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(54) **APPARATUSES AND METHODS FOR
FACILITATING A DYNAMIC REPORTING
MECHANISM FOR DEVICES ENGAGING IN
COMMUNICATIONS OVER NETWORKS
AND SYSTEMS**

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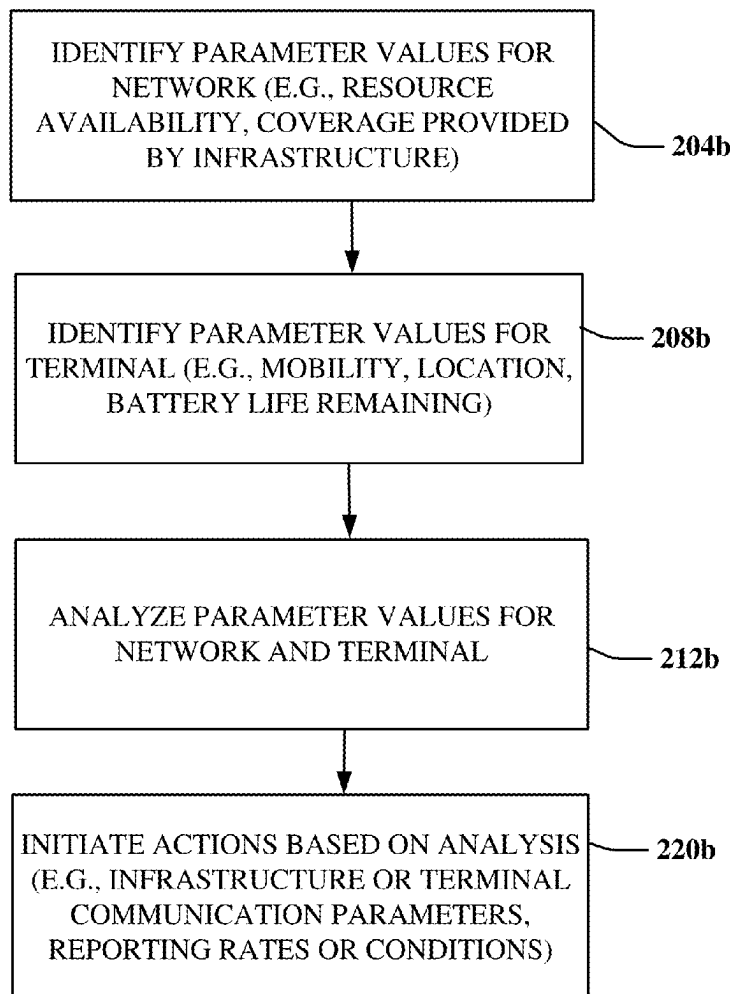
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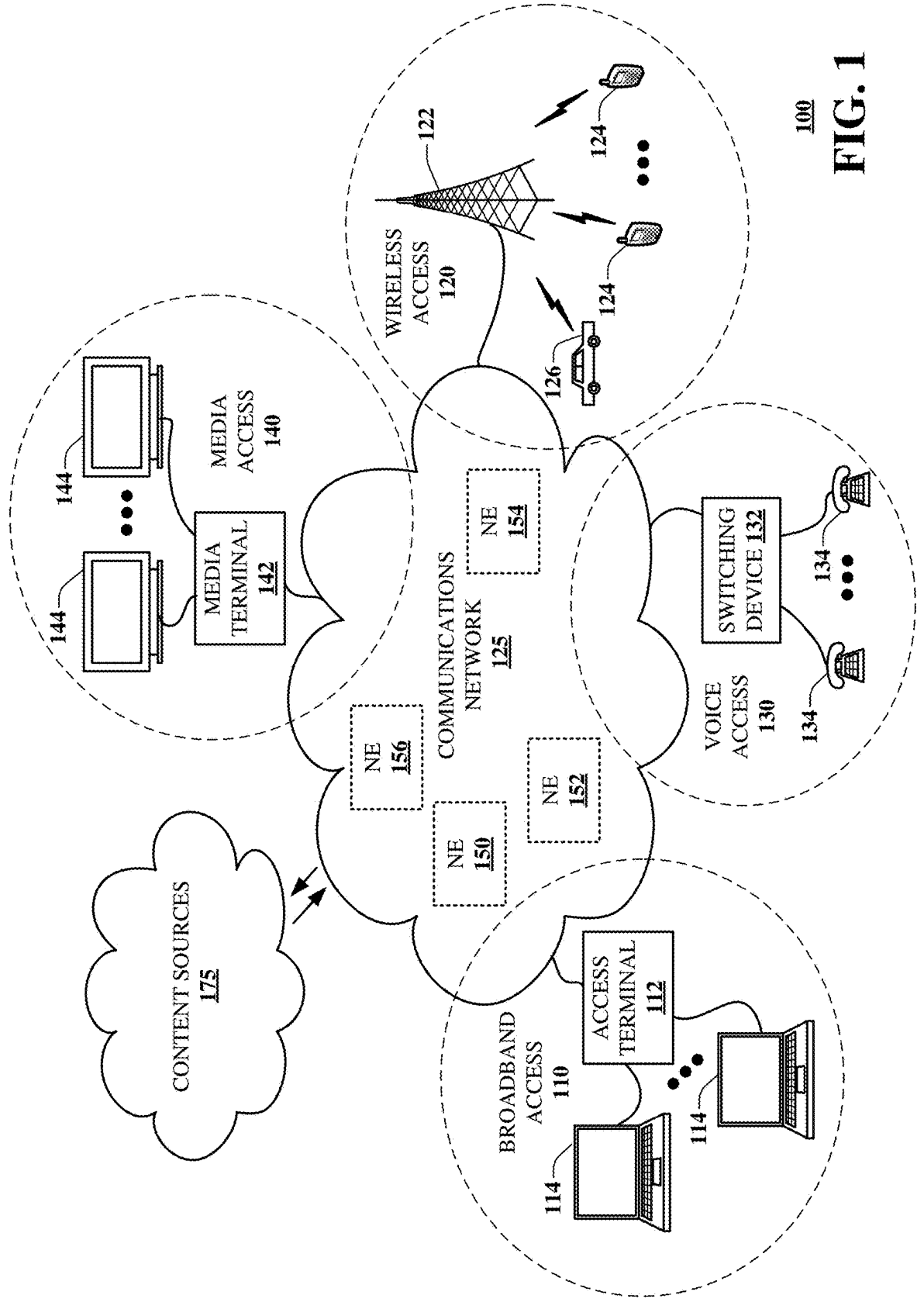
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(57) **ABSTRACT**

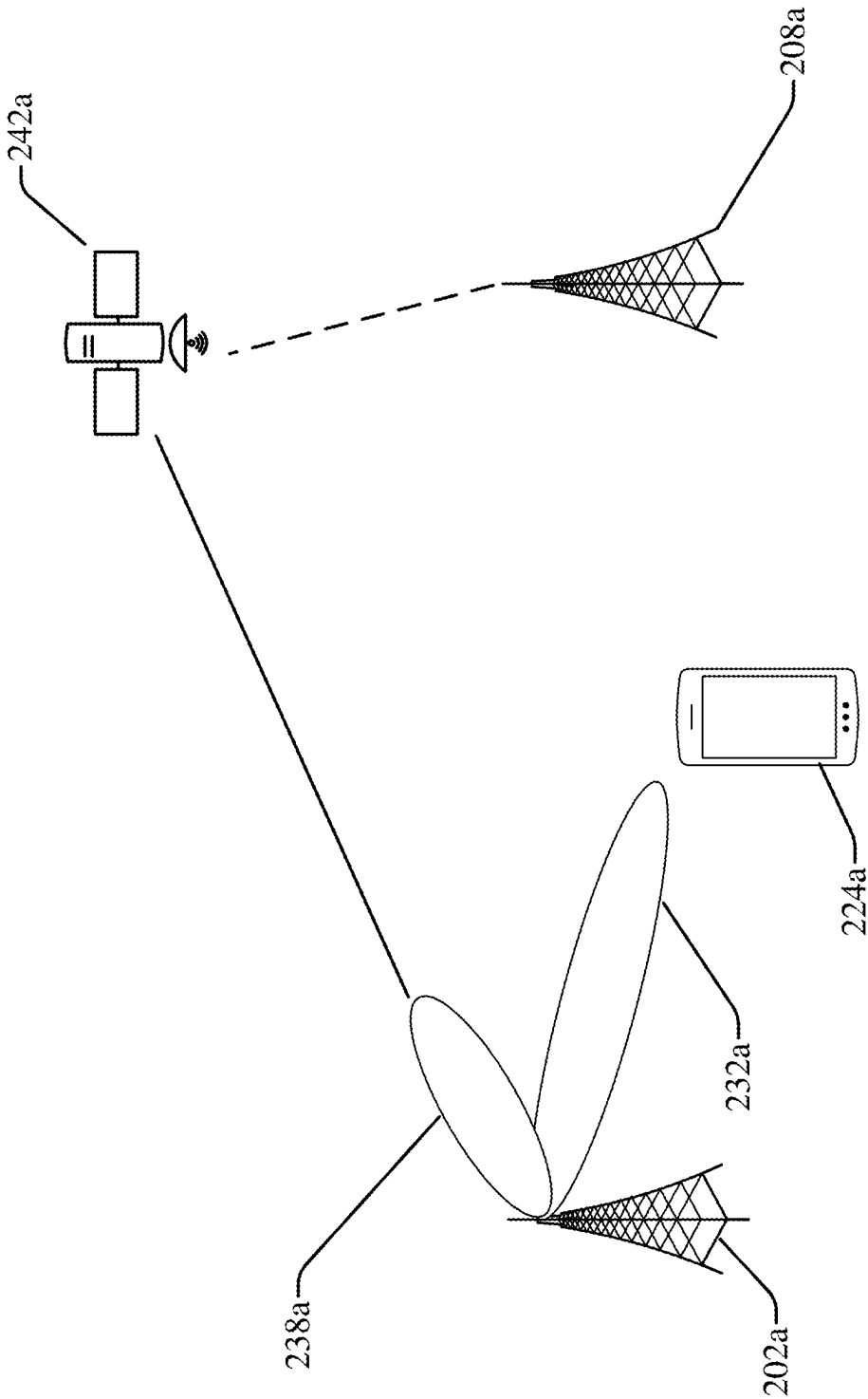
Aspects of the subject disclosure may include, for example, comparing a mobility of a terminal to a first threshold, resulting in a first comparison, comparing a location of the terminal to a map of network coverage, resulting in a second comparison, comparing a remaining battery life of a battery of the terminal to a second threshold, resulting in a third comparison, and transmitting a message to the terminal that causes the terminal to issue at least one report in accordance with the first comparison, the second comparison, and the third comparison. Other embodiments are disclosed.

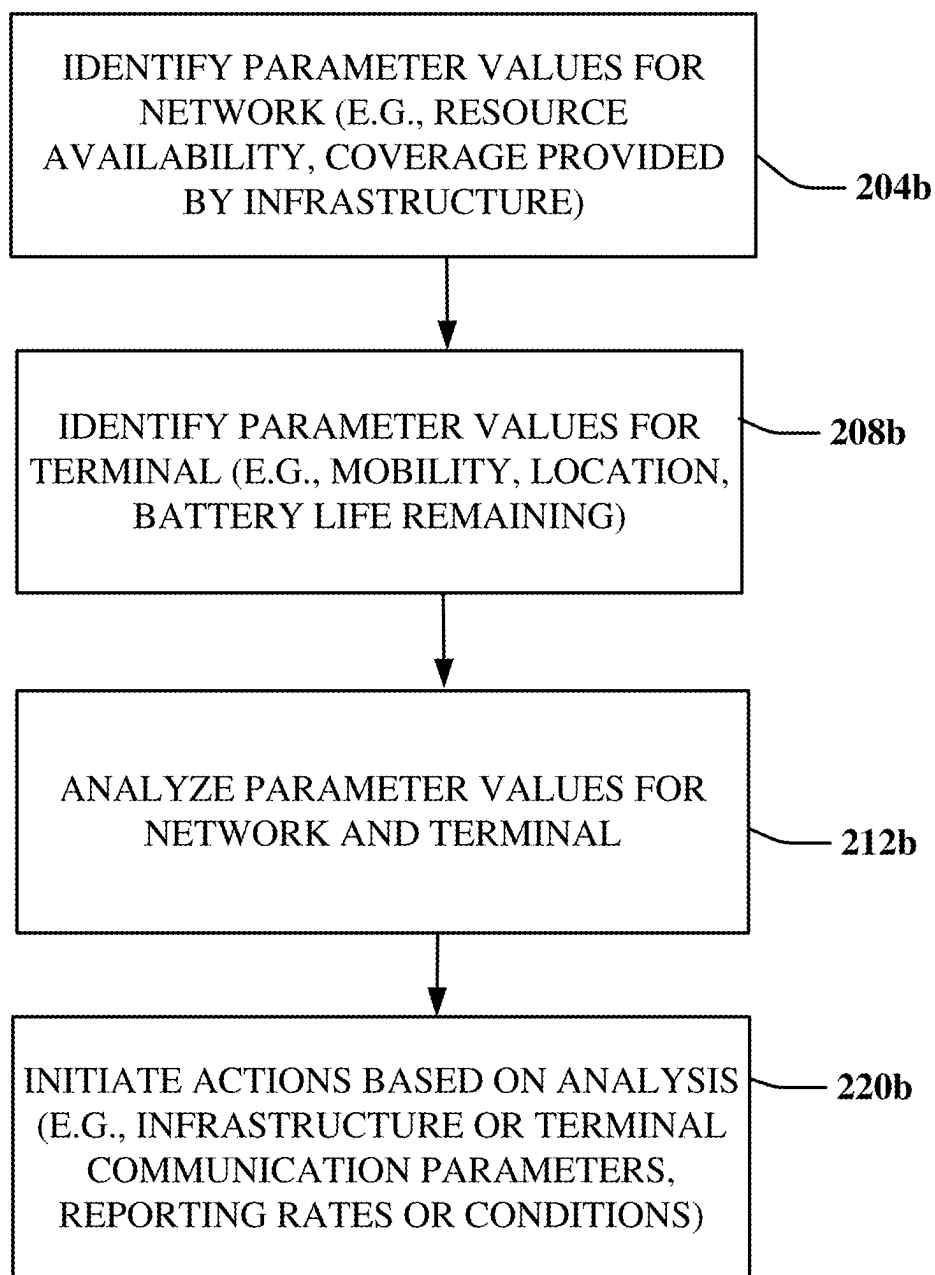




100
FIG. 1

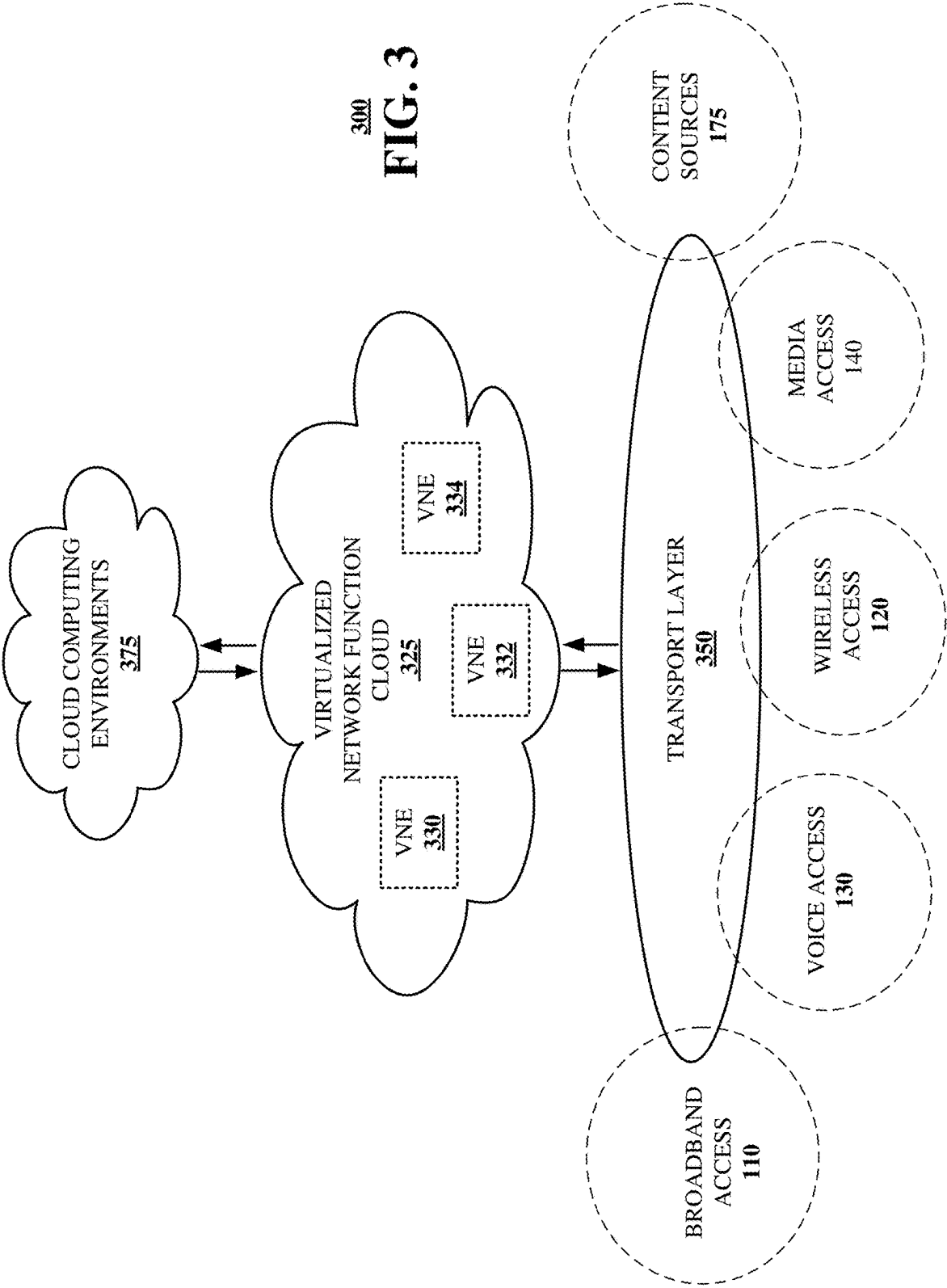
FIG. 2A
200a





200b

FIG. 2B



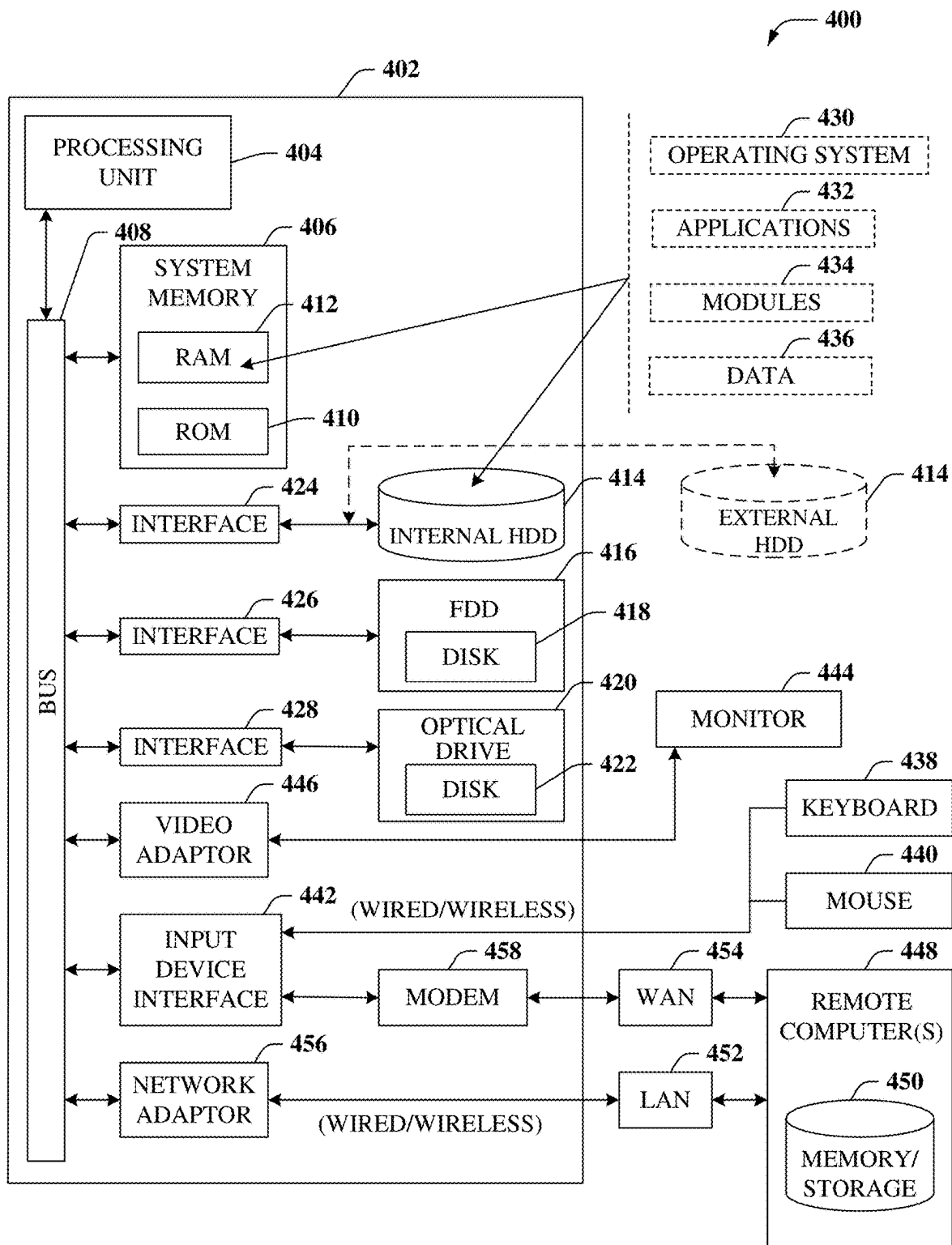


FIG. 4

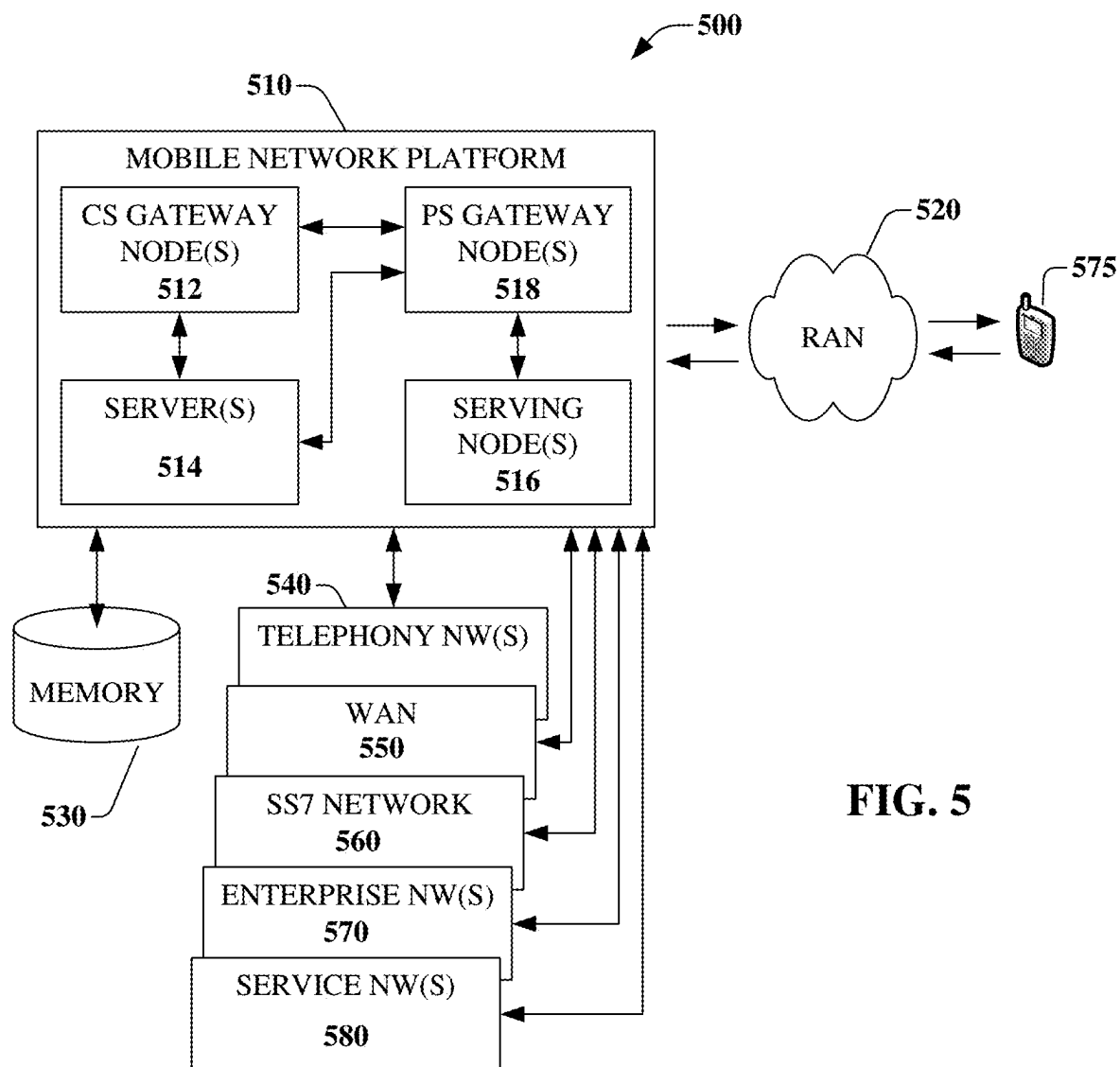
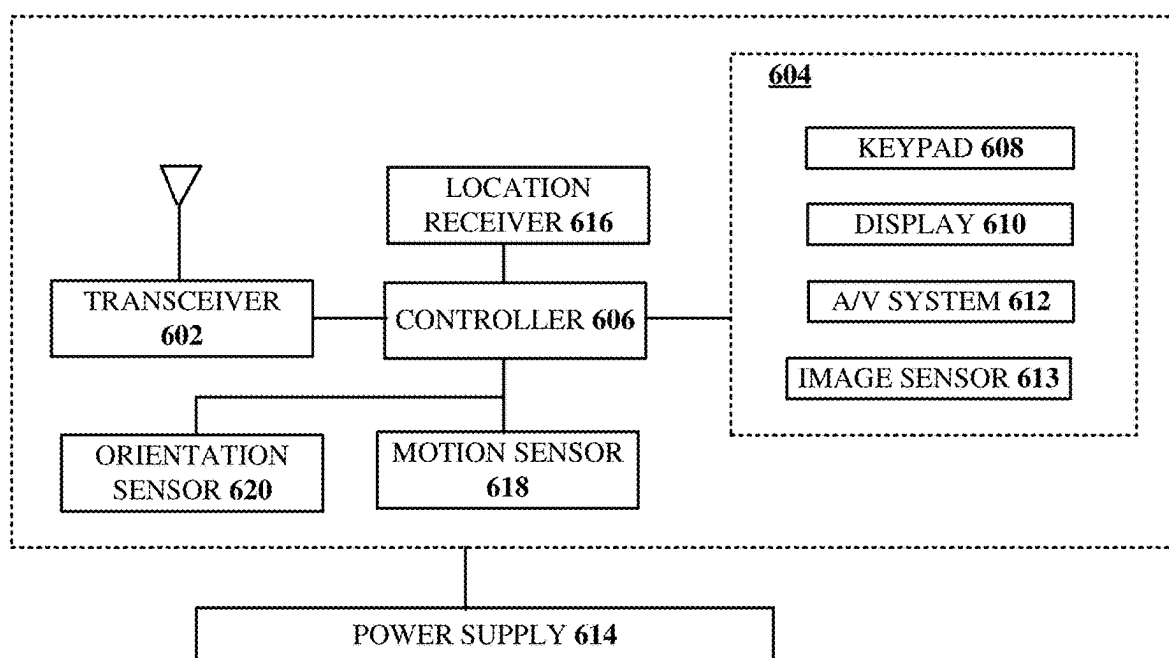


FIG. 5



600
FIG. 6

**APPARATUSES AND METHODS FOR
FACILITATING A DYNAMIC REPORTING
MECHANISM FOR DEVICES ENGAGING IN
COMMUNICATIONS OVER NETWORKS
AND SYSTEMS**

FIELD OF THE DISCLOSURE

[0001] The subject disclosure relates to apparatuses and methods for facilitating a dynamic reporting mechanism for devices engaging in communications over networks and systems.

BACKGROUND

[0002] As the world increasingly becomes connected via vast communication networks and systems and via various communication devices, additional opportunities are generated to provision communication services. Unmanned aerial vehicles (UAVs), or more generally aerial devices, are examples of types of terminals/communication devices that have been the subject of tremendous growth in use and popularity over recent years. For example, UAVs can be deployed for facilitating various types of important, practical applications, such as monitoring or detecting threats, performing surveillance, deploying munitions, mitigating (e.g., “fighting”) forest or brush fires, applying fertilizers or pesticides in relation to agriculture, etc.

[0003] Terminals/Communication devices may transmit reports to network/system infrastructure (e.g., base stations) pertaining to parameters or characteristics of signals that are emitted by the infrastructure as part of provisioning communication services, controls, and the like. The values of the parameters/characteristics may change quickly/rapidly. For example, aerial vehicles potentially have a higher degree of mobility relative to terrestrial vehicles, and thus, signal characteristics (e.g., signal strength, interference, noise, etc.) pertaining to aerial vehicles may change drastically over short periods of time. Thus, on the one hand, there may be a desire for reports to be transmitted by the terminals frequently to enable network infrastructure to obtain accurate and current data/information. On the other hand, the transmission of the reports represents, in some sense, a penalty in terms of overhead (e.g., bandwidth utilization, processing resource consumption, etc.) and may tend to deplete a power source (e.g., a battery) of a terminal (e.g., an aerial vehicle), such that there is also a desire to transmit the reports infrequently.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

[0005] FIG. 1 is a block diagram illustrating an exemplary, non-limiting embodiment of a communications network in accordance with various aspects described herein.

[0006] FIG. 2A is a block diagram illustrating an example, non-limiting embodiment of a system in accordance with various aspects described herein.

[0007] FIG. 2B depicts an illustrative embodiment of a method in accordance with various aspects described herein.

[0008] FIG. 3 is a block diagram illustrating an example, non-limiting embodiment of a virtualized communication network in accordance with various aspects described herein.

[0009] FIG. 4 is a block diagram of an example, non-limiting embodiment of a computing environment in accordance with various aspects described herein.

[0010] FIG. 5 is a block diagram of an example, non-limiting embodiment of a mobile network platform in accordance with various aspects described herein.

[0011] 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

[0012] The subject disclosure describes, among other things, illustrative embodiments for managing reports issued by terminals in accordance with an analysis of one or more conditions. Other embodiments are described in the subject disclosure.

[0013] One or more aspects of the subject disclosure include, in whole or in part, obtaining first data that indicates an amount of mobility of an aerial vehicle; obtaining second data that indicates a first location of the aerial vehicle; obtaining third data that indicates a remaining battery life of a battery of the aerial vehicle; analyzing at least the first data, the second data, and the third data to identify a first triggering condition associated with reports that are issued by the aerial vehicle and a first rate at which the reports are issued by the aerial vehicle, resulting in a first analysis; and causing, based on the first analysis, the aerial vehicle to issue the reports in accordance with the first triggering condition and the first rate.

[0014] One or more aspects of the subject disclosure include, in whole or in part, comparing a mobility of a terminal to a first threshold, resulting in a first comparison; comparing a location of the terminal to a map of network coverage, resulting in a second comparison; comparing a remaining battery life of a battery of the terminal to a second threshold, resulting in a third comparison; and transmitting a message to the terminal that causes the terminal to issue at least one report in accordance with the first comparison, the second comparison, and the third comparison.

[0015] One or more aspects of the subject disclosure include, in whole or in part, configuring, by a processing system including a processor, an aerial vehicle to issue reports in accordance with a first configuration; subsequent to the configuring of the aerial vehicle, detecting, by the processing system, a change in at least one condition associated with the aerial vehicle or a network that provides communication services to the aerial vehicle, wherein the at least one condition pertains to: a mobility of the aerial vehicle, an available capacity of resources of the network, a remaining battery life of a battery of the aerial vehicle, or any combination thereof; and based on the detecting, configuring, by the processing system, the aerial vehicle to issue the reports in accordance with a second configuration that is different from the first configuration.

[0016] 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, the system 100 can facilitate in whole or in part obtaining first data that indicates an amount of mobility of an aerial vehicle, obtaining second data that indicates a first location of the aerial vehicle, obtaining third data that indicates a remaining battery life of a battery of the aerial vehicle, analyzing at least the first data, the second data, and the third data to identify a first triggering condition

associated with reports that are issued by the aerial vehicle and a first rate at which the reports are issued by the aerial vehicle, resulting in a first analysis, and causing, based on the first analysis, the aerial vehicle to issue the reports in accordance with the first triggering condition and the first rate. The system **100** can facilitate in whole or in part comparing a mobility of a terminal to a first threshold, resulting in a first comparison, comparing a location of the terminal to a map of network coverage, resulting in a second comparison, comparing a remaining battery life of a battery of the terminal to a second threshold, resulting in a third comparison, and transmitting a message to the terminal that causes the terminal to issue at least one report in accordance with the first comparison, the second comparison, and the third comparison. The system **100** can facilitate in whole or in part configuring, by a processing system including a processor, an aerial vehicle to issue reports in accordance with a first configuration, subsequent to the configuring of the aerial vehicle, detecting, by the processing system, a change in at least one condition associated with the aerial vehicle or a network that provides communication services to the aerial vehicle, wherein the at least one condition pertains to: a mobility of the aerial vehicle, an available capacity of resources of the network, a remaining battery life of a battery of the aerial vehicle, or any combination thereof, and based on the detecting, configuring, by the processing system, the aerial vehicle to issue the reports in accordance with a second configuration that is different from the first configuration.

[0017] 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).

[0018] 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.

[0019] 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.

[0020] 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.

[0021] 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.

[0022] 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.

[0023] 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.

[0024] 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.

[0025] By way of introduction, and as described above, in some embodiments a terminal or user equipment (UE), such as an aerial vehicle, may be configured to transmit reports pertaining to signal characteristics or parameters, events, and the like. For example, the Third Generation Partnership Project (3GPP) has defined a message (referred to as an RRC.Connection.Reconfiguration message) that may be used to configure a UE in terms of reporting. Table 1 shown below represents a number of events that may be monitored by a UE as far as an event serving as a triggering condition for generating and transmitting a report. The events/triggering conditions shown in Table 1 are illustrative, which is to say that other types or kinds of events or triggering conditions may be utilized in conjunction with various embodiments of this disclosure.

TABLE 1

Exemplary UE Measurement Reporting Events	
Event	Triggering Condition
A1	Serving cell signal strength becomes better than a threshold
A2	Serving cell signal strength becomes worse than a threshold
A3	Neighbor cell signal strength is greater than serving cell signal strength by at least an offset amount
A4	Neighbor cell signal strength is greater than a threshold
A5	Serving cell signal strength is less than a first threshold and neighbor cell signal strength is greater than a second threshold
B1	Inter radio access technology (RAT) neighbor cell signal strength exceeds a threshold
B2	Serving cell signal strength is less than a first threshold and inter RAT neighbor cell signal strength is greater than a second threshold

[0026] The events shown in Table 1 above may be based on measurements (e.g., reference signal received power [RSRP], reference signal received quality [RSRQ], etc.) performed by a UE or terminal in respect of one or more serving cells or neighboring cells (as represented by the Triggering Condition column of Table 1). The criteria for triggering, and subsequently revoking/cancelling, each event may be evaluated after filtering (e.g., layer-3 filtering) has been applied. The criteria for each event may need to be satisfied during a time period when the triggering condition is being monitored for. The time period may be set universally for all events, may be established for a subset of the events, or may be independently set for each event on an individual basis.

[0027] As described above, the network infrastructure may configure a terminal based on, e.g., the RRC.Connection.Reconfiguration message (which may be sent during a terminal attachment procedure), in terms defining when, and under what conditions, the terminal is to generate and transmit a report. In this respect, in practical applications the network infrastructure may have an ability to exercise control over/regulate the nature or extent of the reporting that is provided by the terminal.

[0028] As described above, there may effectively exist a tradeoff between quality and timeliness of terminal reports on the one hand, and the overhead or consumption of resources that reporting entails on the other hand. Accordingly, and as described in further detail below, aspects of this disclosure may tend to balance these competing interests to enhance (e.g., optimize) the nature or extent by/which a terminal or UE is instructed/commanded to generate and/or transmit reports. These aspects may be applied in respect of one or more environments, an example of which is described below in relation to FIG. 2A.

[0029] FIG. 2A is a block diagram of an example, non-limiting embodiment of a system 200a in accordance with various aspects described herein. In some embodiments, one or more parts/portions of the system 200a may function within, or may be operatively overlaid upon, one or more parts/portions of the system 100 of FIG. 1.

[0030] The system 200a may include first network infrastructure, as illustratively represented by a first tower 202a, and second network infrastructure, as illustratively represented by a second tower 208a. Each of the towers 202a and 208a may be configured to facilitate communication services in respect of one or more communication devices or terminals, such as a user equipment (UE) 224a and an

unmanned aerial vehicle (UAV) 242a. At the particular instant of time represented by FIG. 2A, the tower 202a may be responsible for facilitating services for both the UE 224a and the UAV 242a.

[0031] Conventionally, network infrastructure (such as the towers 202a and 208a) may be configured to primarily support ground or terrestrial based terminals or devices. In this respect, the tower 202a is shown as emitting a main lobe or main beam 232a, that is primarily oriented towards the ground and in a direction of the UE 224a (where the UE 224a may be carried by a person walking on the ground, located within a building, etc.). The tower 202a may emit one more ancillary lobes/sidelobes 238a that may be associated with signals that reach the UAV 242a. In this respect, the sidelobe(s) 238a are shown as being oriented in an upward direction towards the UAV 242a in FIG. 2A. Due to the presence of possible nulls in the sidelobe(s) 238a, and due to the close-to-free-space propagation in the sky, the UAV 242a may detect several towers (potentially including the towers 202a and 208a) in any given area. Further, the UAV 242a may experience/obtain a higher quality of signal (e.g., a signal with a greater signal strength) in respect of a tower (e.g., the tower 202a) that is further away from the UAV 242a relative to a tower (e.g., the tower 208a) that is closer to the UAV 242a. As a result, it is noted that these impacts can serve as a benefit or a detriment, depending on the circumstances/conditions. For example, the close-to-free-space propagation characteristics may extend the geographical scope/reach of service (from a serving tower) to the UAV 242a (relative to ground-based terminals or devices). However, the close-to-free-space propagation characteristics may also tend to increase the amount or extent of interference that the UAV 242a may experience from signals/beams emitted from a non-serving tower. Signal characteristics associated with the towers 202a and 208a may be measured by the UE 224a and/or the UAV 242a as part of monitoring for (triggering) conditions and/or generating one or more reports as described above.

[0032] It is noted that, with particular reference to the UAV 242a (although potentially also in relation to the UE 224a), that operations of the UAV 242a may be controlled by the tower 202a (or, in some instances, the tower 208a) based on the signal characteristics/parameters associated with the tower 202a or the tower 208a as detected by the UAV 242a. For example, the tower 202a (or an associated controller) may use signal strength and signal quality readings (as potentially included in one or more reports) to determine an appropriate course or route of navigation (e.g., a trajectory) for the UAV 242a. In some instances, the tower 202a (or an associated controller) may determine or decide to assign or modify characteristics of operations associated with the UAV 242a on the basis of one or more measurements (as potentially represented within one or more reports). To demonstrate an assignment or modification of one or more communication parameters (e.g., a signal transmission power level associated with signals emitted by the UAV 242a, a receiver sensitivity level associated with the UAV 242a, a frequency band or frequency of signals emitted by the UAV 242a or received by the UAV 242a, a modulation/demodulation scheme utilized by the UAV 242a, a security mechanism (e.g., an encryption/decryption scheme) utilized by the UAV 242a, etc.) may be provided or obtained. In some embodiments, the tower 202a (or an associated controller) may choose to handover/transfer responsibility

for some or all of a communication session involving the UAV **242a** to another entity (such as, for example, the tower **208a** or an associated controller). The foregoing represents just some of the decisions that may be made in respect of the operations of the UAV **242a** on the basis of measured or detected signal characteristics; other types or kinds of decisions/determinations may be made in conjunction with this disclosure.

[0033] As described above, aspects of this disclosure (as potentially applied to, e.g., the system **200a**) may be used to control, manage, or regulate a rate, and conditions under which, a terminal (e.g., a UE, such as an aerial vehicle) generates and issues one or more reports. To facilitate a description of the same, reference may now be made to FIG. 2B, which depicts an illustrative embodiment of a method **200b** in accordance with various aspects described herein. One or more parts/portions of 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 be implemented or executed via a processing system that may include one or more processors. The processing system may execute instructions that facilitate a performance of operations; the operations are described below in relation to the blocks of the method **200b**. The instructions may be stored by, e.g., one or more memory devices, memories, a computer or machine readable-medium, or the like.

[0034] In block **204b**, one or more parameter/parametric values may be identified in relation to a network or system. For example, block **204b** may include an identification of resource utilization or resource availability/capacity. Block **204b** may include an identification of coverage in respect of infrastructure. For example, and in the context of a terminal that is attached to a network, the coverage may pertain to a serving cell and/or one or more nearby (e.g., neighbor) cells. One or more lists, maps, or the like may provide an indication of coverage in a given area or region proximal to where the terminal is located.

[0035] In block **208b**, parameter/parametric values may be identified for the terminal. For example, the values of block **208b** may pertain to a mobility of the terminal, a location of the terminal (on an absolute or relative basis), and/or an amount of battery life/capacity remaining at the terminal.

[0036] In block **212b**, an analysis may be performed in respect of the values identified as part of block **204b** and/or block **208b**. Based on that analysis, one or more actions may be initiated/undertaken/performed as shown in respect of block **220b**. The actions of block **220b** may include an assignment or modification of: one or more communication parameters associated with network or system infrastructure or the terminal (or one or more other terminals), an imposition of conditions or rates/frequencies of reports generated and issued/transmitted by the terminal, etc.

[0037] To demonstrate aspects of the method **200b** by way of example, and with reference to Table 1 and FIG. 2A, it may be assumed that an analysis of the parameter values associated with the network/system and/or the UAV **242a** (see blocks **204b**, **208b**, **212b** of FIG. 2B described above) may conform to one of the following use cases/scenarios:

[0038] Scenario #1: [1] the UAV has high mobility, [2] the UAV is located in a non-continuous coverage area, and [3] the UAV has high battery life remaining (all of the aforementioned conditions [1]-[3] are satisfied). In this scenario

#1, block **220b** may include mandating the serving tower/base station to utilize an A1 event threshold with a very low RSRP value (e.g., -110 dBm), ensuring that the UAV will almost always be sending reports. In this scenario #1, block **220b** may include mandating the serving tower/base station to provide an A/B event (e.g., any of A1-A5, B1, B2 shown in Table 1 above) reporting periodicity by setting a reporting interval to a small value, meaning that reports will be generated and issued/transmitted by the UAV very frequently.

[0039] Scenario #2: [1] the UAV has high mobility, [2] the UAV is located in a non-continuous coverage area, or [3] the UAV has high battery life remaining (one or more, but less than all, of these conditions [1]-[3] are satisfied). In this scenario #2, block **220b** may include mandating the serving tower/base station to utilize an A1 event threshold with a low RSRP value (e.g., -90 dBm), ensuring that the UAV will almost always be sending reports. In this scenario #2, block **220b** may include mandating the serving tower/base station to provide an A/B event reporting periodicity by setting a reporting interval to a medium value, meaning that reports will be generated and issued/transmitted by the UAV frequently/regularly (although potentially less frequently than in scenario #1 described above).

[0040] Scenario #3: [1] the UAV has low mobility or non-mobility (e.g., is stationary or hovering), [2] the UAV is located in a (substantially) continuous coverage area, or [3] the UAV has low battery life remaining (one or more, but less than all, of these conditions [1]-[3] are satisfied). In this scenario #3, block **220b** may include mandating the serving tower/base station to utilize an A1 event threshold with a moderate RSRP value (e.g., -70 dBm), meaning that the UAV will be sending reports with some degree of regularity. In this scenario #3, block **220b** may include mandating the serving tower/base station to provide an A/B event reporting periodicity by setting a reporting interval to a large value, meaning that reports will be generated and issued/transmitted by the UAV somewhat rarely.

[0041] Scenario #4: [1] the UAV has low mobility or non-mobility (e.g., is stationary or hovering), [2] the UAV is located in a (substantially) continuous coverage area, and [3] the UAV has low battery life remaining (all of the aforementioned conditions [1]-[3] are satisfied). In this scenario #4, the UAV may be treated as a standard terrestrial UE (e.g., the UE **224a**) in terms of A1 event threshold utilization/value and reporting periodicity.

[0042] 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 the method **200b** may be executed iteratively or repeatedly to account for changes in conditions or circumstances that may warrant a change in the nature or extent of reporting facilitated by a terminal. The Scenarios #1-4 set forth above are examples; additional scenarios may be included or provided in a given embodiment, and/or the values referenced in relation to the scenarios may be modified/adjusted, without departing from the scope and spirit of this disclosure. In some embodiments, one or more thresholds may be defined or utilized to determine whether the

UAV (or the network/system infrastructure) has satisfied or provided a given condition in relation to the conditions [1]-[3] described above in relation to each of the Scenarios #1-4. Furthermore, one or more thresholds may be utilized to avoid changing a reporting parameter or configuration of a terminal unnecessarily/excessively; e.g., a current reporting configuration may be maintained unless a change in conditions is of a sufficient nature or degree so as to warrant a change in the reporting configuration. The parameter/parametric values described above may be embodied as one or more items of data (e.g., “first data”, “second data”, “third data”, “fourth data”, etc.).

[0043] In some embodiments, distinctions may be provided for as between aerial terminals or vehicles and terrestrial terminals or vehicles in terms of parameters pertaining to reporting. Such distinctions may be based on a terminal identifier, a subscription identifier, or the like.

[0044] In some embodiments, operations associated with a terminal (e.g., an aerial vehicle) may be determined or modified based on an analysis of data/data items. For example, as described above a trajectory of the terminal may be modified or adjusted (e.g., from a first trajectory to a second trajectory that is different from the first trajectory), a location of the terminal may be modified or adjusted (e.g., from a first location to a second location that is different from the first location), etc.

[0045] As set forth herein, practical applications of this disclosure may enhance an efficiency of operations associated with a network or system in accordance with a reporting of signal characteristics/conditions associated with a terminal. Aspects of such practical applications may enable an appropriate tradeoff to be made in terms of the conditions and periodicity or rate at which reports are generated and issued by terminals. As a result, a more efficient use of battery life associated with a terminal may be obtained, and a more efficient utilization of network/system resources may be realized. Thus, the various aspects of this disclosure represent substantial improvements to technology.

[0046] As described above, aspects of this disclosure are directed to practical applications involving a management and utilization of network/system resources. Recognizing that resources are scarce, aspects of this disclosure enable a more efficient use of the resources by focusing the resources towards ends that are more critical or important in nature based on determined/identified conditions or parameters/parameter values. In this respect, aspects of this disclosure represent substantial improvements relative to conventional techniques/technologies. In brief, and as would be clearly understood and appreciated by one of skill in the art based on a review of this disclosure, aspects of this disclosure are not directed to abstract ideas. To the contrary, the various aspects of this disclosure are directed to, and encompass, significantly more than any abstract idea standing alone.

[0047] Referring now to FIG. 3, a block diagram 300 is shown illustrating an example, non-limiting embodiment of a virtualized 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, the virtualized communication network 300 can facilitate in whole or in part obtaining first data that indicates an amount of mobility of an aerial vehicle, obtaining second

data that indicates a first location of the aerial vehicle, obtaining third data that indicates a remaining battery life of a battery of the aerial vehicle, analyzing at least the first data, the second data, and the third data to identify a first triggering condition associated with reports that are issued by the aerial vehicle and a first rate at which the reports are issued by the aerial vehicle, resulting in a first analysis, and causing, based on the first analysis, the aerial vehicle to issue the reports in accordance with the first triggering condition and the first rate. The virtualized communication network 300 can facilitate in whole or in part comparing a mobility of a terminal to a first threshold, resulting in a first comparison, comparing a location of the terminal to a map of network coverage, resulting in a second comparison, comparing a remaining battery life of a battery of the terminal to a second threshold, resulting in a third comparison, and transmitting a message to the terminal that causes the terminal to issue at least one report in accordance with the first comparison, the second comparison, and the third comparison. The virtualized communication network 300 can facilitate in whole or in part configuring, by a processing system including a processor, an aerial vehicle to issue reports in accordance with a first configuration, subsequent to the configuring of the aerial vehicle, detecting, by the processing system, a change in at least one condition associated with the aerial vehicle or a network that provides communication services to the aerial vehicle, wherein the at least one condition pertains to: a mobility of the aerial vehicle, an available capacity of resources of the network, a remaining battery life of a battery of the aerial vehicle, or any combination thereof, and based on the detecting, configuring, by the processing system, the aerial vehicle to issue the reports in accordance with a second configuration that is different from the first configuration.

[0048] 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.

[0049] 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 substrate 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.

[0050] 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.

[0051] 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**.

[0052] 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.

[0053] 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 commer-

cial cloud, or might simply orchestrate workloads supported entirely in NFV infrastructure from these third party locations.

[0054] 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, the computing environment **400** can facilitate in whole or in part obtaining first data that indicates an amount of mobility of an aerial vehicle, obtaining second data that indicates a first location of the aerial vehicle, obtaining third data that indicates a remaining battery life of a battery of the aerial vehicle, analyzing at least the first data, the second data, and the third data to identify a first triggering condition associated with reports that are issued by the aerial vehicle and a first rate at which the reports are issued by the aerial vehicle, resulting in a first analysis, and causing, based on the first analysis, the aerial vehicle to issue the reports in accordance with the first triggering condition and the first rate. The computing environment **400** can facilitate in whole or in part comparing a mobility of a terminal to a first threshold, resulting in a first comparison, comparing a location of the terminal to a map of network coverage, resulting in a second comparison, comparing a remaining battery life of a battery of the terminal to a second threshold, resulting in a third comparison, and transmitting a message to the terminal that causes the terminal to issue at least one report in accordance with the first comparison, the second comparison, and the third comparison. The computing environment **400** can facilitate in whole or in part configuring, by a processing system including a processor, an aerial vehicle to issue reports in accordance with a first configuration, subsequent to the configuring of the aerial vehicle, detecting, by the processing system, a change in at least one condition associated with the aerial vehicle or a network that provides communication services to the aerial vehicle, wherein the at least one condition pertains to: a mobility of the aerial vehicle, an available capacity of resources of the network, a remaining battery life of a battery of the aerial vehicle, or any combination thereof, and based on the detecting, configuring, by the processing system, the aerial vehicle to issue the reports in accordance with a second configuration that is different from the first configuration.

[0055] 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.

[0056] 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.

[0057] 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.

[0058] 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.

[0059] 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.

[0060] 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.

[0061] 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.

[0062] 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.

[0063] 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.

[0064] 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.

[0065] 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.

[0066] 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.

[0067] 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.

[0068] 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.

[0069] 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.

[0070] 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**.

[0071] 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.

[0072] 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.

[0073] 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.

[0074] 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, the platform **510** can facilitate in whole or in part obtaining first data that indicates an amount of mobility of an aerial vehicle, obtaining second data that indicates a first location of the aerial vehicle, obtaining third data that indicates a remaining battery life of a battery of the aerial vehicle, analyzing at least the first data, the second data, and the third data to identify a first triggering condition associated with reports that are issued by the aerial vehicle and a first rate at which the reports are issued by the aerial vehicle, resulting in a first analysis, and causing, based on the first analysis, the aerial vehicle to issue the reports in accordance with the first triggering condition and the first rate. The platform **510** can facilitate in whole or in part comparing a mobility of a terminal to a first threshold, resulting in a first comparison, comparing a location of the terminal to a map of network coverage, resulting in a second comparison, comparing a remaining battery life of a battery of the terminal to a second threshold, resulting in a third comparison, and transmitting a message to the terminal that causes the terminal to issue at least one report in accordance with the first comparison, the second comparison, and the third comparison. The platform **510** can facilitate in whole or in part configuring, by a processing system including a processor, an aerial vehicle to issue reports in accordance with a first configuration, subsequent to the configuring of the aerial vehicle, detecting, by the processing system, a change in at least one condition associated with the aerial vehicle or a network that provides communication services to the aerial vehicle, wherein the at least one condition pertains to: a mobility of the aerial vehicle, an available capacity of resources of the network, a remaining battery life of a battery of the aerial vehicle, or any combination thereof, and based on the detecting, configuring, by the processing

system, the aerial vehicle to issue the reports in accordance with a second configuration that is different from the first configuration.

[0075] 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**.

[0076] 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.

[0077] 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 pack-

etized 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).

[0078] 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.

[0079] 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.

[0080] 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.

[0081] 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.

[0082] 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, the computing device 600 can facilitate in whole or in part obtaining first data that indicates an amount of mobility of an aerial vehicle, obtaining second data that indicates a first location of the aerial vehicle, obtaining third data that indicates a remaining battery life of a battery of the aerial vehicle, analyzing at least the first data, the second data, and the third data to identify a first triggering condition associated with reports that are issued by the aerial vehicle and a first rate at which the reports are issued by the aerial vehicle, resulting in a first analysis, and causing, based on the first analysis, the aerial vehicle to issue the reports in accordance with the first triggering condition and the first rate. The computing device 600 can facilitate in whole or in part comparing a mobility of a terminal to a first threshold, resulting in a first comparison, comparing a location of the terminal to a map of network coverage, resulting in a second comparison, comparing a remaining battery life of a battery of the terminal to a second threshold, resulting in a third comparison, and transmitting a message to the terminal that causes the terminal to issue at least one report in accordance with the first comparison, the second comparison, and the third comparison. The computing device 600 can facilitate in whole or in part configuring, by a processing system including a processor, an aerial vehicle to issue reports in accordance with a first configuration, subsequent to the configuring of the aerial vehicle, detecting, by the processing system, a change in at least one condition associated with the aerial vehicle or a network that provides communication services to the aerial vehicle, wherein the at least one condition pertains to: a mobility of the aerial vehicle, an available capacity of resources of the network, a remaining battery life of a battery of the aerial vehicle, or any combination thereof, and based on the detecting, configuring, by the processing system, the aerial vehicle to issue the reports in accordance with a second configuration that is different from the first configuration.

[0083] 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 technologies 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.

[0084] 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.

[0085] 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.

[0086] 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.

[0087] 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.

[0088] 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).

[0089] 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**.

[0090] 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.

[0091] 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.

[0092] 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.

[0093] 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.

[0094] 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.

[0095] 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.

[0096] 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.

[0097] 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.

[0098] 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.

[0099] 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.

[0100] 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.

[0101] 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.

[0102] 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.

[0103] 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.

[0104] 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 be inclusive in a manner similar to the term “comprising” as “comprising” is interpreted when employed as a transitional word in a claim.

[0105] 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.

[0106] 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.

[0107] 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:
obtaining first data that indicates an amount of mobility of an aerial vehicle;
obtaining second data that indicates a first location of the aerial vehicle;
obtaining third data that indicates a remaining battery life of a battery of the aerial vehicle;
analyzing at least the first data, the second data, and the third data to identify a first triggering condition associated with reports that are issued by the aerial vehicle and a first rate at which the reports are issued by the aerial vehicle, resulting in a first analysis; and
causing, based on the first analysis, the aerial vehicle to issue the reports in accordance with the first triggering condition and the first rate.

2. The device of claim 1, wherein the aerial vehicle is an unmanned aerial vehicle.

3. The device of claim 1, wherein the analyzing comprises comparing the first data to at least a first threshold, comparing the second data to at least a second threshold, and comparing the third data to at least a third threshold.

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

obtaining fourth data that indicates an identifier of the aerial vehicle,
wherein the analyzing is further based on the fourth data.

5. The device of claim 1, wherein the first triggering condition pertains to a first signal strength of a first signal emitted by first network or system infrastructure.

6. The device of claim 5, wherein the first triggering condition pertains to a second signal strength of a second signal emitted by second network or system infrastructure.

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

obtaining fourth data that indicates an amount or extent of coverage provided by network or system infrastructure,
wherein the analyzing is further based on the fourth data.

8. The device of claim 1, wherein the causing of the aerial vehicle to issue the reports in accordance with the first triggering condition and the first rate is based on transmitting a message from a base station to the aerial vehicle.

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

subsequent to the causing, obtaining fourth data that indicates a second amount of mobility of the aerial vehicle;

subsequent to the causing, obtaining fifth data that indicates a second location of the aerial vehicle;

subsequent to the causing, obtaining sixth data that indicates a second remaining battery life of the battery of the aerial vehicle;

analyzing at least the fourth data, the fifth data, and the sixth data to identify a second triggering condition associated with the reports that are issued by the aerial vehicle and a second rate at which the reports are issued by the aerial vehicle, resulting in a second analysis; and

causing, based on the second analysis, the aerial vehicle to issue the reports in accordance with the second triggering condition and the second rate.

10. The device of claim **9**, wherein the second triggering condition is different from the first triggering condition, the second rate is different from the first rate, or a combination thereof.

11. The device of claim **9**, wherein the second analysis indicates that: the fourth data differs from the first data in an amount that is greater than a first threshold, the fifth data differs from the second data in an amount that is greater than a second threshold, the sixth data differs from the third data in an amount that is greater than a third threshold, or any combination thereof.

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

causing, based on the first analysis, a modification of one or more communication parameters associated with: the aerial vehicle, a terrestrial user equipment, a base station, or any combination thereof.

13. The device of claim **12**, wherein the one or more communication parameters pertain to: a signal transmission power level, a receiver sensitivity level, a frequency band or frequency associated with signals that are transmitted, a modulation scheme that is utilized, a demodulation scheme that is utilized, an encryption scheme that is utilized, a decryption scheme that is utilized, or any combination thereof.

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

causing, based on the first analysis, at least a portion of responsibility for a communication session involving the aerial vehicle to be transferred from a first base station to a second base station.

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

causing, based on the first analysis, the aerial vehicle to change a trajectory of travel from a first trajectory to a second trajectory that is different from the first trajectory.

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

causing, based on the first analysis, the aerial vehicle to change location from the first location to a second location that is different from the first location.

17. 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:

comparing a mobility of a terminal to a first threshold, resulting in a first comparison;

comparing a location of the terminal to a map of network coverage, resulting in a second comparison;

comparing a remaining battery life of a battery of the terminal to a second threshold, resulting in a third comparison; and

transmitting a message to the terminal that causes the terminal to issue at least one report in accordance with the first comparison, the second comparison, and the third comparison.

18. The non-transitory machine-readable medium of claim **17**, wherein the terminal is an aerial vehicle, and wherein the message identifies at least one triggering condition for the terminal to issue the at least one report and a rate at which the terminal issues the at least one report.

19. A method, comprising:

configuring, by a processing system including a processor, an aerial vehicle to issue reports in accordance with a first configuration;

subsequent to the configuring of the aerial vehicle, detecting, by the processing system, a change in at least one condition associated with the aerial vehicle or a network that provides communication services to the aerial vehicle, wherein the at least one condition pertains to: a mobility of the aerial vehicle, an available capacity of resources of the network, a remaining battery life of a battery of the aerial vehicle, or any combination thereof; and

based on the detecting, configuring, by the processing system, the aerial vehicle to issue the reports in accordance with a second configuration that is different from the first configuration.

20. The method of claim **19**, wherein the aerial vehicle executes an application that pertains to: security, agriculture, forestry, or any combination thereof.

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