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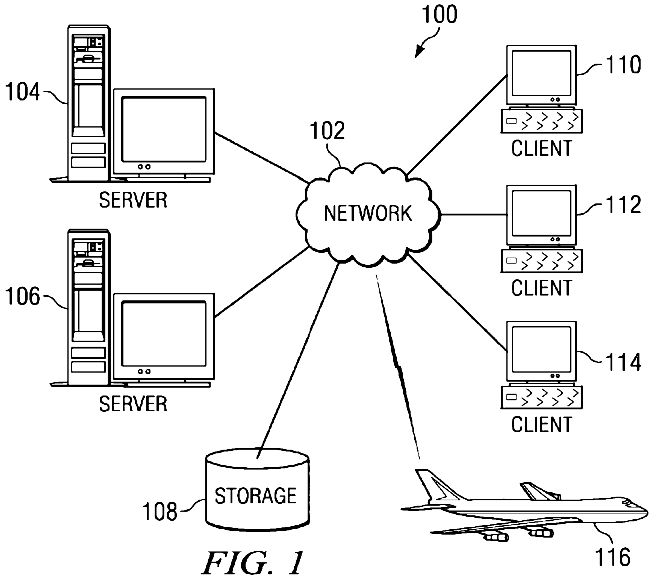


*FIG. 1*

(57) **Abstract:** A method, apparatus, and computer program product for simulating aircraft and other mobile platforms. In one advantageous embodiment, a method for simulating a mobile platform includes identifying a plurality of components for a virtual network for the mobile platform to form a plurality of identified components, designing a set of virtual versions of components for at least a portion of the plurality of identified components, placing the set of virtual versions of components on a data processing system, and configuring a set of physical network connections on the data processing system.

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# METHOD AND APPARATUS FOR SIMULATING AIRCRAFT DATA PROCESSING SYSTEMS

## BACKGROUND INFORMATION

The present disclosure relates generally to an improved data processing system and in particular to a method and apparatus for processing data. Still more particularly, the present disclosure relates to a computer implemented method, apparatus, and computer usable program product for simulating a network, the attached computer systems, and the applications on those systems in a fully integrated system simulation.

Modern aircraft are extremely complex. For example, an aircraft may have many types of electronic systems on board. A particular electronic system on an aircraft may also be referred to as a line replaceable unit (LRU). Each line replaceable unit may further take on various forms. A line replaceable unit may be, for example, without limitation, a flight management system, an autopilot, an in flight entertainment system, a communications system, a navigation system, a flight controller, a flight recorder, and a collision avoidance system.

Line replaceable units such as these may use software or programming to provide the logic or control for various operations and functions. The software used in these line replaceable units may also commonly be treated as aircraft parts in the airline industry. In particular, a software application for use in a line replaceable unit on an aircraft may be tracked separately and referred to as a loadable software aircraft part (LSAP) or a software aircraft part.

These different systems on the aircraft are part of an aircraft network. Maintenance for components within an aircraft network is performed at an airport or other suitable maintenance facility. This maintenance may include, for example, performing diagnostics, sending software aircraft parts to the aircraft, and downloading downlink data. This maintenance also may include, for example, updating or reloading software for the line replaceable units.

Currently, airlines manage the handling and maintenance of software on aircraft in a manner that is cumbersome and time consuming. Software aircraft parts are stored on physical media, such as diskettes, compact discs, flash memories, or digital versatile

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discs. An airline receives a delivery of the physical media and stores that physical media in a location, such as, for example, a filing cabinet.

Maintenance operations with currently used systems involve locating the media containing software aircraft parts and transporting that media to the aircraft. This type of storage and retrieval process takes up space and time. Further, data may be retrieved from aircraft to perform maintenance operations.

Therefore, it would be advantageous to have a method and apparatus for overcoming or minimizing the problems discussed above as well as other system integration problems.

**SUMMARY**

The different advantageous embodiments provide a method and apparatus, and computer program product for simulating aircraft and other mobile platforms. In one advantageous embodiment, a method is used to performing operations with a virtual aircraft network. A data processing system with the virtual aircraft network is connected to a ground network. The operations are performed with the virtual aircraft network connected to the ground network.

There is provided a method for simulating a mobile platform, the method comprising:

identifying a plurality of components for a virtual network for the mobile platform to form a plurality of identified components;

designing a set of virtual versions of components for at least a portion of the plurality of identified components;

placing the set of virtual versions of components on a data processing system;

configuring a set of physical network connections on the data processing system; and

housing the data processing system in a van or mobile communications shelter situatable at a particular airport location in order to exercise, test, validate or certify the airport location prior to receiving the mobile platform, suitably configured.

There is further provided an apparatus comprising:

a virtual aircraft network capable of simulating operations executed by a physical aircraft network;

a data processing system capable of communicating with a ground network, wherein the virtual aircraft network is located on the data processing system; and

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a van or mobile communications shelter comprising the data processing system, the van or mobile communications shelter being situatable at a particular airport location in order to exercise, test, validate or certify the airport location prior to receiving the physical aircraft network, suitably configured.

The features, functions, and advantages can be achieved independently in various embodiments of the present disclosure or may be combined in yet other embodiments in which further details can be seen with reference to the following description and drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the advantageous embodiments are set forth in the appended claims. The advantageous embodiments, however, as well as a preferred mode of use, further objectives and advantages thereof, will best be understood by reference to the following detailed description of an advantageous embodiment of the present disclosure when read in conjunction with the accompanying drawings, wherein:

**Figure 1** is an exemplary diagram of a data processing environment in which advantageous embodiments may be implemented;

**Figure 2** is a diagram of a data processing system in accordance with an illustrative embodiment;

**Figure 3** is a diagram illustrating components used to perform operations with an aircraft network in accordance with an advantageous embodiment;

**Figure 4** is a diagram illustrating a virtual aircraft network in accordance with an advantageous embodiment;

**Figure 5** is a diagram illustrating an example of a test environment in accordance with an advantageous embodiment;

**Figure 6** is a diagram illustrating components used to simulate a network in accordance with an advantageous embodiment;

**Figure 7** is a flowchart of a process for testing a ground network with a virtual aircraft network in accordance with an advantageous embodiment; and

**Figure 8** is a flowchart of a process for creating a virtual aircraft network in accordance with an advantageous embodiment.

## DETAILED DESCRIPTION

With reference now to the figures and in particular with reference to **Figure 1**, an exemplary diagram of a data processing environment is provided in which advantageous embodiments may be implemented. As used herein, the term exemplary indicates an example and not necessarily an ideal. It should be appreciated that **Figure**

**1** is only exemplary and is not intended to assert or imply any limitation with regard to the environments in which different embodiments may be implemented. Many modifications to the depicted environments may be made.

**Figure 1** depicts a pictorial representation of a network of data processing systems in which the advantageous embodiments of the present invention may be implemented. Network data processing system **100** is a network of computers in which embodiments may be implemented. Network data processing system **100** contains network **102**, which is the medium used to provide communications links between various devices and computers connected together within network data processing system **100**. Network **102** may include connections, such as wire, wireless communication links, or fiber optic cables.

In the depicted example, server **104** and server **106** connect to network **102** along with storage unit **108**. In addition, clients **110**, **112**, and **114** connect to network **102**. These clients **110**, **112**, and **114** may be, for example, personal computers or network computers. In the depicted example, server **104** provides data, such as boot files, operating system images, and applications to clients **110**, **112**, and **114**. Clients **110**, **112**, and **114** are clients to server **104** in this example.

Aircraft **116** also is a client that may exchange information with clients **110**, **112**, and **114**. Aircraft **116** also may exchange information with servers **104** and **106**. Aircraft **116** has a physical aircraft network and may exchange data with different computers through a wireless communications link while in-flight or any other type of communications link while on the ground. Network data processing system **100** may include additional servers, clients, and other devices not shown. Aircraft **116** also may include a network with computers and line replaceable units connected to the network.

In these examples, network **102** and the different data processing systems and devices connected to network **102** may be formed from a number of different networks. The different advantageous embodiments recognize that the current systems for performing maintenance operations on an aircraft containing a network of line replaceable units and other data processing systems is cumbersome and time consuming.

The different advantageous embodiments may implement a ground network that communicates with the aircraft network in which software aircraft parts may be stored within a library or storage system within the ground network. In this manner, storing actual physical media becomes unnecessary.

With a ground network, the aircraft network may communicate with the ground network in a number of different ways. For example, a wireless radio frequency communications link or a satellite communications link may be used between the ground network and the aircraft network. For example, server **104** and client **110** may be part of a ground network at one airport while server **106** is part of another ground network at a maintenance facility. Aircraft **116**, in these examples, takes the form of a client, but is comprised of a network of line replaceable units and other computers.

The different advantageous embodiments provide a computer implemented method, apparatus, and program product for enabling a customer or user at a ground network to test connectivity and perform various operations with aircraft **116** in a manner that reduces the unavailability of aircraft **116** or other operations.

In the depicted example, network data processing system **100** is the Internet with network **102** representing a worldwide collection of networks and gateways that use the Transmission Control Protocol/Internet Protocol (TCP/IP) suite of protocols to communicate with one another. Of course, network data processing system **100** also may be implemented as a number of different types of networks, such as for example, an intranet, a local area network (LAN), or a wide area network (WAN). **Figure 1** is intended as an example, and not as an architectural limitation for different embodiments.

Turning now to **Figure 2**, a diagram of a data processing system is depicted in accordance with an illustrative embodiment. In this illustrative example, data processing system **200** includes communications fabric **202**, which provides communications between processor unit **204**, memory **206**, persistent storage **208**, communications unit **210**, input/output (I/O) unit **212**, and display **214**.

Processor unit **204** serves to execute instructions for software that may be loaded into memory **206**. Processor unit **204** may be a set of one or more processors or may be a multi-processor core, depending on the particular implementation. Further, processor unit **204** may be implemented using one or more heterogeneous processor systems in which a main processor is present with secondary processors on a single chip. As another illustrative example, processor unit **204** may be a symmetric multi-processor system containing multiple processors of the same type.

Memory **206**, in these examples, may be, for example, a random access memory or any other suitable volatile or non-volatile storage device. Persistent storage **208** may take various forms depending on the particular implementation. For example, persistent storage **208** may contain one or more components or devices. For example, persistent storage **208** may be a hard drive, a flash memory, a rewritable optical disk, a rewritable magnetic tape, or some combination of the above. The media used by persistent storage **208** also may be removable. For example, a removable hard drive may be used for persistent storage **208**.

Communications unit **210,** in these examples, provides for communications with other data processing systems or devices. In these examples, communications unit **210** is a network interface card. Communications unit **210** may provide communications through the use of either or both physical and wireless communications links.

Input/output unit **212** allows for input and output of data with other devices that may be connected to data processing system **200**. For example, input/output unit **212** may provide a connection for user input through a keyboard and mouse. Further, input/output unit **212** may send output to a printer. Display **214** provides a mechanism to display information to a user.

Instructions for the operating system and applications or programs are located on persistent storage **208**. These instructions may be loaded into memory **206** for execution by processor unit **204**. The processes of the different embodiments may be performed by processor unit **204** using computer implemented instructions, which may be located in a memory, such as memory **206**. These instructions are referred to as program code, computer usable program code, or computer readable program code that may be read and executed by a processor in processor unit **204**. The program code in the different embodiments may be embodied on different physical or tangible computer readable media, such as memory **206** or persistent storage **208**.

Program code **216** is located in a functional form on computer readable media **218** and may be loaded onto or transferred to data processing system **200** for execution by processor unit **204**. Program code **216** and computer readable media **218** form computer program product **220** in these examples. Computer program product may be selectively removable or may be permanently installed.

In one example, computer readable media **218** may be in a tangible form, such as, for example, an optical or magnetic disc that is inserted or placed into a drive or other device that is part of persistent storage **208** for transfer onto a storage device, such as a hard drive that is part of persistent storage **208**. In a tangible form, computer readable media **218** also may take the form of a persistent storage, such as a hard drive or a flash memory that is connected to data processing system **200**. The tangible form of computer readable media **218** is also referred to as computer recordable storage media.

Alternatively, program code **216** may be transferred to data processing system **200** from computer readable media **218** through a communications link to communications unit **210** and/or through a connection to input/output unit **212**. The communications link and/or the connection may be physical or wireless in the illustrative examples. The computer readable media also may take the form of non-tangible media, such as communications links or wireless transmissions containing the program code.

The different components illustrated for data processing system **200** are not meant to provide architectural limitations to the manner in which different embodiments may be implemented. The different illustrative embodiments may be implemented in a data processing system including components in addition to or in place of those illustrated for data processing system **200**. Other components shown in **Figure 2** can be varied from the illustrative examples shown.

As one example, a storage device in data processing system **200** is any hardware apparatus that may store data. Memory **206**, persistent storage **208** and computer readable media **218** are examples of storage devices in a tangible form.

In another example, a bus system may be used to implement communications fabric **202** and may be comprised of one or more buses, such as a system bus or an input/output bus. Of course, the bus system may be implemented using any suitable type of architecture that provides for a transfer of data between different components or devices attached to the bus system. Additionally, a communications unit may include one or more devices used to transmit and receive data, such as a modem or a network adapter. Further, a memory may be, for example, memory **206** or a cache such as found in an interface and memory controller hub that may be present in communications fabric **202**.

With the use of ground networks, maintenance operations may be performed in a number of different ways. For example, a user may travel to the aircraft with a portable data processing system and perform the different operations. In other instances, the aircraft may communicate with a ground network located at an airport or other suitable maintenance facility.

In addition to using ground networks that communicate with aircraft networks, the different advantageous embodiments recognize that different types of aircraft have different configurations for their aircraft networks. Further, different airports have different configurations for their ground networks. As a result, a ground network for a particular airport may need to be reconfigured or adjusted to properly communicate with an aircraft network.

Performing these types of changes is time consuming when performed after receiving a new aircraft. Having to perform these adjustments may require having the aircraft present at the particular location to determine whether the ground network can communicate properly with the aircraft network for the new aircraft. Also, a customer may order multiple aircraft of a particular type.

Further, the manufacturer of the aircraft also may provide software for use in the ground network to perform various maintenance operations. This software often requires the customer to gain familiarly with the different tools and test processes and develop various regulatory compliance plans. These types of processes may be performed after the aircraft has been delivered. This type of process is costly because one of the new aircraft is required to perform the different operations.

As a result, this new aircraft is unavailable for revenue generation operations. Further, if the new aircraft is unable to effectively communicate with a ground network, use of any of the other new aircraft of the same type may be delayed until adjustments and modifications are made to the ground network.

With reference now to **Figure 3**, a diagram illustrating components used to perform operations with an aircraft network is depicted in accordance with an advantageous embodiment. In this example, ground network **300** and virtual aircraft network **302** are present. Ground network **300** may be, for example, a ground network located at an airport or other maintenance facility. Ground network **300** may be comprised of one or more networks and may be found within network data processing system **100** in **Figure 1**. Virtual aircraft network **302**, in this example, is a simulation or model of an aircraft network, such as one found on aircraft **116** in **Figure 1**.

Virtual aircraft network **302**, in these examples, may have one or more network interfaces that externally connect to various communications systems to allow virtual aircraft network **302** to communicate with ground network **300** through a communications links **304,** which are a set of communications links. The set of communications links is one or more communications links that may take various forms, such as for example, wired, wireless radio frequency, and satellite communications links. These network interfaces may be, for example, wireless access points or other network devices. In these examples, communications links **304** may be, for example, wired or wireless. Wireless communications links within communications links **304** may be, for example, radio frequency or satellite links.

Virtual aircraft network **302** simulates and may execute different line replaceable units, software aircraft parts, and other components that may be present in an actual aircraft network for an aircraft. These other components may include, for example, a set of networks used to connect the different line replaceable units and other data processing systems that may be present within the aircraft network.

In this manner, users at ground network **300** may perform various operations to determine whether connectivity and operations can be successfully performed with virtual aircraft network **302**. These different simulations may provide information to allow users to make adjustments to ground networks as needed to provide for proper communications links **304**.

In addition to being able to establish communications links **304**, these simulations allow for users to determine whether ground network **300** can properly exchange information with virtual aircraft network **302**. This exchange of information includes, for example, sending commands, software aircraft parts, and other information to virtual aircraft network **302**.

Additionally, the transferred information may also include receiving downlink data and status information from line replaceable units. The downlink data may be, for example, data generated during the operation of different line replaceable units. This downlink data also may be, for example, a log of events and data from a flight recorder. The status information may include the status of software aircraft parts to virtual aircraft network **302**.

Further, users or operators of ground network **300** may be able to gain familiarity with tools used to perform various operations with virtual aircraft network **302**. Also, this type of environment also allows users to test processes before actually receiving a first aircraft containing virtual aircraft network **302**. In this manner, a new aircraft may be put into use immediately rather than being tied up in testing to determine whether the aircraft is able to properly communicate with the ground network.

Each airport at each different location may have different configurations for their ground networks. Consequently, an aircraft network for a new aircraft may be able to communicate with one ground network at one airport but may be unable to communicate properly with another ground network at another airport location. As a result, when a new aircraft is introduced, an airline or other customer typically tests the new aircraft at the different locations to determine whether changes or adjustments are needed in the configurations of the ground networks at these different locations.

The user of virtual aircraft network **302** allows an airline or other customer to test the aircraft networks at different locations prior to actually receiving the aircraft. In one example, virtual aircraft network **302** may be housed within a van or mobile communications shelter that may be situated at a particular airport location in order to exercise, test, validate, or certify the airport location prior to receiving a suitably configured aircraft.

Of course, ground network **300** also may be simulated as a virtual ground network in addition to or in place of virtual aircraft network **302**. In this manner, a customer or user may be able to identify modifications and changes without interrupting operations at the ground network. By simulating ground network **300** in addition to virtual aircraft network **302**, these simulations may be used during development phases for new aircraft and new ground networks.

An additional feature provided by the different advantageous embodiments is a capability to add test equipment and/or other devices to virtual aircraft network **302**. The different advantageous embodiments allow for the use of nonstandard devices, physical devices, and virtual devices. A nonstandard device is a device that is not allowed to be connected to an aircraft network because of a rule or regulation. These rules or regulations may be set by different entities, such as, for example, an aircraft manufacturer, a government entity, a safety organization, or some other suitable entity. A device may become a nonstandard device if the device is modified.

The different advantageous embodiments recognize that with an actual aircraft network, limitations may be present as to what devices can be connected to the aircraft network. These limitations may be set by government regulations, such as those promulgated by the Federal Aviation Agency. In other examples, the limitations may be set based on safety standards identified by an aircraft manufacturer or other entity.

These limitations are not present with virtual aircraft network **302.** As a result, other devices may be attached to virtual aircraft network **302** and/or existing hardware may be modified in virtual aircraft network **302** for simulation purposes in the different advantageous embodiments. These additions may be virtual devices, such as a virtual computer or line replaceable unit. In other examples, these additional devices may be a physical line replaceable unit that is connected to virtual aircraft network **302**.

In other words, the additional device may be at least one of a virtual device and a physical device. As used herein, the phrase “at least one of”, when used with a list of items, means that different combinations one or more of the items may be used and only one of each item in the list may be needed. For example, “at least one of item A, item B, and item C” may include, for example, without limitation, item A, or item A and item B. This example also may include item A, item B, and item C, or item B and item C. In other examples, “at least one of” may be, for example, without limitation, two of item A, one of item B, and ten of item C; four of item B and seven of item C; and other suitable combinations.

Unlike the Part 25 certified airplane computer systems/(LRU's), emulation devices, probe-cards, and other debugging tools could be connected to virtual aircraft network **302**, while it is connected to the network system. These tools provide information that is otherwise unattainable when troubleshooting microprocessor based systems. In many cases, the microprocessor is removed from the computer and replaced with an emulator. This feature allows for collection of information from internal registers, internal buffers and internal data busses that are not normally available. This information can provide significant insight into the dynamics of a network system and significantly reduce the time required to troubleshoot a system.

With reference now to **Figure 4**, a diagram illustrating a virtual aircraft network is depicted in accordance with an advantageous embodiment. In this example, virtual aircraft network **400** may be simulated or executed on a data processing system, such as data processing system **200** in **Figure 2**. Virtual aircraft network **400** is an example of virtual aircraft network **302** in **Figure 3**.

Virtual aircraft network **400** includes virtual computer **402**, virtual computer **404**, virtual network **406**, virtual network **408**, control user interface **410**, physical network interface **412**, physical network interface **414**, and physical network interface **416**. In these examples, physical network interface **412**, physical network interface **414**, and physical network interface **416** may be components located within the data processing system in which virtual aircraft network **400** executes.

Virtual computers **402** and **404** are simulations of computers, such as line replaceable units, that may be found in an aircraft network. Virtual network **408** simulates the network present within the aircraft network. Virtual network **408** may be a simulation of an open data network in an aircraft in which this network provides access to devices outside of the aircraft. Virtual network **408** may provide access to computers in the ground network and portable computers. Virtual network **406** may be, for example, an isolated data network in which access to this network is provided only for internal data processing systems, such as line replaceable units.

Control user interface **410** is a user interface that allows a user to set various parameters and control the simulation in virtual aircraft network **400**. Physical network interface **414** and physical network interface **416**, in these examples, provide a point at which a communications link may be established with another component, such as a ground network. Physical network interface **414** and physical network interface **416** may provide a simulation of communications links, such as satellite links or wireless links at a ground network.

Although many different components in an aircraft network may be simulated, in some cases, actual components from an aircraft network may be used in conjunction with virtual aircraft network **400**. For example, line replaceable unit **420** may be connected to virtual aircraft network **400** through a communications link established between physical network interface **412** and virtual aircraft network **400**, and physical network interface **422** and line replaceable unit **420**.

Line replaceable unit **420**, in this example, is used when a simulation or when the real functions of an actual component is not possible or feasible with respect to complexity, time, and/or expense. Although line replaceable unit **420** is not a virtual component, this component is considered part of virtual aircraft network **400**, in these examples. At least one of a physical nonstandard device 424 and a virtual nonstandard device 426 may be connected to the virtual aircraft network.

Virtual computer **402** and virtual computer **404** may execute actual software aircraft parts found in the line replaceable units that these virtual computers simulate. In other embodiments, these virtual computers may simulate various aspects of the software aircraft part that may not actually execute those parts. For example, if virtual aircraft network **400** is used to test the ability of a ground network to transfer data with virtual aircraft network **400**, virtual computers **402** and **404** may include processes to simulate or perform the same actions in transferring data, but not include processes for generating the data.

Virtual computer **402** and virtual computer **404** may simulate various line replaceable units. These line replaceable units include, for example, a flight entertainment system, an autopilot, a flight management system, and a flight recorder. Additionally, virtual computer **402** and virtual computer **404** may be used to simulate other components within the aircraft network other than just line replaceable units. For example, virtual computer **402** may simulate a crew information system/management system.

Turning now to **Figure 5**, a diagram illustrating an example of a test environment is depicted in accordance with an advantageous embodiment. In this example, test environment **500** includes virtual aircraft network **502** and virtual ground network **504**. In this example, both virtual aircraft network **502** and virtual ground network **504** are simulated within a computer. Virtual aircraft network **502** and virtual ground network **504** may each be simulated in a data processing system, such as data processing system **200** in **Figure 2**.

Virtual aircraft network **502**, in this example, includes virtual computer **503**, virtual computer **505**, virtual network **506**, virtual network **508**, control user interface **510**, physical network interface **512**, physical network interface **514**, and physical network interface **516**. Virtual ground network **504** includes virtual computer **518**, virtual computer **520**, virtual network **522**, virtual network **524**, control user interface **526**, physical network interface **528**, and physical network interface **530**. Additionally, test environment **500** also includes portable computer **532** which has physical network interface **534**.

Physical network interface **512** is connected to physical network interface **528**, and physical network interface **514** connects to physical network interface **530**. These connections are configured to be connections that are present between an actual aircraft network and an actual ground network. These connections may be, for example, wireless or wired connections. Physical network interface **516** provides a connection to physical network interface **534**.

Portable computer **532** may be a computer that is used to provide various maintenance operations in an aircraft. In other advantageous embodiments, portable computer **532** may be a virtual device that is simulated within ground network **504** in which this virtual device is capable of communicating with virtual aircraft network **502** as well as with other virtual components within virtual ground network **504**. By using virtual network and virtual computers, a single airline laptop computer may be able to support several versions of maintenance laptop software for an aircraft type, such as a Boeing 787, as well as the potential to support multiple versions of several different aircraft types, such as a Boeing 787, a Boeing 747-800, a Boeing 777-200ER, and a Boeing 737-800

In this example, test environment **500** provides a simulation of an entire system, such as an aircraft connected to a ground network at an airport. The physical network interfaces, in these examples, allow the simulation of a particular network to communicate with actual physical data processing systems.

The different configurations illustrated in **Figures 4** and **5** for the virtual aircraft networks and the virtual ground networks are presented for purposes of illustrating one embodiment. These illustrations are not meant to limit the manner in which different networks may be designed or implemented. For example, virtual aircraft network **400** in **Figure 4** illustrates two virtual computers and two virtual networks 406 and 408. Other numbers of virtual computers and virtual networks may be used, depending on the particular implementation. For example, virtual aircraft network **400** in **Figure 4** may employ ten virtual computers and two virtual networks, or in other examples, seven virtual computers and one virtual network.

Turning now to **Figure 6**, a diagram illustrating components used to simulate a network is depicted in accordance with an advantageous embodiment. In this example, virtual environment **600** depicts components that may be used to simulate a network, such as, for example, virtual aircraft network **502** and virtual ground network **504** in **Figure 5**.

Virtual environment **600**, in this example, includes base operating system **602**, virtual machine server **604**, control base **606**, virtual network **608**, virtual machine **610**, virtual machine **612**, virtual machine **614**, and control specific **616**. The different components within virtual environment **600** may execute on a data processing system, such as data processing system **200** in **Figure 2**.

Base operating system **602** is an operating system located on the data processing system. Base operating system **602** may be implemented using any available operating system. For example, a Windows® operating system or a Linux® operating system may be used. A Windows® operating system may be selected from one produced by Microsoft® Corporation of Palo Alto, CA, USA.

Virtual machine server **604** is a process that is used to host virtual computers, such as virtual machines **610**, **612**, and **614**. Additionally, virtual machine server **604** also allows the hosting of virtual network **608**. Virtual machine server **604** allows a user to select and configure different components within virtual environment **600**. Virtual machine server **604** may be implemented using different types of servers. For example, VMware server may be used VMware server is a product available from VMware, Inc.

Virtual machine **610**, virtual machine **612**, virtual machine **614**, and virtual network **608** are components that are simulated for the particular virtual network. Control base **606** is a user interface for the simulation and provides an interface, such as control user interface **510** or control user interface **526** in **Figure 5**. Control base **606**, in one embodiment, may be a set of web pages that allows a user to start and stop a simulation as well as select various configurations. Further, control base **606** also may allow a user to restore or revert the simulation to a prior state or actually enter specific parameters.

Control specific **616**, in this example, provides a user interface that may be part of a control user interface, such as control user interface **510** or control user interface **526** in **Figure 5**. Control specific **616** provides user interfaces for a particular configuration. This interface may vary, depending on the particular simulation, such as an aircraft network or a ground network.

The different components illustrated in **Figure 6** are provided for purposes of depicting one manner in which a virtual network may be implemented. Of course, the depiction of the different components is not meant to limit the manner in which other advantageous embodiments may be implemented.

Turning now to **Figure 7**, a flowchart of a process for testing a ground network with a virtual aircraft network is depicted in accordance with an advantageous embodiment. The process begins by running the virtual aircraft network (operation **700**). This operation involves executing the simulation for the aircraft network. Thereafter, the data processing system with the virtual network is connected to the ground network (operation **702**). This operation may involve establishing the various communications links used by the actual aircraft network to communicate with the ground network.

Next, the process performs operations with the virtual aircraft network connected to the ground network (operation **704**). These operations may include, for example, various processes to assess whether the ground network can properly communicate with the aircraft network. Further, these operations may be performed by users to become familiar with the operation of software on the ground network used to perform operations with the aircraft network.

Data is collected from the operations performed (operation **706**). The collected data is analyzed (operation **708**). Changes are implemented as needed (operation **710**). These changes may include, for example, adding or reconfiguring various components within the ground network to provide for proper operability with the aircraft network. The process terminates thereafter.

With reference now to **Figure 8**, a flowchart of a process for creating a virtual aircraft network is depicted in accordance with an advantageous embodiment. The process begins by identifying components for a virtual aircraft network (operation **800**). These components include, for example, different data processing systems, such as computers and line replaceable units on the aircraft. The components also include the various networks used to inner connect the different computers and line replaceable units. These components also include the physical adapters present in the aircraft network that provide for communication with a ground network.

Next, the process designs virtual versions of the identified components (operation **802**). In operation **802**, the designing may include created code for a program to simulate the input and outputs that occur in the identified component. For example, a virtual network may be, for example, program code that simulates the routing of data from one component to another component attached to the virtual network.

In some cases, an actual line replaceable unit or physical device may be used instead of a virtual component. This type of selection may depend on factors, such as time, complexity, and cost. The process then configures the physical connections for the virtual aircraft network (operation **804**). Operation **804** may include installing the appropriate network adapters to provide the same types of connections available in the aircraft network. The process terminates thereafter.

In this manner, ground networks are able to perform communications with simulated aircraft networks to allow a checkout or review of airline and airport ground infrastructures present in the ground network and their ability to support the particular aircraft. Further, the different advantageous embodiments also allow customers or purchasers of aircraft to test systems from end to end prior to delivery of the first aircraft.

In different examples, the components used are actual software aircraft parts when possible. These different advantageous embodiments also allow for testing validation of ground to aircraft interfaces. Further, testing validation of the aircraft in the customer's environment also is enabled.

The different advantageous embodiments can take the form of an entirely hardware embodiment, an entirely software embodiment or an embodiment containing both hardware and software elements. Some embodiments are implemented in software, which includes but is not limited to forms, such as, for example, firmware, resident software, and microcode.

In this manner different components in an environment, such as an aircraft network and/or a ground network can be simulated. These virtual components can be connected to physical components to perform various operations, such as, for example, testing and training for one or more users.

Furthermore, the different embodiments can take the form of a computer program product accessible from a computer-usable or computer-readable medium providing program code for use by or in connection with a computer or any device or system that executes instructions. For the purposes of this disclosure, a computer-usable or computer readable medium can generally be any tangible apparatus that can contain, store, communicate, propagate, or transport the program for use by or in connection with the instruction execution system, apparatus, or device.

The computer usable or computer readable medium can be, for example, without limitation an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, or a propagation medium. Non limiting examples of a computer-readable medium include a semiconductor or solid state memory, magnetic tape, a fixed or selectively removable computer diskette, a random access memory (RAM), a read-only memory (ROM), a rigid magnetic disk, and an optical disk. Optical disks may include compact disk – read only memory (CD-ROM), compact disk – read/write (CD-R/W) and DVD.

Further, a computer-usable or computer-readable medium may contain or store a computer readable or usable program code such that when the computer readable or usable program code is executed on a computer, the execution of this computer readable or usable program code causes the computer to transmit another computer readable or usable program code over a communications link. This communications link may use a medium that is, for example without limitation, physical or wireless.

A data processing system suitable for storing and/or executing computer readable or computer usable program code will include one or more processors coupled directly or indirectly to memory elements through a communications fabric, such as a system bus. The memory elements may include local memory employed during actual execution of the program code, bulk storage, and cache memories which provide temporary storage of at least some computer readable or computer usable program code to reduce the number of times code may be retrieved from bulk storage during execution of the code.

Input/output or I/O devices can be coupled to the system either directly or through intervening I/O controllers. These devices may include, for example, without limitation to keyboards, touch screen displays, and pointing devices. Different communications adapters may also be coupled to the system to enable the data processing system to become coupled to other data processing systems or remote printers or storage devices through intervening private or public networks. Non-limiting examples are modems and network adapters are just a few of the currently available types of communications adapters.

The description of the different advantageous embodiments has been presented for purposes of illustration and description, and is not intended to be exhaustive or limited to the embodiments in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art. For example, the different embodiments are any mobile platform with networked systems onboard and any large scale control system with networked elements such as a power grid or petrochemical supervisory control and data acquisition systems.

As some additional non-limiting examples, the different advantageous embodiments may be applied to mobile platform networks, such as a network in an aircraft, an automobile, a tank, a ship, a spacecraft, a submarine, and a missile.

As another example, different maintenance devices also may be simulated as part of a ground network. These maintenance devices may be ones used by aircraft mechanics to work with an aircraft network or a ground network.

Additional embodiments may be claimed as follows:

A1. A method for performing operations with a virtual aircraft network, the computer implemented method comprising:

connecting a data processing system with the virtual aircraft network to a ground network; and

performing the operations with the virtual aircraft network connected to the ground network.

A2. The method of claim A1 further comprising:

collecting data from performing the operations to form collected data;

analyzing the collected data; and

selectively making changes to the ground network.

A3. The method of claim A2 further comprising:

identifying a plurality of components for the virtual aircraft network to form a plurality of identified components; and

designing a set of virtual versions of components to at least a portion of the plurality of identified components.

A4. The method of claim A3, wherein a component within the plurality of components is a line replaceable unit and wherein the designing step comprises:

designing a virtual machine for the line replaceable unit.

5. The method of claim 4, wherein a software aircraft part is executed by the virtual machine.

Further, different advantageous embodiments may provide different advantages as compared to other advantageous embodiments. The embodiment or embodiments selected are chosen and described in order to best explain the principles of the embodiments, the practical application, and to enable others of ordinary skill in the art to understand the disclosure for various embodiments with various modifications as are suited to the particular use contemplated.

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CLAIMS

1. A method for simulating a mobile platform, the method comprising:

identifying a plurality of components for a virtual network for the mobile platform to form a plurality of identified components;

designing a set of virtual versions of components for at least a portion of the plurality of identified components;

placing the set of virtual versions of components on a data processing system;

configuring a set of physical network connections on the data processing system; and

housing the data processing system in a van or mobile communications shelter situatable at a particular airport location in order to exercise, test, validate or certify the airport location prior to receiving the mobile platform, suitably configured.

2. The method of claim 1, further comprising:

connecting the set of physical network connections to another network, wherein the virtual network is connected to the another network; and

performing operations with a network and the another network.

3. The method of claim 2, further comprising:

collecting data from performing the operations to form collected data; and

changing the other network in response to the collected data.

4. The method of claim 1, wherein the performing step comprises:

performing operations with a network and the another network to train a set of users on how to perform the operations.

5. The method of claim 2, further comprising:

utilizing a physical component of one of the plurality of components.

6. The method of claim 5, wherein the physical component is a line replaceable unit.

7. The method of claim 4, wherein the network is a virtual aircraft network and the another network is a ground network.

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8. The method of claim 1, wherein the network is selected from one of a network in an aircraft, a network in an automobile, a network in a tank, a network in a ship, a network in a spacecraft, a network in a submarine, and a network in a missile.

9. The method of claim 1, wherein a selected component in the plurality of components is a simulated software aircraft part in a line replaceable unit.

10. The method of claim 9, wherein the designing step comprises:
designing a virtual machine for the line replaceable unit to execute the software aircraft part.

11. The method of claim 10, wherein the designing a virtual machine for the line replaceable unit with a software component capable of simulating inputs and outputs to the software aircraft part.

12. An apparatus comprising:
a virtual aircraft network capable of simulating operations executed by a physical aircraft network;
a data processing system capable of communicating with a ground network, wherein the virtual aircraft network is located on the data processing system; and
a van or mobile communications shelter comprising the data processing system, the van or mobile communications shelter being situatable at a particular airport location in order to exercise, test, validate or certify the airport location prior to receiving the physical aircraft network, suitably configured.

13. The apparatus of claim 12, wherein the virtual aircraft network comprises:
a set of virtual machines representing line replaceable units on an aircraft;
a set of virtual networks representing networks within the physical aircraft network; and
a control user interface capable of receiving user input to control the virtual aircraft network.

14. The apparatus of claim 13, further comprising at least one of:

a virtual ground device capable of communicating with the virtual aircraft network and the ground network; and

at least one of a physical nonstandard device and a virtual nonstandard device connected to the virtual aircraft network.

15. The apparatus of claim 12, wherein the data processing system is a portable computer.

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**Patent Attorneys for the Applicant/Nominated Person**
**SPRUSON & FERGUSON**

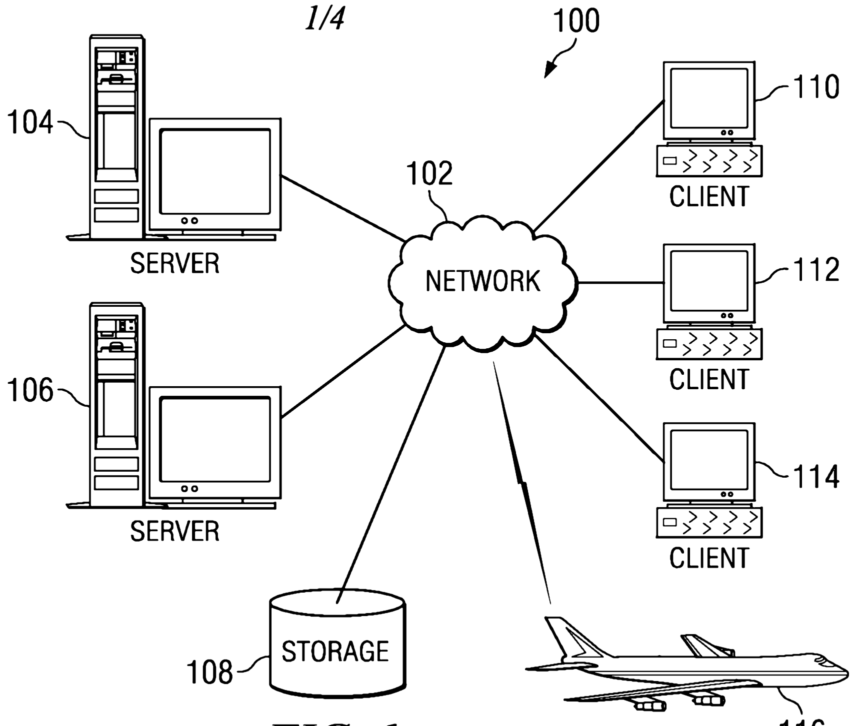
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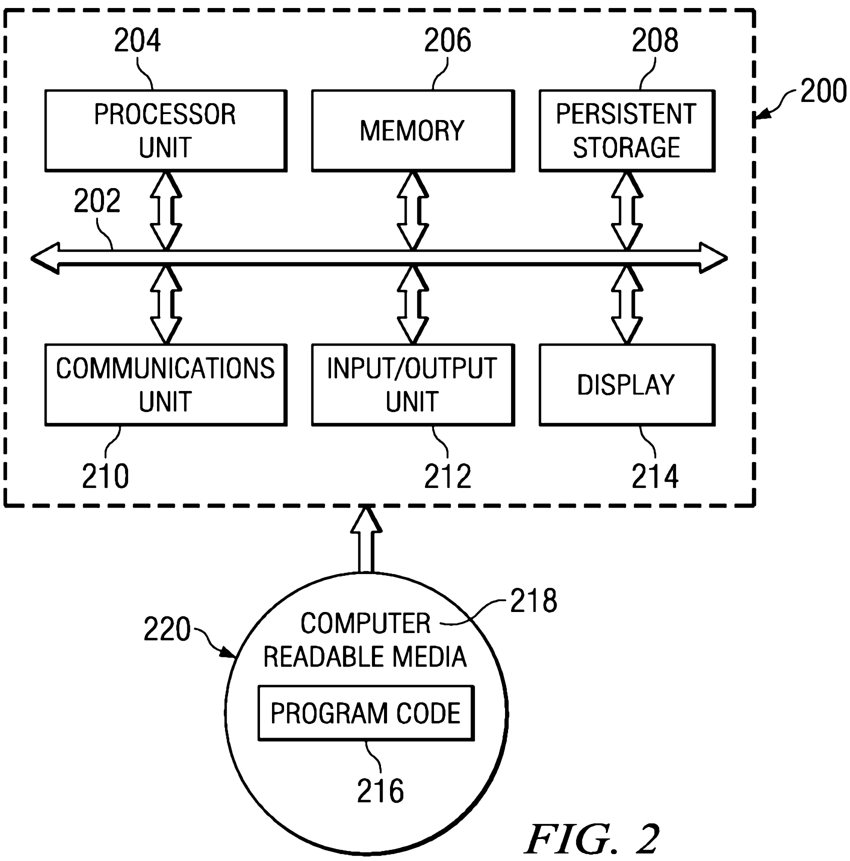
*FIG. 1*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206
MEMORY
208
PERSISTENT STORAGE
200
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COMMUNICATIONS UNIT
INPUT/OUTPUT UNIT
DISPLAY
210
212
214
220
COMPUTER READABLE MEDIA
218
PROGRAM CODE
216

*FIG. 2*

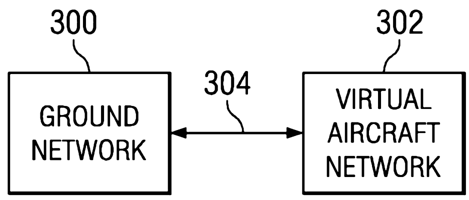
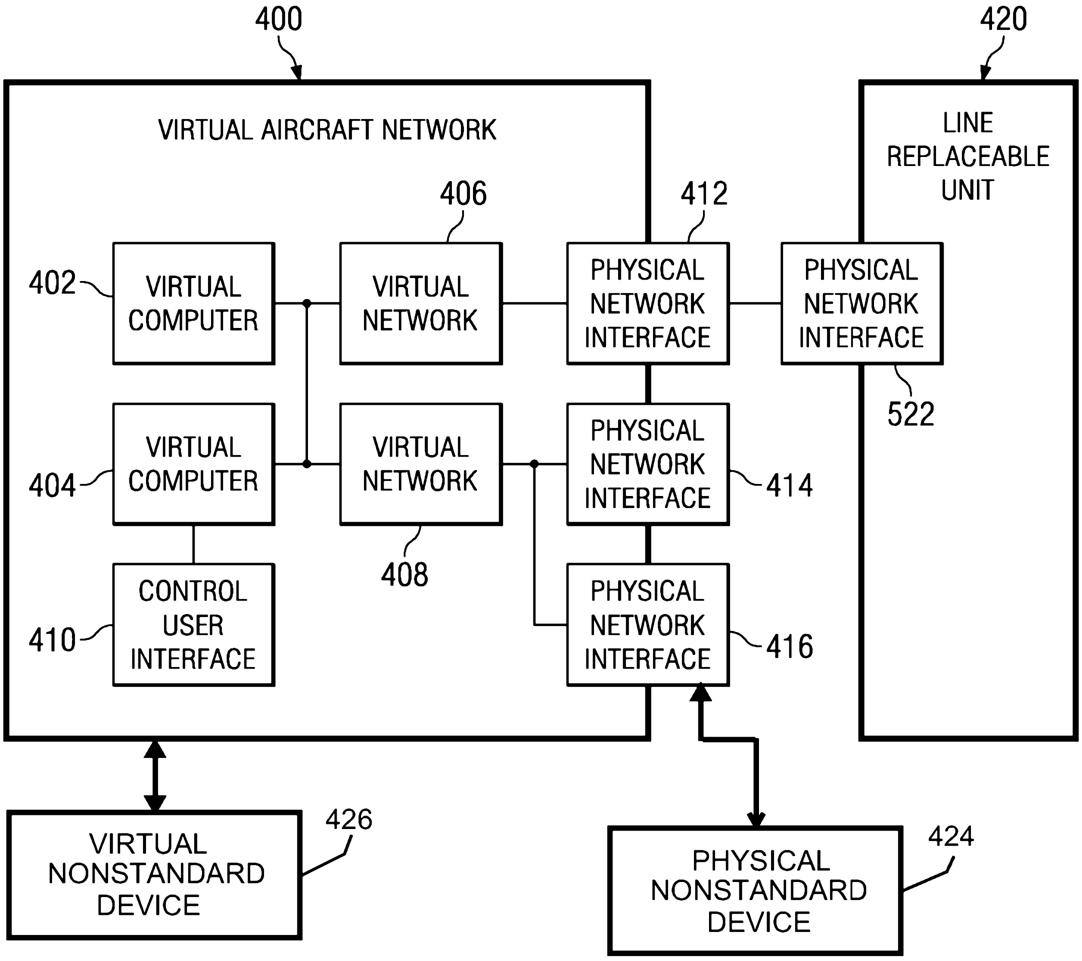

300
302
304
GROUND NETWORK
VIRTUAL AIRCRAFT NETWORK

*FIG. 3*

*FIG. 4*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420
VIRTUAL AIRCRAFT NETWORK
LINE REPLACEABLE UNIT
406
412
402
VIRTUAL COMPUTER
VIRTUAL NETWORK
PHYSICAL NETWORK INTERFACE
PHYSICAL NETWORK INTERFACE
522
404
VIRTUAL COMPUTER
VIRTUAL NETWORK
PHYSICAL NETWORK INTERFACE
414
408
410
CONTROL USER INTERFACE
PHYSICAL NETWORK INTERFACE
416
VIRTUAL NONSTANDARD DEVICE
426
PHYSICAL NONSTANDARD DEVICE
424

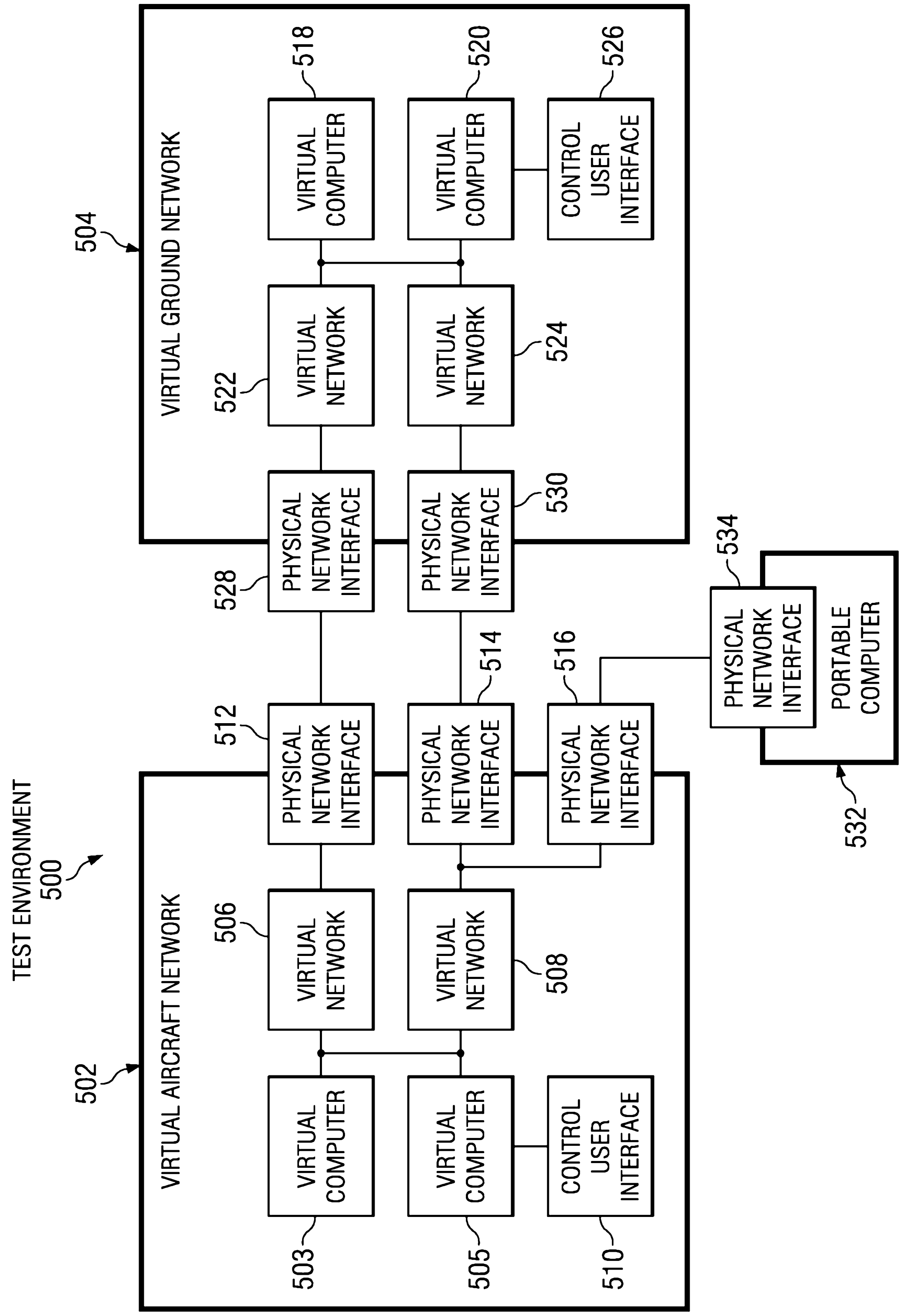
TEST ENVIRONMENT
500
502
VIRTUAL AIRCRAFT NETWORK
VIRTUAL COMPUTER
503
VIRTUAL COMPUTER
505
CONTROL USER INTERFACE
510
VIRTUAL NETWORK
506
VIRTUAL NETWORK
508
PHYSICAL NETWORK INTERFACE
512
PHYSICAL NETWORK INTERFACE
514
PHYSICAL NETWORK INTERFACE
516
504
VIRTUAL GROUND NETWORK
VIRTUAL COMPUTER
518
VIRTUAL COMPUTER
520
CONTROL USER INTERFACE
526
VIRTUAL NETWORK
522
VIRTUAL NETWORK
524
PHYSICAL NETWORK INTERFACE
528
PHYSICAL NETWORK INTERFACE
530
PHYSICAL NETWORK INTERFACE
534
PORTABLE COMPUTER
532

*FIG. 5*

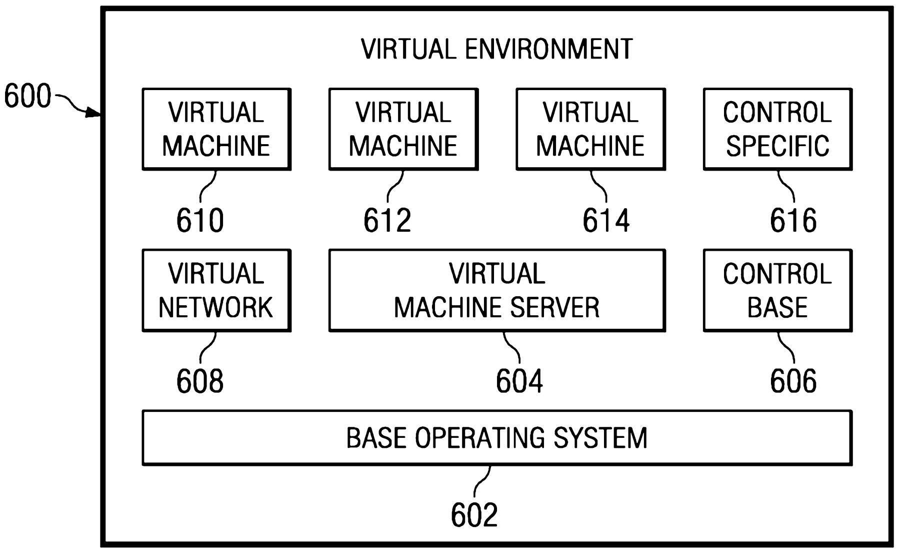


*FIG. 6*

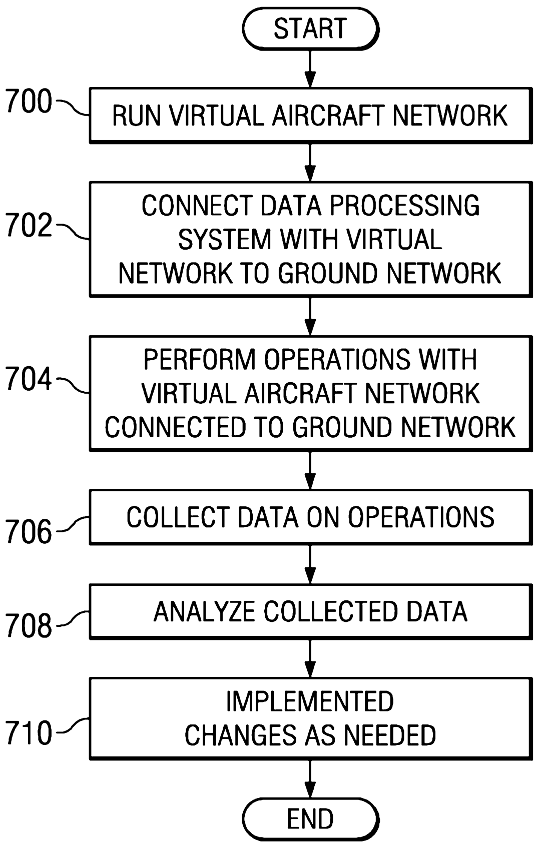


*FIG. 7*

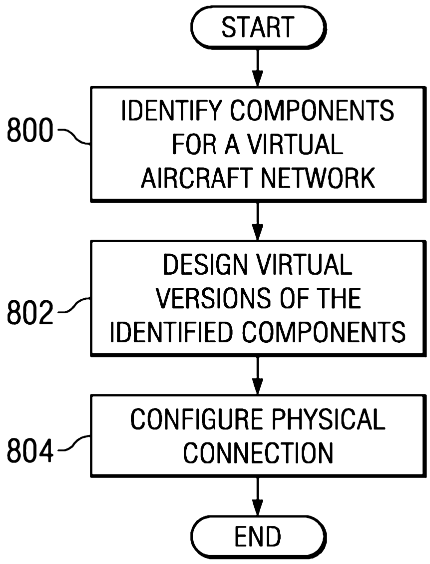


*FIG. 8*