



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
15.06.2022 Bulletin 2022/24

(51) International Patent Classification (IPC):
G08G 5/00 ^(2006.01)

(21) Application number: **20213789.9**

(52) Cooperative Patent Classification (CPC):
G08G 5/0026; G08G 5/0082

(22) Date of filing: **14.12.2020**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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(54) **AIR TRAFFIC MANAGEMENT SYSTEM, USE OF AIR TRAFFIC MANAGEMENT SYSTEM AND METHOD OF ESTABLISHING AN IP-BASED AIR TRAFFIC MANAGEMENT SYSTEM**

(57) The invention relates to an air traffic management (ATM) system (10) for monitoring an airspace (12). The ATM system (10) comprises an IP-based voice communication system (16) and a direction finding system (18). The ATM system (10) comprises at least one radio base station (20) for voice communication between a pilot and a controller. The radio base station (20) has an IP interface (34) via which the radio base station (20) is connected to the IP-based voice communication system (16). The direction finding system (18) has at least one

reception radio (46) and an IP interface (32) via which the direction finding system (18) is connected to the IP-based voice communication system (16). The voice communication system (16) and the direction finding system (18) are configured to communicate with each other. The direction finding system (18) is configured to receive and process control signals issued by the voice communication system (16). Further, the use of the ATM system (10) and a method of establishing an IP-based ATM system (10) are described.

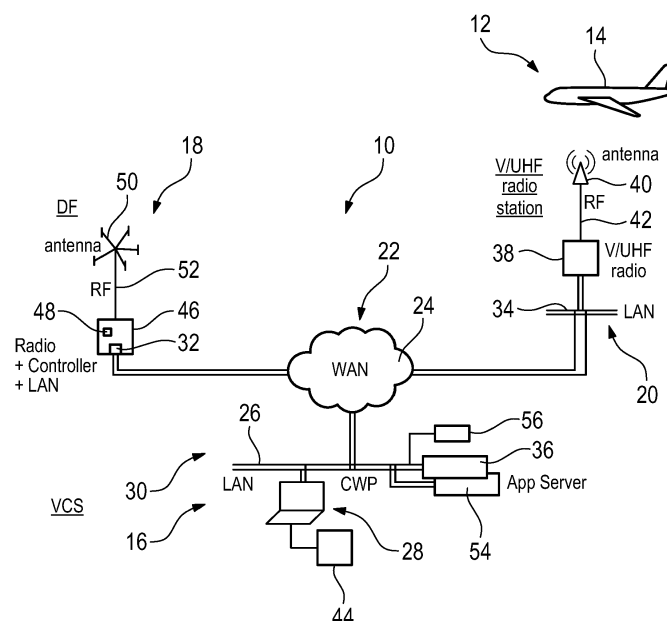


Fig. 1

Description

[0001] The invention relates to an air traffic management system for monitoring an airspace. The invention also relates to the use of the air traffic management system as well as a method of establishing an IP-based air traffic management system.

[0002] Air traffic control (ATC) is a service provided by ground-based air traffic controllers who direct an aircraft on the ground and through the controlled airspace. Typically, a radio communication is established between the air traffic controller and a pilot of the aircraft, thereby ensuring a voice communication with each other by exchanging voice signals. In addition, the air traffic controller obtains information concerning the aircraft within the airspace monitored such that the controlling of the airspace is simplified.

[0003] For instance, direction finding systems are used at airports and other air traffic control (ATC) installations in order to identify the respective direction of the aircraft with which the air traffic controller is communicating. However, the direction finding system has to be protected from being damaged in case the air traffic controller is transmitting signals with a high transmission power. Therefore, a mechanical relay is typically used that is controlled appropriately in order to interrupt a radio frequency connection of the direction finding system in case of a voice signal transmission of the air traffic controller, thereby ensuring that the direction finding system is not disturbed or even damaged by the transmission power of the voice signal transmitted by the air traffic controller.

[0004] The mechanical relay however is subjected to wear and other influences that might impair its operability. Therefore, the relay has to be maintained in order to ensure proper operability of the relay. This results in additional costs.

[0005] Accordingly, there is a need for a more cost-efficient system that requires less maintenance.

[0006] The invention provides an air traffic management (ATM) system for monitoring an airspace. The air traffic management system comprises an IP-based voice communication system (VCS) and a direction finding (DF) system. The air traffic management system further comprises at least one radio base station for voice communication between a pilot and a controller. The radio base station has an IP interface via which the radio base station is connected to the IP-based voice communication system. The direction finding system has at least one reception radio and an IP interface via which the direction finding system is connected to the IP-based voice communication system. The voice communication system and the direction finding system are configured to communicate with each other. The direction finding system is configured to receive and process control signals issued by the voice communication system.

[0007] In general, an air traffic management (ATM) system comprises the systems that assist an aircraft to depart from an aerodrome, to transit the airspace con-

trolled, and to land at a destination aerodrome. Therefore, the air traffic management system typically includes air traffic services (ATS), airspace management (ASM) as well as air traffic flow and capacity management (AT-FCM). The air traffic services typically include the air traffic control (ATC), flight information service (FIS), alerting service (ALRS) and further services.

[0008] The invention is based on the idea to provide a pure IP-based air traffic management system such that the mechanical relay used for muting the direction finding system can be omitted. Accordingly, a conversion from IP data to the relay, particularly a relay contact, is not necessary anymore. This improves the overall operability since the conversion may also be prone to failure. Since the mechanical relay can be omitted by the air traffic management system according to the invention, a reliable and cost-effective solution is provided, as no extra hardware is needed that requires maintenance. Accordingly, the capital expenditure (CAPEX) as well as the operational expenditure (OPEX) can be reduced.

[0009] Generally, the mechanical relay that is replaced by the IP connection is also called antenna switch, as it switches a respective antenna of the direction finding system.

[0010] Since the IP-based voice communication system uses IP technology, namely Internet Protocol technology, for transmitting and/or receiving voice signals, it is ensured that the respective voice signals are transmitted via the respective IP interface to/from the radio base station.

[0011] Further, the respective control signals issued by the IP-based voice communication system are also received by the direction finding system via the respective IP interface of the direction finding system, particularly the one of the reception radio. Accordingly, the control signals correspond to IP packets that are transmitted from the IP-based voice communication system to the direction finding system, particularly the reception radio, which receives the IP packets accordingly. The IP packets received are internally processed by the reception radio or a separately formed control module of the direction finding system.

[0012] Hence, the direction finding system may comprise a separately formed control module that has the IP interface used for receiving the IP packets issued by the voice communication system. The separately formed control module may receive and process the control signals, namely the IP packets, appropriately.

[0013] An aspect provides that the voice communication system and the direction finding system are configured to communicate according to the interoperability standard ED-137. Generally, the interoperability standard ED-137 allows to implement Voice over IP (VoIP) technology for voice services for air traffic control (ATC). The same interoperability standard is also used by the direction finding system, particularly for receiving control signals from the voice communication system over the IP interface of the direction finding system. Hence, a com-

munication between the IP-based voice communication system and the direction finding system is established, which is based on IP-technology, particularly based on rules associated with the interoperability standard ED-137. The interoperability standard ED-137 is used even though no voice signals may be exchanged between the direction finding system and the IP-based voice communication system, but control signals, namely IP packets, following the interoperability standard, particularly the rules associated therewith.

[0014] Another aspect provides that the voice communication system has a push-to-talk (PTT) module, wherein the voice communication system is configured to send an activation signal the radio base station via the IP interface when the controller activates the push-to-talk functionality, wherein the voice communication system is configured to send an indication signal to the direction finding system simultaneously, thereby indicating the activation of the push-to-talk functionality. The IP-based voice communication system is the main component of the air traffic management system with regard to voice communication. Once the air traffic controller has activated the push-to-talk functionality, particularly via the PTT module, the voice communication system issues respective signals to the direction finding system and the radio base station in order to ensure that the direction finding system is enabled to protect itself from high transmission power of the radio base station. Accordingly, the voice communication system may interact with a control module of the direction finding system, thereby ensuring that the direction finding system processes the indication signal received from the voice communication system appropriately in order to mute itself. The indication signal issued by the voice communication system corresponds to a control signal that is transmitted to the direction finding system via its IP interface. Accordingly, the indication signal is based on at least one IP packet that is transmitted or rather forwarded to the direction finding system for being processed by the direction finding system. The respective communication between the voice communication system and the direction finding system follows the rules according to the interoperability standard ED-137. The air traffic controller is enabled to activate the push-to-talk functionality by means of the push-to-talk module. Moreover, the interoperability standard ED-137 enables interworking with different equipment following the respective standard.

[0015] According to another aspect, the reception radio or a separately formed control module is configured to receive the indication signal issued by the voice communication system. The reception radio or the control module is configured to process the indication signal, thereby enabling a mute operation mode of the direction finding system. The reception radio has an internal control module that is configured to process the indication signal received. In fact, the mechanical relay has been replaced by the IP connection established between the IP-based voice communication system and the direction

finding system having the IP interface. The voice communication system is enabled to send control signals like the indication signal towards the direction finding system, wherein the IP packets of the control signals are received and processed by the direction finding system internally, particularly the reception radio or rather the separately formed control module. By processing the control signals, particularly the indication signal, the direction finding system is enabled to activate the mute operation mode, thereby protecting the direction finding system.

[0016] Another aspect provides that the air traffic management system comprises at least one controller working position (CWP). The air traffic controller is working at the controller working position when controlling the airspace. The PPT module may be associated with the CWP such that the controller is enabled to activate the push-to-talk functionality via the push-to-talk module while working at the CWP. Hence, the PTT module may be connected to the CWP.

[0017] Therefore, it may be the CWP that is configured to send the activation signal to the radio base station via the IP interface when the controller activates the push-to-talk functionality. Moreover, the CWP is configured to send the indication signal to the direction finding system simultaneously, thereby indicating the activation of the push-to-talk functionality.

[0018] Furthermore, the reception radio or the separately formed control module is configured to receive the indication signal issued by the CWP.

[0019] At the CWP, a display for displaying radar information gathered and other information may be provided that is used by the air traffic controller for monitoring/controlling the respective airspace.

[0020] The air traffic management system may comprise an IP network to which the voice communication system, the direction finding system and the radio base station are connected. Particularly, the controller working position is also connected to the IP network. The IP network may comprise a wide area network (WAN) and/or a local area network (LAN). Particularly, the IP network comprises a wide area network to which the direction finding system as well as the radio base station are connected. In addition, a local area network is also provided by the IP network, which is connected with the wide area network. For instance, the voice communication system, particularly the controller working position, is connected to the local area network such that the voice communication system, particularly the controller working position, is connected with the direction finding system as well as the radio base station via the LAN and the WAN, which together establish the IP network.

[0021] The respective connections to the IP network may be established by means of Ethernet cables and/or fiber cables.

[0022] Another aspect provides that the air traffic management system comprises a delay balancing module that is configured to balance time delays. Particularly, time delays in the IP network are balanced by means of

the air traffic management system. In fact, the respective connection lines established between the respective components of the air traffic management system may have different lengths, yielding different time delays or rather lags. The delay balancing module is used to balance the respective time delays, thereby balancing different time delays among the respective components of the air traffic management system. Particularly, the different time delays are equalized by means of the delay balancing module such that the time delays are the same.

[0023] For instance, the component connected to the IP network having a lower time delay compared to another component may be actively delayed such that both components have the same time delay, resulting in a balanced time delay even though the time delay associated with the first component is increased intentionally.

[0024] Generally, different time delays or rather time delay differences within the air traffic management system may be acceptable, which depends on the respective component having the higher time delay. For instance, a lower time delay between the voice communication system and the direction finding system compared to the time delay between the voice communication system and the radio base station may be deemed to be appropriate, as this would result in an earlier muting of the direction finding system due to the lower time delay.

[0025] However, a lower time delay between the voice communication system and the radio base station compared to the time delay between the voice communication system and the direction finding system would not be acceptable. This could result in the occurrence of a voice signal transmission prior to muting the direction finding system, thereby running the risk of damage of the direction finding system. Therefore, the respective time delays would be balanced.

[0026] For instance, the delay balancing module is configured to balance the time delay between the transmission time from the voice communication system to the radio base station and the transmission time from the voice communication system to the direction finding system, thereby adapting signal reception at the radio base station and/or the direction finding system. The delay balancing module is enabled to obtain the respective time delays available within the respective communication lines, for instance between the voice communication system and the radio base station and/or between the voice communication system and the direction finding system. Based on the delay results obtained, the delay balancing module is further configured to evaluate the respective time delays, particularly for each push-to-talk activation, thereby ensuring that deviations within the IP connection established are taken to count appropriately.

[0027] For instance, the transmission time from the voice communication system to the radio base station is adapted accordingly such that no adaption of the transmission from the voice communication system to the direction finding system takes place. In fact, the direction finding system shall receive the indication signal at least

simultaneously with the radio base station receiving the activation signal or even earlier than the radio base station. Therefore, the transmission time or rather the delay within the IP communication between the voice communication system and the radio base station may be adapted, particularly additionally delayed. By delaying the transmission time from the voice communication system to the radio base station, it is ensured that the radio base station and the direction finding system receive the signals at least simultaneously. Alternatively, the transmission time be adapted, particularly additionally delayed. By delaying the transmission time from the voice communication system to the radio base station is intentionally delayed such that the direction finding system receives the respective signal earlier than the radio base station.

[0028] Another aspect provides, that the air traffic management system comprises a network time protocol (NTP) server for time synchronization. The network time protocol server may be connected with the IP network. The network time protocol server is used by the delay balancing module for balancing the respective time delays that occur within the air traffic management system, particularly the IP network to which the respective components of the air traffic management system are connected. The NTP server provides a reliable time that is used for gathering the respective time delays of the individual IP connections.

[0029] Moreover, the at least one radio base station may be connected to a radio frequency (RF) antenna. The respective connection may be established by means of a radio frequency line. Thus, the radio base station is enabled to convert the IP packets received via the IP interface into a radio frequency signal that is forwarded to the radio frequency antenna via the radio frequency line accordingly. The radio frequency antenna is used for transmitting the voice communication signals towards the aircraft that is communicating with the air traffic controller.

[0030] In addition, the reception radio may be connected to a direction finding (DF) antenna. The respective connection may also be established by means of a radio frequency line. In a similar manner, the reception radio is enabled to convert radio frequency signals received, particularly radar signals, into IP packets that are forwarded to the voice communication system or other components of the air traffic management system. The respective radio frequency signals received, namely the radar signals received, are processed by the air traffic management system in order to provide the respective information to the air traffic controller, for instance on a radar screen or rather a display used for displaying information gathered.

[0031] The radio base station may have at least one radio that is a high frequency radio, particularly a very high frequency (VHF) or an ultra-high frequency (UHF) radio. Thus, the at least one radio of the radio base station may relate to a V/UHF radio. Generally, the V/UHF radio

ensures a radio coverage of several tens of kilometers, particularly 100 kilometers and even more.

[0032] Generally, the radio base station may have a radio that can be operated at other frequencies as well.

[0033] Furthermore, the voice communication system may be connected with the direction finding system in a relay-less manner. As mentioned above, the IP connection established between the voice communication system and the direction finding system is used for replacing the mechanical relay, thereby ensuring that the respective connection may be established in a relay-less manner, as no mechanical relay is interconnected. Hence, maintenance costs for the relay or rather the relays can be saved accordingly.

[0034] The invention also provides the use of the air traffic management system mentioned above for establishing a radio communication with a pilot of an airplane. A push-to-talk functionality is activated by the controller who interacts with the IP-based voice communication system, particularly via a controller working position (CWP) to which the push-to-talk module is connected. When the push-to-talk functionality is activated, the IP-based voice communication system sends an activation signal to the radio base station and an indication signal to the direction finding system simultaneously, thereby indicating the activation of the push-to-talk functionality. Accordingly, the air traffic management system using IP technology, particularly the IP-based voice communication system, is used for controlling the direction finding system.

[0035] In addition, the invention provides a method of establishing an IP-based air traffic management system, with the steps of:

- Providing an IP-based voice communication system,
- Providing at least one radio base station having an IP interface,
- Providing a direction finding system with a reception radio and/or a separately formed control module and an IP interface,
- Connecting the IP-based voice communication system with the at least one radio base station via its IP interface, and
- Connecting the IP-based voice communication system with the direction finding system via its IP interface, thereby establishing an IP communication connection which ensures that the direction finding system is enabled to receive and process control signals issued by the voice communication system.

[0036] Hence, the IP-based air traffic management system is provided, as the IP-based voice communication system is connected with the radio base station and the direction finding system via the respective IP inter-

faces.

[0037] The above-mentioned characteristics and advantages apply for the air traffic management system, the usage of the air traffic management system and the method of establishing an IP-based air traffic management system in a similar manner.

[0038] Generally, the IP-based air traffic management system, particularly the IP-based voice communication system, uses end-to-end IP technology from the CWP all the way to the base radio station while addressing increased safety requirements. In addition, the IP-based air traffic management system, particularly the IP-based voice communication system, also uses end-to-end IP technology from the CWP all the way to the direction finding system in order to control the direction finding system, particularly muting the direction finding system.

[0039] Moreover, the direction finding system enables air traffic controllers to accurately determine the direction to the aircraft on the basis of its radio transmissions.

[0040] Specifically, the direction finding system may also use IP technology for forwarding information received to the voice communication system or other components of the air traffic management system.

[0041] Certain embodiments disclosed herein, particularly the respective module(s), utilize circuitry (e.g., one or more circuits) in order to implement standards, protocols, methodologies or technologies disclosed herein, operably couple two or more components, generate information, process information, analyze information, generate signals, encode/decode signals, convert signals, transmit and/or receive signals, control other devices, etc. Circuitry of any type can be used.

[0042] In an embodiment, circuitry includes, among other things, one or more computing devices such as a processor (e.g., a microprocessor), a central processing unit (CPU), a digital signal processor (DSP), an application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA), a system on a chip (SoC), or the like, or any combinations thereof, and can include discrete digital or analog circuit elements or electronics, or combinations thereof. In an embodiment, circuitry includes hardware circuit implementations (e.g., implementations in analog circuitry, implementations in digital circuitry, and the like, and combinations thereof).

[0043] In an embodiment, circuitry includes combinations of circuits and computer program products having software or firmware instructions stored on one or more computer readable memories that work together to cause a device to perform one or more protocols, methodologies or technologies described herein. In an embodiment, circuitry includes circuits, such as, for example, microprocessors or portions of microprocessor, that require software, firmware, and the like for operation. In an embodiment, circuitry includes one or more processors or portions thereof and accompanying software, firmware, hardware, and the like.

[0044] The present application may reference quantities and numbers. Unless specifically stated, such quan-

ties and numbers are not to be considered restrictive, but exemplary of the possible quantities or numbers associated with the present application. Also in this regard, the present application may use the term "plurality" to reference a quantity or number. In this regard, the term "plurality" is meant to be any number that is more than one, for example, two, three, four, five, etc. The terms "about", "approximately", "near" etc., mean plus or minus 5% of the stated value.

[0045] The forgoing aspect and many of the attendant advantages of the claim subject matter will become readily appreciated as the same become better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings.

[0046] The detailed description set forth below in connection with the appended drawings, where like numerals reference like elements, is intended as a description of various embodiments of the disclosed subject matter and is not intended to represent the only embodiments. Each embodiment described in this disclosure is provided merely as an example or illustration and should not be construed as preferred or advantageous over other embodiments. The illustrative examples provided herein are not intended to be exhaustive or to limit the claimed subject matter to the precise forms disclosed.

[0047] For the purposes of the present disclosure, the phrase "at least one of A, B, and C", for example, means (A), (B), (C), (A and B), (A and C), (B and C), or (A, B, and C), including all further possible permutations when more than three elements are listed. In other words, the term "at least one of A and B" generally means "A and/or B", namely "A" alone, "B" alone or "A and B".

[0048] In the drawings, Figure 1 schematically shows an overview of the air traffic management system according to the invention.

[0049] In Figure 1, an air traffic management system 10 is shown for monitoring an airspace 12 that is used by different aircrafts 14.

[0050] The air traffic management system 10 comprises an IP-based voice communication system (VCS) 16, a direction finding system 18 as well as at least one radio base station 20.

[0051] In addition, the air traffic management system 10 has an IP network 22 to which the respective components of the air traffic management system 10 are connected, namely the IP-based voice communication system 16, the direction finding system 18 as well as the radio base station 20. The components of the air traffic management system 10 are established by means of Ethernet cables and/or fiber cables.

[0052] In the shown embodiment, the IP network 22 comprises a wide area network (WAN) 24 as well as a local area network (LAN) 26. LAN 26 is assigned to the voice communication system 16 as well as a controller working position 28 at which an air traffic controller works in order to control or rather monitor the airspace 12.

[0053] LAN 26 and the direction finding system 18 as well as the radio base station 20 are connected with WAN

24.

[0054] Accordingly, all components of the air traffic management system 10 mentioned above, namely the IP-based voice communication system 16, the direction finding system 18 as well as the radio base station 20 comprise a respective IP interface 30, 32, 34 via which these components are embedded in the IP network 22.

[0055] In the shown embodiment, the voice communication system 16 comprises an application server 36 on which respective algorithms and programs run, which inter alia ensure that the voice signals of the air traffic controller who works at the CWP 28 are forwarded to the ground base station 20.

[0056] Accordingly, the air traffic controller speaks with the pilot of the aircraft 14 wherein the voice signals are converted into IP packets that are forwarded to the radio base station 20 via the IP network 22, namely LAN 26 as well as WAN 24.

[0057] The radio base station 20 converts the IP packets received via its IP interface 34 into radio frequency signals that are forwarded to the aircraft 14, particularly the pilot. For this purpose, the radio base station 20 comprises at least one radio 38 as well as a radio frequency antenna 40 that is connected to the radio 38.

[0058] The radio 38 may be established as a very high frequency (VHF) or an ultra-high frequency (UHF) radio, resulting in a V/UHF radio 38. The respective radio frequency antenna 40 is connected with the radio 38 via a radio frequency (RF) line 42.

[0059] Accordingly, the radio 38 is enabled to convert the IP packets received into a radio frequency signal that is forwarded to the radio frequency antenna 40 via the radio frequency line 42 in order to be transmitted via the RF antenna 40 towards the aircraft 14.

[0060] The voice communication system 16 comprises a push-to-talk (PTT) module 44 that is activated by the air traffic controller when the controller wants to start a communication with the pilot of the aircraft 14.

[0061] For this purpose, the controller activates the respective push-to-talk functionality via the push-to-talk module 44 which is connected to the controller working position (CWP) 28 such that the controller can activate the PTT functionality easily via the CWP 28.

[0062] Then, the voice communication system 16, particularly the CWP 28, sends an activation signal to the radio base station 20 via the IP network 22, namely the local area network 26 and the wide area network 24, thereby preparing the radio base station 20 for radio transmission.

[0063] As mentioned above, the radio base station 20 receives the respective IP packets associated with the activation signal, wherein the IP packets are internally processed such that the radio base station 20 is enabled for radio transmission, namely transmission of voice signals spoken by the air traffic controller once the push-to-talk functionality has been activated.

[0064] Simultaneously, the voice communication system 16, particularly the CWP 28, transmits an indication

signal to the direction finding system 18 via the IP network 22, namely LAN 26 and WAN 24, when the controller activates the respective push-to-talk functionality via the push-to-talk module 44.

[0065] The direction finding system 18 comprises a reception radio 46 that may comprise an internal control module 48 that is used for receiving and processing the respective IP packets associated with the indication signal. The internal control module 48 processes the IP packets such that a direction finding antenna 50 of the direction finding system 18 is muted in order to ensure that the direction finding system 18 protects itself from the upcoming radio transmission.

[0066] In an alternative embodiment, the control module 48 may be separately established with respect to the reception radio 46.

[0067] Generally, the direction finding antenna 50 is connected with the reception radio 46 via a radio frequency (RF) line 52, wherein the reception radio 46 typically receives radio frequency (RF) signals from the direction finding antenna 50. The respective RF signals may encompass information concerning the location or rather position of aircrafts 14 within the airspace 12. For instance, the RF signals relate to radar signals.

[0068] As mentioned above, the reception radio 46 is however also enabled to receive and process control signals received from the voice communication system 16, particularly the CWP 28, in order to protect the direction finding system 18.

[0069] The respective control signal received and processed relate to the indication signal issued by the voice communication system 16, namely the CWP 28.

[0070] Since the direction finding system 18 also receives the control signals, particularly the indication signal, via the IP network 22, it is ensured that the direction finding system 18 is also enabled to communicate according to the interoperability standard ED-137 as well as the voice communication system 16 and the radio base station 20.

[0071] In general, the interoperability standard ED-137 allows to implement Voice over IP (VoIP) technology for voice services for the air traffic control (ATC), namely the voice communication system 16. The same interoperability standard is used by the direction finding system 18 for receiving the control signals or rather the indication signal from the voice communication system 16 over the IP interface 32.

[0072] Generally, the respective components of the air traffic management system 10 may be located at different locations such that different distances are provided, resulting in different time delays for the respective communications.

[0073] Accordingly, the voice communication system 16 also comprises a network time protocol (NTP) server 54 as well as a delay balancing module 56, which are used to gather information concerning the time delays (in an absolute and comparable manner) and to balance the occurring time delays.

[0074] The network time protocol server 54 embedded in the IP network 22 is used for time synchronization, as the NTP server 54 provides a reliable time that is used for gathering the respective time delays of the individual IP connections to be balanced.

[0075] The delay balancing module 56 gathers the individual time delays of the respective IP connections, particularly the delay times of the IP connections established between the voice communication system 16 and the direction finding system 18 as well as between the voice communication system 16 and the radio ground station 20. After gathering the individual time delays, the delay balancing module 56 balances these time delays, for instance by actively/intentionally delaying at least one signal transmission in order to adjust/align the different time delays.

[0076] Accordingly, the time delay balancing module 56 balances the time delay between the transmission time from the voice communication system 16 to the radio base station 20 and the transmission time from the voice communication system 16 to the direction finding system 18. Hence, signal reception at the radio base station 20 and/or the direction finding system 18 are/is adapted in order to ensure that the direction finding system 18 is muted or its mute operation mode is activated concurrent or rather prior to the voice signal transmission via the radio base station 20. Hence, the direction finding system 18 is protected from receiving a high transmission power used when transmitting voice signals via the radio base station 20 towards the aircraft 14.

[0077] The air traffic management system 10 is enabled to protect the direction finding system 18 in a relayless manner, as the direction finding system 18, particularly the reception radio 32, is controlled by the voice communication system 16 via IP packets exchanged. The IP packets are forwarded via the IP network 22 that is established between the voice communication system 16 and the direction finding system 18.

Claims

1. An air traffic management system for monitoring an airspace (12), wherein the air traffic management system (10) comprises an IP-based voice communication system (16) and a direction finding system (18), wherein the air traffic management system (10) further comprises at least one radio base station (20) for voice communication between a pilot and a controller, wherein the radio base station (20) has an IP interface (34) via which the radio base station (20) is connected to the IP-based voice communication system (16), wherein the direction finding system (18) has at least one reception radio (46) and an IP interface (32) via which the direction finding system (18) is connected to the IP-based voice communication system (16),

and

wherein the voice communication system (16) and the direction finding system (18) are configured to communicate with each other, wherein the direction finding system (18) is configured to receive and process control signals issued by the voice communication system (16).

2. The air traffic management system according to claim 1, **characterized in that** the voice communication system (16) and the direction finding system (18) are configured to communicate according to the interoperability standard ED-137.
3. The air traffic management system according to claim 1 or 2, **characterized in that** the voice communication system (16) has a push-to-talk module (44), wherein the voice communication system (16) is configured to send an activation signal to the radio base station (20) via the IP interface (34) when the controller activates the push-to-talk functionality, wherein the voice communication system (16) is configured to send an indication signal to the direction finding system (18) simultaneously, thereby indicating the activation of the push-to-talk functionality.
4. The air traffic management system according to claim 3, **characterized in that** the reception radio (46) or a separately formed control module (48) is configured to receive the indication signal issued by the voice communication system (16), wherein the reception radio (46) or the control module (48) is configured to process the indication signal, thereby enabling a mute operation mode of the direction finding system (18).
5. The air traffic management system according to any of the preceding claims, **characterized in that** the air traffic management system (10) comprises at least one controller working position (28).
6. The air traffic management system according to any of the preceding claims, **characterized in that** the air traffic management system (10) comprises an IP network (22) to which the voice communication system (16), the direction finding system (18) and the radio base station (20) are connected.
7. The air traffic management system according to any of the preceding claims, **characterized in that** the air traffic management system (10) comprises a delay balancing module (56) that is configured to balance time delays, in particular time delays in the IP network (22).
8. The air traffic management system according to claim 7, **characterized in that** the delay balancing module (56) is configured to balance the time delay

between a transmission time from the voice communication system (16) to the radio base station (20) and a transmission time from the voice communication system (16) to the direction finding system (18), thereby adapting signal reception at the radio base station (20) and/or the direction finding system (18).

9. The air traffic management system according to any of the preceding claims, **characterized in that** the air traffic management system (10) comprises a network time protocol server (54) for time synchronization, in particular wherein the network time protocol server (54) is connected with the IP network (22).
10. The air traffic management system according to any of the preceding claims, **characterized in that** the at least one radio base station (20) is connected to a radio frequency antenna (40), in particular by means of a radio frequency line (42).
11. The air traffic management system according to any of the preceding claims, **characterized in that** the reception radio (46) is connected to a direction finding antenna (50), in particular by means of a radio frequency line (52).
12. The air traffic management system according to any of the preceding claims, **characterized in that** the radio base station (20) has at least one radio (38) that is a high frequency radio, particularly a very high frequency (VHF) or an ultra-high frequency (UHF) radio.
13. The air traffic management system according to any of the preceding claims, **characterized in that** the voice communication system (16) is connected with the direction finding system (18) in a relay-less manner.
14. Use of the air traffic management system (10) according to any of the preceding claims for establishing a radio communication with a pilot of an airplane, wherein a push-to-talk functionality is activated by the controller that interacts with the IP-based voice communication system (16), wherein, when the push-to-talk functionality is activated, the IP-based voice communication system (16) sends an activation signal to the radio base station (20) and an indication signal to the direction finding system (18) simultaneously, thereby indicating the activation of the push-to-talk functionality.
15. A method of establishing an IP-based air traffic management system (10), with the steps of:
 - Providing an IP-based voice communication system (16),
 - Providing at least one radio base station (20)

having an IP interface (34),

- Providing a direction finding system (18) with a reception radio (46) and/or a separately formed control module (48) and an IP interface (32),

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- Connecting the IP-based voice communication system (16) with the at least one radio base station (20) via its IP interface (34), and

- Connecting the IP-based voice communication system (16) with the direction finding system (18) via its IP interface (32), thereby establishing an IP communication connection which ensures that the direction finding system (18) is enabled to receive and process control signals issued by the voice communication system (16).

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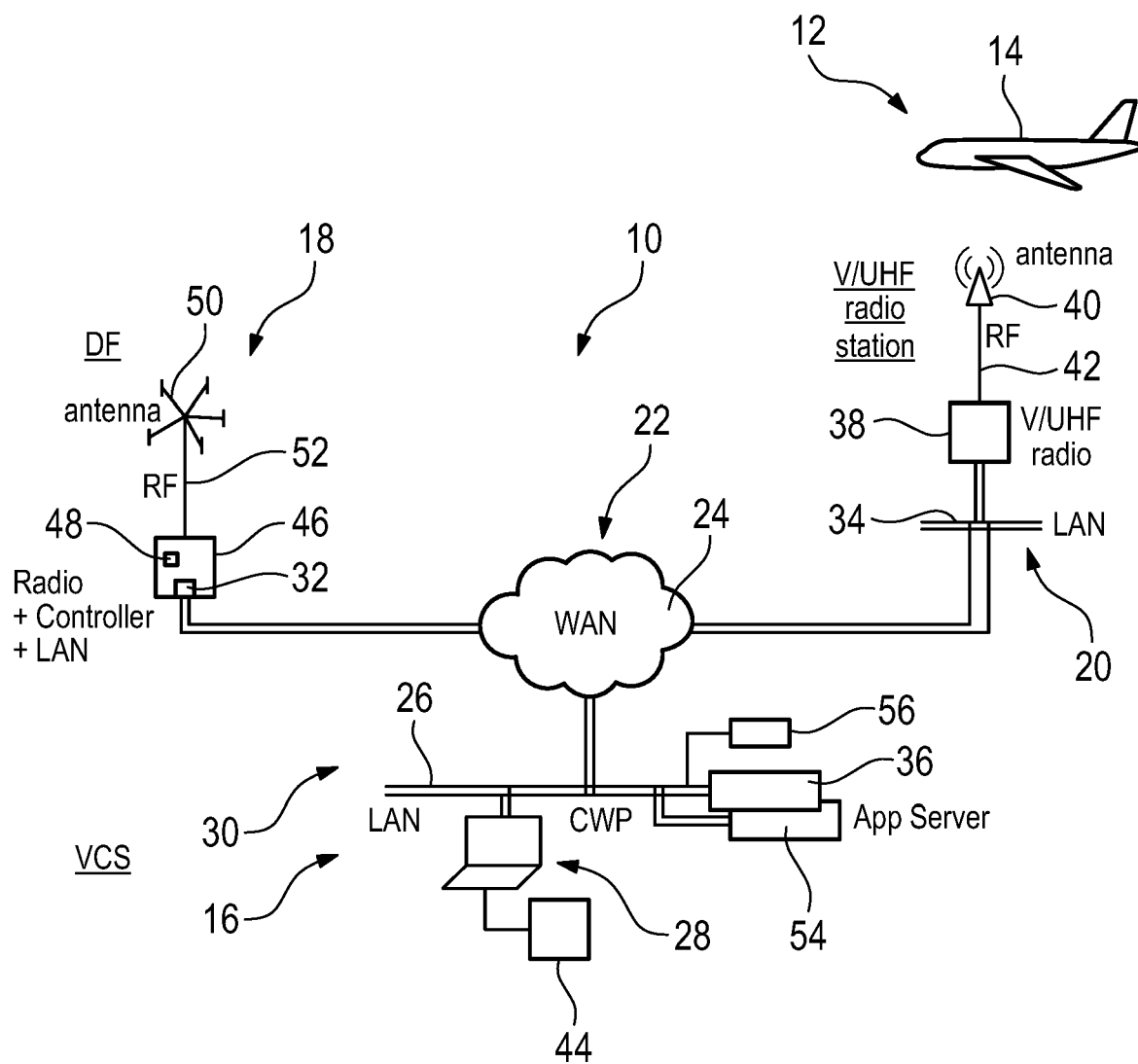


Fig. 1



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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 27 May 2021	Examiner Schröter, Marcel
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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