the communication device 600 based on signals generated by a constellation of GPS satellites, which can be used for facilitating location services such as navigation. The motion sensor 618 can utilize motion sensing technology such as an accelerometer, a gyroscope, or other suitable motion sensing technology to detect motion of the communication device 600 in three-dimensional space. The orientation sensor 620 can

utilize orientation sensing technology such as a magnetometer to detect the orientation of the communication device 600 (north, south, west, and east, as well as combined orientations in degrees, minutes, or other suitable orientation metrics).

The communication device 600 can use the transceiver 602 to also determine a proximity to a cellular, WiFi, Bluetooth®, or other wireless access points by sensing techniques such as utilizing a received signal strength indicator (RSSI) and/or signal time of arrival (TOA) or time of flight (TOF) measurements. The controller 606 can utilize computing technologies such as a microprocessor, a digital signal processor (DSP), programmable gate arrays, application specific integrated circuits, and/or a video processor with associated storage memory such as Flash, ROM, RAM, SRAM, DRAM or other storage technologies for executing computer instructions, controlling, and processing data supplied by the aforementioned components of the communication device 600.

Other components not shown in FIG. 6 can be used in one or more embodiments of the subject disclosure. For instance, the communication device 600 can include a slot for adding or removing an identity module such as a Subscriber Identity Module (SIM) card or Universal Integrated Circuit Card (UICC). SIM or UICC cards can be used for identifying subscriber services, executing programs, storing subscriber data, and so on.

The terms “first,” “second,” “third,” and so forth, as used in the claims, unless otherwise clear by context, is for clarity only and doesn’t otherwise indicate or imply any order in time. For instance, “a first determination,” “a second determination,” and “a third determination,” does not indicate or imply that the first determination is to be made before the second determination, or vice versa, etc.

In the subject specification, terms such as “store,” “storage,” “data store,” data storage,” “database,” and substantially any other information storage component relevant to operation and functionality of a component, refer to “memory components,” or entities embodied in a “memory” or components comprising the memory. It will be appreciated that the memory components described herein can be either volatile memory or nonvolatile memory, or can comprise both volatile and nonvolatile memory, by way of illustration, and not limitation, volatile memory, non-volatile memory, disk storage, and memory storage. Further, non-volatile memory can be included in read only memory (ROM), programmable ROM (PROM), electrically programmable ROM (EPROM), electrically erasable ROM (EEPROM), or flash memory. Volatile memory can comprise random access memory (RAM), which acts as external cache memory. By way of illustration and not limitation, RAM is available in many forms such as synchronous RAM (SRAM), dynamic RAM (DRAM), synchronous DRAM (SDRAM), double data rate SDRAM (DDR SDRAM), enhanced SDRAM (ESDRAM), Synchlink DRAM (SL-DRAM), and direct Rambus RAM (DRRAM). Additionally, the disclosed memory components of systems or methods herein are intended to comprise, without being limited to comprising, these and any other suitable types of memory.

Moreover, it will be noted that the disclosed subject matter can be practiced with other computer system configurations, comprising single-processor or multiprocessor computer systems, mini-computing devices, mainframe computers, as well as personal computers, hand-held computing devices (e.g., PDA, phone, smartphone, watch, tablet computers, netbook computers, etc.), microprocessor-based or programmable consumer or industrial electronics, and the

like. The illustrated aspects can also be practiced in distributed computing environments where tasks are performed by remote processing devices that are linked through a communications network; however, some if not all aspects of the subject disclosure can be practiced on stand-alone computers. In a distributed computing environment, program modules can be located in both local and remote memory storage devices.

In one or more embodiments, information regarding use of services can be generated including services being accessed, media consumption history, user preferences, and so forth. This information can be obtained by various methods including user input, detecting types of communications (e.g., video content vs. audio content), analysis of content streams, sampling, and so forth. The generating, obtaining and/or monitoring of this information can be responsive to an authorization provided by the user. In one or more embodiments, an analysis of data can be subject to authorization from user(s) associated with the data, such as an opt-in, an opt-out, acknowledgement requirements, notifications, selective authorization based on types of data, and so forth.

Some of the embodiments described herein can also employ artificial intelligence (AI) to facilitate automating one or more features described herein. The embodiments (e.g., in connection with automatically identifying acquired cell sites that provide a maximum value/benefit after addition to an existing communication network) can employ various AI-based schemes for carrying out various embodiments thereof. Moreover, the classifier can be employed to determine a ranking or priority of each cell site of the acquired network. A classifier is a function that maps an input attribute vector,  $x=(x_1, x_2, x_3, x_4, \dots, x_n)$ , to a confidence that the input belongs to a class, that is,  $f(x)=\text{confidence}(\text{class})$ . Such classification can employ a probabilistic and/or statistical-based analysis (e.g., factoring into the analysis utilities and costs) to determine or infer an action that a user desires to be automatically performed. A support vector machine (SVM) is an example of a classifier that can be employed. The SVM operates by finding a hypersurface in the space of possible inputs, which the hypersurface attempts to split the triggering criteria from the non-triggering events. Intuitively, this makes the classification correct for testing data that is near, but not identical to training data. Other directed and undirected model classification approaches comprise, e.g., naïve Bayes, Bayesian networks, decision trees, neural networks, fuzzy logic models, and probabilistic classification models providing different patterns of independence can be employed. Classification as used herein also is inclusive of statistical regression that is utilized to develop models of priority.

As will be readily appreciated, one or more of the embodiments can employ classifiers that are explicitly trained (e.g., via a generic training data) as well as implicitly trained (e.g., via observing UE behavior, operator preferences, historical information, receiving extrinsic information). For example, SVMs can be configured via a learning or training phase within a classifier constructor and feature selection module. Thus, the classifier(s) can be used to automatically learn and perform a number of functions, including but not limited to determining according to predetermined criteria which of the acquired cell sites will benefit a maximum number of subscribers and/or which of the acquired cell sites will add minimum value to the existing communication network coverage, etc.

As used in some contexts in this application, in some embodiments, the terms “component,” “system” and the like

are intended to refer to, or comprise, a computer-related entity or an entity related to an operational apparatus with one or more specific functionalities, wherein the entity can be either hardware, a combination of hardware and software, software, or software in execution. As an example, a component may be, but is not limited to being, a process running on a processor, a processor, an object, an executable, a thread of execution, computer-executable instructions, a program, and/or a computer. By way of illustration and not limitation, both an application running on a server and the server can be a component. One or more components may reside within a process and/or thread of execution and a component may be localized on one computer and/or distributed between two or more computers. In addition, these components can execute from various computer readable media having various data structures stored thereon. The components may communicate via local and/or remote processes such as in accordance with a signal having one or more data packets (e.g., data from one component interacting with another component in a local system, distributed system, and/or across a network such as the Internet with other systems via the signal). As another example, a component can be an apparatus with specific functionality provided by mechanical parts operated by electric or electronic circuitry, which is operated by a software or firmware application executed by a processor, wherein the processor can be internal or external to the apparatus and executes at least a part of the software or firmware application. As yet another example, a component can be an apparatus that provides specific functionality through electronic components without mechanical parts, the electronic components can comprise a processor therein to execute software or firmware that confers at least in part the functionality of the electronic components. While various components have been illustrated as separate components, it will be appreciated that multiple components can be implemented as a single component, or a single component can be implemented as multiple components, without departing from example embodiments.

Further, the various embodiments can be implemented as a method, apparatus or article of manufacture using standard programming and/or engineering techniques to produce software, firmware, hardware or any combination thereof to control a computer to implement the disclosed subject matter. The term "article of manufacture" as used herein is intended to encompass a computer program accessible from any computer-readable device or computer-readable storage/communications media. For example, computer readable storage media can include, but are not limited to, magnetic storage devices (e.g., hard disk, floppy disk, magnetic strips), optical disks (e.g., compact disk (CD), digital versatile disk (DVD)), smart cards, and flash memory devices (e.g., card, stick, key drive). Of course, those skilled in the art will recognize many modifications can be made to this configuration without departing from the scope or spirit of the various embodiments.

In addition, the words "example" and "exemplary" are used herein to mean serving as an instance or illustration. Any embodiment or design described herein as "example" or "exemplary" is not necessarily to be construed as preferred or advantageous over other embodiments or designs. Rather, use of the word example or exemplary is intended to present concepts in a concrete fashion. As used in this application, the term "or" is intended to mean an inclusive "or" rather than an exclusive "or". That is, unless specified otherwise or clear from context, "X employs A or B" is intended to mean any of the natural inclusive permutations.

That is, if X employs A; X employs B; or X employs both A and B, then "X employs A or B" is satisfied under any of the foregoing instances. In addition, the articles "a" and "an" as used in this application and the appended claims should generally be construed to mean "one or more" unless specified otherwise or clear from context to be directed to a singular form.

Moreover, terms such as "user equipment," "mobile station," "mobile," "subscriber station," "access terminal," "terminal," "handset," "mobile device" (and/or terms representing similar terminology) can refer to a wireless device utilized by a subscriber or user of a wireless communication service to receive or convey data, control, voice, video, sound, gaming or substantially any data-stream or signaling-stream. The foregoing terms are utilized interchangeably herein and with reference to the related drawings.

Furthermore, the terms "user," "subscriber," "customer," "consumer" and the like are employed interchangeably throughout, unless context warrants particular distinctions among the terms. It should be appreciated that such terms can refer to human entities or automated components supported through artificial intelligence (e.g., a capacity to make inference based, at least, on complex mathematical formalisms), which can provide simulated vision, sound recognition and so forth.

As employed herein, the term "processor" can refer to substantially any computing processing unit or device comprising, but not limited to comprising, single-core processors; single-processors with software multithread execution capability; multi-core processors; multi-core processors with software multithread execution capability; multi-core processors with hardware multithread technology; parallel platforms; and parallel platforms with distributed shared memory. Additionally, a processor can refer to an integrated circuit, an application specific integrated circuit (ASIC), a digital signal processor (DSP), a field programmable gate array (FPGA), a programmable logic controller (PLC), a complex programmable logic device (CPLD), a discrete gate or transistor logic, discrete hardware components or any combination thereof designed to perform the functions described herein. Processors can exploit nano-scale architectures such as, but not limited to, molecular and quantum-dot based transistors, switches and gates, in order to optimize space usage or enhance performance of user equipment. A processor can also be implemented as a combination of computing processing units.

As used herein, terms such as "data storage," "data storage," "database," and substantially any other information storage component relevant to operation and functionality of a component, refer to "memory components," or entities embodied in a "memory" or components comprising the memory. It will be appreciated that the memory components or computer-readable storage media, described herein can be either volatile memory or nonvolatile memory or can include both volatile and nonvolatile memory.

What has been described above includes mere examples of various embodiments. It is, of course, not possible to describe every conceivable combination of components or methodologies for purposes of describing these examples, but one of ordinary skill in the art can recognize that many further combinations and permutations of the present embodiments are possible. Accordingly, the embodiments disclosed and/or claimed herein are intended to embrace all such alterations, modifications and variations that fall within the spirit and scope of the appended claims. Furthermore, to the extent that the term "includes" is used in either the detailed description or the claims, such term is intended to

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be inclusive in a manner similar to the term “comprising” as “comprising” is interpreted when employed as a transitional word in a claim.

In addition, a flow diagram may include a “start” and/or “continue” indication. The “start” and “continue” indications reflect that the steps presented can optionally be incorporated in or otherwise used in conjunction with other routines. In this context, “start” indicates the beginning of the first step presented and may be preceded by other activities not specifically shown. Further, the “continue” indication reflects that the steps presented may be performed multiple times and/or may be succeeded by other activities not specifically shown. Further, while a flow diagram indicates a particular ordering of steps, other orderings are likewise possible provided that the principles of causality are maintained.

As may also be used herein, the term(s) “operably coupled to”, “coupled to”, and/or “coupling” includes direct coupling between items and/or indirect coupling between items via one or more intervening items. Such items and intervening items include, but are not limited to, junctions, communication paths, components, circuit elements, circuits, functional blocks, and/or devices. As an example of indirect coupling, a signal conveyed from a first item to a second item may be modified by one or more intervening items by modifying the form, nature or format of information in a signal, while one or more elements of the information in the signal are nevertheless conveyed in a manner than can be recognized by the second item. In a further example of indirect coupling, an action in a first item can cause a reaction on the second item, as a result of actions and/or reactions in one or more intervening items.

Although specific embodiments have been illustrated and described herein, it should be appreciated that any arrangement which achieves the same or similar purpose may be substituted for the embodiments described or shown by the subject disclosure. The subject disclosure is intended to cover any and all adaptations or variations of various embodiments. Combinations of the above embodiments, and other embodiments not specifically described herein, can be used in the subject disclosure. For instance, one or more features from one or more embodiments can be combined with one or more features of one or more other embodiments. In one or more embodiments, features that are positively recited can also be negatively recited and excluded from the embodiment with or without replacement by another structural and/or functional feature. The steps or functions described with respect to the embodiments of the subject disclosure can be performed in any order. The steps or functions described with respect to the embodiments of the subject disclosure can be performed alone or in combination with other steps or functions of the subject disclosure, as well as from other embodiments or from other steps that have not been described in the subject disclosure. Further, more than or less than all of the features described with respect to an embodiment can also be utilized.

What is claimed is:

1. A device, comprising:

a processing system including a processor; and

a memory that stores executable instructions that, when executed by the processing system, facilitate performance of operations, the operations comprising:

detecting a scenario that warrants a pooling of first resources associated with a first network operator with second resources associated with at least a second network operator that is different from the first network operator;

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based on the detecting, obtaining first data indicating an availability of a first portion of the first resources and second data indicating an availability of a first portion of the second resources;

processing at least the first data and the second data to generate a plan for facilitating a communication service involving the first portion of the first resources and the first portion of the second resources; and

facilitating the communication service based on the plan, wherein the detecting is based on a determination that a combination of a quality of communication services in a first network associated with the first network operator and a quality of communication services in at least a second network associated with the at least a second network operator is less than a threshold amount.

2. The device of claim 1, wherein the detecting is based on a monitoring of user-generated inputs.

3. The device of claim 1, wherein the detecting is based on a monitoring of inputs from an emergency services or government-based command and control center.

4. The device of claim 1, wherein the detecting is based on a determination that a demand for communication services from a pool of subscribers exceeds a threshold as a function of time.

5. The device of claim 1, wherein the detecting is based on monitoring social media activity.

6. The device of claim 1, wherein the operations further comprise:

presenting the plan for approval; and

obtaining, based on the presenting, the approval of the plan, wherein the facilitating of the communication service is based on the obtaining of the approval.

7. The device of claim 6, wherein the approval comprises a selection of an option from among a plurality of options, resulting in a selected option, and wherein the communication service is facilitated in accordance with the selected option.

8. The device of claim 1, wherein the processing of the at least the first data and the second data comprises processing obtained feedback pertaining to a second plan to generate the plan, and wherein the plan is different from the second plan.

9. The device of claim 1, wherein the operations further comprise:

processing at least the first data and the second data to generate a second plan regarding an allocation of emergency services personnel in relation to the scenario; and

commanding the emergency services personnel to perform an action in accordance with the second plan.

10. The device of claim 1, wherein the facilitating of the communication service based on the plan comprises an identification of at least a first communication parameter of first network infrastructure included in the first portion of the first resources that is to be modified.

11. The device of claim 10, wherein the at least a first communication parameter pertains to: a frequency or frequency band, a transmission power level, a receiver sensitivity level, a modulation scheme, a demodulation scheme, an encryption scheme, a decryption scheme, an encoding scheme, a decoding scheme, or any combination thereof.

12. The device of claim 1, wherein the operations further comprise:

based on the detecting, obtaining third data indicating an unavailability of a second portion of the first resources

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and fourth data indicating an unavailability of a second portion of the second resources,

wherein the processing of the at least the first data and the second data to generate the plan comprises processing the third data and the fourth data to generate the plan.

13. The device of claim 1, wherein the plan includes a use of a drone to bridge a communication gap between the first portion of the first resources and the first portion of the second resources.

14. The device of claim 1, wherein the communication service involves a voice call, a text message, a video, an image, or a combination thereof, between a first responder and a second first responder.

15. A non-transitory machine-readable medium, comprising executable instructions that, when executed by a processing system including a processor, facilitate performance of operations, the operations comprising:

detecting a scenario that warrants a pooling of first resources associated with a first network operator with second resources associated with at least a second network operator that is different from the first network operator;

based on the detecting, obtaining first data indicating an availability of a first portion of the first resources and second data indicating an availability of a first portion of the second resources; and

facilitating a communication service using the first portion of the first resources and the first portion of the second resources based on the first data and the second data,

wherein the detecting is based on a determination that a combination of a quality of communication services in a first network associated with the first network operator and a quality of communication services in at least a second network associated with the at least a second network operator is less than a threshold amount.

16. The non-transitory machine-readable medium of claim 15, wherein the facilitating of the communication service comprises identifying at least a first communication parameter of first network infrastructure included in the first portion of the first resources that is to be modified.

17. The non-transitory machine-readable medium of claim 16, wherein the at least a first communication param-

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eter pertains to: a frequency or frequency band, a transmission power level, a receiver sensitivity level, a modulation scheme, a demodulation scheme, an encryption scheme, a decryption scheme, an encoding scheme, or a decoding scheme.

18. A method, comprising:

detecting, by a processing system including a processor, a scenario that warrants a pooling of first resources associated with a first network operator with second resources associated with a second network operator and a third network operator, wherein each of the second network operator and the third network operator is different from the first network operator, and wherein the second network operator is different from the third network operator;

based on the detecting, obtaining, by the processing system, first data indicating an availability of a first portion of the first resources and second data indicating an availability of a first portion of the second resources; and

facilitating, by the processing system, a communication service using the first portion of the first resources and the first portion of the second resources based on the first data and the second data,

wherein the detecting is based on a determination that a combination of a quality of communication services in a first network associated with the first network operator, a quality of communication services in a second network associated with the second network operator, and a quality of communication services in a third network associated with the third network operator is less than a threshold amount.

19. The method of claim 18, wherein the scenario involves property damage, casualties or injuries, a use of a weapon, a use of a vehicle, or any combination thereof.

20. The method of claim 18, further comprising:

processing, by the processing system, at least the first data and the second data to generate a plan regarding an allocation of emergency services personnel in relation to the scenario; and

commanding the emergency services personnel to perform an action in accordance with the plan.

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