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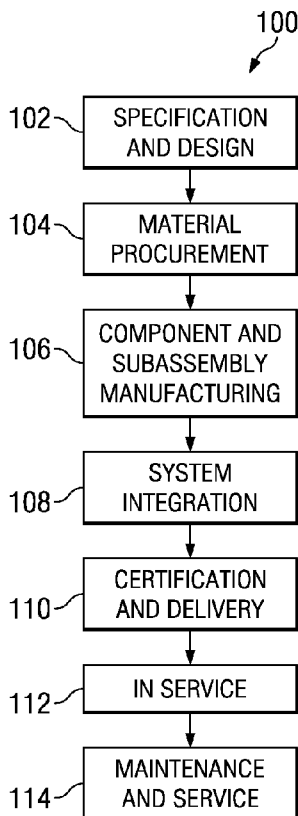


FIG. 1

(57) Abstract: A method and apparatus in a sensor network in an aircraft for collecting data about the aircraft. The sensor network in the aircraft collects the data about the aircraft. The sensor network comprises a set of wireless sensors attached to a first set of locations for the aircraft, a set of wireless routers attached to a second set of locations for the aircraft, and a set of gateways connected to an aircraft data processing system. The set of wireless routers is capable of receiving the data in wireless signals transmitted by the set of wireless sensors. The set of gateways is capable of receiving data in the wireless signals from the set of wireless routers to form received data and is capable of transmitting the received data into the aircraft data processing system.

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WIRELESS AIRCRAFT SENSOR NETWORK

BACKGROUND INFORMATION

5 **1. Field:**

The present disclosure relates generally to an improved data processing system and in particular to a sensor network. Still more particular, the present disclosure relates to a wireless sensor network in an aircraft.

10 **2. Background:**

Modern aircrafts 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 take various forms. A line replaceable unit may be, for example, without limitation,
15 a flight management system, an autopilot, an in-flight entertainment system, an environmental control system, a communications system, a collision avoidance system, a flight controller, and a flight recorder.

These types of systems often rely on the use of sensors to operate. For example, an environmental control system for a passenger cabin in an aircraft may use
20 various temperature sensors and airflow sensors to identify changes that may be needed to maintain a desired environment in the passenger cabin. These sensors are connected to the environmental control system to provide the data needed to maintain a uniform temperature within the cabin. The environmental control system uses this
25 information to control the heating, cooling, and/or airflow within different portions of the passenger cabin. These sensors are connected directly to the environmental control unit to provide the data needed in controlling the environment within the passenger cabin.

Other systems also require data to control various functions within the aircraft. As a result, aircraft today are complex and require an ability to obtain information about
30 various states and conditions in and around the aircraft to function properly. These networks of sensors create wiring systems of high complexity and substantial weight. Means of reducing this complexity and weight are desirable.

SUMMARY

5 The advantageous embodiments provide a method and apparatus in a sensor network in an aircraft for collecting data about the aircraft. In one advantageous embodiment, the sensor network in the aircraft collects the data about the aircraft. The sensor network comprises a set of wireless sensors attached to a first set of locations for the aircraft, a set of wireless routers attached to a second set of locations for the aircraft, and a set of gateways connected to an aircraft data processing system. The set of wireless routers is capable of receiving the data in wireless signals transmitted by the set of wireless sensors. The set of gateways is capable of receiving data in the wireless signals from the set of wireless routers to form received data and is capable of transmitting the received data into the aircraft data processing system.

15 In another advantageous embodiment, a method is provided for detecting data in an aircraft. The data is detected using a set of wireless sensors attached to a first set of locations for the aircraft to form detected data. The detected data is sent in wireless signals from the set of wireless sensors to a set of wireless routers attached to a second set of locations for the aircraft, wherein the set of wireless routers is capable of receiving the data in the wireless signals transmitted by the set of wireless sensors. The data is routed through the set of wireless routers to a set of gateways connected to an aircraft data processing system to form routed data. The routed data is transmitted from the set of gateways into the aircraft data processing system.

25 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

30 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 a diagram illustrating an aircraft manufacturing and service method in which an advantageous embodiment may be implemented;

5 **Figure 2** is a diagram of an aircraft in accordance with an advantageous embodiment;

Figure 3 is a functional block diagram of an aircraft network data processing system in accordance with an advantageous embodiment;

10 **Figure 4** is a diagram of a sensor network in accordance with an advantageous embodiment;

Figure 5 is a diagram of a data processing system in accordance with an advantageous embodiment;

Figure 6 is a block diagram of a wireless sensor in accordance with an advantageous embodiment;

15 **Figure 7** is a diagram illustrating a sensor network layout for an aircraft in accordance with an advantageous embodiment;

Figure 8 is an illustration of a configuration of routers in a cross-sectional view of an aircraft in accordance with an advantageous embodiment;

20 **Figure 9** is an aircraft shown in a top cross sectional view in accordance with an advantageous embodiment;

Figure 10 is a diagram illustrating a configuration of routers in a cross sectional view of an aircraft in accordance with an advantageous embodiment;

Figure 11 is an illustration of a configuration for a wireless router in accordance with an advantageous embodiment;

25 **Figure 12** is an illustration of another configuration for transmitting wireless signals in accordance with an advantageous embodiment;

Figure 13 is another configuration of routers in accordance with an advantageous embodiment;

30 **Figure 14** is yet another configuration of a router in accordance with an advantageous embodiment;

Figure 15 is an illustration of still another configuration for a router in accordance with an advantageous embodiment;

Figure 16 is an illustration of a router with an antenna in accordance with an

advantageous embodiment;

Figure 17 is an illustration of a radio on a window plug in accordance with an advantageous embodiment;

5 **Figure 18** is yet another configuration for a router in accordance with an advantageous embodiment;

Figure 19 is a diagram illustrating placement of a return air grill router in accordance with an advantageous embodiment; and

Figure 20 is a flowchart of a process for processing data in a wireless aircraft sensor network in accordance with an advantageous embodiment.

10

DETAILED DESCRIPTION

Referring more particularly to the drawings, embodiments of the disclosure may
15 be described in the context of the aircraft manufacturing and service method **100** as shown in **Figure 1** and aircraft **200** as shown in **Figure 2**. Turning first to **Figure 1**, a diagram illustrating an aircraft manufacturing and service method is depicted in accordance with an advantageous embodiment. During pre-production, exemplary aircraft manufacturing and service method **100** may include specification and design
20 **102** of aircraft **200** in **Figure 2** and material procurement **104**.

During production, component and subassembly manufacturing **106** and system integration **108** of aircraft **200** in **Figure 2** takes place. Thereafter, aircraft **200** in **Figure 2** may go through certification and delivery **110** in order to be placed in service **112**. While in service by a customer, aircraft **200** in **Figure 2** is scheduled for routine
25 maintenance and service **114**, which may include modification, reconfiguration, refurbishment, and other maintenance or service.

Each of the processes of aircraft manufacturing and service method **100** may be performed or carried out by a system integrator, a third party, and/or an operator. In these examples, the operator may be a customer. For the purposes of this description,
30 a system integrator may include, without limitation, any number of aircraft manufacturers and major-system subcontractors; a third party may include, without limitation, any number of vendors, subcontractors, and suppliers; and an operator may be an airline, leasing company, military entity, service organization, and so on.

With reference now to **Figure 2**, a diagram of an aircraft is depicted in which an advantageous embodiment may be implemented. In this example, aircraft **200** is produced by aircraft manufacturing and service method **100** in **Figure 1** and may include airframe **202** with a plurality of systems **204** and interior **206**. Examples of systems **204** include one or more of propulsion system **208**, electrical system **210**, hydraulic system **212**, environmental system **214** and network data processing system **216**. Any number of other systems may be included. Although an aerospace example is shown, different advantageous embodiments may be applied to other industries, such as the automotive industry.

Apparatus and methods embodied herein may be employed during any one or more of the stages of aircraft manufacturing and service method **100** in **Figure 1**. For example, components or subassemblies produced in component and subassembly manufacturing **106** in **Figure 1** may be fabricated or manufactured in a manner similar to components or subassemblies produced while aircraft **200** is in service **112** in **Figure 1**. Also, one or more apparatus embodiments, method embodiments, or a combination thereof may be utilized during production stages, such as component and subassembly manufacturing **106** and system integration **108** in **Figure 1**, for example, without limitation, by substantially expediting the assembly of or reducing the cost of aircraft **200**. Similarly, one or more of apparatus embodiments, method embodiments, or a combination thereof may be utilized while aircraft **200** is in service **112** or during maintenance and service **114** in **Figure 1**.

As an example, the different advantageous embodiments may be implemented in network data processing system **216**. Network data processing system **216** may be implemented during system integration **108**. Further, portions of network data processing system **216** may be added or modified during maintenance and service **114** to include the different advantageous embodiments.

The different advantageous embodiments recognize that line replaceable units that require data from sensors are designed in an inefficient manner. Currently, the different advantageous embodiments recognize that sensors used in aircraft are directly connected to the line replaceable unit receiving the data. Further, the different advantageous embodiments recognize that as the number of sensors increase, the amount of wiring also increases. This increase in wiring leads to weight increases and complexities in routing the wires and the sensors to the line replaceable units.

Further, when the configuration of an aircraft changes, the current locations of the sensors may no longer be feasible with the new configuration. As a result, sensors have to be moved. The different advantageous embodiments recognize that this type of rearrangement may be difficult and costly. Changes in the locations of sensors require rerunning wires within the aircraft for the new locations. This rerunning of wires may require removal of various panels and components in the aircraft.

Thus, the different advantageous embodiments provide a sensor network in an aircraft for collecting data about the aircraft. This sensor network includes a set of wireless sensors attached to a first set of locations for the aircraft. A set used herein refers to one or more items. For example, a set of wireless sensors are one or more wireless sensors. The network also includes a set of wireless routers attached to a second set of locations for the aircraft in which the set of wireless routers are capable of receiving data in wireless signals transmitted by the set of wireless sensors.

Further, the sensor network in the advantageous embodiments also includes a set of gateways connected to an aircraft data processing system. The set of gateways is capable of receiving data in the wireless signals from the set of wireless routers to form received data and is capable of transmitting the received data into the aircraft network data processing system.

This aircraft data processing system may be a line replaceable unit, such as, for example, a central server module, an electronic flight bag, a cabin services system, an environmental control system, an in-flight electronic entertainment system, a navigation system, a flight controller, a collision avoidance system, or some other suitable system. Depending on the particular implementation, the gateway may be directly connected to the aircraft data processing system. In other advantageous embodiments, the gateway may send the information to the aircraft data processing system across a network on which the data processing system is located.

Turning now to **Figure 3**, a functional block diagram of an aircraft network data processing system is depicted in accordance with an advantageous embodiment. Aircraft network data processing system **300** is an example of network data processing system **216** in aircraft **200** in **Figure 2**. In this example, aircraft network data processing system **300** includes aircraft data processing systems **302**, aircraft network **304**, and sensor network **306**. In these illustrative examples, sensor network **306** may be a wireless sensor network. Sensor network **306** may include gateway **308**, wireless

routers **310**, and wireless sensors **312**.

Aircraft data processing systems **302** may be, for example, the computers, controls, and other devices that control various operations and environments within an aircraft. Aircraft network **304** provides connections between aircraft data processing systems **302**. Further, aircraft network **304** also provides a connection to sensor network **306**.

In these examples, wireless sensors **312** may gather information about the environment for the aircraft. Wireless sensors **312** may be attached to locations for the aircraft. Attached to locations in these examples means that wireless sensors **312** may be attached to locations inside and outside of the aircraft. In some embodiments, rather than being attached to locations, one or more wireless sensors **312** may be placed on or in a location. Wireless sensors **312** may include, for example, wireless passenger control units, brake temperature sensors, tire pressure sensors, light control switches, duct overheat sensors, aircraft health monitoring sensor, cabin temperature sensors, flight test instrumentation, door sensors, hatch sensors, cabin monitoring sensors, and other suitable types of sensors.

These wireless sensors **312** may sense data about the environment and are intended to sense a condition or status of various features of the aircraft. In these illustrative examples, this data may be transmitted by wireless sensors **312** to wireless routers **310** through a transmission using wireless signals. Wireless routers **310** are arranged in a manner to relay or transfer data received from sensors and/or other routers in wireless routers **310** to gateway **308**. In some advantageous embodiments, wireless sensors **312** may directly send data to gateway **308**.

Gateway **308** serves as an interface to send data to aircraft data processing systems **302** across aircraft network **304**. The data gathered by wireless sensors **312** may then be used by an aircraft data processing system in aircraft data processing systems **302** to perform various operations. These operations include, for example, maintaining cabin pressure, controlling control surfaces, generating alerts, and other suitable operations.

In these different illustrative examples, the description and arrangement of aircraft network data processing system **300** is not meant to imply architectural limitations in a manner in which various components may be implemented. For example, sensor network **306** may not include only wireless routers **310** and wireless

sensors **312**. As another example, sensor network **306** also may include wired sensors, routers, and gateways. As another example, although only gateway **308** is illustrated, additional gateways may be present in sensor network **306** depending on the particular implementation. These components may be existing components in which the wireless components are additions or supplements.

In other advantageous embodiments, a limited number of wired routers, sensors, and gateways may be present to take into account conditions in which wireless transmissions may not be feasible for certain areas or locations. Further, a combination of a wired device connected to a wireless device also may be used within sensor network **306** in some advantageous embodiments.

Turning now to **Figure 4**, a diagram of a sensor network is depicted in accordance with an advantageous embodiment. In the depicted example, sensor network **400** includes gateway **401**, wireless router **402**, and wireless router **404**. Additionally, sensor network **400** also includes wireless sensors **408, 410, 412, 414, 416, 418, 420, 422, 424, and 426**.

In this illustrative example, wireless sensors **408, 410, 414, and 412** transmit wireless signals containing data to wireless router **402**. In turn, wireless router **402** transmits signals containing the received data to wireless router **404**.

Wireless sensors **416, 418, 420, and 422** transmit wireless signals containing data to wireless router **404**. Wireless router **404** sends this data in wireless signals to gateway **401**. Further, wireless sensors **424 and 426** directly send wireless signals to gateway **401** containing data. The different sensors may transmit data in radio frequency signals. In these examples, the data takes the form of data packets (DP), such as data packets **428, 430, and 432**.

Further, gateway **406** may route the data to the appropriate data processing system. In these examples, gateway **406** also may log data received from the sensor with time stamps. In these examples, the data is received in the form of data packets from the different wireless sensors. Gateway **406** also may provide a user interface to indicate what event or activities have occurred. These activities may include a printout or visual display. Further, gateway **401** also may transmit an activity log to maintenance, operations, security, or other support personnel through an onboard or offboard system.

Gateway **401** may allow personnel to control the sensor system. Various

operations that may be performed to control the sensor system include resetting the system memory to begin logging new activity from a based time line, allowing personnel or other systems to define various phases of operations. These various phases may include, for example, passengers onboard, cabin cleaning, cabin inspection, or some other suitable phase. These different phases may result in a different treatment of the sensor data, and in some cases, turning off the wireless sensors and/or not passing data along to other data processing systems during a specific phase(s). Further, gateway **401** may associate individual sensor transmitter identification numbers with specific sensor locations.

10 Wireless routers **402** and **404** make take various forms. For example, wireless routers **402** and **404** may be a simple computer that simply repeats data packets received from wireless sensors. In other advantageous embodiments, these routers may be a mesh network router, such as, for example, an XBee® ZNet 2.5 OEM FR Module, which is available from Digi International, Inc.

15 Wireless sensors **408**, **410**, **412**, **414**, **416**, **418**, **420**, **422**, **424**, and **426** may be implemented using wireless sensors such as STM110, which is available from EnOcean, GmbH. Gateway **401** is a device used to interface with an aircraft data processing system or aircraft network. Gateway **401** may be, for example, a computer or other device that converts the data from a form transmitted by the wireless sensors to a format used by the aircraft data processing systems. An example of a gateway that may be used to implement gateway **401** is a ConnectPort X8, which is available from Digi International, Inc.

20 Turning now to **Figure 5**, a diagram of a data processing system is depicted in accordance with an advantageous embodiment. Data processing system **500** may be used to implement components, such as gateway **406** in **Figure 4**, wireless router **404** in **Figure 4**, and aircraft data processing systems **302** in **Figure 3**. In this illustrative example, data processing system **500** includes communications fabric **502**, which provides communications between processor unit **504**, memory **506**, persistent storage **508**, communications unit **510**, input/output (I/O) unit **512**, and display **514**.

30 Processor unit **504** serves to execute instructions for software that may be loaded into memory **506**. Processor unit **504** may be a set of one or more processors or may be a multi-processor core, depending on the particular implementation. Further, processor unit **504** 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 **504** may be a symmetric multi-processor system containing multiple processors of the same type.

Memory **506** and persistent storage **508** are examples of storage devices. A storage device is any piece of hardware that is capable of storing information either on a temporary basis and/or a permanent basis. Memory **506**, in these examples, may be, for example, a random access memory or any other suitable volatile or non-volatile storage device. Persistent storage **508** may take various forms depending on the particular implementation. For example, persistent storage **508** may contain one or more components or devices. For example, persistent storage **508** 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 **508** also may be removable. For example, a removable hard drive may be used for persistent storage **508**.

Communications unit **510**, in these examples, provides for communications with other data processing systems or devices. In these examples, communications unit **510** is a network interface card. Communications unit **510** may provide communications through the use of either or both physical and wireless communications links.

Input/output unit **512** allows for input and output of data with other devices that may be connected to data processing system **500**. For example, input/output unit **512** may provide a connection for user input through a keyboard and mouse. Further, input/output unit **512** may send output to a printer. Display **514** provides a mechanism to display information to a user.

Instructions for the operating system and applications or programs are located on persistent storage **508**. These instructions may be loaded into memory **506** for execution by processor unit **504**. The processes of the different embodiments may be performed by processor unit **504** using computer implemented instructions, which may be located in a memory, such as memory **506**. 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 **504**. The program code in the different embodiments may be embodied on different physical or tangible computer readable media, such as memory **506** or persistent storage **508**.

Program code **516** is located in a functional form on computer readable media

518 that is selectively removable and may be loaded onto or transferred to data processing system **500** for execution by processor unit **504**. Program code **516** and computer readable media **518** form computer program product **520** in these examples. In one example, computer readable media **518** 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 **508** for transfer onto a storage device, such as a hard drive that is part of persistent storage **508**. In a tangible form, computer readable media **518** also may take the form of a persistent storage, such as a hard drive, a thumb drive, or a flash memory that is connected to data processing system **500**. The tangible form of computer readable media **518** is also referred to as computer recordable storage media. In some instances, computer readable media **518** may not be removable.

Alternatively, program code **516** may be transferred to data processing system **500** from computer readable media **518** through a communications link to communications unit **510** and/or through a connection to input/output unit **512**. 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 **500** 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 **500**. Other components shown in **Figure 5** can be varied from the illustrative examples shown.

As one example, a storage device in data processing system **500** is any hardware apparatus that may store data. Memory **506**, persistent storage **508** and computer readable media **518** are examples of storage devices in a tangible form.

In another example, a bus system may be used to implement communications fabric **502** 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 **506** or a cache such as found in an interface and memory controller hub that may be present in communications fabric **502**.

5 Turning now to **Figure 6**, a block diagram of a wireless sensor is depicted in accordance with an advantageous embodiment. In this example, wireless sensor **600** includes housing **602**, which contains sensor unit **604**, microprocessor **606**, memory **608**, transmitter **610**, antenna **612**, and power source **614**. Sensor unit **604** may contain a set of sensors.

10 Data may be temporarily stored in memory **608** until transmitted by transmitter **610** over antenna **612**. In these examples, transmitter **610** transmits wireless signals over antenna **612** in the form of radio frequency signals. Further, transmitter **610** also is associated with a unique identification number that is included with a transmitted data packet to allow a gateway to distinguish between different sensors and identify sensor
15 locations. Microprocessor **606** controls the sampling or receipt of data from sensor unit **604**. Microprocessor **606** may be configured to obtain and transmit data from sensor unit **604** based on an event.

These events may be periodic or not periodic. For example, the periodic event may be a schedule in which cabin air temperature is sensed every ten seconds. In
20 other advantageous embodiments, data may be sensed by an external event, such as the physical opening of a door.

Further, wireless sensor **600** also may send data based on these events, and also send data at least periodically to indicate that the sensor is still alive.

25 Sensor unit **604** may take various forms. For example, without limitation, sensor unit **604** may be a temperature sensor, a switch that is associated with a door or other portal, a biometric unit, an airflow detector, or some other suitable transducer or sensor device.

In these examples, power source **614** provides power to transmitter **610**, microprocessor **606**, memory **608**, and sensor unit **604** for the various operations that
30 are needed. In some advantageous embodiments, power source **614** may be only connected to selected components while other components may be provided power through connections to the power components.

Power source **614** may be, for example, battery **616** and/or energy harvesting

device **618**. Energy harvesting device **618** may be, for example, a photovoltaic device that generates electrical power when exposed to a light source, such as sunlight or cabin lighting. In other embodiments, energy harvesting device **618** may be, for example, a vibration harvesting device. This type of device may be, for example, a
5 cantilevered piezoelectric beam, which generates electrical power when exposed to aircraft or operational vibration.

Another non-limiting example of an implementation for energy harvesting device **618** is a thermoelectric device. This type of device generates electrical power when exposed to a thermal gradient. This thermal gradient may be, for example, a hot
10 hydraulic line in ambient air or a thermal gradient across an aircraft insulation blanket.

Energy harvesting device **618** may provide power when various conditions are present. The collusion of battery **616** may provide power to wireless sensor **600** if other conditions are not present to allow energy harvesting device **618** to generate power. Further, energy harvesting device **618** also may charge battery **616**.

15 In some applications, a capacitor or a super-capacitor may be used in lieu of battery **616** to provide power to the various components. This capacitor or super-capacitor may be used in collusion with the energy harvesting device **618**.

In this manner, wireless sensor **600** may not require any wiring in the aircraft. Further, no aircraft power or data wiring is required for the normal operation of these
20 devices. As a result, power requirements and weight from wiring sensors are not incurred. This type of wireless sensor also makes it easy to change the locations of sensors when the aircraft is reconfigured. Further, the use of this type of sensor makes it easy to add sensor networks to already existing aircraft.

In these examples, the wireless sensors are configured in a star network
25 topology in which the different wireless sensors send data to a central node, such as one of the routers. The routers are configured in a wireless mesh network configuration. This configuration provides at least two pathways of communication to each node and may send information back and forth. Further, routes are created between nodes only as needed to transmit information.

30 With reference now to **Figure 7**, a diagram illustrating a sensor network layout for an aircraft is depicted in accordance with an advantageous embodiment. In this example, aircraft **700** may include wireless sensors **702, 704, 706, 708, 710, 712, 714, 716, 718, 720, 722, 724, 726, 728, and 730**. The sensor network also includes wireless

routers **732, 734, 736, 738, 740, 742, 744, 746, and 748**. This sensor network also includes gateway **750**.

As can be seen, the different wireless sensors may be located inside and outside of the aircraft. In these examples, wireless sensor **702, 704, 706, 708, 710, and 712** are located on the exterior of aircraft **700**. Wireless sensors **714, 716, 718, 720, 722, 724, 726, 728, and 730** are located on the interior of the aircraft.

The different wireless routers may be located on the interior or exterior of the aircraft depending on the particular implementation. In these examples, wireless routers **732, 738, 740, 742 and 748** are located on the exterior of aircraft **700**. Wireless routers **734, 736, 744, and 746** are located inside the aircraft. Also, in these examples, gateway **750** is located inside the aircraft **700**. Interior locations may include, for example, passenger cabin, cabin ceiling areas, cargo holds and electrical equipment centers. Exterior locations may include, for example, landing gear wheel wells, engine struts or within the empennage. Also, both wireless and wired connections may be provided from a router sending data directly to gateway **750** in these examples. Multiple routers may send data to gateway **750** provide redundancy.

Turning now to **Figure 8**, an illustration of a configuration of routers in a cross-sectional view of an aircraft is depicted in accordance with an advantageous embodiment. In this example, aircraft **800** may have routers in different locations for aircraft **800**. In particular, section lines X-X and Y-Y are sections shown in **Figures 9 and 10** in which routers may be located on different levels of aircraft **800**. The architecture of routers in aircraft **800** is designed to provide a transfer of data amongst various areas of an aircraft, including from one level of an aircraft to another level of an aircraft, to an aircraft data processing system or other device for processing or use.

With reference now to **Figure 9**, aircraft **800** is shown in a top cross sectional view along section X-X in accordance with an advantageous embodiment. In this example, layout **901** is a first level in aircraft **800** in which the routers include overhead routers **900, 902, and 904**. These routers are located in the passenger cabin **905**. These routers may be located on the ceiling of the passenger cabin **905**. In some advantageous embodiments, the routers may be located inside the crown above the cabin. In yet other advantageous embodiments, the routers may be located on cabin stowage bin supports. In this view, aircraft **800** also includes return air grill routers **906, 908, 916, and 912**. These routers are located in or approximate to the return air grill in

the passenger cabin. Of course, these routers may be located in any location that allows these routers to receive data in wireless signals from one level of the aircraft and transmit the data in wireless signals to another level of the aircraft.

Window routers **914**, **910**, **918**, and **920** also are present in aircraft **800**. These window routers may be located in or attached to windows and/or in window plugs in portals for aircraft **800**.

Strut routers **922**, **924**, **926**, and **928** are located on the struts or engines on the exterior of aircraft **800** in these examples. The strut routers may receive data from sensors located on the exterior of aircraft **800** and route this data inside aircraft **800** by sending the data to the different window routers, such as window routers **914**, **910**, **918**, and/or **920**. These window routers may then route data to the return air grill routers or other routers within the airplane. The different window routers also may receive data directly from sensors located on the outside of aircraft **800**. The overhead routers receive data from sensors located inside aircraft **800** and route the data to the return air grill routers or other routers within the airplane. In a mesh network configuration, in the advantageous embodiments, the routers are designed to route the data amongst themselves towards Gateway **1016** as referenced in **Figure 10** below. The connections between routers is determined amongst themselves and possibly with some coordination from the Gateway **1016** in **Figure 10**. These connections may change dynamically as various links are blocked or interfered within a changing radio frequency environment.

The connections shown in **Figures 9** and **10** are examples of some possible configurations of connections that may be established. For example, data from strut router **922** may make its way to Gateway **1016** in **Figure 10** via strut router **924**, window router **918**, and grill router **912**. If window router **918** failed for some reason, the path may dynamically change to strut router **922** to window router **914**, and grill router **912**, skipping over head router **902** and window router **920** if signal is strong enough, to gateway **1016** in **Figure 10**.

In these examples, the return air grill routers function to exchange the data between the level of layout **901** and a lower level in the aircraft as illustrated in **Figure 10** below. Further, the return air grill routers also may receive data directly from sensors that may be present in the cabin.

With reference now to **Figure 10**, a diagram illustrating a configuration of routers

in a cross sectional view of an aircraft is depicted in accordance with an advantageous embodiment. In this example, a view along lines Y-Y is presented for aircraft **800**. As depicted, layout **1001** is for a lobe of aircraft **800** located below the cabin floor of aircraft **800** in these examples. The lobe of aircraft **800** is a lower level of the aircraft with respect to passenger cabin.

This lower portion of aircraft **800** includes aft cargo hold **1000**, forward cargo hold **1002**, and electronic bay **1004**. This portion of aircraft **800** includes nose wheel well router **1006**, cargo bay router **1008**, cargo bay router **1010**, cargo bay router **1012**, and main gear wheel well router **1014**. Additionally, gateway **1016** also is located on this level of aircraft **800**. Cargo bay routers **1008** and **1010** are located within aft cargo hold **1000**. Cargo bay router **1012** is located within forward cargo hold **1002**.

Gateway **1016** is located within electronic bay **1004** of these examples. The different cargo bay routers may receive data from sensors located within the cargo bays, floor beams, and other nearby areas and route that information to gateway **1016**.

Main gear wheel well router **1014** and nose gear wheel well router **1006** may receive data from sensors located on the exterior of aircraft **800**. In these examples, this data may be received from sensors located on the lower part of the aircraft. Further, these routers may receive/transmit data from/to routers on the exterior aircraft **800**, such as strut routers **922**, **924**, **926**, and **928** in **Figure 9**.

In these examples, the different return air grill routers also function to move data from one level of aircraft **800** to another level of aircraft **800**, such as between the upper level of aircraft **800** in **Figure 9** and the lower level of aircraft **800** in **Figure 10**. This configuration allows data to make its way amongst upper level and lower level meshed routers to gateway **1016**.

For example, return air grill router **908** may receive data from different routers, such as cargo bay router **1008**. Further, return air grill router **908** also may receive data directly from sensors located in the cargo bay **1000**. This data may then be transmitted to overhead router **902**. This information may then be sent directly or indirectly to gateway **1016** through return air grill router **912**. A wireless path may not be between cargo bay router **1010** and cargo bay router **1012** due to the main landing gear wheel well and fuel tank at the center of the plane. Thus, sensor data from aft lower lobe makes its way to gateway **1016** by first having to go up to the upper level illustrated by layout **901** and then back down to the lower level illustrated by layout **1001** via the

return air grill routers.

In this manner, the configuration of routers as shown by layouts **901** and **1001** in aircraft **800** allows for the transfer of data from any level of aircraft **800** to the lower level in which gateway **1016** is located. Although only two levels are shown in these
5 examples, other advantageous embodiments may include additional levels of routers. For example, if aircraft **800** has multiple decks for passengers, routers may be positioned to move data from any level towards the gateway located in the lower level.

With reference now to **Figure 11**, an illustration of a configuration for a wireless router is depicted in accordance with an advantageous embodiment. In this example,
10 wireless router **1100** is an example of a window router. Wireless router **1100** is attached to, embedded in, or part of window plug **1102** in these examples. Window plug **1102** is mounted in fuselage **1104**. Window plug **1102** is transparent to wireless signals. In other words, window plug **1102** may allow the transmission of wireless signals. In these examples, fuselage **1104** is opaque
15 with respect to wireless signals. In other words, wireless signals cannot be transmitted through fuselage **1104**.

In these illustrative examples, wireless router **1100** is capable of receiving wireless signals from another wireless router or wireless sensor located outside of the aircraft. In this example, wireless router **1100** may receive wireless signals transmitted
20 along path **1106**. Wireless router **1100** may retransmit the wireless signal into interior **1108**. Wireless router **1100** retransmits the wireless signal along path **1110** and/or path **1112**. The path along which the wireless signal is retransmitted depends on whether monument **1114** is transparent or opaque with respect to wireless signals.

A material is transparent to a wireless signal if the material passes a wireless
25 signal. A material is considered opaque with respect to wireless signals if the material does not allow a wireless signal to pass through the material. Monument **1114** may be, for example, a laboratory, a galley, a closet, or some other structure within interior **1108** of aircraft **800**. Wireless signal uses path **1110** if monument **1114** is transparent with respect to wireless signals. Path **1112** is used to retransmit the wireless signal if
30 monument **1114** is opaque with respect to wireless signals, particularly if monument **1114** is reflective with respect to wireless signals.

With reference now to **Figure 12**, an illustration of another configuration for transmitting wireless signals is depicted in accordance with an advantageous

embodiment. As depicted, wireless router **1100** transmits the wireless signal received along path **1106** to wireless router **1200** along path **1202** into interior **1108** of aircraft **800**. In this example, monument **1114** is opaque to wireless signals. This configuration of wireless router **1100** allows for the signal to be transmitted around or past this
5 opaque structure.

In **Figure 13**, another configuration of routers is depicted in accordance with an advantageous embodiment. In this example, wireless router **1100** is connected to wireless router **1300** through wire **1302**. These two routers are wireless routers in a sense that wireless router **1100** receives wireless signals along path **1106**.

10 These signals may then be transmitted through wire **1302** to wireless router **1300**. In turn, wireless router **1300** then transmits the data in a wireless signal along path **1304**. This type of configuration also provides an ability to route data around objects through which wireless signals cannot be transmitted.

With reference now to **Figure 14**, yet another configuration of a router is depicted
15 in accordance with an advantageous embodiment. In this example, the same configuration of routers is used as in **Figure 13**. This configuration includes an addition of opaque shield **1400**. Opaque shield **1400** prevents wireless signals such as those transmitted along path **1106** from reaching the interior **1108** of aircraft **800**.

In this manner, the signals retransmitted into interior **1108** are those received by
20 router **1100**. Other signals originating from the exterior of aircraft **800** do not enter interior **1108** of aircraft **800**. Likewise, wireless signals originating from interior **1108** of aircraft **800** do not exit to the exterior of aircraft **800**. In this manner, aircraft **800** may be shielded from unwanted wireless signals.

Turning now to **Figure 15**, an illustration of still another configuration for a router
25 is depicted in accordance with an advantageous embodiment. In this example, router **1500** is connected to antenna **1502** through wire **1504**. In this manner, radio frequency signals received along path **1106** may be retransmitted through antenna **1502** along path **1506** into interior **1108** of aircraft **800**. This configuration provides another configuration to send signals into interior **1108** of the aircraft when an opaque
30 monument, such as monument **1114** is present by window plug **1102**.

Turning now to **Figure 16**, an illustration for a router is depicted in accordance with an advantageous embodiment. In this example, radio **1600** is shown on interior side **1602** of window plug **1102**. In this example, radio **1600** is a portion of wireless

router **1100** in **Figure 15**. In **Figure 17**, an illustration of an antenna for a router is depicted in accordance with an advantageous embodiment. Antenna **1700** is a printed antenna printed on exterior side **1702** of window plug **1102**. Wire **1704** connects antenna **1700** to radio **1600**. Radio **1600** is a router that may retransmit the signal to antenna **1700**.

With reference now to **Figure 18**, yet another configuration for a router is depicted in accordance with an advantageous embodiment. In this example, window plug **1800** includes transparent pane **1802** and opaque pane **1804**. In other words, wireless signals traveling along path **1806** may be transmitted through pane **1802** but may not pass through pane **1804**.

As depicted, router **1808** is placed on or near closeout seal **1810** to receive radio frequency signals. Router **1808** is located between fuselage **1812** and side wall **1814**. In these examples, side wall **1814** is transparent to the wireless signals and passes wireless signals transmitted by router **1808**. This type of arrangement provides another configuration for receiving signals from the exterior of the aircraft and transmitting it into the interior of the aircraft.

The wireless signal paths illustrated in **Figures 11, 12, 13, 14, 15** and **18** show signals traveling from outside the aircraft to inside the aircraft. These configurations also allow for wireless signals to travel in the opposite direction.

With reference now to **Figure 19**, a diagram illustrating placement of a return air grill router is depicted in accordance with an advantageous embodiment. In this example, router **1900** is located on surface **1902** of fuselage **1904**. Router **1900** is positioned proximate to or in a location relative to grill **1906** such that router **1900** is capable of receiving wireless signals from within passenger cabin **1908** or lower lobe **1912**. The signals may originate from sensors or routers located within passenger cabin **1908** from sensors or routers located within lower lobe **1912**.

This type of arrangement may be used when floor **1910** is opaque to wireless signals. In other words, wireless signals cannot be transmitted between passenger cabin **1908** and lower lobe **1912** through floor **1910**. Router **1900** then retransmits the signals received from passenger cabin **1908** into lower lobe **1912** along path **1914** in these examples, or in the reverse direction. Thus, router **1900** makes use of the return air grill designed airflow path, which is from passenger cabin **1908** to lower lobe **1912**, to also provide a convenient route for wireless signal transmission.

The different paths for wireless signals illustrated in the different examples are presented merely for purposes of illustrating one possible path for radio frequency signals. The illustrations of these paths of examples are not intended to limit the manner in which paths may occur. In other words, a router may receive radio frequency signals along multiple paths and transmit those signals along multiple paths.

Also, some of the features above may be combined. For example, a router may be located in the sidewall area or mounted on the back side of the sidewall with this router having an antenna in the window area, such as on the window close-out seal, and an antenna in the return air grill area. Thus, this single router may serve as both a window plug router and a return air grill router. This configuration may provide wireless signal coverage of the exterior, main cabin, and lower lobe and would allow for wireless signal communications between all of these areas.

With reference now to **Figure 20**, a flowchart of a process for processing data in a wireless aircraft sensor network is depicted in accordance with an advantageous embodiment. The process illustrated in **Figure 20** may be implemented in a data processing system, such as aircraft network system **300** in **Figure 3**.

The process begins by detecting data using a set of wireless sensors (operation **2000**). These wireless sensors may be attached to a first set of locations. These locations may be, for example, without limitation, outside the aircraft and inside the aircraft. These sensors may be located on different levels of the aircraft. For example, these sensors may be located in the passenger cabin, in the crown above the passenger cabin, and on a lower lobe on the aircraft. Further, these sensors may be located on another level, such as other passenger cabins if the aircraft has multiple floors of passenger cabins.

The process then sends the detected data and wireless signals from the set of wireless sensors to a set of wireless routers (operation **2002**). These wireless routers are located in a second set of locations for the aircraft. These routers may also be outside and inside the aircraft. The data is then routed through the set of wireless routers to a set of gateways (operation **2004**). The process then transmits the routed data from the set of gateways into aircraft data processing system (operation **2006**), with the process terminating thereafter.

The flowcharts and block diagrams in the different depicted embodiments illustrate the architecture, functionality, and operation of some possible implementations

of apparatus, methods and computer program products. In this regard, each block in the flowchart or block diagrams may represent a module, segment, or portion of computer usable or readable program code, which comprises one or more executable instructions for implementing the specified function or functions. In some alternative implementations, the function or functions noted in the block may occur out of the order noted in the figures. For example, in some cases, two blocks shown in succession may be executed substantially concurrently, or the blocks may sometimes be executed in the reverse order, depending upon the functionality involved.

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.

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 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
5 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
10 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
15 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
20 be apparent to those of ordinary skill in the art.

Further, the different advantageous embodiments may be implemented in vehicles other than aircraft. For example, the different advantageous embodiments may be implemented in vehicles, such as, for example, trains, surface ships, submarines, busses, spacecraft, and other suitable vehicles. The different advantageous
25 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
30 contemplated.

CLAIMS:

What is claimed is:

5

1. A sensor network in an aircraft for collecting data about the aircraft, the sensor network comprising:

a set of wireless sensors attached to a first set of locations for the aircraft;

a set of wireless routers attached to a second set of locations for the aircraft,

10 wherein the set of wireless routers is capable of receiving data in wireless signals transmitted by the set of wireless sensors; and

a set of gateways connected to an aircraft data processing system, wherein the set of gateways is capable of receiving the data in the wireless signals from the set of wireless routers to form received data and capable of transmitting the received data into
15 the aircraft data processing system.

2. The sensor network of claim 1, wherein a first portion of the set of wireless routers is located in a passenger cabin in the aircraft and a second portion of the set of wireless routers is located in an area below a passenger floor of the aircraft.

20

3. The sensor network of claim 2, wherein a third portion of the set of wireless sensors is located in a crown above the passenger cabin.

4. The sensor network of claim 1 further comprising:

25

a window plug capable of passing a wireless signal containing detected data originating from a selected wireless sensor in the set of wireless sensors through the window plug, wherein the selected wireless sensor is attached to a location in the first set of locations located outside of the aircraft; and

a wireless router coupled to the window plug, wherein the wireless router is
30 capable of receiving the wireless signal containing the detected data passed by the window plug to form a received wireless signal and capable of transmitting the received wireless signal to another wireless router in the set of wireless routers.

5. The sensor network of claim 4, wherein the wireless router is connected to the another wireless router by a wired connection, the wireless router transmits the received wireless signal to the another wireless router as a signal over the wired connection, and the another wireless router transmits the signal to a third wireless router as another wireless signal.
6. The sensor network of claim 5, wherein the wire passes through a wireless signal opaque barrier configured to block the passage of wireless signals between areas outside and inside of the aircraft.
7. The sensor network of claim 4, wherein the window plug comprises:
a first pane of material that passes wireless signals; and
a second pane of material that blocks the wireless signals.
8. The sensor network of claim 7, wherein the first pane is attached to a fuselage of the aircraft and the second pane is connected to a sidewall within the aircraft, a gap is present between the first pane and the second pane, a seal is present between edges of the first pane and the second pane, and the wireless router is coupled to the seal.
9. The sensor network of claim 1 further comprising:
a wireless router located in an interior of the aircraft in a position allowing the wireless router to receive a wireless signal through a grill in the cabin sidewall to form a received wireless signal and allowing the wireless router to transmit received wireless signal to one of a second wireless router in the set of wireless routers and a gateway.
10. The sensor network of claim 1, wherein the set of gateways is capable of receiving the data through a wireless transmission from a wireless sensor in the set of wireless sensors.
11. The sensor network of claim 1, wherein a wireless sensor in the set of wireless sensors comprises:
a sensor;
a processor connected to the sensor;

a transmitter connected to the processor; and
a power source capable of providing power to the sensor, processor, and transmitter.

- 5 12. The sensor network of claim 11, wherein the power source is selecting from one of a battery, a capacitor and an energy harvesting device.
13. The sensor network of claim 12, wherein the energy harvesting device is selected from one of a photovoltaic device, a vibration harvesting device, and a
10 thermoelectric device.
14. The sensor network of claim 1, wherein a first portion of the set of wireless routers is located outside of the aircraft and a second portion of the set of wireless routers is located inside the aircraft.
- 15 15. The sensor network of claim 1, wherein a gateway in the set of gateways is located in a lower lobe of the aircraft.
16. The sensor network of claim 1, wherein the aircraft data processing system is selected from one of a line replaceable unit, an in flight entertainment system, and an
20 environmental control system.
17. A method for detecting data in an aircraft, the method comprising:
detecting the data using a set of wireless sensors attached to a first set of locations for the aircraft to form detected data;
25 sending the detected data in wireless signals from the set of wireless sensors to a set of wireless routers attached to a second set of locations for the aircraft, wherein the set of wireless routers is capable of receiving the data in the wireless signals transmitted by the set of wireless sensors;
routing the data through the set of wireless routers to a set of gateways
30 connected to an aircraft data processing system to form routed data; and
transmitting the routed data from the set of gateways into the aircraft data processing system.

18. The method of claim 17, wherein the aircraft includes a first level and a second level separated by a floor wherein the routing step comprises:

transmitting the detected data from a first level of the aircraft to a second level of the aircraft a using a wireless router in the set of wireless routers located in a position
5 allowing the wireless router to receive a wireless signal through an opaque section in a cabin sidewall to form a received wireless signal and allowing the wireless router to transmit the received wireless signal to a second wireless router in the set of wireless routers.

10 19. The method of claim 17, wherein the routing step comprises:

receiving the detected data through a window plug in the aircraft from one of a wireless router in the set of wireless routers and a sensor.

20. The method of claim 17, wherein the routing step comprises:

15 transmitting the detected data from an exterior of the aircraft to an interior of the aircraft.

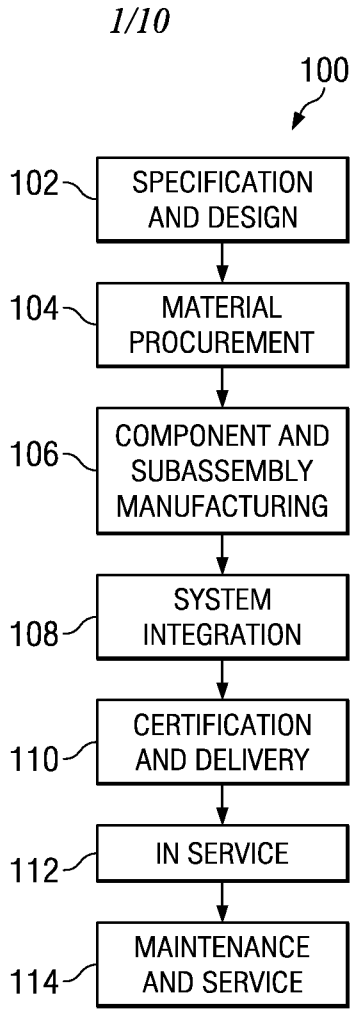


FIG. 1

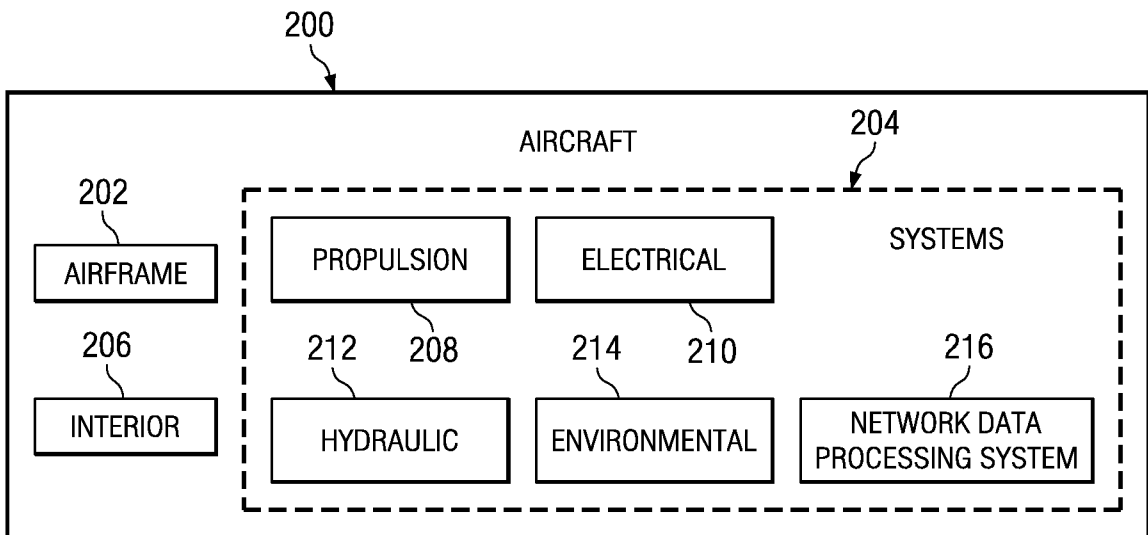


FIG. 2

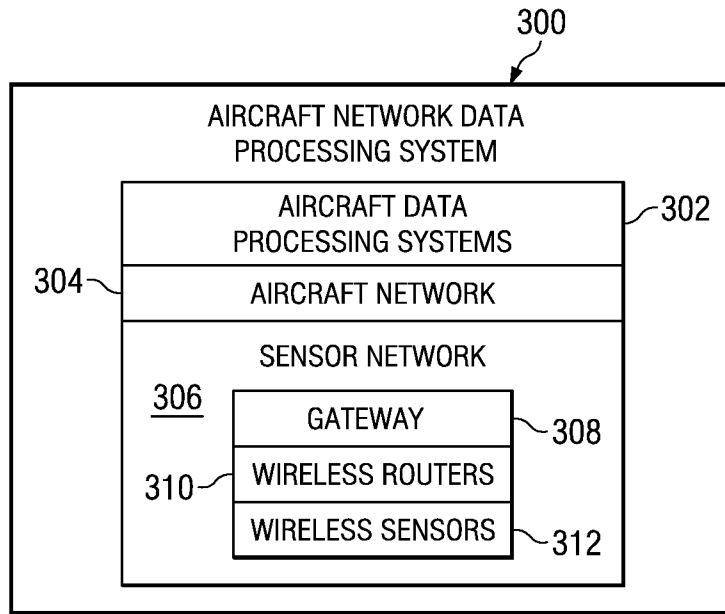


FIG. 3

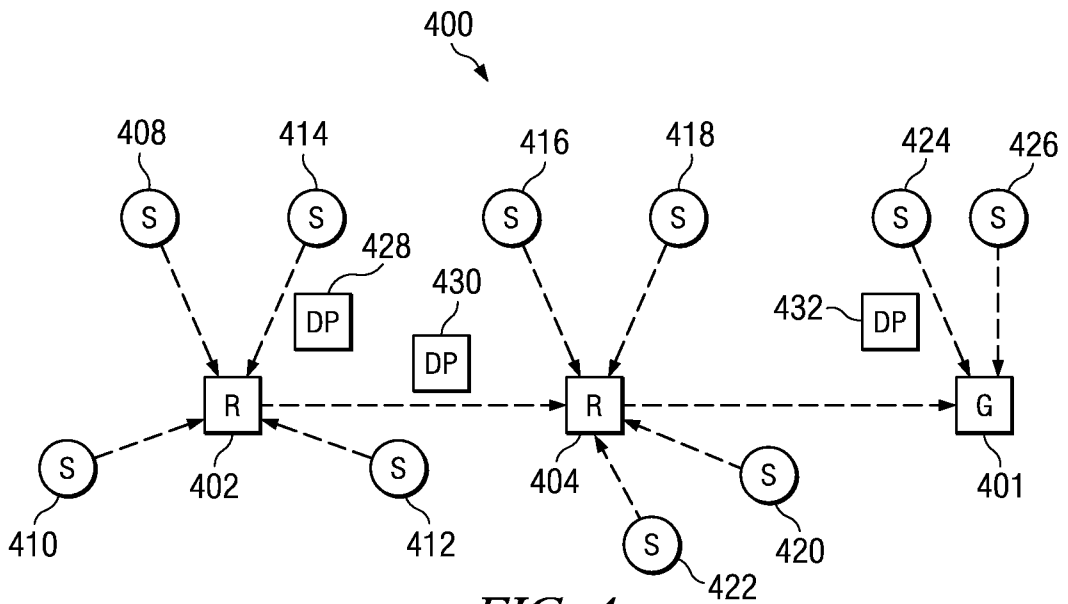


FIG. 4

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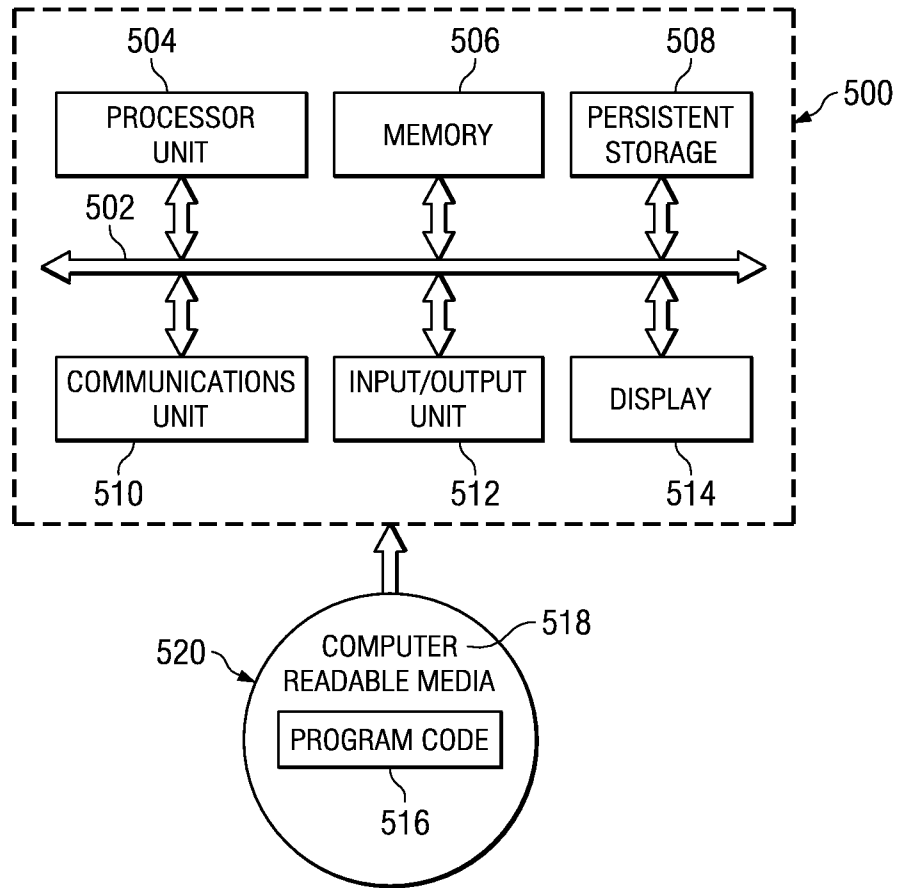


FIG. 5

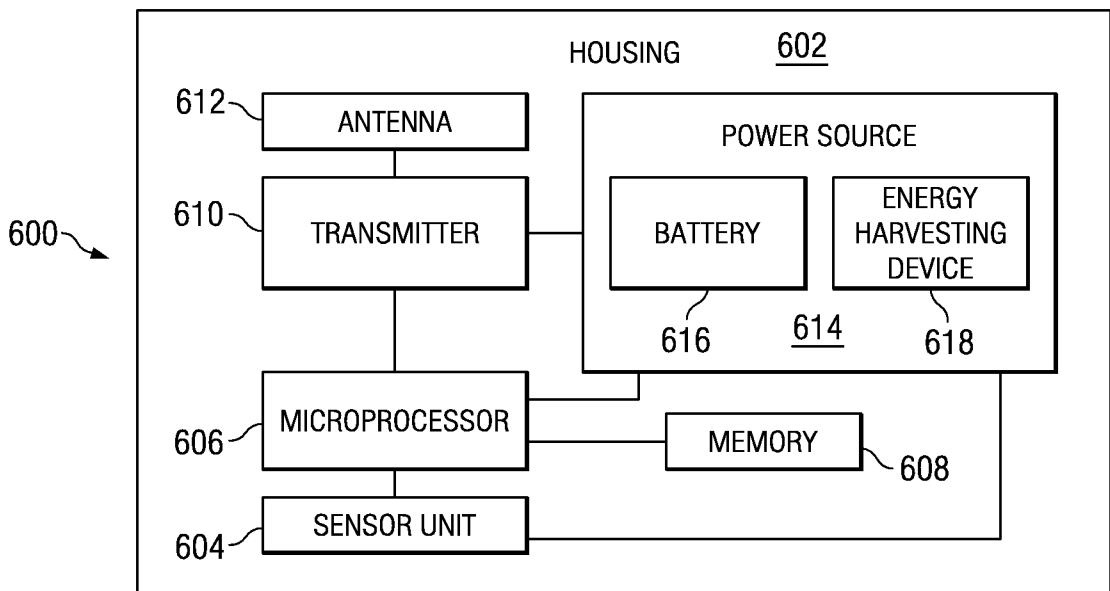


FIG. 6

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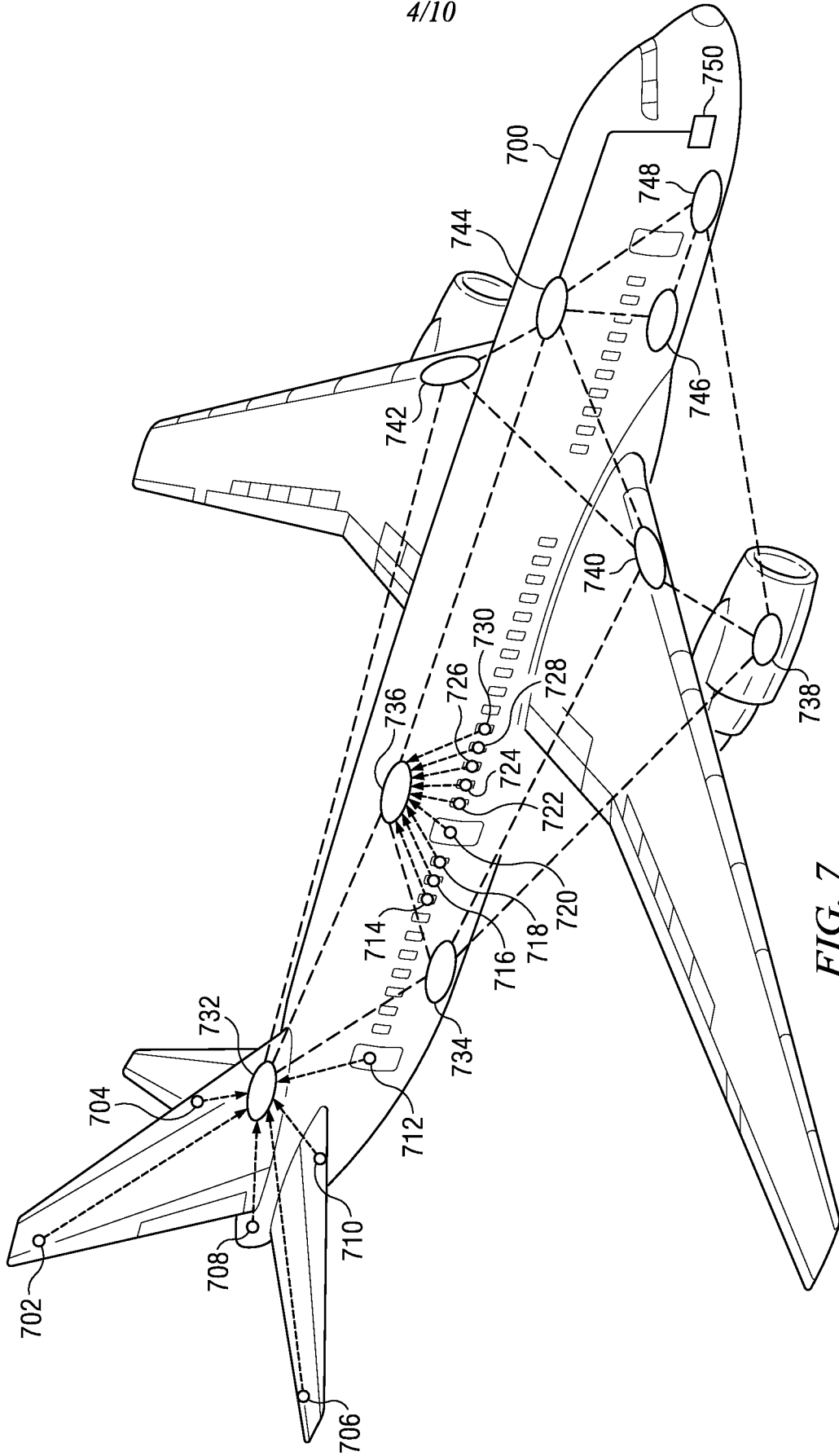


FIG. 7

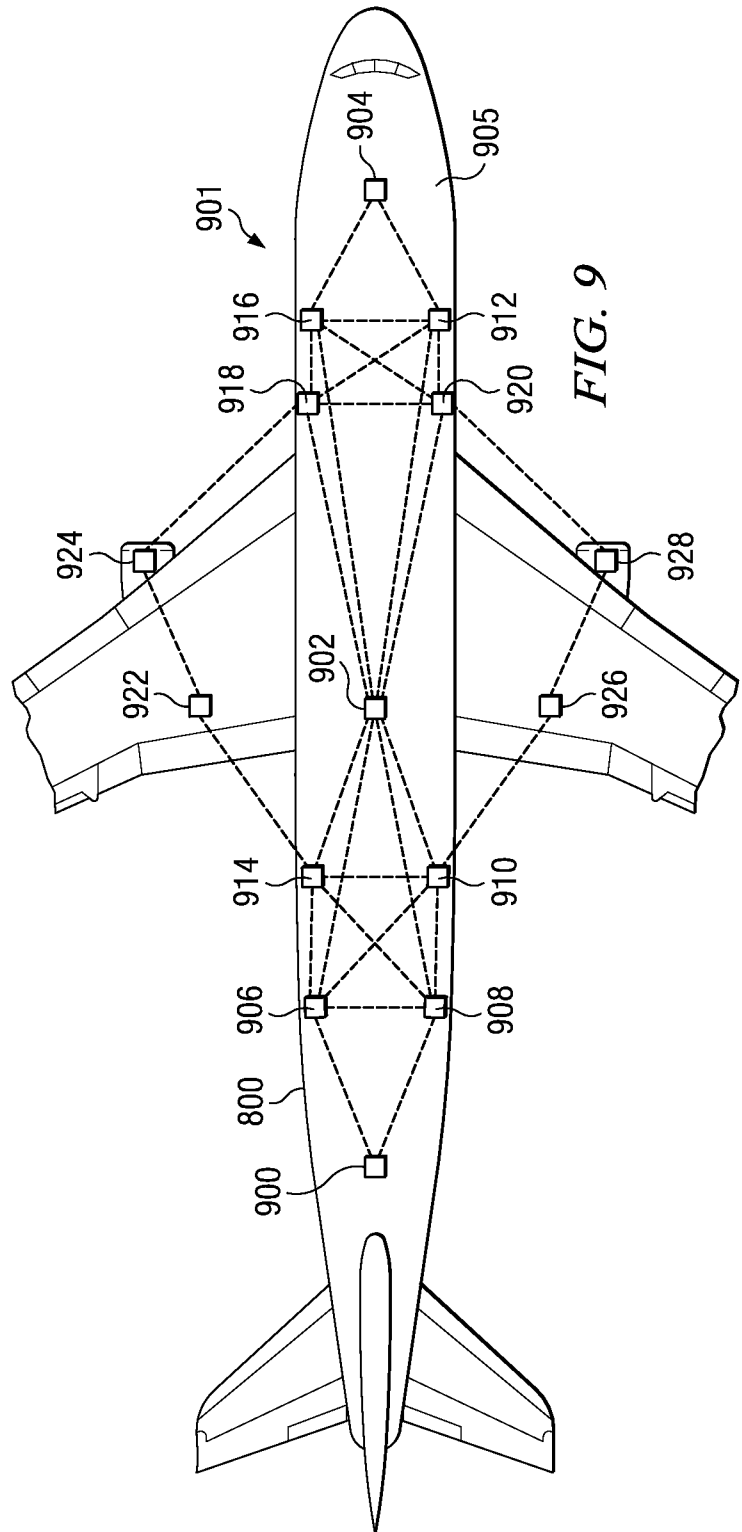
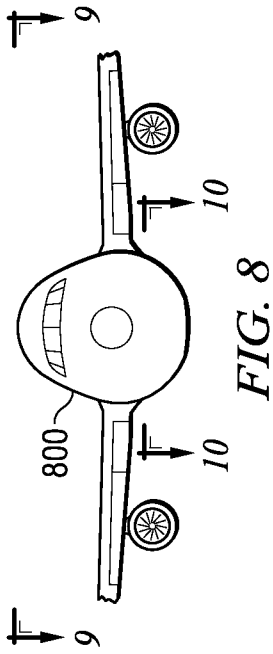


FIG. 9

FIG. 8

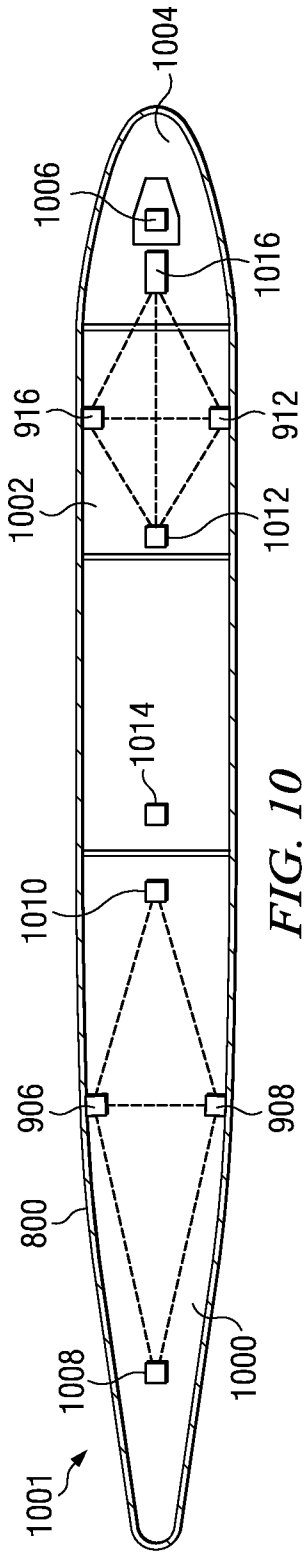


FIG. 10

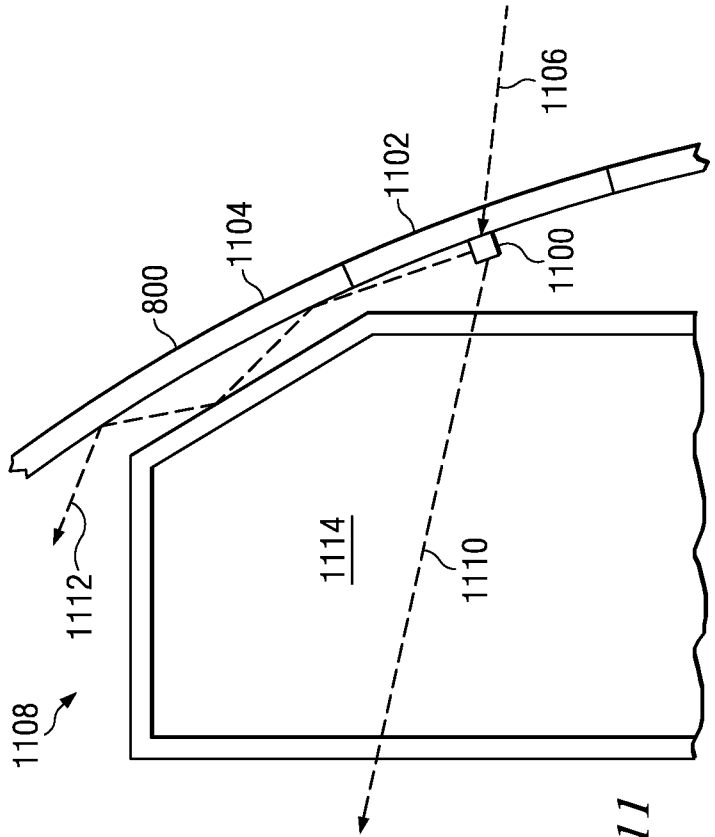


FIG. 11

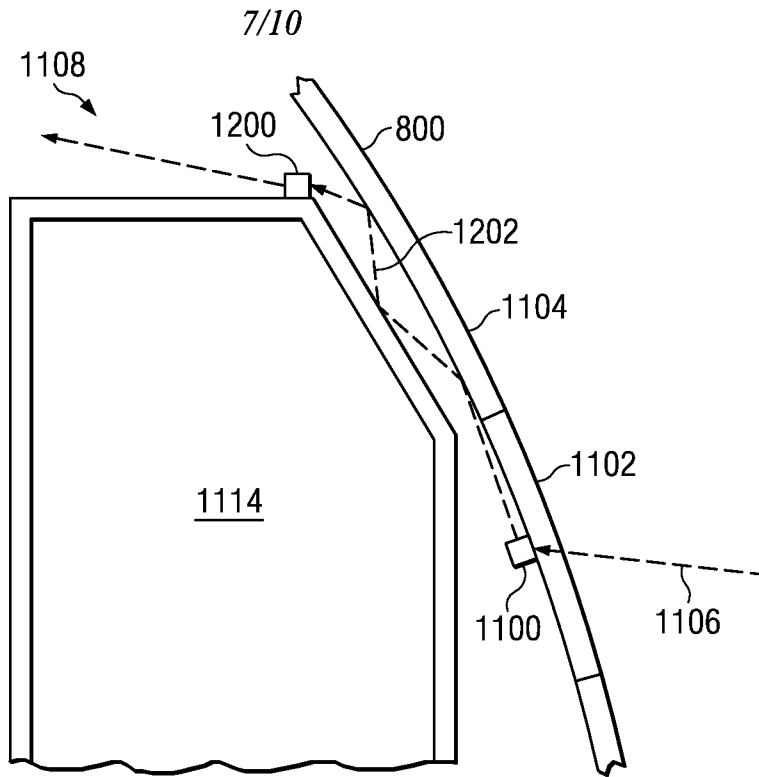


FIG. 12

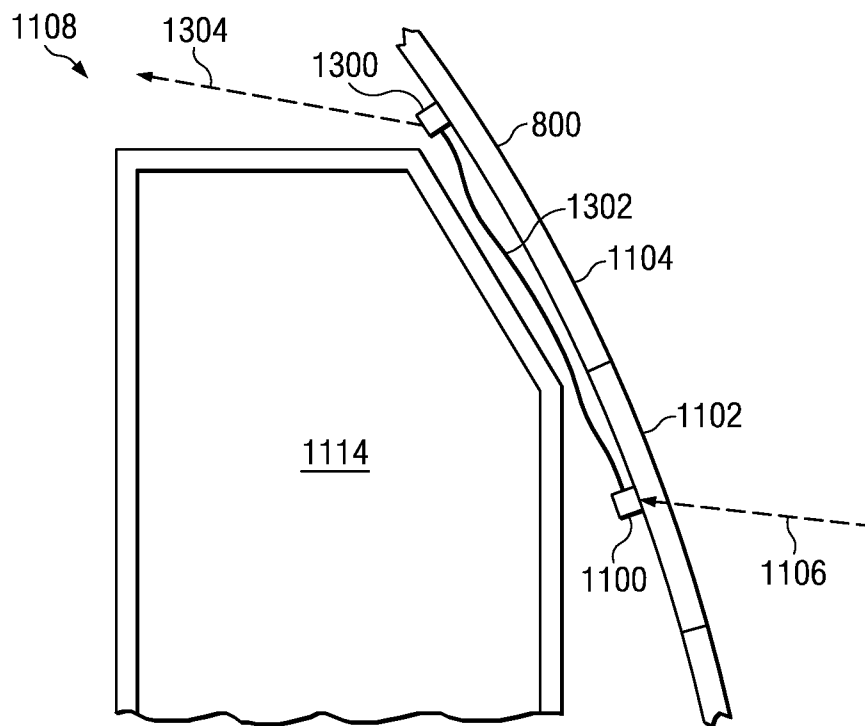


FIG. 13

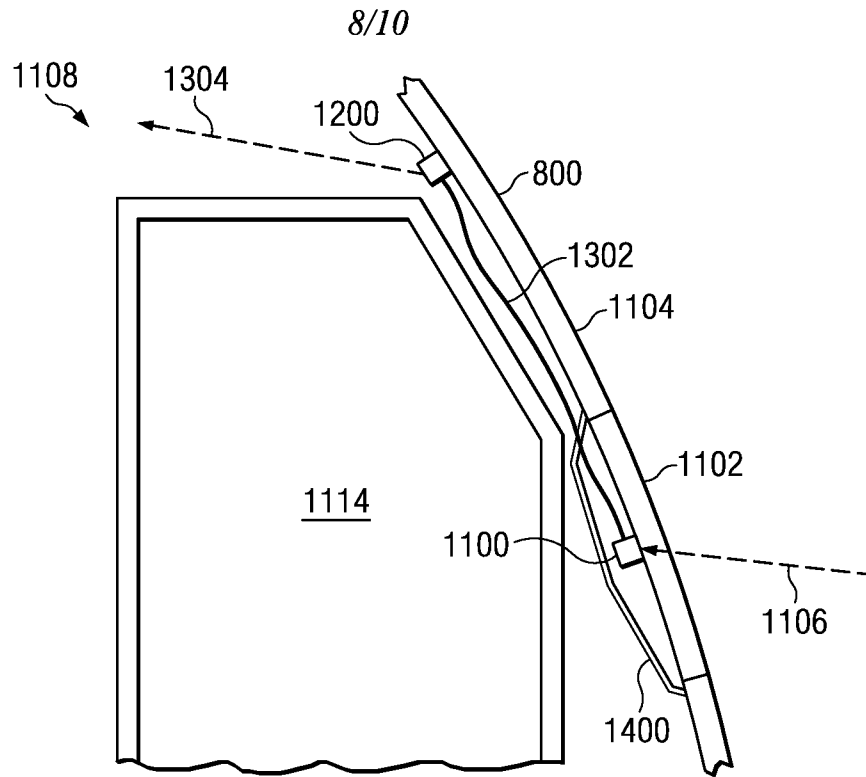


FIG. 14

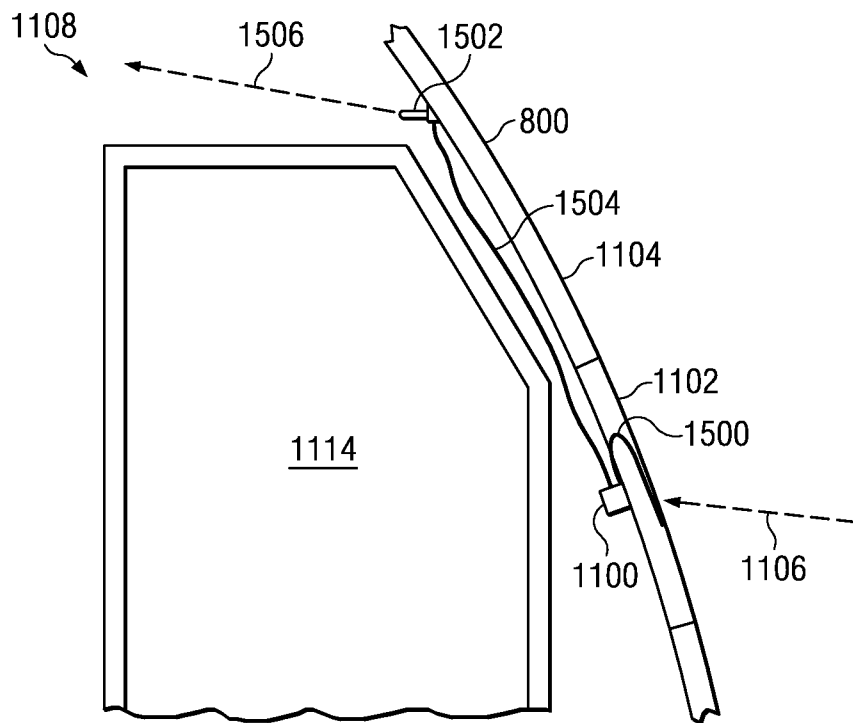


FIG. 15

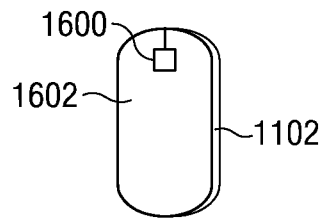


FIG. 16

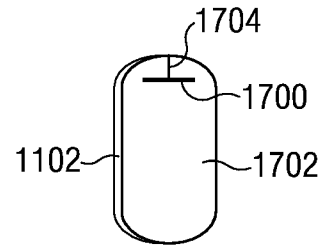


FIG. 17

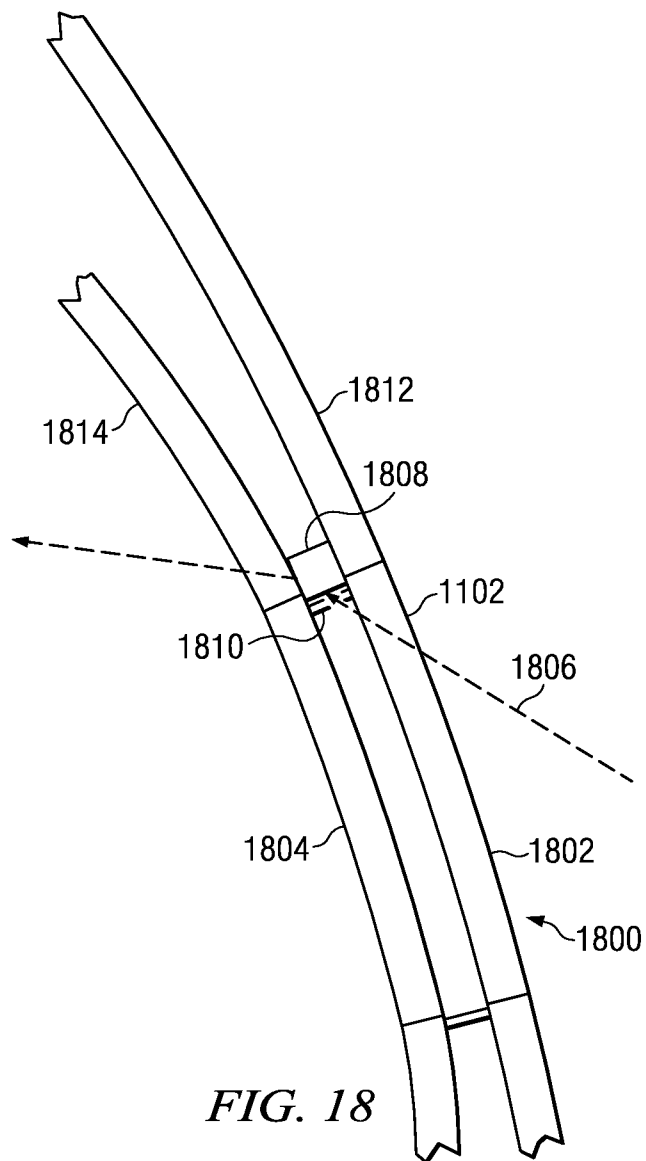


FIG. 18

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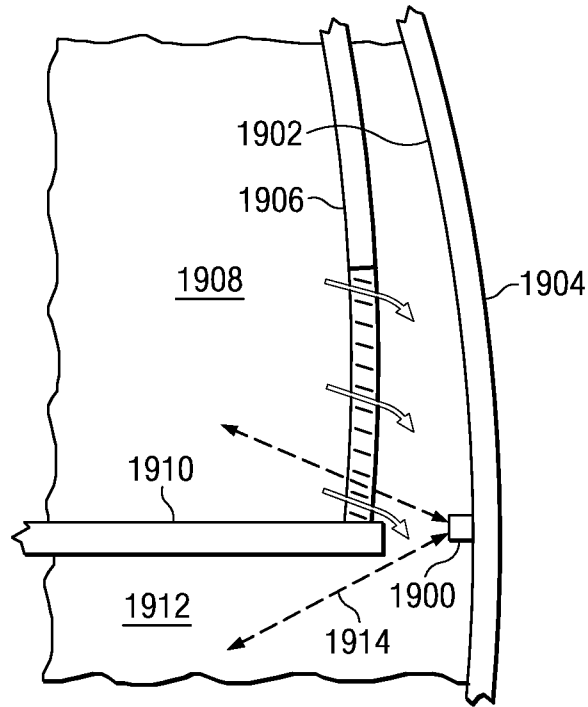


FIG. 19

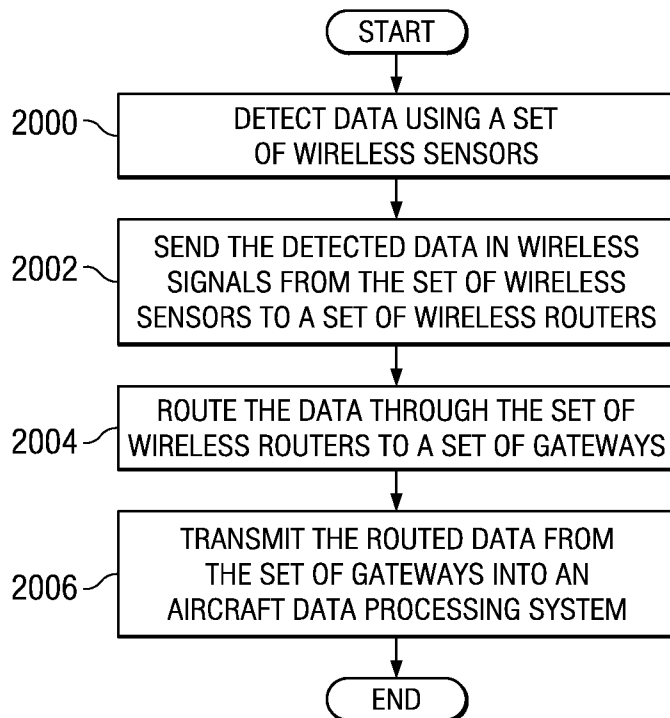


FIG. 20

INTERNATIONAL SEARCH REPORT

International application No PCT/US2009/030714

A. CLASSIFICATION OF SUBJECT MATTER
 INV. H04L29/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
 EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 415 209 B1 (REIMER LAWRENCE B [US]) 2 July 2002 (2002-07-02) the whole document	1-3,10, 15-17
X	US 2007/103289 A1 (DAGCI OGUZ H [US]) 10 May 2007 (2007-05-10) the whole document	1-3,10, 15-17

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents :

A document defining the general state of the art which is not considered to be of particular relevance	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
E earlier document but published on or after the international filing date	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
O document referring to an oral disclosure, use, exhibition or other means	*Z* document member of the same patent family
P document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 6 April 2009	Date of mailing of the international search report 08/07/2009
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Kalabic, Paris
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2009/030714

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable claims.
2. As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-3, 10, 15-17

Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claim: Wireless sensor network in an aircraft

1-3, 10, 15-17

2. claims: 4-8, 14, 19, 20

Wireless router integrated in a window plug

3. claims: 9, 18

Allowing the wireless router to receive a wireless signal
through an opaque section

4. claims: 11-13

Power source

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2009/030714

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6415209	B1	02-07-2002	NONE
US 2007103289	A1	10-05-2007	NONE