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VISUAL REPRESENTATION OF AND INTERACTIONS WITH COMPUTING AND NETWORK EQUIPMENT IN A PHYSICAL SPACE

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ABSTRACT

Techniques are described herein for facilitating user interactions with computing and networking equipment in a physical space using augmented reality/virtual reality (AR/VR) techniques. In particular, the techniques described herein enable a person to, using a AR/VR mobile device, walk through a physical space and have presented to them, against a view of the space, information about the various network equipment in the space, including network switches, wireless local area network access points, routers, video teleconference equipment, Internet of Thing (IoT) switches, ruggedized outdoor network switches, beacon devices, etc.

DETAILED DESCRIPTION

Today, network deployment engineers spend a lot time and effort in site surveys, finding blind spots, holes in wireless network deployments, measuring signals and adjusting radio signals using various tools. In addition, for other computing and network equipment, a network deployment engineer needs to ensure proper cable connections, etc.

Installation engineers are called upon to deploy a network and various types of equipment in the network. For example, the engineers install the network switches, routers and wireless local area network (WLAN) access points (APs), as well as other equipment, such as video teleconference endpoints, wireless beacon devices, etc. After installation, the engineers then need to inspect the network to ensure proper device connectivity, suitable/desirable WLAN coverage, check for interference from other APs, etc. This can be a time-consuming process, and is ripe for inadvertent mistakes.

In the context of wireless network equipment, radio signal strength is ubiquitous in field services applications when technicians are deploying or troubleshooting wireless networks. In each case, signal strength can serve many important functions and provide additional information that accompanies visual images.

From a cognitive point of view, the “visual channel” is an excellent way to present information and give feedback to the person who is deploying or troubleshooting a network. While the background visual clues can be used to enhance the overall experience of the deploying person, a specific visual effect (a band of signal strength) can be used to communicate meaningful signal strength information.

A solution is presented herein to enable a person to, using a AR/VR mobile device, walk through a physical space and have presented to them, against a view of the space, information about the various network equipment in the space (or even outdoors), including network switches, WLAN APs, routers, video teleconference equipment, Internet of Thing (IoT) switches, ruggedized outdoor network switches, beacon devices, etc. Examples of the information that is presented to the person includes static information, such as device names, IP addresses, MAC addresses, associated controllers (e.g., WLAN controllers (WLCs)), network switch that is assigned to a particular building area, network cable connections on ports of a switch (without having to open a door to a wiring closet or other enclosure where switches and other network equipment may be located), network connections to a video conference endpoint, as well as dynamic information, such as signal strength, visualization of coverage to indicate coverage holes, number of clients associated with an AP, radio frequency (RF) channel used by an AP, etc. The solution may be employed, for example, in wireless network diagnostics.

Figure 1 below is a high-level block diagram of a system that visually presents to a user of an augmented reality/virtual reality (AR/VR) mobile device, information about network devices in a network deployment, according to an example embodiment. As shown, the high-level diagram illustrates a system 100 that includes a network deployment 110 that includes a plurality of network switches 112, APs 114, beacons 116, and various other equipment such as at least one video conference endpoint 118 and at least one IP phone 120. A network architecture controller 150 is provided that has connectivity to the network deployment 110 via the Internet 130. There also is a location server 152 and one or more resource databases 154 whose functions are described further hereinafter.

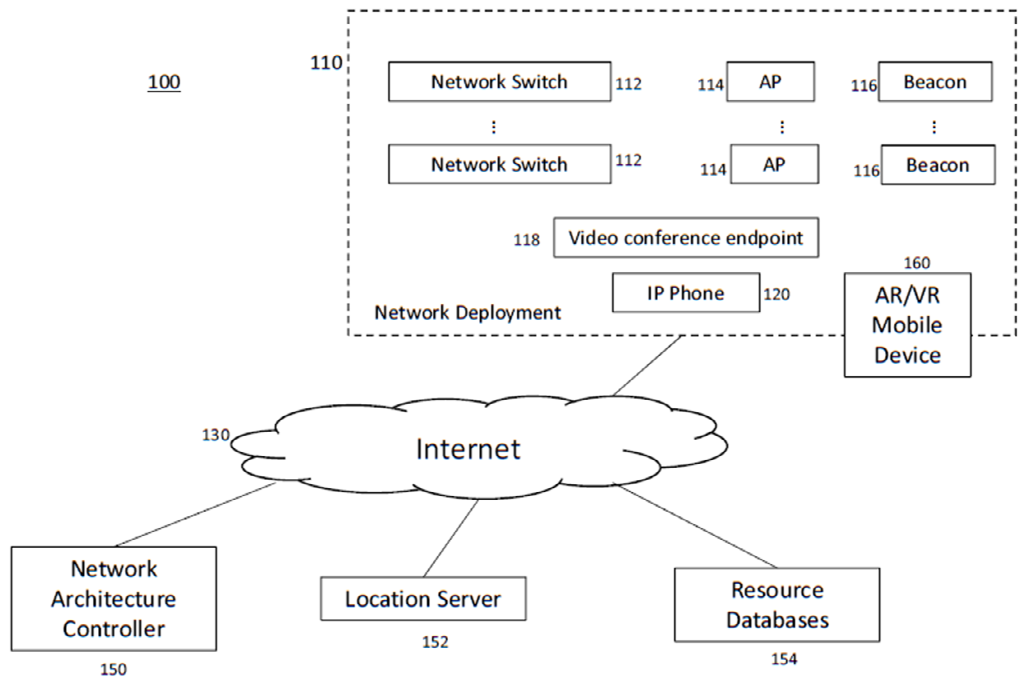

Figure 1

An AR/VR mobile device 160 is provided as part of the system 100. The AR/VR mobile device 160 is configured to facilitate static and dynamic network information about the various network devices in the network deployment 110 as a person moves about the physical space of the network deployment 100. The network architecture controller 150 is in communication with the network devices in network deployment 110 and also with the AR/VR mobile device 150 in order to provide the static and dynamic network information to the AR/VR mobile device 150 based on what is within the AR/VR mobile device user's view and location of the user in the space of the network deployment 110.

The location server 152 tracks and maintains about the locations of all of network devices of network deployment 110, as well as the location of the AR/VR mobile device 160 as it moves about the physical space of the network deployment 110. The network architecture controller 150 is in communication with the location server 152 and resource databases 154 as needed to generate and provide to the AR/VR mobile device 160 applicable static and dynamic network information about the various network devices in physical proximity or view of a user of the AR/VR mobile device 160. The AR/VR mobile device 160 could be a tablet, laptop, Smartphone, VR glasses, etc., that can give an visual experience of what is physically proximate to the AR/VR mobile device 160 and within a view of a camera of the AR/VR mobile device 160.

Figures 2 – 4 below depict examples of an implementation of the system 100 specifically to obtain and visually present on the AR/VR mobile device 160 static and dynamic information about the RF environment associated with one or more WLAN APs 114 and beacon devices 116 in a network deployment. Figure 2 shows the hardware and software functional components of the AR/VR mobile device 160, according to one example. The AR/VR mobile device 160 includes a WLAN interface (e.g., Wi-Fi chipset), wireless wide area network (WWAN) interface (e.g., LTE/4G, 5G, etc. chipset), a processor, a display, camera and memory. The memory stores software instructions for the various AR/VR mobile device functions shown in Figure 2.

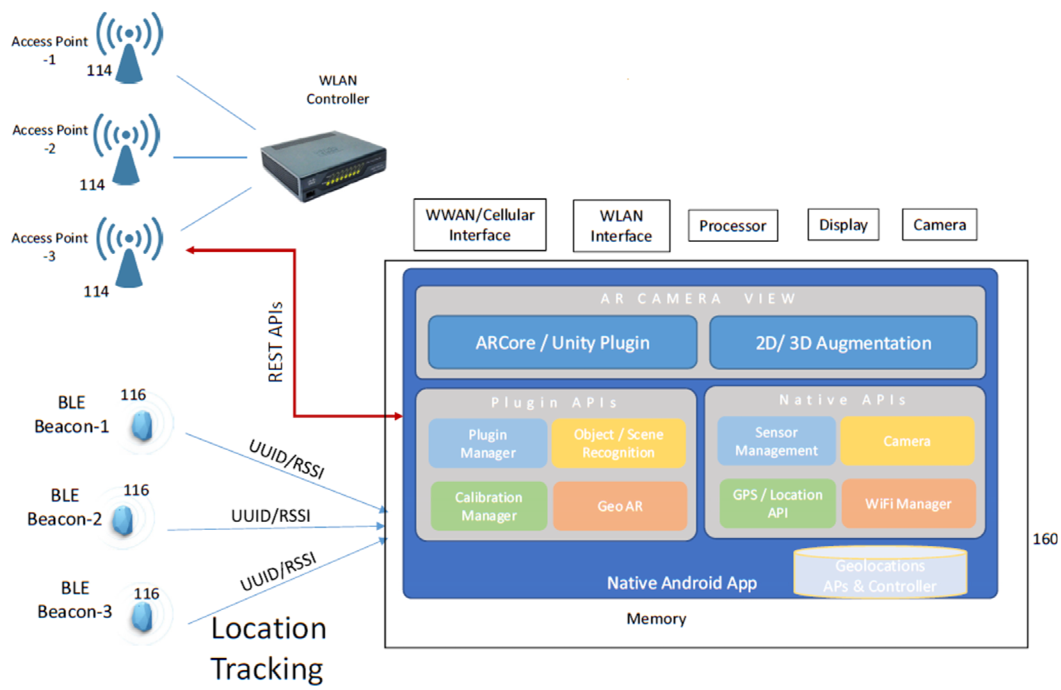

Figure 2

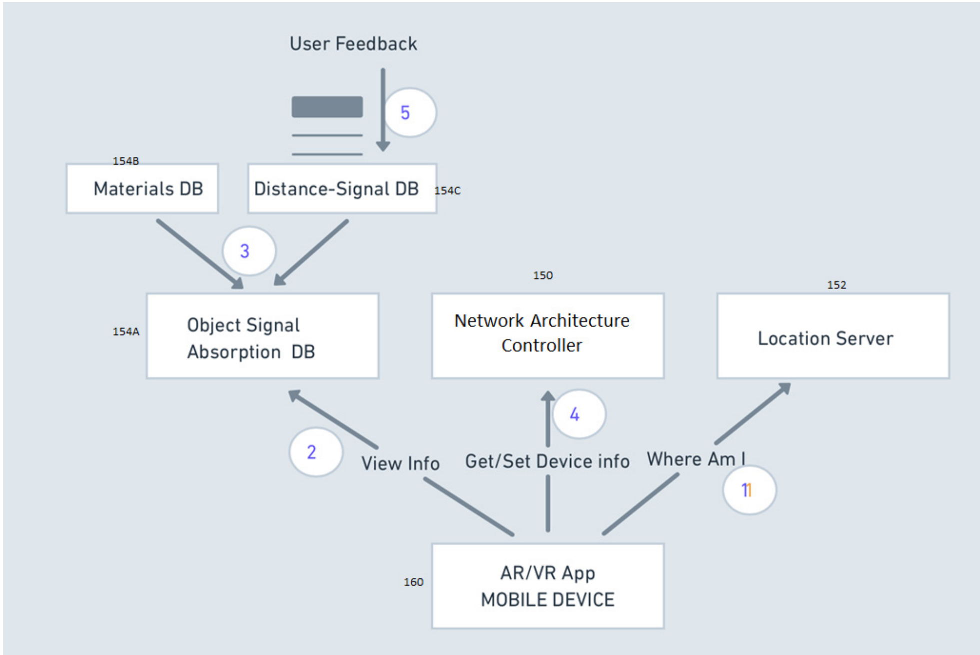

Figure 3

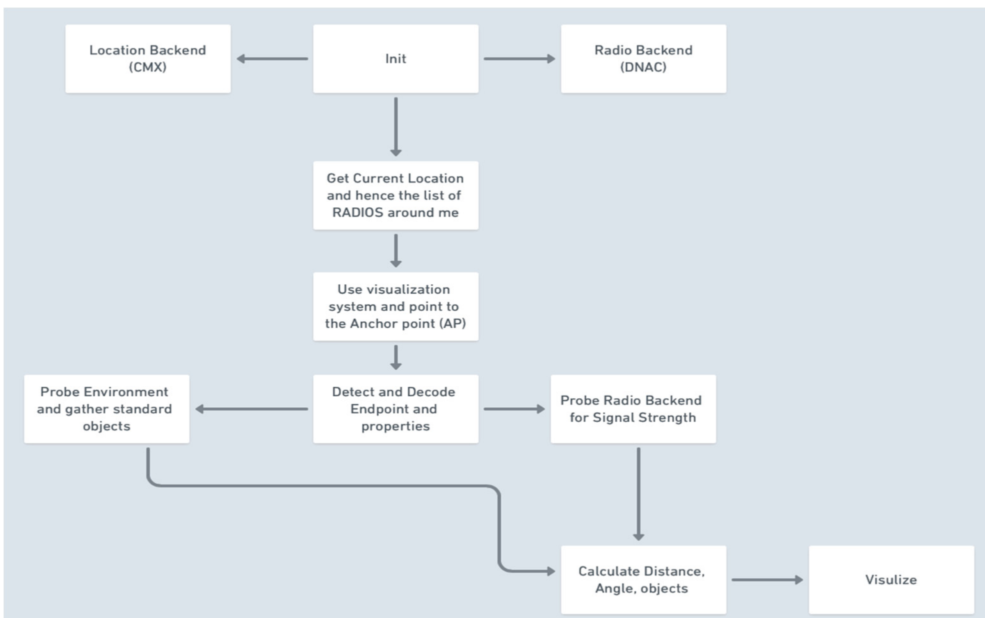

Figure 4

Figures 3 and 4 above are diagrams depicting an operational flow in the context of visualizing information about wireless network devices in a network deployment, according to an example embodiment. With reference to Figures 3 and 4, an operation flow according to one example use case of the system 100 is now described. Reference is also made to Figures 1 and 2 for this description. The operational steps are as follows:

1. The AR/VR mobile device 160 when it first starts, queries the location server 152 and gets the current location of where it is located. If a WLAN does not exists, then the GPS location of the AR/VR mobile device 160 is obtained. At this point, the AR/VR mobile device 160 obtains, from the network architecture controller 150, a list of all the APs that are near the location of the AR/VR mobile device 160.

2. The AR/VR mobile device 160 observes the physical environment where it is located, detects the environment and the objects that are present in the view of the camera of the AR/VR mobile device 160. The AR/VR mobile device 160 consults an object database (DB) 154A that has a library of objects and how objects actually absorb or interact with a radio signal.

3. The object DB 154A also consults with a materials DB 154B to determine the actual signal loss associated with the objects in proximity/view of the AR/VR mobile device 160. In other words, in this step, the signal loss due to the various objects in the view of the AR/VR mobile device 160 is determined. For example, if there is a wooden column or a concrete column the signal loss will be different. There is also a distance-signal DB 154C that the object DB 154A may consult.

4. As mentioned above, the network architecture controller 150 has visibility into the network components including, the wireless LAN controller and the APs. The AR/VR mobile device 160 has the view "on" for the AP detection. Once it detects an AP, the AR/VR mobile device 160 consults the network architecture controller 150 via an Application Programming Interface (API) and retrieves various information, including static information such as configurations, and dynamic information, such as signal strengths or number of clients connected to an AP, etc. Again, the network architecture controller 150 has knowledge of all the network equipment/devices in a given space/network installation. Whatever is controlled by network architecture controller 150 may be added/supplied to the AR/VR mobile device 160 as and when needed.

5. The system also has a mechanism whereby it can connect to the AP under consideration and measure the signal strength and have user feedback to the system.

Figures 5 – 10 below are diagrams illustrating examples of visually presented network information on the AR/VR mobile device, according to one example embodiment. These diagrams illustrate examples of how information may be visually presented to a user of the AR/VR mobile device 160. Figure 5 shows a display on the AR/VR mobile device 160 (in the form of a Smartphone) showing icons 200 for various APs in view of the camera of the AR/VR mobile device 160, and if a user puts his/her finger on the icon for a particular AP, the name of the AP and its distance from the user is presented to the user, as shown at 210.

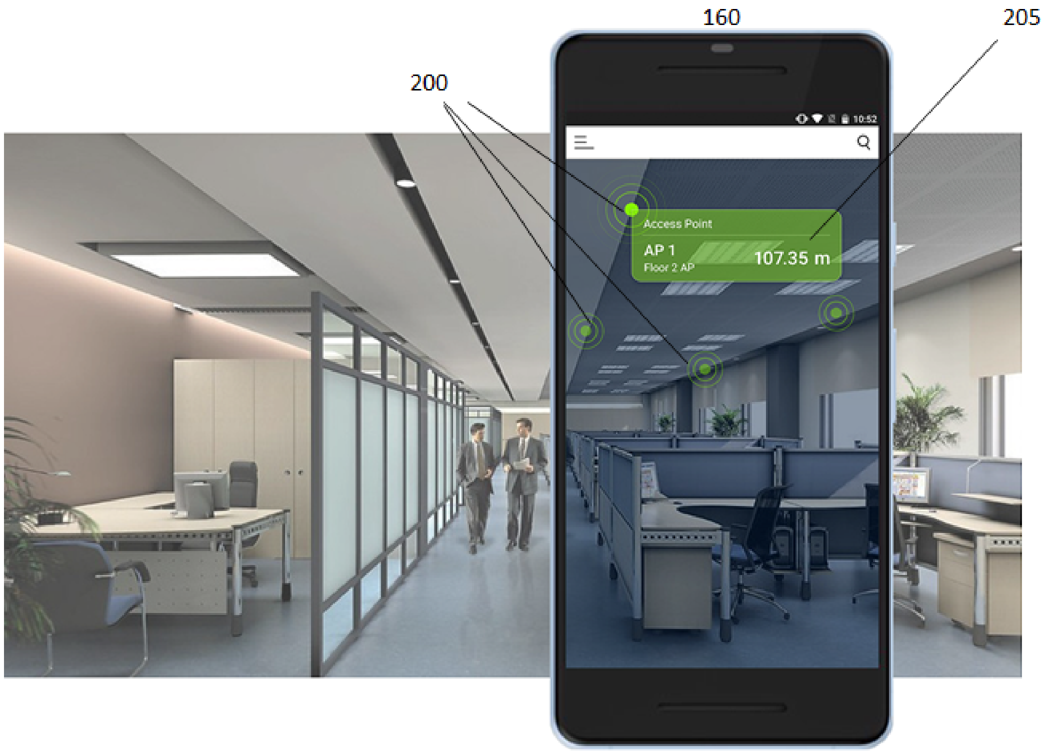

Figure 5

Figure 6 below shows a view of the camera of the AR/VR mobile device 160 in which an AP 114 is present. While the AP 114 is in view, static information about the AP 114 may be displayed on the AR/VR mobile device 160 as shown at 210. Examples of the static information includes name of the AP (SJC11-11A-AP9-P1), IP address of the AP (10.32.52.61), media access control (MAC) address (f8:0g:1e:09:g2:3c), serial number of the AP (XR2YD7764) and name of the wireless LAN controller (WLC) for the AP (WLC_502_FL_01).

Figure 6

Figure 7 below shows a view of the camera of the AR/VR mobile device 160 in which an AP 114 is present, but showing dynamic information associated with the AP displayed to the user at 220. Examples of the dynamic information include location/floor level of the AP (Level 1), number of clients currently associated to the AP (191), the channel on which the AP is operating (81), the receive signal strength at the current location of the AR/VR mobile device 160 relative to the AP 114 in the 2.4GHz band (10 dBm) and the receive signal strength at the current location of the AR/VR mobile device 160 relative to the AP 114 in the 5GHz band (10 dBm).

Figure 7

Figure 8 below shows another example of a visualization on the AR/VR mobile device 160 relative to the AP 114. In this example, the receive signal strength at the current location of the AR/VR mobile device 160 relative to the AP is displayed (55 dBm). In addition, a colored hue/shading is displayed to indicate whether the AR/VR mobile device 160 is within the coverage/range of the AP 114. For example, a green hue/shading may be displayed to indicate that the AR/VR mobile device 160 is within the coverage/range of the AP 114.

Figure 8

Figures 9 and 10 below show another example of a visualization on the AR/VR mobile device 160 relative to AP 114. Specifically, a colored boundary 230 is displayed to indicate the signal strength associated with the AP 114 at different distances from the AP 114. As shown in Figure 9, some portions (e.g., shown at 232) of the colored boundary 230 are green to indicate that signal strength is good with respect to the AP 114, whereas other portions of the boundary 230 orange and red to indicate the coverage/signal strength is weak for the AP 114.

Figure 9

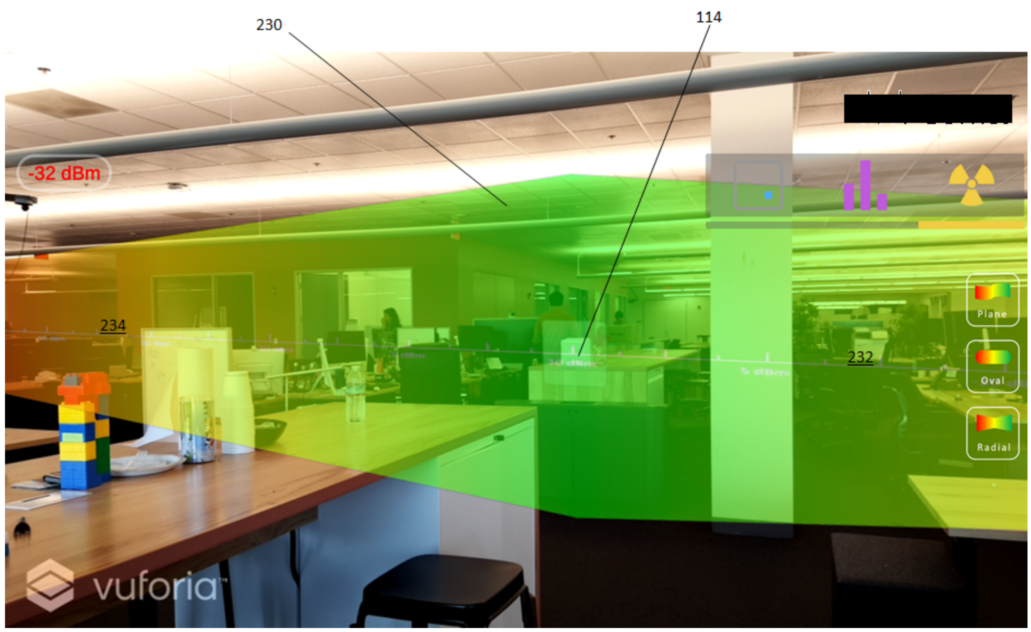

Figure 10

In summary, a system and method are provided for visual representation information about network equipment in a network deployment. In one example, the information relates to radio signals associated with wireless network devices in the network deployment, wherein the system and method obtain radio information about wireless network devices in a physical space; generate an “signal band/boundary” based on the radio signal information; generate a directional indicator based on the radio signal information; and then display the "signal band/boundary" and the directional indicator on a display screen as well as visualize it in a virtual world.

Figure 11 below is a hardware block diagram of a computing device that may perform functions of a control entity, such as a network architecture controller, in connection with the techniques depicted in Figures 1 – 10. As shown, the hardware block diagram illustrates a computing device 300 that may perform the functions of any of the servers or computing or control entities, such as the network architecture controller 140, referred to herein in connection with Figures 1 - 10. It should be appreciated that Figure 11 provides only an illustration of one embodiment and does not imply any limitations with regard to the environments in which different embodiments may be implemented. Many modifications to the depicted environment may be made.

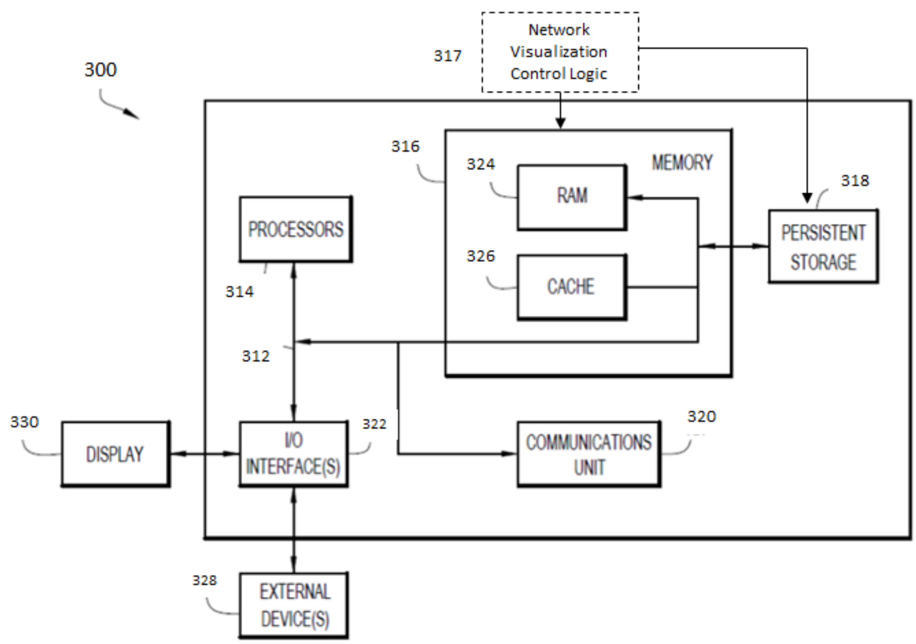

Figure 11

As depicted, the device 300 includes a bus 312, which provides communications between computer processor(s) 314, memory 316, persistent storage 318, communications unit 320, and input/output (I/O) interface(s) 322. Bus 312 can be implemented with any architecture designed for passing data and/or control information between processors (such as microprocessors, communications and network processors, etc.), system memory, peripheral devices, and any other hardware components within a system. For example, bus 312 can be implemented with one or more buses.

Memory 316 and persistent storage 318 are computer readable storage media. In the depicted embodiment, memory 316 includes random access memory (RAM) 324 and cache memory 326. In general, memory 316 can include any suitable volatile or non-volatile computer readable storage media. Instructions for the network visualization control logic 317 may be stored in memory 316 or memory 318 for execution by processor(s) 314.

One or more programs may be stored in persistent storage 318 for execution by one or more of the respective computer processors 314 via one or more memories of memory 316. The persistent storage 318 may be a magnetic hard disk drive, a solid state hard drive, a semiconductor storage device, read-only memory (ROM), erasable programmable read-only memory (EPROM), flash memory, or any other computer readable storage media that is capable of storing program instructions or digital information.

The media used by persistent storage 318 may also be removable. For example, a removable hard drive may be used for persistent storage 318. Other examples include optical and magnetic disks, thumb drives, and smart cards that are inserted into a drive for transfer onto another computer readable storage medium that is also part of persistent storage 318.

Communications unit 320, in these examples, provides for communications with other data processing systems or devices. In these examples, communications unit 320 includes one or more network interface cards. Communications unit 320 may provide communications through the use of either or both physical and wireless communications links.

I/O interface(s) 322 allows for input and output of data with other devices that may be connected to computer device 300. For example, I/O interface 322 may provide a connection to external devices 328 such as a keyboard, keypad, a touch screen, and/or some other suitable input device. External devices 328 can also include portable computer readable storage media such as database systems, thumb drives, portable optical or magnetic disks, and memory cards.

Software and data used to practice embodiments can be stored on such portable computer readable storage media and can be loaded onto persistent storage 318 via I/O interface(s) 322. I/O interface(s) 322 may also connect to a display 330. Display 330 provides a mechanism to display data to a user and may be, for example, a computer monitor.

The programs described herein are identified based upon the application for which they are implemented in a specific embodiment. However, it should be appreciated that any particular program nomenclature herein is used merely for convenience, and thus the embodiments should not be limited to use solely in any specific application identified and/or implied by such nomenclature.

Data relating to operations described herein may be stored within any conventional or other data structures (e.g., files, arrays, lists, stacks, queues, records, etc.) and may be stored in any desired storage unit (e.g., database, data or other repositories, queue, etc.). The data transmitted between entities may include any desired format and arrangement, and may include any quantity of any types of fields of any size to store the data. The definition and data model for any datasets may indicate the overall structure in any desired fashion (e.g., computer-related languages, graphical representation, listing, etc.).

The present embodiments may employ any number of any type of user interface (e.g., Graphical User Interface (GUI), command-line, prompt, etc.) for obtaining or providing information (e.g., data relating to scraping network sites), where the interface may include any information arranged in any fashion. The interface may include any number of any types of input or actuation mechanisms (e.g., buttons, icons, fields, boxes, links, etc.) disposed at any locations to enter/display information and initiate desired actions via any suitable input devices (e.g., mouse, keyboard, etc.). The interface screens may include any suitable actuators (e.g., links, tabs, etc.) to navigate between the screens in any fashion.

The environment of the present embodiments may include any number of computer or other processing systems (e.g., client or end-user systems, server systems, etc.) and databases or other repositories arranged in any desired fashion, where the present embodiments may be applied to any desired type of computing environment (e.g., cloud computing, client-server, network computing, mainframe, stand-alone systems, etc.). The computer or other processing systems employed by the present embodiments may be implemented by any number of any personal or other type of computer or processing system (e.g., desktop, laptop, PDA, mobile devices, etc.), and may include any commercially available operating system and any combination of commercially available and custom software (e.g., machine learning software, etc.). These systems may include any types of monitors and input devices (e.g., keyboard, mouse, voice recognition, etc.) to enter and/or view information.

It is to be understood that the software of the present embodiments may be implemented in any desired computer language and could be developed by one of ordinary skill in the computer arts based on the functional descriptions contained in the specification and flow charts illustrated in the drawings. Further, any references herein of software performing various functions generally refer to computer systems or processors performing those functions under software control. The computer systems of the present embodiments may alternatively be implemented by any type of hardware and/or other processing circuitry.

The various functions of the computer or other processing systems may be distributed in any manner among any number of software and/or hardware modules or units, processing or computer systems and/or circuitry, where the computer or processing systems may be disposed locally or remotely of each other and communicate via any suitable communications medium (e.g., LAN, WAN, Intranet, Internet, hardwire, modem connection, wireless, etc.). For example, the functions of the present embodiments may be distributed in any manner among the various end-user/client and server systems, and/or any other intermediary processing devices. The software and/or algorithms described above and illustrated in the flow charts may be modified in any manner that accomplishes the functions described herein. In addition, the functions in the flow charts or description may be performed in any order that accomplishes a desired operation.

The software of the present embodiments may be available on a non-transitory computer useable medium (e.g., magnetic or optical mediums, magneto-optic mediums, floppy diskettes, CD-ROM, DVD, memory devices, etc.) of a stationary or portable program product apparatus or device for use with stand-alone systems or systems connected by a network or other communications medium.

The communication network may be implemented by any number of any type of communications network (e.g., LAN, WAN, Internet, Intranet, VPN, etc.). The computer or other processing systems of the present embodiments may include any conventional or other communications devices to communicate over the network via any conventional or other protocols. The computer or other processing systems may utilize any type of connection (e.g., wired, wireless, etc.) for access to the network. Local communication media may be implemented by any suitable communication media (e.g., local area network (LAN), hardwire, wireless link, Intranet, etc.).

The system may employ any number of any conventional or other databases, data stores or storage structures (e.g., files, databases, data structures, data or other repositories, etc.) to store information (e.g., data relating to contact center interaction routing). The database system may be implemented by any number of any conventional or other databases, data stores or storage structures (e.g., files, databases, data structures, data or other repositories, etc.) to store information (e.g., data relating to contact center interaction routing). The database system may be included within or coupled to the server and/or client systems. The database systems and/or storage structures may be remote from or local to the computer or other processing systems, and may store any desired data (e.g., data relating to contact center interaction routing).

The present embodiments may employ any number of any type of user interface (e.g., Graphical User Interface (GUI), command-line, prompt, etc.) for obtaining or providing information (e.g., data relating to providing enhanced delivery options), where the interface may include any information arranged in any fashion. The interface may include any number of any types of input or actuation mechanisms (e.g., buttons, icons, fields, boxes, links, etc.) disposed at any locations to enter/display information and initiate desired actions via any suitable input devices (e.g., mouse, keyboard, etc.). The interface screens may include any suitable actuators (e.g., links, tabs, etc.) to navigate between the screens in any fashion.

The embodiments presented may be in various forms, such as a system, a method, and/or a computer program product at any possible technical detail level of integration. The computer program product may include a computer readable storage medium (or media) having computer readable program instructions thereon for causing a processor to carry out aspects of presented herein.

The computer readable storage medium can be a tangible device that can retain and store instructions for use by an instruction execution device. The computer readable storage medium may be, for example, but is not limited to, an electronic storage device, a magnetic storage device, an optical storage device, an electromagnetic storage device, a semiconductor storage device, or any suitable combination of the foregoing. A non-exhaustive list of more specific examples of the computer readable storage medium includes the following: a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), a static random access memory (SRAM), a portable compact disc read-only memory (CD-ROM), a digital versatile disk (DVD), a memory stick, a floppy disk, a mechanically encoded device such as punch-cards or raised structures in a groove having instructions recorded thereon, and any suitable combination of the foregoing. A computer readable storage medium, as used herein, is not to be construed as being transitory signals per se, such as radio waves or other freely propagating electromagnetic waves, electromagnetic waves propagating through a waveguide or other transmission media (e.g., light pulses passing through a fiber-optic cable), or electrical signals transmitted through a wire.

Computer readable program instructions described herein can be downloaded to respective computing/processing devices from a computer readable storage medium or to an external computer or external storage device via a network, for example, the Internet, a local area network, a wide area network and/or a wireless network. The network may comprise copper transmission cables, optical transmission fibers, wireless transmission, routers, firewalls, switches, gateway computers and/or edge servers. A network adapter card or network interface in each computing/processing device receives computer readable program instructions from the network and forwards the computer readable program instructions for storage in a computer readable storage medium within the respective computing/processing device.

Computer readable program instructions for carrying out operations of the present embodiments may be assembler instructions, instruction-set-architecture (ISA) instructions, machine instructions, machine dependent instructions, microcode, firmware instructions, state-setting data, configuration data for integrated circuitry, or either source code or object code written in any combination of one or more programming languages, including an object oriented programming language such as Smalltalk, C++, or the like, and procedural programming languages, such as the "C" programming language or similar programming languages. The computer readable program instructions may execute entirely on the user's computer, partly on the user's computer, as a stand-alone software package, partly on the user's computer and partly on a remote computer or entirely on the remote computer or server. In the latter scenario, the remote computer may be connected to the user's computer through any type of network, including a local area network (LAN) or a wide area network (WAN), or the connection may be made to an external computer (for example, through the Internet using an Internet Service Provider). In some embodiments, electronic circuitry including, for example, programmable logic circuitry, field-programmable gate arrays (FPGA), or programmable logic arrays (PLA) may execute the computer readable program instructions by utilizing state information of the computer readable program instructions to personalize the electronic circuitry, in order to perform aspects presented herein.

Aspects of the present embodiments are described herein with reference to flowchart illustrations and/or block diagrams of methods, apparatus (systems), and computer program products according to the embodiments. It will be understood that each block of the flowchart illustrations and/or block diagrams, and combinations of blocks in the flowchart illustrations and/or block diagrams, can be implemented by computer readable program instructions.

These computer readable program instructions may be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, which execute via the processor of the computer or other programmable data processing apparatus, create means for implementing the functions/acts specified in the flowchart and/or block diagram block or blocks. These computer readable program instructions may also be stored in a computer readable storage medium that can direct a computer, a programmable data processing apparatus, and/or other devices to function in a particular manner, such that the computer readable storage medium having instructions stored therein comprises an article of manufacture including instructions which implement aspects of the function/act specified in the flowchart and/or block diagram block or blocks.

The computer readable program instructions may also be loaded onto a computer, other programmable data processing apparatus, or other device to cause a series of operational steps to be performed on the computer, other programmable apparatus or other device to produce a computer implemented process, such that the instructions which execute on the computer, other programmable apparatus, or other device implement the functions/acts specified in the flowchart and/or block diagram block or blocks.

The flowchart and block diagrams in the figures illustrate the architecture, functionality, and operation of possible implementations of systems, methods, and computer program products according to various embodiments. In this regard, each block in the flowchart or block diagrams may represent a module, segment, or portion of instructions, which comprises one or more executable instructions for implementing the specified logical function(s). In some alternative implementations, the functions noted in the blocks may occur out of the order noted in the figures. For example, two blocks shown in succession may, in fact, be executed substantially concurrently, or the blocks may sometimes be executed in the reverse order, depending upon the functionality involved. It will also be noted that each block of the block diagrams and/or flowchart illustration, and combinations of blocks in the block diagrams and/or flowchart illustration, can be implemented by special purpose hardware-based systems that perform the specified functions or acts or carry out combinations of special purpose hardware and computer instructions.

The descriptions of the various embodiments have been presented for purposes of illustration, but are not intended to be exhaustive or limited to the embodiments disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the described embodiments. The terminology used herein was chosen to best explain the principles of the embodiments, the practical application or technical improvement over technologies found in the marketplace, or to enable others of ordinary skill in the art to understand the embodiments disclosed herein.