

UTILITY PATENT APPLICATION TRANSMITTAL (Only for new nonprovisional applications under 37 CFR 1.53(b))		Attorney Docket No. 32045/50990	
		First Named Inventor Heinz A. Miranda	
		Title Servicing Cell Selection in Air to Ground Communication Systems	
		Express Mail Label No.	

APPLICATION ELEMENTS See MPEP chapter 600 concerning utility patent application contents. 1. ☐ Fee Transmittal Form (PTO/SB/17 or equivalent) 2. ☐ Applicant asserts small entity status. See 37 CFR 1.27 3. ☐ Applicant certifies microentity status. See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent. 4. ☒ Specification [Total Pages <u>29</u>] Both the claims and abstract must start on a new page. (See MPEP § 608.01(a) for information on the preferred arrangement) 5. ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets <u>6</u>] 6. Inventor's Oath or Declaration [Total Pages <u>4</u>] (including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e)) a. ☒ Newly executed (original or copy) b. ☐ A copy from a prior application (37 CFR 1.63(d)) 7. ☒ Application Data Sheet * See note below. See 37 CFR 1.76 (PTO/AIA/14 or equivalent) 8. CD-ROM or CD-R in duplicate, large table, or Computer Program (Appendix) ☐ Landscape Table on CD 9. Nucleotide and/or Amino Acid Sequence Submission (if applicable, items a. – c. are required) a. ☐ Computer Readable Form (CRF) b. ☐ Specification Sequence Listing on: i. ☐ CD-ROM or CD-R (2 copies); or ii. ☐ Paper c. ☐ Statements verifying identity of above copies	ADDRESS TO: Commissioner for Patents P.O. Box 1450 Alexandria, VA 22313-1450 ACCOMPANYING APPLICATION PAPERS 10. ☐ Assignment Papers (cover sheet & document(s)) 11. ☐ 37 CFR 3.73(c) Statement ☐ Power of Attorney (when there is an assignee) 12. ☐ English Translation Document (if applicable) 13. ☒ Information Disclosure Statement (PTO/SB/08 or PTO-1449) ☐ Copies of citations attached 14. ☐ Preliminary Amendment 15. ☐ Return Receipt Postcard (MPEP § 503) (Should be specifically itemized) 16. ☐ Certified Copy of Priority Document(s) (if foreign priority is claimed) 17. ☐ Nonpublication Request Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent. 18. ☐ Other:
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***Note:** (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must** be included in an Application Data Sheet (ADS).
(2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

19. CORRESPONDENCE ADDRESS			
☒ The address associated with Customer Number: <u>04743</u> OR ☐ Correspondence address below			
Name			
Address			
City	State	Zip Code	
Country	Telephone	Email	
Signature /Jeffrey M. Blank, Reg. No.: 71,335/		Date	November 15, 2016
Name (Print/Type) Jeffrey M. Blank		Registration No. (Attorney/Agent)	71,335

Application Data Sheet

Inventor Information

Inventor Number::	1
Given Name::	Heinz
Middle Name::	A.
Family Name::	Miranda
City of Residence::	Cary
State or Province of Residence::	IL
Country of Residence::	US
Street of mailing address::	208 Foxford Drive
City of mailing address::	Cary
State or Province of mailing address::	IL
Country of mailing address::	US
Postal or Zip Code of mailing address::	60013
Inventor Number::	2
Name Prefix::	Mr.
Given Name::	Michael
Middle Name::	H.
Family Name::	Baker
City of Residence::	Elmhurst
State or Province of Residence::	IL
Country of Residence::	US
Street of mailing address::	375 S. Mitchell Avenue
City of mailing address::	Elmhurst

State or Province of mailing address:: IL
Country of mailing address:: US
Postal or Zip Code of mailing address:: 60126

Inventor Number:: 3
Name Prefix:: Mr.
Given Name:: James
Middle Name:: P.
Family Name:: Michels
City of Residence:: Lake Zurich
State or Province of Residence:: IL
Country of Residence:: US
Street of mailing address:: 1050 Westberry Ct
City of mailing address:: Lake Zurich
State or Province of mailing address:: IL
Country of mailing address:: US
Postal or Zip Code of mailing address:: 60047

Inventor Number:: 4
Given Name:: Yong
Family Name:: Liu
City of Residence:: Schaumburg
State or Province of Residence:: IL

Country of Residence::	US
Street of mailing address::	1817 Altoona Court
City of mailing address::	Schaumburg
State or Province of mailing address::	IL
Country of mailing address::	US
Postal or Zip Code of mailing address::	60194

Correspondence Information

Correspondence Customer Number::	04743
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Application Information

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Small Entity?::	No
Petition included?::	No

Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2:: No

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When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

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This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Jeffrey M. Blank, Reg. No.: 71,335/	Date (YYYY-MM-DD)	2016-11-15
Name	Jeffrey M. Blank	Registration Number	71,335

SERVICING CELL SELECTION IN AIR TO GROUND COMMUNICATION SYSTEMS

FIELD OF THE INVENTION

[0001] The disclosure generally relates to apparatus, methods, and articles of manufacture to select serving cells in air to ground communication systems and, more particularly, to maximize throughput available to a user of an air to ground communication system in the presence of high interference.

BACKGROUND

[0002] Given the scarcity of allocated radio frequency spectrum, providers of air-to-ground (ATG) communication systems may make secondary use of already allocated spectrum, for example in the 14 gigahertz (GHz) range or use unlicensed bands, for example in the 2.4 GHz range, while providing ATG services. Unfortunately, radio frequency (RF) spectrum surveys show that RF noise and interference sources have risen over time, and are expected to continue to rise in the future. Some example surveys of the 2.4 GHz band observed noise rise on the order of 30dB over a short period of time. Noise surveys also show a non-uniform distribution of noise levels over time or space. Such high levels of interference have the ability to significantly degrade the quality and available data bandwidth of the radio link, particularly if the objective is to provide consistent and reliable data rates that meet customer and industry expectations.

[0003] Given the presence of high RF noise and/or interference, at a given time, it is possible to find particular locations where noise or interference is low enough to guarantee an acceptable data rate. For example, for a given aircraft location, establishing a connection with acceptable data rate may utilize a scheme that selects the serving cell considering the noise levels from multiple candidate serving cell locations.

[0004] Network operators may establish primary communications for control information with the aircraft using their existing equipment and allocated spectrum and use the noisy 2.4 GHz spectrum primarily for data traffic. Primary in-flight communication networks may require reliable connectivity between ground and the aircraft, whereas supplementary in-flight communication networks may operate over noisy radio frequency spectrum. Some examples of

primary networks may include satellite networks or other ATG networks that operate over licensed spectrum.

[0005] Schemes to select among ATG serving cells that maximize throughput to a given aircraft in the forward and return directions in a high interference frequency band may provide significant performance advantages in terms of stability of connection, available bandwidth, and latency

SUMMARY

[0006] One exemplary embodiment includes a non-transitory computer readable medium, comprising processor executable instructions that when executed by a computer processor disposed within an airborne aircraft cause the computer processor to command a directional antenna installed on the aircraft and a transceiver disposed within the aircraft to measure a first signal-to-noise ratio for a first communication channel at a first location on the ground; command the directional antenna and the transceiver to measure a second signal-to-noise ratio for a second communication channel at a second location on the ground; calculate a first forward-link user capacity estimate using the first signal-to-noise ratio for the first communication channel; calculate a second forward-link user capacity estimate using the second signal-to-noise ratio for the second communication channel; and calculate a forward-link user capacity matrix using the first forward-link user capacity estimate and the second forward-link capacity estimate.

[0007] Another exemplary embodiment includes a computer-implemented method, executed with a computer processor disposed within an air-to-ground communication ground station, that includes commanding, with the computer processor, a directional antenna installed at the ground station and a transceiver disposed within the ground station to measure a first noise power level for a first communication channel at a first elevation and a first azimuth from a current position of the ground station; commanding, with the computer processor, the directional antenna and the transceiver to measure a second noise power level for a second communication channel at a second elevation and a second azimuth from the current position of the ground station; calculating, with the computer processor, a first reverse-link user capacity estimate using the first noise power level for the first communication channel; calculating, with the computer processor,

a second reverse-link user capacity estimate using the second noise power level for the second communication channel; and calculating, with the computer processor, a reverse-link user capacity matrix using the first reverse-link user capacity estimate and the second reverse-link capacity estimate.

[0008] Yet another exemplary embodiment includes a computer system comprising one or more processors and/or transceivers configured to retrieve at least one of (i) a forward-link user capacity matrix comprising a plurality of forward-link user capacity estimates each associated with a location on the ground; and (ii) a return-link capacity matrix comprising a plurality of reverse-link user capacity estimates each associated with an azimuth and elevation from a current location of an airborne aircraft; calculate a candidate serving cell, using at least one of (i) the forward-link user capacity matrix and (ii) the reverse-link user capacity matrix; and command a directional antenna and a transceiver to transmit or receive data with the candidate serving cell.

[0009] Exemplary embodiments may include computer-implemented methods that may in other embodiments include apparatus configured to implement the method, and/or non-transitory computer readable mediums comprising computer-executable instructions that cause a processor to perform the method.

[0010] Advantages will become more apparent to those skilled in the art from the following description of the preferred embodiments which have been shown and described by way of illustration. As will be realized, the present embodiments may be capable of other and different embodiments, and their details are capable of modification in various respects. Accordingly, the drawings and description are to be regarded as illustrative in nature and not as restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The Figures described below depict various aspects of the system and methods disclosed herein. It should be understood that each figure depicts an aspect of a particular aspect of the disclosed system and methods, and that each of the Figures is intended to accord with a possible aspect thereof. Further, wherever possible, the following description refers to the

reference numerals included in the following Figures, in which features depicted in multiple Figures are designated with consistent reference numerals.

[0012] There are shown in the Figures arrangements which are presently discussed, it being understood, however, that the present embodiments are not limited to the precise arrangements and instrumentalities shown, wherein:

[0013] Figure 1 illustrates an exemplary illustration of an air-to-ground communication system, including a variety of ground stations communicating with an airborne aircraft, in accordance with one aspect of the present disclosure;

[0014] Figure 2 illustrates an exemplary block diagram of a method to communicate between a variety of ground stations and an airborne aircraft, in accordance with one aspect of the present disclosure;

[0015] Figure 3 illustrates an exemplary block diagram of a system that includes a variety of geographically distributed ground stations interconnected with ground station controllers, that communicate with an airborne aircraft, in accordance with one aspect of the present disclosure;

[0016] Figure 4 illustrates an exemplary block diagram of a system that includes a variety of geographically distributed ground stations that communicate with an airborne aircraft, where the aircraft builds a forward-link user capacity matrix, in accordance with one aspect of the present disclosure;

[0017] Figure 5 illustrates an exemplary illustration of a forward-link user capacity matrix, in accordance with one aspect of the present disclosure;

[0018] Figure 6 illustrates an exemplary block diagram of a system that includes a variety of geographically distributed ground stations that communicate with an airborne aircraft, where the ground stations build a reverse-link noise matrix and reverse-link user capacity matrix, in accordance with one aspect of the present disclosure;

[0019] Figure 7 illustrates an exemplary illustration of a reverse-link noise matrix, in accordance with one aspect of the present disclosure;

[0020] Figure 8 illustrates an exemplary illustration of a reverse-link user capacity matrix, in accordance with one aspect of the present disclosure;

[0021] Figure 9 illustrates an exemplary block diagram of a computing system, in accordance with one aspect of the present disclosure; and

[0022] Figure 10 illustrates an exemplary non-transitory computer readable medium, in accordance with one aspect of the present disclosure.

[0023] The Figures depict preferred embodiments for purposes of illustration only. Alternative embodiments of the systems and methods illustrated herein may be employed without departing from the principles of the invention described herein.

DETAILED DESCRIPTION

[0024] Although the following text sets forth a detailed description of numerous different embodiments, it should be understood that the legal scope of the description is defined by the words of the claims set forth at the end of this patent and equivalents. The detailed description is to be construed as exemplary only and does not describe every possible embodiment since describing every possible embodiment would be impractical. Numerous alternative embodiments may be implemented, using either current technology or technology developed after the filing date of this patent, which would still fall within the scope of the claims.

[0025] In one embodiment, aircraft air-to-ground (ATG) communication equipment performs power measurements across an allocated or unallocated operating frequency bandwidth using a high directivity antenna steered in the directions of the ATG stations. This procedure may end with the creation of a prioritized list of candidate forward link (FL) serving cells along with their corresponding SINR levels at different frequency sub-bands, or communication channels.

[0026] The ground stations may also perform periodic power measurements across the operating frequency in different directions using steerable high directivity antennas. Such a procedure may end with the characterization of the return link (RL) noise at different frequency sub-bands on different directions, and the creation of a RL noise matrix. The ground stations may then forward the RL noise matrix to the Ground Station (GS) ATG network controller, for example in a centralized implementation, or to all neighbor ground stations, for example in a distributed implementation.

[0027] In embodiments where the aircraft is ready to access a supplementary in-flight communication (IFC) system, the aircraft may send the candidate FL serving cell list and its location information to the ATG network controller over the primary IFC network.

[0028] The ATG network controller may receive the candidate FL serving cell list and begin antenna resource allocation in a predetermined or calculated order of priority. Once allocation is successful, the corresponding serving cell may steer a FL beam towards the known or calculated aircraft location, and thus the UE, or aircraft, is now ready for FL transmission. Subsequently, the ground station controller, using the location information from the aircraft and the RL noise matrix, may generate or calculate a prioritized list of RL candidate serving cells in a listing or order of priority. Following the successful creation of this list, the network controller may begin resource allocation procedures attempts in order of priority. Once the RL allocation is successful, the corresponding serving cell may steer a RL beam toward the aircraft, and the UE is now ready for RL transmissions.

[0029] In one embodiment the air interface technology may require the FL and RL serving cells to be the same, and thus the ground station controller may determine a cell where the FL and RL meet certain data rate criteria.

[0030] By employing a high directivity antenna to measure the noise levels in many different possible directions of communication and refreshing such information periodically, the ATG supplementary IFC network may select serving cells that provide the best available SINR. Such an embodiment ensures that the aircraft will always be served by the cell that provides the best possible data rate to an aircraft.

[0031] The use of a high reliability out-of-band link between the aircraft UE and the GS network allows communication of the noise measurements, channel status information, and location information for the purpose of selecting a suitable serving cell and aligning a steerable antenna that tracks the aircraft. In one embodiment, use of the out-of-band channel enables identification of the best server and antenna steering.

[0032] One embodiment includes a scheme that uses short term power measurements with steerable directive antennas on the aircraft to identify the serving cell in the direction with the highest SINR. A FL User Capacity Matrix may be built, for example, based on SINR measurements in the direction of all possible servers.

[0033] Another embodiment includes short and long term power measurements with steerable directive antennas on the ground station to create three dimensional noise plus interference characterization matrix and a cell barring matrix with the objective of identifying serving cells with the lowest RL noise rise. Such an embodiment includes a RL Noise Matrix as a three dimensional characterization of the RL to enable quick identification of the most effective RL serving cell.

[0034] Yet another embodiment includes a method to perform FL and RL serving cell selection based on noise characterization provided by the UE, or aircraft, in a centralized or distributed manner. Such an embodiment may include use of FL and RL User Capacity matrix to enable identification of the FL and RL metric that meets any desired selection criteria and is suitable for a centralized or distributed processing implementation.

[0035] The following terms may include their associated definitions as stated below, in accordance with the present disclosure:

[0036] Primary IFC network: the network that provides the primary IFC link to the aircraft. This network provides a reliable connection between aircraft and ground networks.

[0037] ATG: Air to Ground System that provides supplemental IFC connectivity using noisya spectrum or uses spectrum as secondary use.

[0038] Primary GSC: Gateway of the primary IFC network. If the Primary IFC network is an ATG system, this can be defined as the Primary Ground Station Controller. If the Primary IFC network is a satellite system, this can be a teleport.

[0039] PGS: fixed stations of the Primary IFC network. If the Primary IFC network is an ATG system, these can be defined as the Primary Ground Stations. If the Primary IFC network is a satellite system, these would be the transponders.

[0040] GSC: Ground station controller of the supplementary IFC system. This is also known as the ATG Ground Station Controller. If the ATG system uses a distributed implementation, the GSC only performs routing of control plane messages. Otherwise if the implementation is centralized, it performs some computation and decision functions that are part of the antenna resource allocation procedures.

[0041] GS: Ground stations of the supplementary IFC system. These are also referred as base stations. The area of coverage of a ground station can be divided into cells to increase spectral reuse and to allow practical deployment of beam forming technology. This includes the high directivity steerable antennas or antenna beams. A GS may have one or more antenna beams per cell.

[0042] Aircraft or UE: ATG mobile equipment that is installed in the aircraft. This includes modem and the high directivity steerable antennas or antenna beams for the ATG system.

[0043] Forward link: radio link for wireless transmission from the GS to the UE.

[0044] Return link: radio link for wireless transmission from the UE to the GS.

[0045] In-band transmission: transmission using the noisy frequency band (e.g. unlicensed spectrum).

[0046] Out-of-band transmission: transmission using a licensed band that guarantees good reliability

[0047] ATG OOB Control: ATG signaling messages exchanged out-of-band between the UE and the GS or GSC.

[0048] GPS Information: the set of information that includes: latitude, longitude, altitude, heading and speed of the aircraft.

[0049] Turning to the exemplary air-to-ground communication system 100 illustrated in Figure 1, an aircraft 110 may include a transceiver 112 and antenna 113 to communicate with a number of ground stations 120, 135, 150, and 165, geographically dispersed from one another. Each ground station 120, 135, 150, and 165 may include a respective ground station transceiver 125, 140, 155, and 160 to transmit and receive signals. For example, ground station 150 with ground station transceiver 155 may communicate a radio frequency signal 145 to the with the antenna 113 and transceiver 112 on the aircraft 110.

[0050] Likewise for each ground station 125, 140, and 170, each within communication range of the aircraft 110, RF signals 115, 139, and 160 may be transmitted between the ground stations and the aircraft antenna 113 and transceiver 112. Each of the ground stations 125, 140, 155, and 170 may be disposed a different physical distances from the aircraft 110, and experience differing path attenuation, local area interference and noise, etc. that interfere with transmission

of the signals 115, 130, 145, and 160 in differing ways. However, in some embodiments, the data services provided by the aircraft transceiver 112 may require use of some or all of the ground stations, or a changing set of the ground stations as channel conditions change.

[0051] For example, in the illustrated block diagram 200 of Figure 2, serving and neighbor ground stations and aircraft stations use a method to measure and use changing channel conditions to ensure reliable data services. The serving ground station may measure power levels in various directions (block 205) and build a return link noise matrix (block 210) using the results of such measurements. Likewise, a neighbor ground station may measure power levels in various directions (block 225) and build a return link noise matrix (230) using the results. In one embodiment, both the serving and neighbor ground stations may share the return link noise matrices with a centralized controller, or with other neighbor ground stations (blocks 215 and 235).

[0052] In some embodiments, the aircraft station may measure power levels in the direction of the serving and neighbor ground stations (block 240). The aircraft station may calculate or determine forward link candidate serving stations and record SINR measurements in for example a forward link user capacity matrix and transmit such candidates to a network controller (block 250). The aircraft station (block 255) and serving ground station allocated by the network controller based on the noise matrix (block 220) may steer a communications beam towards the aircraft, and communicate over forward and return links. As such, the most effective ground station communicates with the aircraft station as determined by knowledge of the forward and return link channel conditions.

Effective Use of Forward-Link and Return-Link Data

[0053] Figure 3 illustrates an exemplary system with interconnected ground stations 315, 320, 370, 330, and 335, and ground station controllers 305 and 310 communicating with an airborne aircraft, or UE 340. A variety of primary ground stations (PGS) 315 and 325 are connected to the primary ground station controller (GSC) 305 by communication links 365 and 375. Likewise a variety of ground stations (GS) 320 and 325 are connected to the ground station controller (GSC) 310 by communication links 340 and 345. The primary GSC 305 may be connected by a communication link 307 to the GSC 310.

[0054] The UE, or aircraft 340, may in some embodiments send an Antenna Resource Request 350 message to the GSC 310 over the Primary IFC link 370. The message may include the FL User Capacity Matrix sorted by forward-link data rate (FR). The UE 340 also may begin sending the GPS information periodically to the GSC 310. Depending on whether a centralized or distributed embodiment is employed, the GSC 310 may execute most of the serving cell antenna resource allocation procedures or act as a signaling layer proxy between the UE 340 and the GSs.

[0055] In the centralized case, the GSC 310 parses the GSC message and selects the GS with the highest FR, then sends a FL Antenna Allocation Request 350 message along with the GPS information. The GS, for example 320 upon successful allocation of antenna resources respond with a FL Antenna Allocation Accept message and starts tracking the aircraft. Note that the GSC 310 continues forwarding the periodic GPS information to the GS to allow continuous tracking of the aircraft. If the GS is not able to allocate antenna resources to the aircraft, it responds with a FL Antenna Allocation Reject. Then the GSC 310 selects the GS with the second highest FR and the process repeats. After completion the GSC 310 sends an OOB indication 350 to the UE 340 signaling that the FL antenna allocation is complete.

[0056] In parallel or sequentially, the GSC 310, using the GPS information, creates a list of candidate RL serving cells based on free space loss characteristics only. Then, for each candidate cell, the azimuth from the cell to the UE 340 is determined, if the GS supports steering of the beam 355 in elevation, the elevation angle is also determined. With the azimuth and elevation information and its corresponding RL Noise Matrix the RL Noise plus interference for each sub-band is obtained. The GSC 310 calculates distance between the UE 340 and the candidate serving cell based on UE 340 and GS GPS information. Given the distance to the UE 340, the RL power capabilities of the UE and the RL Noise plus interference the GSC can estimate the RL data rate (RR) for each sub-band and the total maximum RL data for each candidate serving cell.

[0057] The RL User Capacity Matrix captures the maximum data rate the candidate GSs can deliver, for example over the ATG link 360. Similar to the FL case, the GSC performs resource allocation procedures for the RL. Starting from the cell with the highest RR, the GSC attempts to allocate antenna resources by sending a RL Antenna Allocation Request 350. Upon

successful setup of RL resources the GSC sends confirmation to the UE, at this point the UE is ready to receive RL data over the ATG link.

[0058] In the distributed case, the GSC 310 sends an Antenna Allocation Request message 350 along with FL User Capacity Matrix and the GPS information to the GS with the highest FR, this is referred to as the anchor GS. The anchor GS 320 attempts to secure FL antenna resources, if this fails, it sends a FL Antenna Allocation Request and the last GPS information to the GS with the second highest FR. This process continues until FL antenna resources are secured. In parallel, RL antenna resources are secured in the same way, for example by steering the beam 355 towards the UE 340. Since anchor GS 320 has the RL Noise Metric of all neighbor cells, it can perform RL antennal allocation procedures in the same way. Upon successful setup of FL and RL allocation, the anchor GS 320 sends an Antenna Allocation Accept to the GSC 310 which includes the identification of the GS 320 where resources were allocated. The GSC changes the delivery of the periodic GPS information to the GS 320 where resources were setup and notifies the UE 340 over the OOB link 350 that FL and RL antenna resources had been allocated. After this the UE 340 is ready to exchange data over the ATG network.

[0059] In some embodiments, the air interface technology may require the FL and RL serving cell to be the same. In that case, the selection of the FL and RL serving cell cannot be done independently since it is possible that the cell that provides the highest FL data rate does not offer the highest RL data rate, or could even offer the worse RL data rate. Therefore, additional criteria such as the current UE RL and FL traffic type and loading and the anticipated traffic type and loading for the ATG network, need to be introduced to select the FL and RL serving cells. The exact criteria may depend on the type of traffic the ATG is expected to carry. In one embodiment, candidate serving cells that meet minimum thresholds for both RL and FL data rates could be identified, and then one of those selected as serving cell based on either highest RL or highest FL data rate. In the general case of TCP type traffic, the FL and RL bandwidth requirement may not be symmetric. For example, analysis of some traffic pattern in IFC services show that the ratio between RL and FL offer load is about 1:7. Then a possible embodiment could be to identify all cells that offer RL to FL data rate ratio greater than a given threshold and then sort this list in descending order of FR. The GSC or the anchor GS attempts to secure FL and RL antenna resources starting from the cell with the highest FR.

[0060] After successful setup of FL and RL serving cell antenna resources the UE can perform access procedures on the air interface following the procedures defined for the corresponding air interface technology. Note that GPS information is continuously sent to the ATG network over the Primary IFC link, this enables antenna steering to track the aircraft. Once the UE gains access to the ATG network it can continue updating the FL User Capacity Matrix taking measurements during silence periods or using a second antenna. When the SINR degrades below a certain threshold or better candidates are found, the UE sends a Handover Request message, which includes the FL User Capacity Matrix, to the GSC. This enables mobility throughout the ATG network.

[0061] In an alternative embodiment, the GSC, centralized implementation, or GS sites, distributed implementation, use GPS Information of each aircraft provided via the OOB control channel. With this information the GSC or GS sites can estimate the current elevation and azimuth angle and projected path or heading for each aircraft. The ATG network may use this information to surgically update the RL Noise Matrices by steering antennas to make noise plus interference measurements at the current aircraft location and at the projected aircraft locations in the future.

Forward-Link User Capacity Characterization

[0062] An exemplary system 400 illustrated in Figure 4 to collect and calculate forward link user capacity includes a primary GSC 405 connected to a GSC 410 through a communication link 415. A set of primary ground stations 420 and 425 are connected to the primary GSC 405 by communication links 430 and 435. Likewise a set of ground stations 440 and 445 are connected by communication links 455 and 460 to the GSC 410. The aircraft, or UE 470 communicates with three ground stations 440, 445, and 450 via wireless communication links 475, 480, and 485.

[0063] The UE 470 starts the process of accessing the ATG network by estimating SINR for each surrounding cell, for example 440, 445, and 450. This can be performed by making SINR measurements or by measuring noise plus interference and deriving the SINR based on the power settings configured for the corresponding cell. In the former case, the UE 470 needs to know the times when each candidate serving cell pilot signal is transmitted to enable SINR

measurements, therefore time synchronization with each candidate serving cell may be necessary. To address this problem, prior to start the power measurements the UE 470 sends a pre-allocation message to the GSC 410 over the Primary IFC link, as illustrated in Figure 3, this message contains the GPS information for the aircraft. The GSC 410 forwards this messages to a number of cells surrounding the aircraft, for example 440, 445, and 450. Upon reception of the pre-allocation message, the cells bring up a FL beam, for example 475, 480, and 485, in the direction of the aircraft and starts transmission of pilot signals. Using the pilot signals the UE 470 performs time synchronization followed by SINR measurements for each candidate serving cell 440, 445, and 450. Once the FL antenna resources is complete, the beams are brought down.

[0064] Alternatively, the UE 470 can estimate the SINR based on noise plus interference measurements and the power settings of each candidate serving cell 440, 445, and 450. This approach is simpler to implement however it has stricter requirements on the antennas. Specifically, this approach may work well if the GS FL beams are narrow enough so that the probability of two aircrafts being served by the same cell is very low. The UE 470 may steer its narrow beam directional antenna pointing to each neighboring cell to enable the measurements. The UE 470 may know the location and basic configuration of all cells in the ATG network, this is configured during UE provisioning or downloaded over the Primary ATG network after provisioning. Because the FL transmission beam is narrow and the GS is not transmitting in the direction of the aircraft, all the measured power is expected to be noise plus interference only. This measurement will give the denominator for the SINR calculation. The signal power is estimated based on the known power level of the candidate serving cell adjusted by propagation losses. The propagation loss can be derived from the distance between the aircraft and the GS. With that information, the SINR is estimated.

[0065] In some embodiments the SINR measurements or estimations are performed at different sub-bands of the operational bandwidth. With that information, the UE 470 estimates the expected FL data rate (FR) for each candidate serving cell, and builds a FL User Capacity Matrix. An exemplary illustration of a FL User Capacity Matrix is shown in Figure 5. In exemplary embodiment, the bandwidth B is divided into N sub-bands (e.g. SB1, SB2, SBN) 505. Furthermore, the matrix 500 depicts the case where expected data rate for S ground stations (e.g. GS1, GS2, GSS) 510 is characterized. Using the SINR at each sub-band and the spectral efficiency vs SINR for the air interface technology in use the UE can estimate the expected data

rate for each sub-band and the total expected data rate for each GS (e.g. FR1, FR2, FRS) 515. The FR is a single metric that accounts for the SINR and the total available bandwidth, this number can be used as the figure of merit to identify the serving cell that can provide the highest FL throughput. Once the UE 470 completes the creation of the FL User Capacity Matrix 500 it is ready to access the ATG system.

Return-Link User Capacity Characterization

[0066] One exemplary system 600 to determine return-link capacity is illustrated in the block diagram of Figure 6. The system 600 includes a primary GSC 605 connected to a GSC 610 through a communication link 615. A set of primary ground stations 620 and 625 are connected to the primary GSC 605 by communication links 645 and 650. Likewise a set of ground stations 630, 635, and 640 are connected by communication links 655, 660, and 665 to the GSC 610.

[0067] To obtain high SINR levels, good spatial isolation is needed in the radio link, enabled by using high directivity antennas with narrow beamwidths and steerable capabilities in order to track the aircraft. In one embodiment, the elevation plane pattern of the antenna can be constant and optimized to provide good coverage in elevation, then the azimuth antenna beamwidth should be narrow enough to reduce interference in the azimuth plane. In this case, an azimuth beamwidth of 10 degrees or less could be used. If the antenna technology allows to form a pencil beam, for example the beams 670, 675, and 680, then a beamwidth in azimuth and elevation of 10 degrees or less could be used. This invention does not define the exact beamwidth since that would depend on the specific link budgets, levels of interference and antenna technology available.

[0068] The GSs 630, 635, and 640 periodically measures the RL noise plus interference levels. If frequency division duplexing is used, measurements can be performed at any time the RL is not used, or by scheduling silence periods. Otherwise, if time division duplexing is used, measurements can be performed any time the RL is not used or by using the guard time period. Power measurements are used to estimate the RL noise power. Considering that the GS controls the FL and RL scheduling, RL power measurements performed when no transmissions are expected represent only noise and interference power. The entire RL noise plus interference power characterization is captured in a RL Noise Matrix 700, as illustrated in Figure 7.

[0069] The RL Noise Matrix 700 is a three dimensional characterization of the RL noise plus interference. The bandwidth B is divided in N sub-bands (e.g. SB1, SB2, SBN) 705, the value of N would depend on many factors like resource allocation bandwidth, channel state reporting bandwidth, measurement speed, etc. The area of coverage in azimuth plane is divided into M different directions (e.g. Az1, Az2, ..., AzM) 720 according to the azimuth beamwidth of the antenna array. For example, if a sector is intended to cover 60° and the azimuth beamwidth is 10° , then M is 6 and the azimuth directions would be $\pm 5, \pm 15, \pm 25$ (assuming 0° is at the center of the sector). Similarly, the elevation plane is divided into L different elevations (E1, E2, ..., EL) 715 according to the elevation beamwidth. For example, if the sector is intended to cover elevations from 0° to 40° and the elevation beamwidth is 10° , then L is 4 and the elevation directions are 5, 15, 25 and 35. In total the antenna beam is steered across $M \times L$ different directions and on each direction noise plus interference is measured for each of the N sub-bands. The objective is to characterize the noise across the degrees of freedom as the resource allocation will take place. In this document a given sub-band, azimuth and elevation combination is referred as the frequency-space resource. For the case where the antenna is not steerable in the elevation plane and rather has an elevation pattern that allows enough coverage in elevation, the RL Noise Matrix reduces to a two dimensional matrix.

[0070] The simplest way to iterate through all frequency-space resources is a round robin scheme. However other schemes can be depicted to better fit the spatial multiplexing scheduling demands. For example, a weighting scheme where azimuths or elevations with more usage are assigned higher weights and therefore measured more often can be used. Another alternative is to update the RL noise matrix based on the known trajectories of scheduled flights.

[0071] For each frequency-space resource the RL Noise matrix captures the average noise and interference power. The timescales of the variability in interference and implementation constraints define the time duration over which to perform the power average. For the RL Noise matrix the average window is expected to be short term. There could also be other factors that make a certain frequency-space resource unsuitable to use, especially when observed over a long term window. For example, high noise peaks that cause the link to drop often with erratic patterns, in those cases it is better to bar that frequency-space resource from usage. This condition can be captured by another matrix named RL Noise Barring Matrix. The objective of this matrix is to avoid a given cell to be assigned as a server on a given frequency-space if there

is a high probability that the noise conditions will significantly degrade the link. Therefore long term observations define the RL Noise Barring Matrix. Additionally, it could make more sense to bar an azimuth direction all together, in this case an additional barring flag 710 per azimuth can be added to the RL Noise Matrix.

[0072] Once the RL Noise matrix 700 is complete, the GSs send it periodically to the GSC 610, centralized implementation case; or sends it to all its neighbors, distributed implementation case. Note that the RF Noise matrix 700 is continuously updated, in this way the GSC 610 or the neighbor GSs always have the latest information.

[0073] Similar to the FL User Capacity Matrix 500 of Figure 5, The RL User Capacity Matrix 800 illustrated in Figure 8 captures the maximum data rate (RR) 815 the candidate GSs 810 can deliver, for example over the ATG link 360 of Figure 3. . In exemplary embodiment, the bandwidth B is divided into N sub-bands (e.g. SB1, SB2, SBN) 805. Similar to the FL case, the GSC 610 performs resource allocation procedures for the RL. Starting from the cell with the highest RR, the GSC 610 attempts to allocate antenna resources by sending a RL Antenna Allocation Request 350 as illustrated in Figure 3. Upon successful setup of RL resources the GSC 610 sends confirmation to the UE, at this point the UE is ready to receive RL data over the ATG link.

Alternative Data Use and Characterization Embodiments

[0074] Alternative embodiments of the present disclosure include characterization of the noise and interference environment relying on the spatial isolation provided by directivity nature of the antennas. Such an embodiment differs from existing technologies that rely on predefined coverage footprints defined by a wide broadcast beam to determine the serving cell.

[0075] Furthermore, existing technologies fail to select a serving cell following comparison of data rates derived from measured noise at different sub-bands and spatial directions. The use of an OOB link to enable beamforming makes the ATG system more robust to interference and enables completion of the serving cell setup process with additional immunity to interference in the ATG spectrum.

[0076] Other embodiments include selecting the best server making use of capabilities of narrow beam antenna technology and exploiting the spatial diversity that an ATG network creates around the aircraft. Such an embodiment enables full use of all degrees of freedom available for resource allocation and therefore identifies the best possible server.

[0077] Still other embodiments include multiple static beams that allow the aircraft to perform access procedures in the noisy spectrum. However, such an embodiment does not guarantee that the serving cell provides the best possible throughput and reliable link. Furthermore, a large number of beams may be required to provide sufficient coverage.

[0078] Yet another alternative embodiment includes sending the GPS information over an OOB link, but leaving all the other control messages in-band. One aspect includes configuring a wide broadcast beam on each cell to perform FL SINR measurements. Furthermore, this embodiment may provide advantages for the case where the FL and RL need to be served by the same cell.

[0079] In some embodiments an 800 MHz ATG network may serve as the Primary IFC link and a 2.4 GHz ATG LTE network may serve as a supplemental service. However, in other embodiments IFC solutions may operate over LEO satellite constellations when available. LEO links may provide low enough latency to serve as an OOB link to enable exchange of control information to support the configuration of steerable beams between the aircraft and the ATG network.

[0080] Still more embodiments may include technologies other than LTE. For example, air interface technologies that allow supplementing the data pipe in only one direction, for example DVB, can be used and the information to enable tracking of the aircraft with a steerable beam can be sent over a reliable OOB connection.

[0081] Figure 9 illustrates an exemplary computing system 900, for example that may in some embodiments correspond to one or more GSCs, GS, and UE of Figures 1, 3, 4 and 6, or otherwise, that includes one or more microprocessors 905, coupled to supporting devices through multi-access busses 925 and 940. Dynamic random access memory 930 and 935 may interface to data bus 925, and store data used by the one or more microprocessors 905. The system 900 includes instruction registers 920 that store executable instructions for the one or more microprocessors 905, and data registers 915 that store data for execution. In some embodiments,

the system 900 includes one or more arithmetic co-processors 910, to assist or supplement the one or more microprocessors 905. Data bus 940 includes interfaces to a graphics interface 945 that may in some embodiments process and transmit graphical data for a user on a display or similar devices. Likewise, data bus 940 includes interfaces for a digital I/O interface that processes and transmits, for example, keyboard, pointing device, and other digital and analog signals produced and consumed by users or other machines. A network interface 955 processes and transmits encoded information over wired and wireless networks to connect the system 900 to other machines and users. Data bus 940 also includes at least one interface to a non-volatile memory interface, that may process and transmit data that resides on non-volatile memory devices.

[0082] Figure 10 illustrates a non-transitory computer readable medium 1005, that comprises processor executable instructions 1010. Such processor executable instructions may include instructions executed by the one or more microprocessors 905 of Figure 9.

Additional Considerations

[0083] All of the foregoing computer systems may include additional, less, or alternate functionality, including that discussed herein. All of the computer-implemented methods may include additional, less, or alternate actions, including those discussed herein, and may be implemented via one or more local or remote processors and/or transceivers, and/or via computer-executable instructions stored on computer-readable media or medium.

[0084] The processors, transceivers, mobile devices, service terminals, servers, remote servers, database servers, heuristic servers, transaction servers, and/or other computing devices discussed herein may communicate with each via wireless communication networks or electronic communication networks. For instance, the communication between computing devices may be wireless communication or data transmission over one or more radio links, or wireless or digital communication channels.

[0085] Customers may opt into a program that allows them share mobile device and/or customer, with their permission or affirmative consent, with a service provider remote server. In return, the service provider remote server may provide the functionality discussed herein,

including security, fraud, or other monitoring, and generate recommendations to the customer and/or generate alerts for the customers in response to abnormal activity being detected.

[0086] The following additional considerations apply to the foregoing discussion. Throughout this specification, plural instances may implement components, operations, or structures described as a single instance. Although individual operations of one or more methods are illustrated and described as separate operations, one or more of the individual operations may be performed concurrently, and nothing requires that the operations be performed in the order illustrated. Structures and functionality presented as separate components in example configurations may be implemented as a combined structure or component. Similarly, structures and functionality presented as a single component may be implemented as separate components. These and other variations, modifications, additions, and improvements fall within the scope of the subject matter herein.

[0087] Additionally, certain embodiments are described herein as including logic or a number of routines, subroutines, applications, or instructions. These may constitute either software (*e.g.*, code embodied on a machine-readable medium or in a transmission signal) or hardware. In hardware, the routines, etc., are tangible units capable of performing certain operations and may be configured or arranged in a certain manner. In example embodiments, one or more computer systems (*e.g.*, a standalone, client or server computer system) or one or more hardware modules of a computer system (*e.g.*, a processor or a group of processors) may be configured by software (*e.g.*, an application or application portion) as a hardware module that operates to perform certain operations as described herein.

[0088] In various embodiments, a hardware module may be implemented mechanically or electronically. For example, a hardware module may comprise dedicated circuitry or logic that is permanently configured (*e.g.*, as a special-purpose processor, such as a field programmable gate array (FPGA) or an application-specific integrated circuit (ASIC)) to perform certain operations. A hardware module may also comprise programmable logic or circuitry (*e.g.*, as encompassed within a general-purpose processor or other programmable processor) that is temporarily configured by software to perform certain operations. It will be appreciated that the decision to implement a hardware module mechanically, in dedicated and permanently configured circuitry,

or in temporarily configured circuitry (*e.g.*, configured by software) may be driven by cost and time considerations.

[0089] Accordingly, the term “hardware module” should be understood to encompass a tangible entity, be that an entity that is physically constructed, permanently configured (*e.g.*, hardwired), or temporarily configured (*e.g.*, programmed) to operate in a certain manner or to perform certain operations described herein. Considering embodiments in which hardware modules are temporarily configured (*e.g.*, programmed), each of the hardware modules need not be configured or instantiated at any one instance in time. For example, where the hardware modules comprise a general-purpose processor configured using software, the general-purpose processor may be configured as respective different hardware modules at different times. Software may accordingly configure a processor, for example, to constitute a particular hardware module at one instance of time and to constitute a different hardware module at a different instance of time.

[0090] Hardware modules may provide information to, and receive information from, other hardware modules. Accordingly, the described hardware modules may be regarded as being communicatively coupled. Where multiple of such hardware modules exist contemporaneously, communications may be achieved through signal transmission (*e.g.*, over appropriate circuits and buses) that connect the hardware modules. In embodiments in which multiple hardware modules are configured or instantiated at different times, communications between such hardware modules may be achieved, for example, through the storage and retrieval of information in memory structures to which the multiple hardware modules have access. For example, one hardware module may perform an operation and store the output of that operation in a memory device to which it is communicatively coupled. A further hardware module may then, at a later time, access the memory device to retrieve and process the stored output. Hardware modules may also initiate communications with input or output devices, and may operate on a resource (*e.g.*, a collection of information).

[0091] The various operations of example methods described herein may be performed, at least partially, by one or more processors that are temporarily configured (*e.g.*, by software) or permanently configured to perform the relevant operations. Whether temporarily or permanently configured, such processors may constitute processor-implemented modules that operate to

perform one or more operations or functions. The modules referred to herein may, in some example embodiments, comprise processor-implemented modules.

[0092] Similarly, the methods or routines described herein may be at least partially processor-implemented. For example, at least some of the operations of a method may be performed by one or more processors or processor-implemented hardware modules. The performance of certain of the operations may be distributed among the one or more processors, not only residing within a single machine, but deployed across a number of machines. In some example embodiments, the processor or processors may be located in a single location (*e.g.*, within a home environment, an office environment or as a server farm), while in other embodiments the processors may be distributed across a number of locations.

[0093] The performance of certain of the operations may be distributed among the one or more processors, not only residing within a single machine, but deployed across a number of machines. In some example embodiments, the one or more processors or processor-implemented modules may be located in a single geographic location (*e.g.*, within a home environment, an office environment, or a server farm). In other example embodiments, the one or more processors or processor-implemented modules may be distributed across a number of geographic locations.

[0094] Unless specifically stated otherwise, discussions herein using words such as “processing,” “computing,” “calculating,” “determining,” “presenting,” “displaying,” or the like may refer to actions or processes of a machine (*e.g.*, a computer) that manipulates or transforms data represented as physical (*e.g.*, electronic, magnetic, or optical) quantities within one or more memories (*e.g.*, volatile memory, non-volatile memory, or a combination thereof), registers, or other machine components that receive, store, transmit, or display information.

[0095] As used herein any reference to “one embodiment” or “an embodiment” means that a particular element, feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment. The appearances of the phrase “in one embodiment” in various places in the specification are not necessarily all referring to the same embodiment.

[0096] Some embodiments may be described using the expression “coupled” and “connected” along with their derivatives. For example, some embodiments may be described using the term

“coupled” to indicate that two or more elements are in direct physical or electrical contact. The term “coupled,” however, may also mean that two or more elements are not in direct contact with each other, but yet still co-operate or interact with each other. The embodiments are not limited in this context.

[0097] As used herein, the terms “comprises,” “comprising,” “includes,” “including,” “has,” “having” or any other variation thereof, are intended to cover a non-exclusive inclusion. For example, a process, method, article, or apparatus that comprises a list of elements is not necessarily limited to only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. Further, unless expressly stated to the contrary, “or” refers to an inclusive or and not to an exclusive or. For example, a condition A or B is satisfied by any one of the following: A is true (or present) and B is false (or not present), A is false (or not present) and B is true (or present), and both A and B are true (or present).

[0098] In addition, use of the “a” or “an” are employed to describe elements and components of the embodiments herein. This is done merely for convenience and to give a general sense of the description. This description, and the claims that follow, should be read to include one or at least one and the singular also includes the plural unless it is obvious that it is meant otherwise.

[0099] The patent claims at the end of this patent application are not intended to be construed under 35 U.S.C. § 112(f) unless traditional means-plus-function language is expressly recited, such as “means for” or “step for” language being explicitly recited in the claim(s).

[0100] The systems and methods described herein are directed to improvements to computer functionality, and improve the functioning of conventional computers.

[0101] This detailed description is to be construed as exemplary only and does not describe every possible embodiment, as describing every possible embodiment would be impractical, if not impossible. One may be implement numerous alternate embodiments, using either current technology or technology developed after the filing date of this application.

What is claimed is:

1. A non-transitory computer readable medium, comprising processor executable instructions that when executed by a computer processor disposed within an airborne aircraft cause the computer processor to:
 - command a directional antenna installed on the aircraft and a transceiver disposed within the aircraft to measure a first signal-to-noise ratio for a first communication channel at a first location on the ground;
 - command the directional antenna and the transceiver to measure a second signal-to-noise ratio for a second communication channel at a second location on the ground;
 - calculate a first forward-link user capacity estimate using the first signal-to-noise ratio for the first communication channel;
 - calculate a second forward-link user capacity estimate using the second signal-to-noise ratio for the second communication channel; and
 - calculate a forward-link user capacity matrix using the first forward-link user capacity estimate and the second forward-link capacity estimate.
2. The medium of claim 1, wherein the first communication channel comprises a first center frequency and a first bandwidth, and wherein the second communication channel comprises a second center frequency and a second bandwidth, and wherein the first communication channel does not overlap the second communication channel.
3. The medium of claim 1, further comprising processor executable instructions that when executed by the computer processor cause the computer processor to:
 - command the directional antenna and the transceiver to measure a short-term average of the first signal-to-noise ratio for the first communication channel at the first location on the ground;
 - command the directional antenna and the transceiver to measure a short-term average of the second signal-to-noise ratio for the second communication channel at the second location on the ground;
 - calculate the first forward-link user capacity estimate using the short-term average of the first signal-to-noise ratio for the first communication channel; and

calculate the second forward-link user capacity estimate using the short-term average of the second signal-to-noise ratio for the second communication channel.

4. The medium of claim 1, further comprising processor executable instructions that when executed by the computer processor cause the computer processor to:

command the directional antenna and the transceiver to measure a long-term average of the first signal-to-noise ratio for the first communication channel at the first location on the ground;

command the directional antenna and the transceiver to measure a long-term average of the second signal-to-noise ratio for the second communication channel at the second location on the ground;

calculate the first forward-link user capacity estimate using the long-term average of the first signal-to-noise ratio for the first communication channel; and

calculate the second forward-link user capacity estimate using the long-term average of the second signal-to-noise ratio for the second communication channel.

5. The medium of claim 1, further comprising processor executable instructions that when executed by the computer processor cause the computer processor to command the directional antenna and the transceiver to transmit the forward-link user capacity matrix to a ground station controller using an out-of-band communication channel.

6. The medium of claim 1, further comprising processor executable instructions that when executed by the computer processor cause the computer processor to:

command the directional antenna and the transceiver to measure a third signal-to-noise ratio for a third communication channel at a third location on the ground;

calculate a third forward-link user capacity estimate using the third signal-to-noise ratio for the third communication channel; and

calculate the forward-link user capacity matrix using the first forward-link user capacity estimate, the second forward-link capacity estimate, and the third forward-link capacity estimate.

7. A computer-implemented method, executed with a computer processor disposed within an air-to-ground communication ground station, comprising:

commanding, with the computer processor, a directional antenna installed at the ground station and a transceiver disposed within the ground station to measure a first noise power level for a first communication channel at a first elevation and a first azimuth from a current position of the ground station;

commanding, with the computer processor, the directional antenna and the transceiver to measure a second noise power level for a second communication channel at a second elevation and a second azimuth from the current position of the ground station;

calculating, with the computer processor, a first reverse-link user capacity estimate using the first noise power level for the first communication channel;

calculating, with the computer processor, a second reverse-link user capacity estimate using the second noise power level for the second communication channel; and

calculating, with the computer processor, a reverse-link user capacity matrix using the first reverse-link user capacity estimate and the second reverse-link capacity estimate.

8. The method of claim 7, wherein the first communication channel comprises a first center frequency and a first bandwidth, and wherein the second communication channel comprises a second center frequency and a second bandwidth, and wherein the first communication channel does not overlap the second communication channel.

9. The method of claim 7, further comprising:

commanding, with the computer processor, the directional antenna and the transceiver to measure a short-term average of the first noise power level for the first communication channel at the first elevation and the first azimuth;

commanding, with the computer processor, the directional antenna and the transceiver to measure a short-term average of the second noise power level for the second communication channel at the second elevation and the second azimuth;

calculating, with the computer processor, the first reverse-link user capacity estimate using the short-term average of the first noise power level for the first communication channel; and

calculating, with the computer processor, the second reverse-link user capacity estimate using the short-term average of the second noise power level for the second communication channel.

10. The method of claim 7, further comprising:

commanding, with the computer processor, the directional antenna and the transceiver to measure a long-term average of the first noise power level for the first communication channel at the first elevation and the first azimuth;

commanding, with the computer processor, the directional antenna and the transceiver to measure a long-term average of the second noise power level for the second communication channel at the second elevation and the second azimuth;

calculating, with the computer processor, the first reverse-link user capacity estimate using the long-term average of the first noise power level for the first communication channel; and

calculating, with the computer processor, the second reverse-link user capacity estimate using the long-term average of the second noise power level for the second communication channel.

11. The method of claim 7, further comprising commanding, with the computer processor, the ground station to transmit the reverse-link user capacity matrix to a ground station controller.

12. The method of claim 7, further commanding, with the computer processor, the directional antenna and the transceiver to measure a third noise power level for a third communication channel at a third elevation and a third azimuth from the current position of the ground station;

calculating, with the computer processor, a third reverse-link user capacity estimate using the third noise power level for the third communication channel; and

calculating, with the computer processor, the reverse-link user capacity matrix using the first reverse-link user capacity estimate, the second reverse-link capacity estimate, and the third reverse-link user capacity matrix.

13. A computer system comprising one or more processors and/or transceivers configured to:
- retrieve at least one of:
- (i) a forward-link user capacity matrix comprising a plurality of forward-link user capacity estimates each associated with a location on the ground; and
 - (ii) a return-link capacity matrix comprising a plurality of reverse-link user capacity estimates each associated with an azimuth and elevation from a current location of an airborne aircraft;
- calculate a candidate serving cell, using at least one of (i) the forward-link user capacity matrix and (ii) the reverse-link user capacity matrix; and
- command a directional antenna and a transceiver to transmit or receive data with the candidate serving cell.
14. The system of claim 13, further comprising one or more processors and/or transceivers configured to:
- retrieve from an air-to-ground network controller at least one of (i) the forward-link user capacity matrix and (ii) the return-link user capacity matrix.
15. The system of claim 13, wherein the candidate serving cell comprises a noise power level above a threshold.
16. The system of claim 13, wherein the transceiver transmits at least one of (i) the forward-link user capacity matrix and (ii) the return-link capacity matrix using an out-of-band channel.
17. The system of claim 13, wherein the forward-link user capacity matrix indicates a lower signal-to-noise ratio associated with the candidate serving cell than an alternative serving cell, wherein the alternative serving cell is located further from the airborne aircraft than the candidate serving cell is located from the airborne aircraft.
18. The system of claim 13, wherein the reverse-link user capacity matrix indicates a higher noise power level associated with the candidate serving cell than an alternative serving cell,

wherein the alternative serving cell is located further from the airborne aircraft than the candidate serving cell is located from the airborne aircraft.

19. The system of claim 13, wherein at least one of the forward-link user capacity matrix and the return-link capacity matrix comprises a plurality of user capacity estimates associated with a plurality of communication channels.

20. The system of claim 15, wherein the threshold comprises at least one of:
a short-term noise threshold that enables an serving cell selection decision among a plurality of serving cells; and
a long-term noise threshold that enables a future serving cell restriction decision.

ABSTRACT

Selecting serving cells in air to ground communication systems efficiently and with maximum knowledge of forward and return link channel conditions allows maximum throughput available to a user at any point in time, particularly in the presence of high interference. Airborne based and ground based systems may collect forward and return link channel conditions and develop user capacity estimates to be used by aircraft and ground based transceivers. Such user capacity estimates may be shared among distributed air-to-ground networks to ensure the latest channel conditions are available for serving cell selection decisions.

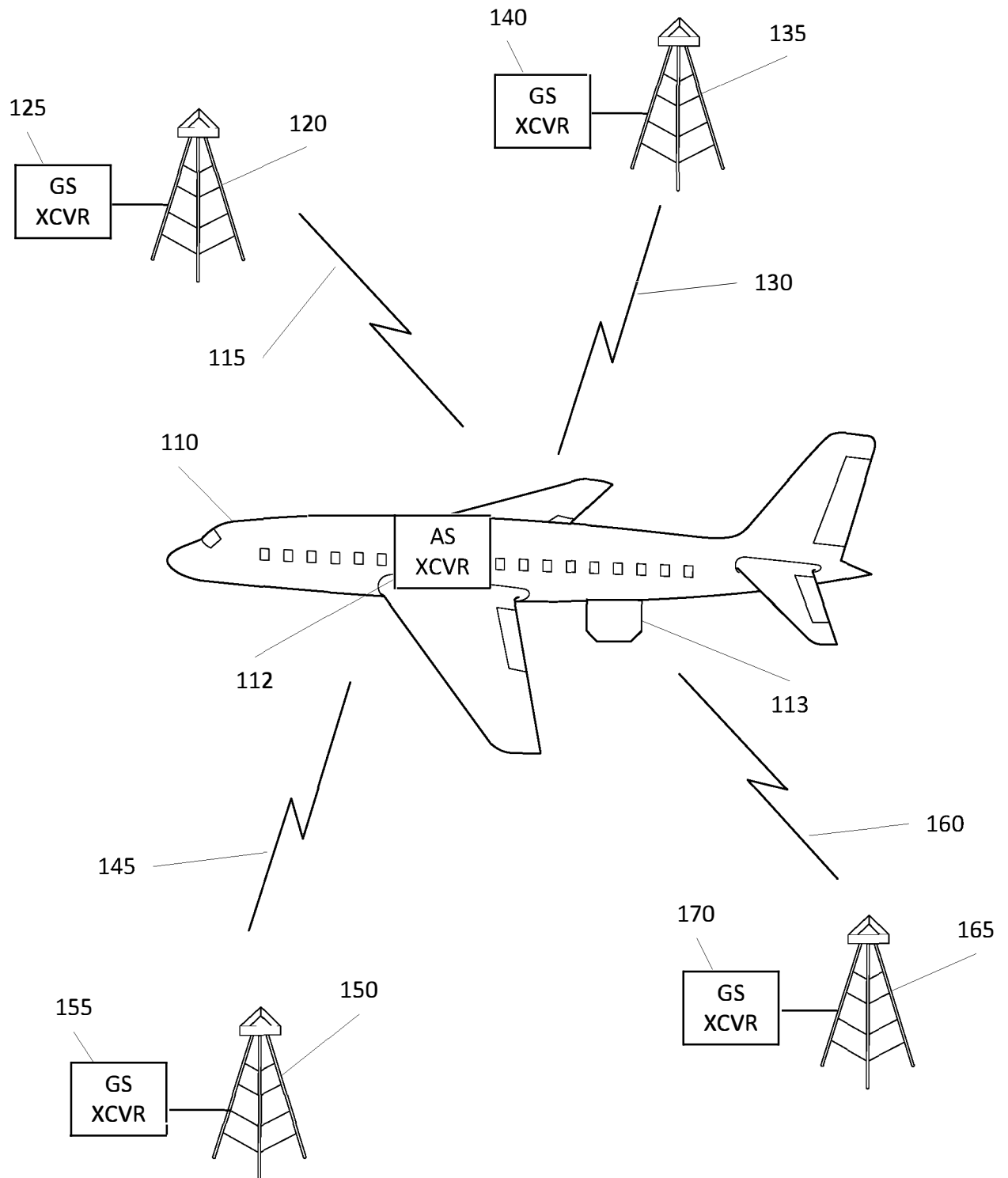
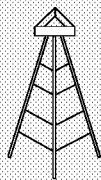


FIG. 1



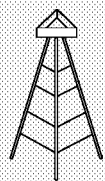
Serving Ground Station

Ground Station measures power levels in various directions

Ground Station builds return link noise matrix

Ground Station shares return link noise matrix with neighbor ground stations and/or centralized network controller

Ground Station allocated by network controller and steers beam towards aircraft

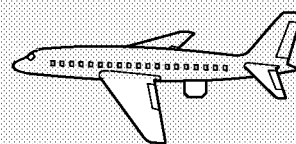


Neighbor Ground Station

Ground Station measures power levels in various directions

Ground Station builds return link noise matrix

Ground Station shares return link noise matrix with neighbor ground stations and/or centralized network controller



Aircraft Station

Aircraft Station measures power levels in direction of primary and secondary stations

Aircraft Station determines forward link candidates and records associated SINR measurements

Aircraft Station transmits forward link candidates and aircraft location to network controller

Aircraft Station communicates with Ground Station over Forward and Return Links

FIG. 2

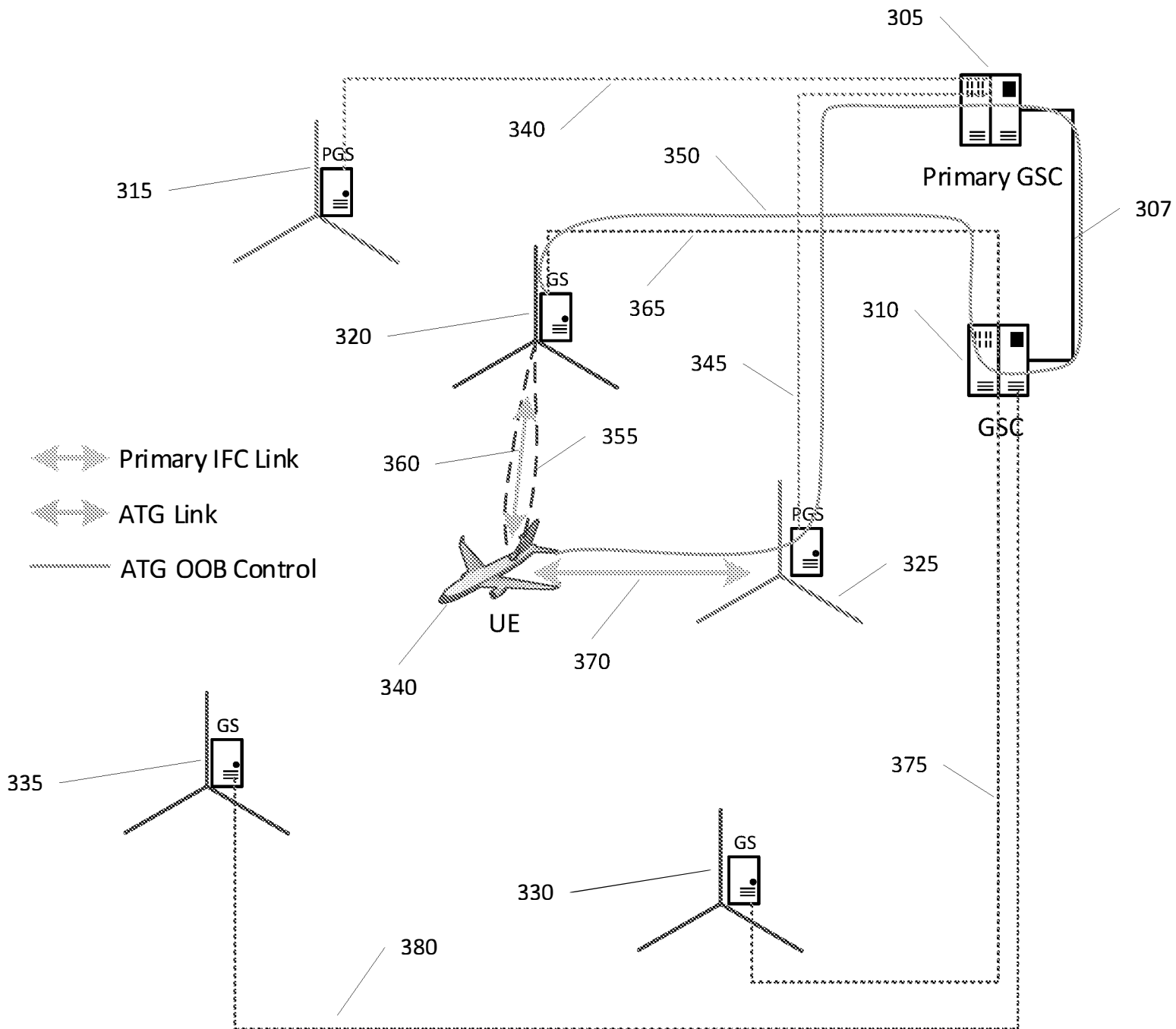


FIG. 3

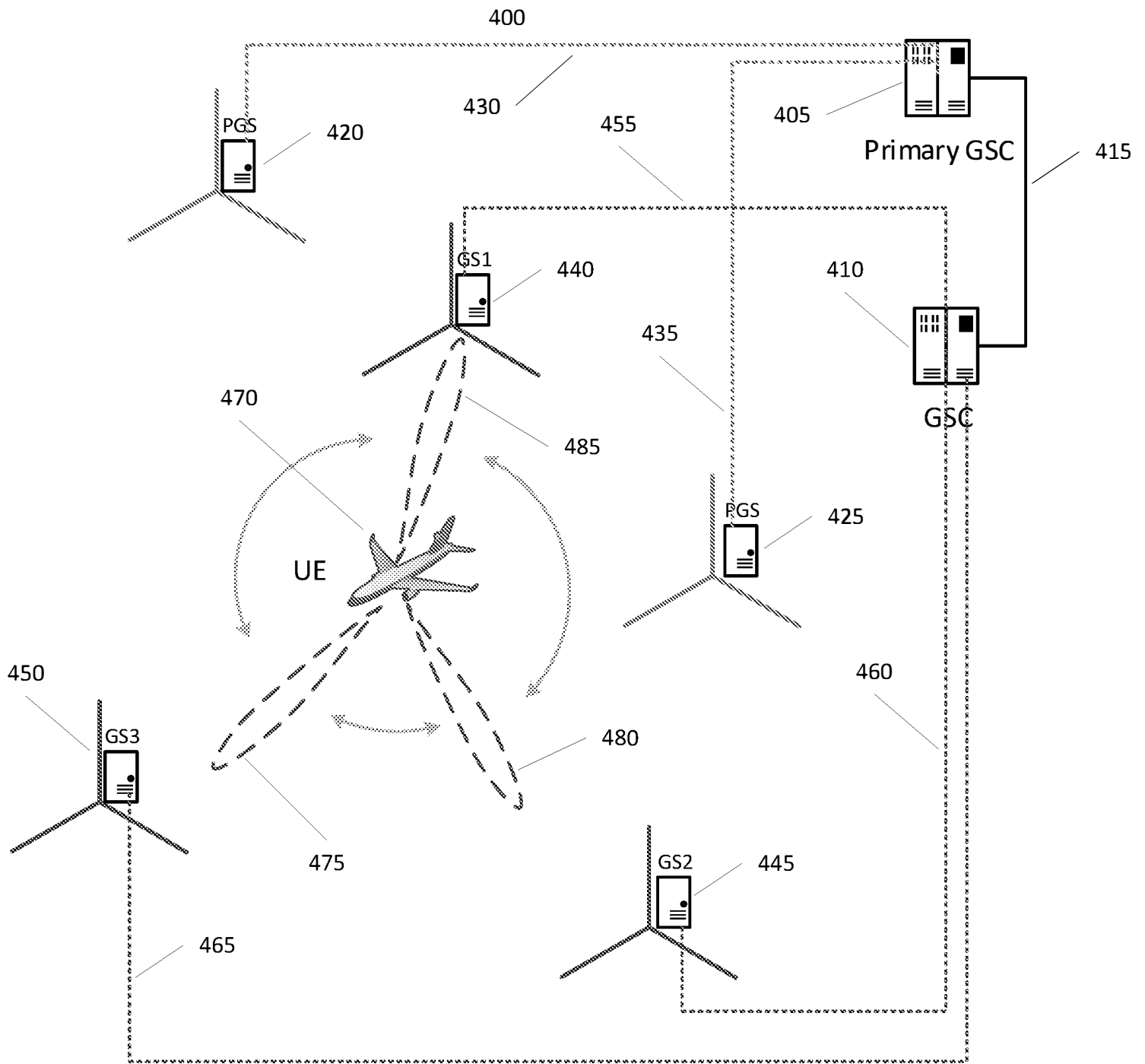


FIG. 4

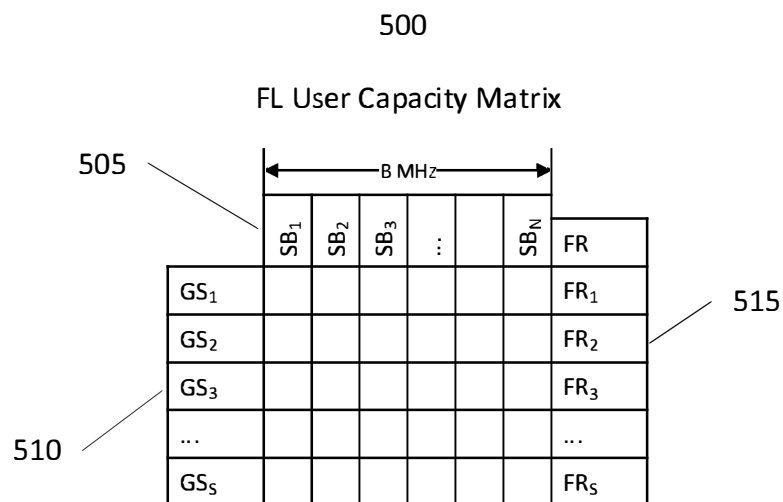


FIG. 5

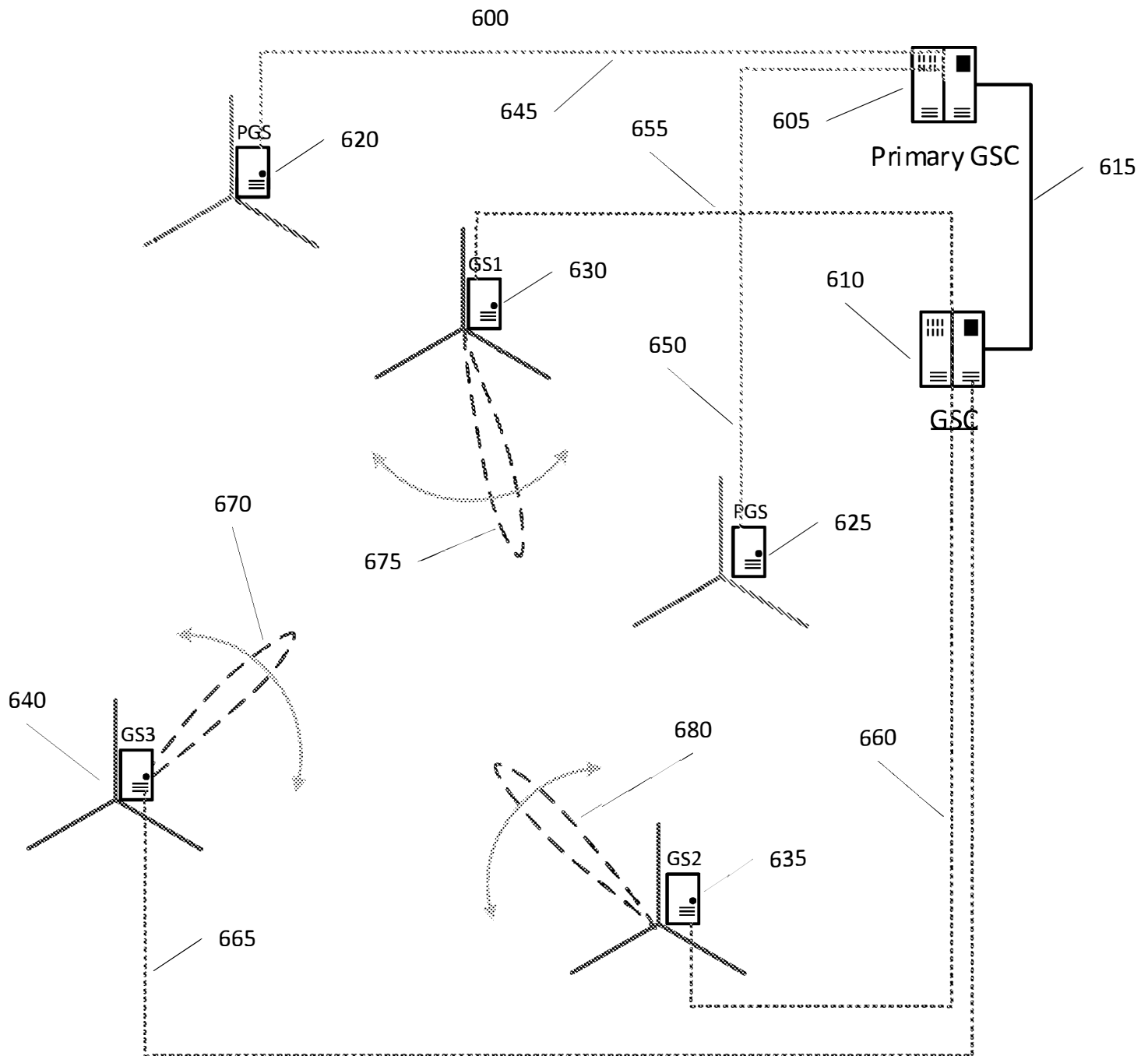


FIG. 6

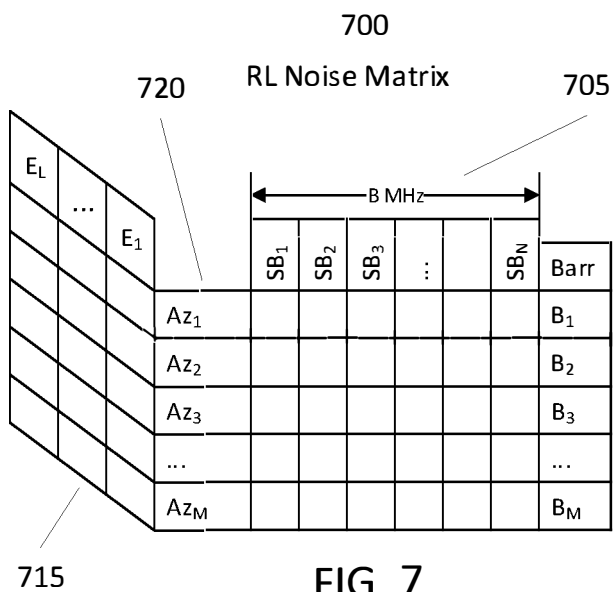


FIG. 7

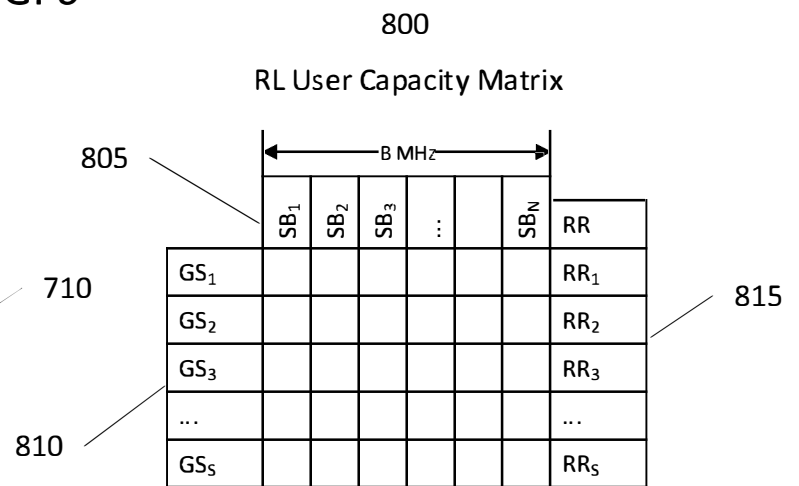


FIG. 8

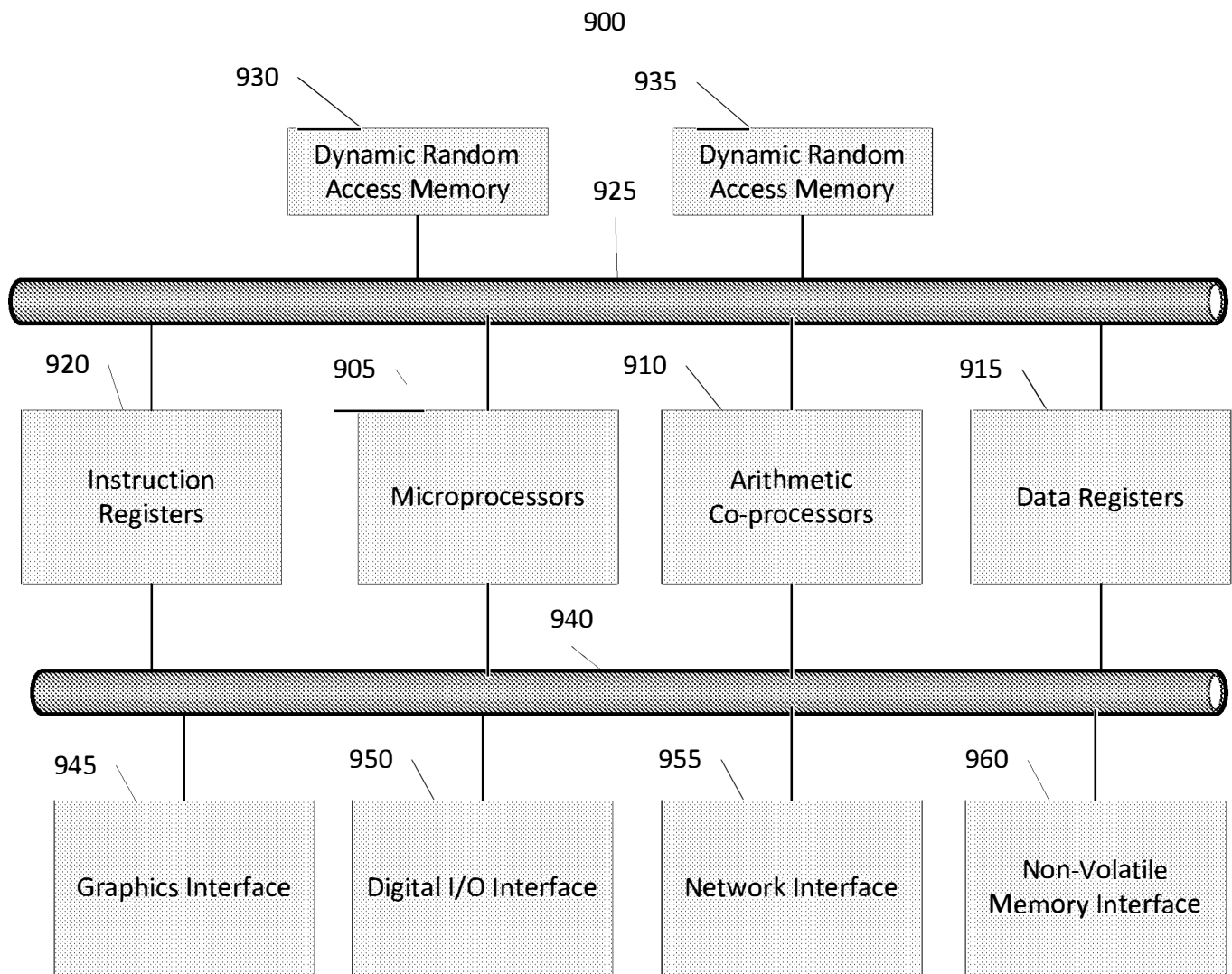


FIG. 9

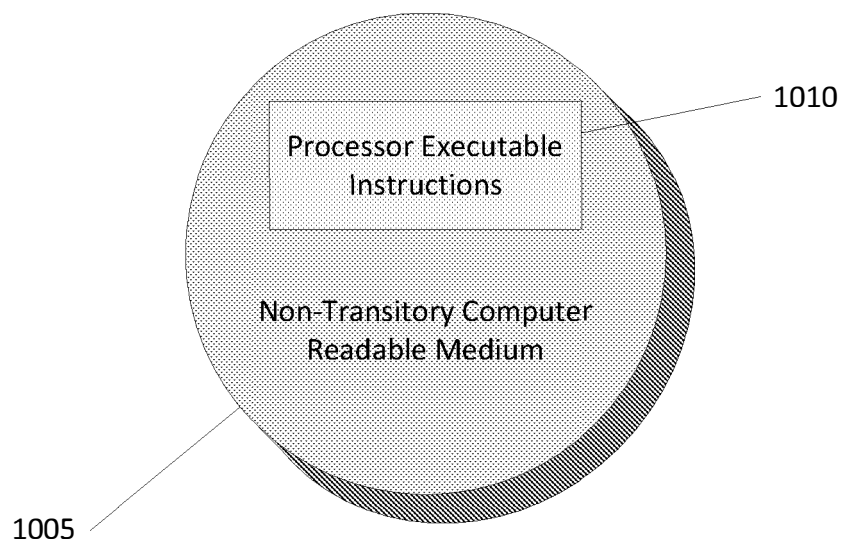


FIG. 10

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA/82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	Not Yet Assigned		
Filing Date	Concurrently Herewith		
First Named Inventor	Heinz A. Miranda		
Title	Servicing Cell Selection in Air to Ground Communication Systems		
Art Unit	Not Yet Assigned		
Examiner Name	Not Yet Assigned		
Attorney Docket Number	32045/50990		
SIGNATURE of Applicant or Patent Practitioner			
Signature	/Jeffrey M. Blank, Reg. No.: 71,335/	Date (Optional)	November 15, 2016
Name	Jeffrey M. Blank	Registration Number	71,335
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			
NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.			
☐	*Total of <u>1</u> form is submitted.		

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number

Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☒ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above:

04743

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☐ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

Firm or
Individual Name

Address

City

State

Zip

Country

Telephone

Email

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

GOGO LLC

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature

Date (Optional)

July 10, 2014

Name

Saumil Menta

Title

Assistant General Counsel, GOGO LLC

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.



Total of 1 forms are submitted.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)**Title of Invention**

Servicing Cell Selection in Air to Ground Communication Systems

As the below named inventor, I hereby declare that:

This declaration ☒ The attached application, or
is directed to:☐ United States application or PCT international application number _____
filed on _____☐ As Amended on _____ (if applicable)

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I have reviewed and understand the contents of the above identified specification, including the claims, as amended by an amendment, if any, specifically referred to herein. I acknowledge the duty to disclose information that is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information that became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: _____ Heinz A. Miranda _____

Date (Optional): _____

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)**Title of
Invention**

Servicing Cell Selection in Air to Ground Communication Systems

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LEGAL NAME OF INVENTORInventor: Michael H. BakerDate (Optional): 11/14/2016Signature: Michael H Baker

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)**Title of
Invention**

Servicing Cell Selection in Air to Ground Communication Systems

As the below named inventor, I hereby declare that:

This declaration ☒ The attached application, or
is directed to:☐ United States application or PCT international application number _____
filed on _____☐ As Amended on _____ (if applicable)

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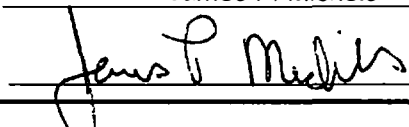
WARNING:

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LEGAL NAME OF INVENTOR

Inventor: James P. Michels

Date (Optional): _____

Signature: 

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)**Title of
Invention**

Servicing Cell Selection in Air to Ground Communication Systems

As the below named inventor, I hereby declare that:

This declaration ☒ The attached application, or
is directed to:☐ United States application or PCT international application number _____
filed on _____.☐ As Amended on _____ (if applicable)

The above-identified application was made or authorized to be made by me.

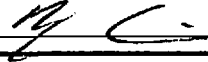
I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I have reviewed and understand the contents of the above identified specification, including the claims, as amended by an amendment, if any, specifically referred to herein. I acknowledge the duty to disclose information that is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information that became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

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LEGAL NAME OF INVENTORInventor: Yong Liu Date (Optional): _____Signature:  _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Heinz A. Miranda et al.

Application No.: Not Yet Assigned

Confirmation No.: Not Yet Assigned

Filed: Concurrently Herewith

Art Unit: Not Yet Assigned

For: Servicing Cell Selection in Air to Ground
Communication Systems

Examiner: Not Yet Assigned

INFORMATION DISCLOSURE STATEMENT (IDS)

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Pursuant to 37 C.F.R. § 1.56, 1.97 and 1.98, the attention of the United States Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08. It is respectfully requested that the information be expressly considered during the prosecution of the above-identified application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

This Information Disclosure Statement accompanies the new patent application submitted herewith.

In accordance with 37 C.F.R. § 1.98(a)(2)(ii), copies of U.S. patents and U.S. patent application publications are not submitted.

This Information Disclosure Statement cites a U.S. provisional patent application. By bringing this provisional patent application to the Examiner's attention, Applicants do not waive the confidentiality provision of 35 U.S.C. § 122. In accordance with M.P.E.P. 609.04(a).II(C)-(D), Applicant has not submitted a copy of the provisional patent application, which states that the requirement for a legible copy of the specification, including the claims and drawings of each cited pending U.S. patent application (or portion of the application which caused it to be listed) is *sua sponte* waived where the cited pending application is stored in the USPTO's IFW system.

In accordance with 37 C.F.R. § 1.97(g), the filing of this Information Disclosure Statement shall not be construed as a representation that a search has been made. In accordance with 37 C.F.R. § 1.97(h), the filing of this Information Disclosure Statement shall not be construed to be an admission that the information cited in this Information Disclosure Statement is, or is considered to be, material to the patentability as defined in 37 C.F.R. § 1.56(b).

It is submitted that the Information Disclosure Statement is in compliance with 37 C.F.R. § 1.98, and the Examiner is respectfully requested to consider the listed references.

Dated: November 15, 2016

Respectfully submitted,
Electronic signature:
/Jeffrey M. Blank, Reg. No.: 71,335/
Jeffrey M. Blank
Registration No.: 71,335
MARSHALL, GERSTEIN & BORUN LLP
233 S. Wacker Drive
6300 Willis Tower
Chicago, Illinois 60606-6357
(312) 474-6300
Agent for Applicant

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Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT <i>(Use as many sheets as necessary)</i>				Complete if Known	
				Application Number	Not Yet Assigned
				Filing Date	Concurrently Herewith
				First Named Inventor	Heinz A. Miranda
				Art Unit	Not Yet Assigned
				Examiner Name	Not Yet Assigned
				Attorney Docket Number	32045/50990
Sheet	1	of	2		

[illegible][illegible]

Examiner Signature		Date Considered	
-----------------------	--	--------------------	--

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. ¹ Applicant's unique citation designation number (optional). ² See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. ³ Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁶ Applicant is to place a check mark here if English language Translation is attached.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT <i>(Use as many sheets as necessary)</i>				Complete if Known	
				Application Number	Not Yet Assigned
				Filing Date	Concurrently Herewith
				First Named Inventor	Heinz A. Miranda
				Art Unit	Not Yet Assigned
				Examiner Name	Not Yet Assigned
Sheet	2	of	2	Attorney Docket Number	32045/50990

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No. ¹	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
		US Provisional Patent Application No. 61/875,724, Interference Mitigation in an Air-to-Ground Wireless Communication Network, filed September 10, 2013.	

Examiner Signature		Date Considered	
-----------------------	--	--------------------	--

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ Applicant's unique citation designation number (optional). ² Applicant is to place a check mark here if English language Translation is attached.

Electronic Patent Application Fee Transmittal

Application Number:

Filing Date:

Title of Invention:

Servicing Cell Selection in Air to Ground Communication Systems

First Named Inventor/Applicant Name:

Heinz A. Miranda

Filer:

Jeffrey Michael Blank/Gina Scianni

Attorney Docket Number:

32045/50990

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	280	280
UTILITY SEARCH FEE	1111	1	600	600
UTILITY EXAMINATION FEE	1311	1	720	720

Pages:

Claims:

Miscellaneous-Filing:

Petition:

Patent-Appeals-and-Interference:

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1600

Electronic Acknowledgement Receipt

EFS ID:	27520278
Application Number:	15352255
International Application Number:	
Confirmation Number:	7058
Title of Invention:	Servicing Cell Selection in Air to Ground Communication Systems
First Named Inventor/Applicant Name:	Heinz A. Miranda
Customer Number:	04743
Filer:	Jeffrey Michael Blank/Gina Scianni
Filer Authorized By:	Jeffrey Michael Blank
Attorney Docket Number:	32045/50990
Receipt Date:	15-NOV-2016
Filing Date:	
Time Stamp:	17:10:12
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$ 1600
RAM confirmation Number	111616INTEFSW17121600
Deposit Account	132855
Authorized User	Gina Scianni

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal of New Application	50990_Application_Transmittal.PDF	32689	no	1
			a0bdec060071c6cec9e2eee05af10c3fd86cd4b2		
Warnings:					
Information:					
2	Application Data Sheet	Application_Data_Sheet.PDF	29162	no	6
			3fd67fe7105f1699ec89917cfc8d34db03ee0f		
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
3		GG18_Patent_Application_as_Filed.PDF	106392	yes	29
			661aef92224f39d01ad1156d4bd766e769a6a5c6		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Specification		1	22	
	Claims		23	28	
	Abstract		29	29	
Warnings:					
Information:					
4	Drawings-only black and white line drawings	GG18_Drawings_as_Filed.PDF	196052	no	6
			638580c2bb0157c44132f3d6c690b257a8a43db7		
Warnings:					
Information:					

5	Power of Attorney	POA_or_Authorization_of_Agent.PDF	86202	no	2
			c489fa769af691dbf1b8bd508d5dc85639f207d		
Warnings:					
Information:					
6	Oath or Declaration filed	50990_Executed_Declaration.PDF	540502	no	4
			22ed16ab1993fc70a321b5489ed591502be56dd9		
Warnings:					
Information:					
7	Transmittal Letter	Information_Disclosure_Statement.PDF	20639	no	2
			db3ed0487b94f27a135cafa5e1c4657fa6d4f435		
Warnings:					
Information:					
8	Information Disclosure Statement (IDS) Form (SB08)	IDS_Citation_by_Applicant_5_References.PDF	34868	no	2
			2252ad086eaf29e29eea5ff1d0b56e62e1773883		
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
9	Fee Worksheet (SB06)	fee-info.pdf	35294	no	2
			c1f4bd298eae8b83e8c324622951a8de3556a6ae		
Warnings:					
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Total Files Size (in bytes):			1081800		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

SCORE Placeholder Sheet for IFW Content

Application Number: 15352255

Document Date: 11/15/2016

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

- Drawings – Other than Black and White Line Drawings

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded in PALM, and no paper documents or physical media exist. The TIFF images in the IFW record were created from the original documents that are stored in SCORE.

To access the documents in the SCORE database, refer to instructions below.

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
15/352,255	11/15/2016	2414	1600	32045/50990	20	3

CONFIRMATION NO. 7058

FILING RECEIPT

4743

MARSHALL, GERSTEIN & BORUN LLP
233 SOUTH WACKER DRIVE
6300 WILLIS TOWER
CHICAGO, IL 60606-6357



0000000087428917

Date Mailed: 11/25/2016

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Heinz A. Miranda, Cary, IL;
Michael H. Baker, Elmhurst, IL;
James P. Michels, Lake Zurich, IL;
Yong Liu, Schaumburg, IL;

Applicant(s)

GOGO LLC, Chicago, IL;

Power of Attorney: The patent practitioners associated with Customer Number 04743

Domestic Applications for which benefit is claimed - None.

A proper domestic benefit claim must be provided in an Application Data Sheet in order to constitute a claim for domestic benefit. See 37 CFR 1.76 and 1.78.

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.) - None.

Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 11/23/2016

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/352,255**

Projected Publication Date: 05/17/2018

Non-Publication Request: No

Early Publication Request: No
Title

Servicing Cell Selection in Air to Ground Communication Systems

Preliminary Class

370

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

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Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 15/352,255			
APPLICATION AS FILED - PART I									
(Column 1)		(Column 2)		SMALL ENTITY		OTHER THAN SMALL ENTITY			
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)		
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280		
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A			N/A	600		
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720		
TOTAL CLAIMS (37 CFR 1.16(j))	20	minus 20 = *			OR	x 80 =	0.00		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3	minus 3 = *				x 420 =	0.00		
APPLICATION SIZE FEE (37 CFR 1.16(s))			If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))						0.00			
			TOTAL			TOTAL	1600		
* If the difference in column 1 is less than zero, enter "0" in column 2.									
APPLICATION AS AMENDED - PART II									
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OTHER THAN SMALL ENTITY	
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)	RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=	OR	x
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=	OR	x
	Application Size Fee (37 CFR 1.16(s))							OR	
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR	
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)	RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=	OR	x
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=	OR	x
	Application Size Fee (37 CFR 1.16(s))							OR	
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR	
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.									

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with 37 CFR § 1.6(a)(4).

Dated: June 27, 2017

Signature: /Lilian Y. Ficht #64,514/
(Lilian Y. Ficht)

Docket No.: 32045/50990
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Heinz A. Miranda et al.

Application No.: 15/352,255

Confirmation No.: 7058

Filed: November 15, 2016

Art Unit: 2645

For: Servicing Cell Selection in Air to Ground
Communication Systems

Examiner: N. T. Huynh

FIRST PRELIMINARY AMENDMENT UNDER 37 C.F.R. § 1.115

MS Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

INTRODUCTORY COMMENTS

This paper is filed concurrently in conjunction with a corrected Application Data Sheet. Prior to examination on the merits, please amend the above-identified U.S. patent application as follows:

Amendments to the Specification begin on page 2 of this paper.

Amendments to the Claims are reflected in the listing of claims which begins on page 3 of this paper.

Remarks/Arguments begin on page 10 of this paper.

AMENDMENTS TO THE SPECIFICATION

Please insert the following section heading and paragraph after the title:

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority to and the benefit of U.S. Provisional Patent Application No. 62/358,437 entitled “Hybrid Air-to-Ground Network Incorporating Unlicensed Bands” and filed on July 5, 2016, the disclosure of which is hereby incorporated by reference herein in its entirety.

AMENDMENTS TO THE CLAIMS

1. (Currently amended) A non-transitory computer readable medium, comprising processor executable instructions that when executed by a computer processor disposed within an airborne aircraft cause the computer processor to:

command a directional antenna installed on the aircraft and a transceiver disposed within the aircraft to measure a first signal-to-noise ratio [[for]]of a first communication channel [[at]]corresponding to a first location on the ground, the first communication channel configured to support transmissions to/from the airborne aircraft;

command the directional antenna and the transceiver to measure a second signal-to-noise ratio [[for]]of a second communication channel [[at]]corresponding to a second location on the ground, the second communication channel configured to support transmissions to/from the airborne aircraft;

calculate a first forward-link user capacity estimate using the first signal-to-noise ratio [[for]]of the first communication channel;

calculate a second forward-link user capacity estimate using the second signal-to-noise ratio [[for]]of the second communication channel; and

calculate a forward-link user capacity matrix using the first forward-link user capacity estimate and the second forward-link user_capacity estimate,

wherein the forward-link user capacity matrix is utilized to select communication channels to utilize for transmissions between a plurality of ground stations disposed on the ground and the airborne aircraft.

2. (Currently amended) The medium of claim 1, wherein the first communication channel comprises a first center frequency and a first bandwidth, [[and]] wherein the second communication channel comprises a second center frequency and a second bandwidth, and wherein the first communication channel does not overlap the second communication channel.

3. (Currently amended) The medium of claim 1, ~~further comprising~~ wherein the processor executable instructions, [[that]] when executed by the computer processor, cause the computer processor to:

command the directional antenna and the transceiver to measure a short-term average of the first signal-to-noise ratio [[for]]of the first communication channel ~~at the first location on the ground;~~

command the directional antenna and the transceiver to measure a short-term average of the second signal-to-noise ratio [[for]]of the second communication channel ~~at the second location on the ground;~~

calculate the first forward-link user capacity estimate using the short-term average of the first signal-to-noise ratio [[for]]of the first communication channel; and

calculate the second forward-link user capacity estimate using the short-term average of the second signal-to-noise ratio [[for]]of the second communication channel.

4. (Currently amended) The medium of claim 1, ~~further comprising~~ wherein the processor executable instructions, ~~[[that]]~~ when executed by the computer processor, cause the computer processor to:

command the directional antenna and the transceiver to measure a long-term average of the first signal-to-noise ratio [[for]]of the first communication channel ~~at the first location on the ground;~~

command the directional antenna and the transceiver to measure a long-term average of the second signal-to-noise ratio [[for]]of the second communication channel ~~at the second location on the ground;~~

calculate the first forward-link user capacity estimate using the long-term average of the first signal-to-noise ratio [[for]]of the first communication channel; and

calculate the second forward-link user capacity estimate using the long-term average of the second signal-to-noise ratio [[for]]of the second communication channel.

5. (Currently amended) The medium of claim 1, further comprising additional processor executable instructions that when executed by the computer processor cause the computer processor to command the directional antenna and the transceiver to transmit the forward-link user capacity matrix to a ground station controller using an out-of-band communication channel, the ground station controller disposed on the ground and in communicative connection with the plurality of ground stations.

6. (Currently amended) The medium of claim 1, further comprising additional processor executable instructions that when executed by the computer processor cause the computer processor to:

command the directional antenna and the transceiver to measure a third signal-to-noise ratio [[for]]of a third communication channel [[at]]corresponding to, a third location on the ground, the third communication channel configured to support transmissions to/from the airborne aircraft;

calculate a third forward-link user capacity estimate using the third signal-to-noise ratio [[for]]of the third communication channel; and

calculate the forward-link user capacity matrix using the first forward-link user capacity estimate, the second forward-link user capacity estimate, and the third forward-link user capacity estimate.

7. (Currently amended) A computer-implemented method, executed with a computer processor disposed within an air-to-ground communication ground station, comprising:

commanding, with the computer processor, a directional antenna installed at the ground station and a transceiver disposed within the ground station to measure a first noise power level [[for]]of a first communication channel at a first elevation and a first azimuth from a current position of the ground station, the first communication channel configured to support transmissions between the ground station and airborne aircraft;

commanding, with the computer processor, the directional antenna and the transceiver to measure a second noise power level [[for]]of a second communication channel at a second elevation and a second azimuth from the current position of the ground station, the second communication channel configured to support transmissions between the ground station and the airborne aircraft;

calculating, with the computer processor, a first reverse-link noise user capacity estimate using the first noise power level [[for]]of the first communication channel;

calculating, with the computer processor, a second reverse-link noise user capacity estimate using the second noise power level [[for]]of the second communication channel; and

calculating, with the computer processor, a reverse-link noise user capacity matrix using the first reverse-link noise user capacity estimate and the second reverse-link noise capacity estimate,

wherein the reverse-link noise matrix is utilized to select communication channels to utilize for transmissions between a plurality of ground stations disposed on the ground and the airborne aircraft.

8. (Currently amended) The method of claim 7, wherein the first communication channel comprises a first center frequency and a first bandwidth, [[and]] wherein the second communication channel comprises a second center frequency and a second bandwidth, and wherein the first communication channel does not overlap the second communication channel.

9. (Currently amended) The method of claim 7, further comprising:
commanding, with the computer processor, the directional antenna and the transceiver to measure a short-term average of the first noise power level [[for]]of the first communication channel at the first elevation and the first azimuth;
commanding, with the computer processor, the directional antenna and the transceiver to measure a short-term average of the second noise power level [[for]]of the second communication channel at the second elevation and the second azimuth;
calculating, with the computer processor, the first reverse-link noise user capacity estimate using the short-term average of the first noise power level [[for]]of the first communication channel; and
calculating, with the computer processor, the second reverse-link noise user capacity estimate using the short-term average of the second noise power level [[for]]of the second communication channel.

10. (Currently amended) The method of claim 7, further comprising:
commanding, with the computer processor, the directional antenna and the transceiver to measure a long-term average of the first noise power level [[for]]of the first communication channel at the first elevation and the first azimuth;
commanding, with the computer processor, the directional antenna and the transceiver to measure a long-term average of the second noise power level [[for]]of the second communication channel at the second elevation and the second azimuth;

calculating, with the computer processor, the first reverse-link ~~noise user capacity~~ estimate using the long-term average of the first noise power level ~~[[for]]~~of the first communication channel; and

calculating, with the computer processor, the second reverse-link ~~noise user capacity~~ estimate using the long-term average of the second noise power level ~~[[for]]~~of the second communication channel.

11. (Currently amended) The method of claim 7, further comprising commanding, with the computer processor, the ground station to transmit the reverse-link ~~noise user capacity~~ matrix to a ground station controller, the ground station controller disposed on the ground and in communicative connection with the plurality of ground stations.

12. (Currently amended) The method of claim 7, further commanding, with the computer processor, the directional antenna and the transceiver to measure a third noise power level ~~[[for]]~~of a third communication channel at a third elevation and a third azimuth from the current position of the ground station, the third communication channel configured to support transmissions between the ground station and the airborne aircraft;

calculating, with the computer processor, a third reverse-link ~~noise user capacity~~ estimate using the third noise power level ~~[[for]]~~of the third communication channel; and

calculating, with the computer processor, the reverse-link ~~noise user capacity~~ matrix using the first reverse-link ~~noise user capacity~~ estimate, the second reverse-link ~~noise capacity~~ estimate, and the third reverse-link ~~noise user capacity~~ matrix.

13. (Currently amended) A computer system comprising one or more processors and/or transceivers configured to:

retrieve at least one of:

(i) a forward-link user capacity matrix comprising a plurality of forward-link user capacity estimates each associated with a respective location on the ground; ~~[[and]]~~or

(ii) a return-link user capacity matrix comprising a plurality of reverse-link user capacity estimates each associated with ~~[[an]]~~a respective azimuth and elevation from a current location of an airborne aircraft;

~~determine~~~~calculate a candidate serving cell~~, using at least one of (i) the forward-link user capacity matrix ~~[[and]]~~or (ii) the reverse-link user capacity ~~matrix, a candidate serving cell that is disposed on the ground;~~ and

command a directional antenna and a particular transceiver to transmit or receive data between the airborne aircraft and ~~[[with]]~~ the candidate serving cell.

14. (Currently amended) The system of claim 13, ~~further comprising wherein the one or more processors and/or transceivers are configured to~~ ~~retrieve from an air-to-ground network controller~~ the at least one of (i) the forward-link user capacity matrix ~~[[and]]~~or (ii) the return-link user capacity matrix from an air-to-ground network controller disposed on the ground and in communicative with a plurality of serving cells, the plurality of serving cells including the candidate serving cell.

15. (Original) The system of claim 13, wherein the candidate serving cell comprises a noise power level above a threshold.

16. (Currently amended) The system of claim 13, wherein the one or more processors and/or transceivers are further configured to transmit the ~~transceiver transmits~~ at least one of (i) the forward-link user capacity matrix ~~[[and]]~~or (ii) the return-link user capacity matrix using an out-of-band channel.

17. (Currently amended) The system of claim 13, wherein the forward-link user capacity matrix indicates a lower signal-to-noise ratio associated with the candidate serving cell than an alternative serving cell, and wherein the alternative serving cell is located at a distance ~~further~~ from the airborne aircraft that is greater than a distance from the airborne aircraft of the candidate serving cell ~~is located from the airborne aircraft.~~

18. (Currently amended) The system of claim 13, wherein the reverse-link user capacity matrix indicates a higher noise power level associated with the candidate serving cell than an alternative serving cell, and wherein the alternative serving cell is located at a distance ~~further~~ from the airborne aircraft that is greater than a distance from the airborne aircraft of the candidate serving cell ~~is located from the airborne aircraft.~~

19. (Currently amended) The system of claim 13, wherein at least one of the plurality of forward-link user capacity estimates matrix ~~[[and]]~~ or the plurality of return-link user capacity matrix ~~comprises a plurality of user capacity estimates~~ is associated with a plurality of communication channels.

20. (Currently amended) The system of claim 15, wherein the threshold comprises at least one of:

a short-term noise threshold that enables ~~[[an]]~~ a serving cell selection decision among a plurality of serving cells; ~~[[and]]~~ or

a long-term noise threshold that enables a future serving cell restriction decision.

REMARKS

The specification is amended in the self-evident manner shown above to claim the benefit of a prior-filed provisional application. A reference to the prior-filed provisional application to which the present application claims priority is also provided in the corrected Application Data Sheet filed concurrently herewith.

Claims 1-14 and 16-20 are amended. Support for the amendments to claims 1-6 and 14 may be found, for example, in the specification at paragraphs [0025], [0060], and [0062]-[0065] and in FIGS. 3-4, and support for the amendments to claims 7-12 and 14 may be found, for example, in the specification at paragraphs [0066]-[0073] and in FIGS. 6-7. Support for the amendments to claims 17-18 may be found, for example, in the specification at paragraphs [0050], [0056], and [0064]. Additionally, various claims are amended in the self-evident manner shown above to correct grammar, correct antecedent basis, and provide clarity. As such, no new matter is added by this amendment.

In view of the above amendment, Applicant believes the pending application is in condition for allowance.

Dated: June 27, 2017

Respectfully submitted,

By: /Lilian Y. Ficht #64,514/
Lilian Y. Ficht
Registration No.: 64,514
MARSHALL, GERSTEIN & BORUN LLP
233 S. Wacker Drive
6300 Willis Tower
Chicago, Illinois 60606-6357
(312) 474-6300
Patent Agent for Applicant

Corrected Application Data Sheet

Inventor Information

Inventor Number::	1
Given Name::	Heinz
Middle Name::	A.
Family Name::	Miranda
City of Residence::	Cary
State or Province of Residence::	IL
Country of Residence::	US
Street of mailing address::	208 Foxford Drive
City of mailing address::	Cary
State or Province of mailing address::	IL
Country of mailing address::	US
Postal or Zip Code of mailing address::	60013

Inventor Number::	2
Name Prefix::	Mr.
Given Name::	Michael
Middle Name::	H.
Family Name::	Baker
City of Residence::	Elmhurst
State or Province of Residence::	IL
Country of Residence::	US

Street of mailing address:: 375 S. Mitchell Avenue
City of mailing address:: Elmhurst
State or Province of mailing address:: IL
Country of mailing address:: US
Postal or Zip Code of mailing address:: 60126

Inventor Number:: 3
Name Prefix:: Mr.
Given Name:: James
Middle Name:: P.
Family Name:: Michels
City of Residence:: Lake Zurich
State or Province of Residence:: IL
Country of Residence:: US
Street of mailing address:: 1050 Westberry Ct
City of mailing address:: Lake Zurich
State or Province of mailing address:: IL
Country of mailing address:: US
Postal or Zip Code of mailing address:: 60047

Inventor Number:: 4
Given Name:: Yong
Family Name:: Liu

City of Residence::	Schaumburg
State or Province of Residence::	IL
Country of Residence::	US
Street of mailing address::	1817 Altoona Court
City of mailing address::	Schaumburg
State or Province of mailing address::	IL
Country of mailing address::	US
Postal or Zip Code of mailing address::	60194

Correspondence Information

Correspondence Customer Number::	04743
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Application Information

<u>Application Number::</u>	<u>15/352,255</u>
<u>Filing Date::</u>	<u>11/15/16</u>
Application Type::	Regular
Subject Matter::	Utility
CD-ROM or CD-R?::	None
Sequence submission?::	None
Computer Readable Form (CRF)?::	No
Title::	Servicing Cell Selection in Air to Ground Communication Systems
Attorney Docket Number::	32045/50990
Request for Early Publication?::	No

Request for Non-Publication?:: No

Total Drawing Sheets:: 6

Small Entity?:: No

Petition included?:: No

Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2:: No

Representative Information

Representative Customer Number:: 04743

Domestic Priority Information

<u>Application::</u>	<u>Continuity Type::</u>	<u>Parent Application::</u>	<u>Parent Filing Date::</u>	<u>Prior Appl Status::</u>
<u>This Application</u>	<u>Claims benefit of provisional</u>	<u>62/358,437</u>	<u>07/05/16</u>	<u>Pending</u>

Foreign Priority Information

Applicant Information

Applicant Number:: 1

Applicant Type:: Assignee

Organization Name:: GOGO LLC

Street of mailing address:: 111 North Canal Street
Suite 1500

City of mailing address:: Chicago

State or Province of mailing address:: IL
Country of mailing address:: US
Postal or Zip Code of mailing address:: 60606

~~Assignee Information Including Non-Applicant Assignee Information~~

~~Assignee Number::~~ ~~4~~
~~Organization Name::~~ ~~GOGO LLC~~
~~Street of mailing address::~~ ~~411 North Canal Street~~
~~City of mailing address::~~ ~~Chicago~~
~~State or Province of mailing address::~~ ~~IL~~
~~Country of mailing address::~~ ~~US~~
~~Postal or Zip Code of mailing address::~~ ~~60606~~

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Lilian Y. Ficht #64,514/	Date (YYYY-MM-DD)	2017-06-27
Name	Lilian Y. Ficht	Registration Number	64,514

Electronic Acknowledgement Receipt

EFS ID:	29625404
Application Number:	15352255
International Application Number:	
Confirmation Number:	7058
Title of Invention:	Servicing Cell Selection in Air to Ground Communication Systems
First Named Inventor/Applicant Name:	Heinz A. Miranda
Customer Number:	4743
Filer:	Lilian Y. Ficht/Yvonne Hernandez
Filer Authorized By:	Lilian Y. Ficht
Attorney Docket Number:	32045/50990
Receipt Date:	27-JUN-2017
Filing Date:	15-NOV-2016
Time Stamp:	17:22:17
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		First_Preliminary_Amendment _Under_37_CFR1.PDF	55398	yes	10
			8da6bec86b139bea22900471900f263c46420600		

IPR2025-00672

Petitioner's Exhibit 1004

Page 79 of 214

	Multipart Description/PDF files in .zip description		
	Document Description	Start	End
	Preliminary Amendment	1	1
	Specification	2	2
	Claims	3	9
	Applicant Arguments/Remarks Made in an Amendment	10	10

Warnings:

Information:

2	Application Data Sheet	Application_Data_Sheet.PDF	23377	no	5
			d26e1cd49f9101695993a88491cb3933cb60dc0c		

Warnings:

Information:

This is not an USPTO supplied ADS fillable form

Total Files Size (in bytes):	78775
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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.



UNITED STATES PATENT AND TRADEMARK OFFICE

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www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

4743 7590 12/07/2017
MARSHALL, GERSTEIN & BORUN LLP
233 SOUTH WACKER DRIVE
6300 WILLIS TOWER
CHICAGO, IL 60606-6357

EXAMINER

HUYNH, NAM TRUNG

ART UNIT

PAPER NUMBER

2645

DATE MAILED: 12/07/2017

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/352,255	11/15/2016	Heinz A. Miranda	32045/50990	7058

TITLE OF INVENTION: Servicing Cell Selection in Air to Ground Communication Systems

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$960	\$0	\$0	\$960	03/07/2018

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

**Complete and send this form, together with applicable fee(s), to: Mail Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885**

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

4743 7590 12/07/2017
MARSHALL, GERSTEIN & BORUN LLP
233 SOUTH WACKER DRIVE
6300 WILLIS TOWER
CHICAGO, IL 60606-6357

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/352,255	11/15/2016	Heinz A. Miranda	32045/50990	7058

TITLE OF INVENTION: Servicing Cell Selection in Air to Ground Communication Systems

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$960	\$0	\$0	\$960	03/07/2018

EXAMINER	ART UNIT	CLASS-SUBCLASS
HUYNH, NAM TRUNG	2645	455-431000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

- (1) The names of up to 3 registered patent attorneys or agents OR, alternatively, 1 _____
- (2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. 2 _____
- 3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☐ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

- ☐ A check is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☐ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
- ☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____

Date _____

Typed or printed name _____

Registration No. _____

IPR2025-00072



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/352,255	11/15/2016	Heinz A. Miranda	32045/50990	7058

4743 7500 12/07/2017
MARSHALL, GERSTEIN & BORUN LLP
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6300 WILLIS TOWER
CHICAGO, IL 60606-6357

EXAMINER

HUYNH, NAM TRUNG

ART UNIT PAPER NUMBER

2645

DATE MAILED: 12/07/2017

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 15/352,255	Applicant(s) MIRANDA ET AL.	
	Examiner NAM HUYNH	Art Unit 2645	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to application filed on 11/15/16.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are 1-18 and 20. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

- a) ☐ All b) ☐ Some *c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.

THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.
Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

- | | |
|--|--|
| 1. ☒ Notice of References Cited (PTO-892) | 5. ☒ Examiner's Amendment/Comment |
| 2. ☒ Information Disclosure Statements (PTO/SB/08),
Paper No./Mail Date _____ | 6. ☒ Examiner's Statement of Reasons for Allowance |
| 3. ☐ Examiner's Comment Regarding Requirement for Deposit
of Biological Material | 7. ☐ Other _____. |
| 4. ☒ Interview Summary (PTO-413),
Paper No./Mail Date _____. | |

/NAM HUYNH/
Primary Examiner, Art Unit 2645

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Information Disclosure Statement

2. The information disclosure statement (IDS) submitted on 11/15/16 is being considered by the examiner.

EXAMINER'S AMENDMENT

3. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in an interview with Lilian Ficht on 11/13/17.

The application has been amended as follows:

12. (Currently amended) The method of claim 7, further comprising:
commanding, with the computer processor, the directional antenna and the transceiver to measure a third noise power level of a third communication channel at a third elevation and a third azimuth from the current position of the ground station, the

Art Unit: 2645

third communication channel configured to support transmissions between the ground station and airborne aircraft;

calculating, with the computer processor, a third reverse-link noise estimate using the third noise power level of the third communication channel; and

calculating, with the computer processor, the reverse-link noise matrix using the first reverse-link noise estimate, the second reverse-link noise estimate, and the third reverse-link noise matrix.

13. (Currently amended) A computer system comprising one or more processors and/or transceivers configured to:

retrieve at least one of:

(i) a forward-link user capacity matrix comprising a plurality of forward-link user capacity estimates each associated with a respective signal-to-noise ratio measurement of a respective communication channel corresponding to a respective location on the ground; or

(ii) a return-link user capacity matrix comprising a plurality of reverse-link user capacity estimates each associated with a respective noise power level of a respective communication channel corresponding to a respective azimuth and a respective elevation from a current location of an airborne aircraft;

determine, using at least one of (i) the forward-link user capacity matrix or (ii) the reverse-link user capacity matrix, a candidate serving cell that is disposed on the ground; and

command a directional antenna and a particular transceiver to transmit or receive data between the airborne aircraft and the candidate serving cell.

15. (Currently amended) The system of claim 13, wherein the candidate serving cell comprises a respective noise power level above a threshold.

18. (Currently amended) The system of claim 13, wherein the reverse-link user capacity matrix indicates a higher noise power level associated with the candidate serving cell than a power noise level associated with an alternative serving cell, and wherein the alternative serving cell is located at a distance from the airborne aircraft that is greater than a distance from the airborne aircraft of the candidate serving cell.

19. (Cancelled).

Allowable Subject Matter

4. Claims 1-18 and 20 are allowed.

5. The following is an examiner's statement of reasons for allowance:

Regarding claim 1, the closest prior art of record, Lynch et al. (US 2008/0240029) teaches a non-transitory computer readable medium, comprising processor executable instructions that when executed by a computer processor disposed within an airborne aircraft cause the computer processor to: command a directional antenna (**air-to-ground antenna**) installed on the aircraft and a transceiver (**air-to-ground transceiver**) disposed within the aircraft to measure a first signal-to-noise ratio of a first communication channel corresponding to a first location on the ground (**first base station**), the first communication channel configured to support

Art Unit: 2645

transmissions to/from the airborne aircraft [paragraph 78]; command the directional antenna and the transceiver to measure a second signal-to-noise ratio of a second communication channel corresponding to a second location on the ground (**second base station**), the second communication channel configured to support transmissions to/from the airborne aircraft [paragraph 78]; select communication channels to utilize for transmissions between a plurality of ground stations disposed on the ground and the airborne aircraft (aircraft performs handoff between base stations based on capacity or measured signal-to-noise ratio) [paragraphs 75-78]. However, none of the prior art either alone or in combination provides the motivation to teach “*calculate a first forward-link user capacity estimate using the first signal-to-noise ratio of the first communication channel; calculate a second forward-link user capacity estimate using the second signal-to-noise ratio of the second communication channel; and calculate a forward-link user capacity matrix using the first forward-link user capacity estimate and the second forward-link user capacity estimate, wherein the forward-link user capacity matrix is utilized to select communication channels to utilize for transmissions between a plurality of ground stations disposed on the ground and the airborne aircraft*”.

Regarding claim 7, none of the prior art either alone or in combination provides the motivation to teach “*a directional antenna installed at the ground station and a transceiver disposed within the ground station to measure a first noise power level of a first communication channel at a first elevation and a first azimuth from a current position of the ground station, the first communication channel configured to support transmissions between the ground station and airborne aircraft; commanding, with the*

computer processor, the directional antenna and the transceiver to measure a second noise power level of a second communication channel at a second elevation and a second azimuth from the current position of the ground station, the second communication channel configured to support transmissions between the ground station and the airborne aircraft; calculating, with the computer processor, a first reverse-link noise user capacity estimate using the first noise power level of the first communication channel; calculating, with the computer processor, a second reverse-link noise user capacity estimate using the second noise power level of the second communication channel; and calculating, with the computer processor, a reverse-link noise user capacity matrix using the first reverse-link noise estimate and the second reverse-link noise wherein the reverse-link noise matrix is utilized to select communication channels to utilize for transmissions between a plurality of ground stations disposed on the ground and the airborne aircraft”.

Claim 13 recites similar subject matter as claims 1 and 7 and is allowed for the same reasons.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled “Comments on Statement of Reasons for Allowance.”

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to NAM HUYNH whose telephone number is (571)272-5970. The examiner can normally be reached on 8 a.m.-5 p.m..

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, George Eng can be reached on 571-272-7495. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/NAM HUYNH/

Application/Control Number: 15/352,255

Page 8

Art Unit: 2645

Primary Examiner, Art Unit 2645

Notice of References Cited	Application/Control No. 15/352,255	Applicant(s)/Patent Under Reexamination MIRANDA ET AL.	
	Examiner NAM HUYNH	Art Unit 2645	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-2008/0240029 A1	10-2008	LYNCH; Michael J.	H04B7/18508	370/329
	B	US-				
	C	US-				
	D	US-				
	E	US-				
	F	US-				
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Issue Classification 	Application/Control No. 15352255	Applicant(s)/Patent Under Reexamination MIRANDA ET AL.	
	Examiner NAM HUYNH	Art Unit 2645	

CPC						
Symbol				Type	Version	
H04B		7	/	18506	F	2013-01-01
H04B		17	/	336	I	2015-01-15
H04L		43	/	0882	I	2013-01-01
H04L		5	/	006	I	2013-01-01
H04W		48	/	20	I	2013-01-01
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CPC Combination Sets				
Symbol	Type	Set	Ranking	Version

NONE		Total Claims Allowed:	
		19	
(Assistant Examiner)	(Date)		
/NAM HUYNH/ Primary Examiner.Art Unit 2645	11/13/17	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

Issue Classification 	Application/Control No. 15352255	Applicant(s)/Patent Under Reexamination MIRANDA ET AL.
	Examiner NAM HUYNH	Art Unit 2645

☐ Claims renumbered in the same order as presented by applicant															
☐ CPA															
☐ T.D.															
☐ R.1.47															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	17	17												
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NONE	Total Claims Allowed:	
(Assistant Examiner)	(Date)	19
/NAM HUYNH/ Primary Examiner.Art Unit 2645	11/13/17	O.G. Print Claim(s) 1
(Primary Examiner)	(Date)	O.G. Print Figure 1

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.																	
Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT <i>(Use as many sheets as necessary)</i>		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th colspan="2" style="text-align: center; padding: 5px;"><i>Complete if Known</i></th> </tr> <tr> <td style="width: 30%; padding: 5px;">Application Number</td> <td style="padding: 5px;">Not Yet Assigned 15352255</td> </tr> <tr> <td style="padding: 5px;">Filing Date</td> <td style="padding: 5px;">Concurrently Herewith</td> </tr> <tr> <td style="padding: 5px;">First Named Inventor</td> <td style="padding: 5px;">Heinz A. Miranda</td> </tr> <tr> <td style="padding: 5px;">Art Unit</td> <td style="padding: 5px;">Not Yet Assigned</td> </tr> <tr> <td style="padding: 5px;">Examiner Name</td> <td style="padding: 5px;">Not Yet Assigned</td> </tr> <tr> <td style="padding: 5px;">Attorney Docket Number</td> <td style="padding: 5px;">32045/50990</td> </tr> </table>		<i>Complete if Known</i>		Application Number	Not Yet Assigned 15352255	Filing Date	Concurrently Herewith	First Named Inventor	Heinz A. Miranda	Art Unit	Not Yet Assigned	Examiner Name	Not Yet Assigned	Attorney Docket Number	32045/50990
<i>Complete if Known</i>																	
Application Number	Not Yet Assigned 15352255																
Filing Date	Concurrently Herewith																
First Named Inventor	Heinz A. Miranda																
Art Unit	Not Yet Assigned																
Examiner Name	Not Yet Assigned																
Attorney Docket Number	32045/50990																
Sheet	1	of	2														

[illegible][illegible]

Examiner Signature	/NAM T HUYNH/	Date Considered	11/13/2017
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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. ¹ Applicant's unique citation designation number (optional). ² See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. ³ Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁶ Applicant is to place a check mark here if English language Translation is attached.

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Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT <i>(Use as many sheets as necessary)</i>				Complete if Known	
				Application Number	Not Yet Assigned
				Filing Date	Concurrently Herewith
				First Named Inventor	Heinz A. Miranda
				Art Unit	Not Yet Assigned
				Examiner Name	Not Yet Assigned
Sheet	2	of	2	Attorney Docket Number	32045/50990

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No. ¹	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
		US Provisional Patent Application No. 61/875,724, Interference Mitigation in an Air-to-Ground Wireless Communication Network, filed September 10, 2013.	

Examiner Signature	/NAM T HUYNH/	Date Considered	11/13/2017
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¹ Applicant's unique citation designation number (optional). ² Applicant is to place a check mark here if English language Translation is attached.

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<i>Index of Claims</i> 	Application/Control No. 15352255	Applicant(s)/Patent Under Reexamination MIRANDA ET AL.
	Examiner NAM HUYNH	Art Unit 2645

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant			☐ CPA			☐ T.D.			☐ R.1.47		
CLAIM		DATE									
Final	Original	11/13/2017									
1	1	=									
2	2	=									
3	3	=									
4	4	=									
5	5	=									
6	6	=									
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BIB DATA SHEET

CONFIRMATION NO. 7058

SERIAL NUMBER 15/352,255	FILING or 371(c) DATE 11/15/2016 RULE	CLASS 455	GROUP ART UNIT 2645	ATTORNEY DOCKET NO. 32045/50990	
APPLICANTS GOGO LLC, Chicago, IL; INVENTORS Heinz A. Miranda, Cary, IL; Michael H. Baker, Elmhurst, IL; James P. Michels, Lake Zurich, IL; Yong Liu, Schaumburg, IL; ** CONTINUING DATA ***** ** FOREIGN APPLICATIONS ***** ** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** 11/23/2016					
Foreign Priority claimed ☐ Yes ☒ No 35 USC 119(a-d) conditions met ☐ Yes ☒ No Verified and /NAM TRUNG HUYNH/ Acknowledged Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY IL	SHEETS DRAWINGS 6	TOTAL CLAIMS 20	INDEPENDENT CLAIMS 3
ADDRESS MARSHALL, GERSTEIN & BORUN LLP 233 SOUTH WACKER DRIVE 6300 WILLIS TOWER CHICAGO, IL 60606-6357 UNITED STATES					
TITLE Servicing Cell Selection in Air to Ground Communication Systems					
FILING FEE RECEIVED 1600	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:		☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit		

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	71607	(noise "sn" "s/n" capacity bandwidth) with matrix	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/07 12:26
S2	6008	(noise "sn" "s/n" capacity bandwidth) with matrix with (select\$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/07 12:26
S3	7857	(noise "sn" "s/n" capacity bandwidth sir interference) with matrix with (select\$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/07 12:28
S4	382	S3 AND ((H04B17/336 OR H04L25/0242 OR H04W72/0413 OR H04W72/0453 OR H04W72/0446 OR H04W72/042).CPC.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/07 12:32
S5	21351	(noise "sn" "s/n" capacity bandwidth sir interference) near2 matrix	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/07 12:34
S6	746	S5 AND ((H04B17/336 OR H04L25/0242 OR H04W72/0413 OR H04W72/0453 OR H04W72/0446 OR H04W72/042).CPC.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/07 12:34
S7	21512	(noise "sn" "s/n" capacity bandwidth sir interference sinr) near2 matrix	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/07 12:36
S8	762	S7 AND ((H04B17/336 OR H04L25/0242	US-	OR	ON	2017/11/07

		OR H04W72/0413 OR H04W72/0453 OR H04W72/0446 OR H04W72/042).CPC.)	PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT			12:36
S9	4513	(noise "sn" "s/n" capacity bandwidth sir interference sinr) near2 matrix and (airplane aircraft airborne airbourne plane)	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:14
S10	45180	(H04B7/18506 or H04W48/20 or H04L5/006 or H04B17/336 or H04L43/0882).cpc.	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:15
S11	89533	(noise "sn" "s/n" capacity bandwidth sir interference sinr) with matrix	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:15
S12	904	S10 and S11	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:15
S13	3655	(noise "sn" "s/n" capacity bandwidth sir interference sinr) with matrix same (select\$3 choos\$3 determin\$5) with (AP BS NB eNB WAP BTS HNB HeNB H-eNB (access adj2 point) (base near2 station\$1)(micro near2 BS)(micro near2 base near2 station\$1)(micro near2 (nodeb enodeb enb e-nb)) (wireless near2 access near2 point\$1) (node near2 b) (pico near2 cell) (pico near2 (base near2 station\$1)) (nodeb)(enodeb)(base near2 transceiver near2 station\$1)(home adj2 nodeb)(nodeb near2 gateway) (nodeb near2 GW)(femto near2 BS) (femto near2 base near2 station\$1) (femto near2 nodeb)(femto near2 enodeb))	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:19
S14	4860	(noise "sn" "s/n" capacity bandwidth sir interference sinr) with matrix same (select\$3 choos\$3 determin\$5 handoff handover (hand adj off) (hand adj over)) with (cell AP BS NB eNB WAP BTS HNB HeNB H-eNB (access adj2 point) (base near2 station\$1)(micro near2 BS)(micro near2 base near2 station\$1)(micro near2 (nodeb enodeb enb e-nb)) (wireless near2 access near2 point\$1) (node near2 b) (pico near2 cell) (pico near2 (base	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:20

		near2 station\$1)) (nodeb)(enodeb)(base near2 transceiver near2 station\$1)(home adj2 nodeb)(nodeb near2 gateway) (nodeb near2 GW)(femto near2 BS) (femto near2 base near2 station\$1) (femto near2 nodeb)(femto near2 enodeb))				
S15	144	S14 and S10	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:23
S16	10	("20080188228" "20090296681" "8699403" "8848605").pn.	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:28
S17	6	S16 AND ((H04B7/18506 OR H04W48/18 OR H04W72/04 OR H04W72/042 OR H04W84/06 OR H04W36/08 OR H04W36/14 OR H04W36/30).CPC.)	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:37
S18	148626	((H04B7/18506 OR H04W48/18 OR H04W72/04 OR H04W72/042 OR H04W84/06 OR H04W36/08 OR H04W36/14 OR H04W36/30).CPC.)	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:37
S19	89533	(noise "sn" "s/n" capacity bandwidth sir interference sinr) with matrix	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:37
S20	1119	S18 AND S19	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:37
S21	32285	(capacity bandwidth) with matrix	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:38
S22	6560	((H04B7/18506 OR H04W84/06).CPC.)	US- PGPUB; USPAT; USOCR; FPRS;	OR	ON	2017/11/08 15:38

			EPO; JPO; DERWENT			
S23	19	S22 AND S21	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:38
S24	783	(handoff handover (hand adj off) (hand adj over)) and S22	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:40
S25	1	"20170311178".pn.	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:43
S26	67888	((H04B7/18506 OR H04B7/18541 OR H04W16/28 OR H04W84/06 OR H04W36/08 OR H04W36/14 OR H04W36/30).CPC.)	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:47
S27	915	(handoff handover (hand adj off) (hand adj over)) and S26 and matrix	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:48
S28	152	S21 and S26	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:50
S29	785	(handoff handover (hand adj off) (hand adj over) reselect\$3) and S22	US- PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2017/11/08 15:54

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L3	53	((airborne aircraft) and channel and matrix).clm.	USPAT	OR	ON	2017/11/13 12:09

Search Notes 	Application/Control No. 15352255	Applicant(s)/Patent Under Reexamination MIRANDA ET AL.
	Examiner NAM HUYNH	Art Unit 2645

CPC- SEARCHED		
Symbol	Date	Examiner
H04B7/18506; H04B7/18541; H04W16/28; H04W84/06; H04W36/08; H04W36/14; H04W36/30	11/9/2017	NTH

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor/Assignee search conducted	11/9/2017	NTH
Consulted with Michael Mapa	11/9/2017	NTH
See EAST search notes	11/9/2017	NTH
Interference search conducted	11/9/2017	NTH

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
Same	As Above	11/9/2017	NTH

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
15/352,255	11/15/2016	2645	1600	32045/50990	20	3

CONFIRMATION NO. 7058

CORRECTED FILING RECEIPT



0000000096118294

4743

MARSHALL, GERSTEIN & BORUN LLP
233 SOUTH WACKER DRIVE
6300 WILLIS TOWER
CHICAGO, IL 60606-6357

Date Mailed: 12/15/2017

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Heinz A. Miranda, Cary, IL;
Michael H. Baker, Elmhurst, IL;
James P. Michels, Lake Zurich, IL;
Yong Liu, Schaumburg, IL;

Applicant(s)

GOGO LLC, Chicago, IL;

Power of Attorney: The patent practitioners associated with Customer Number 04743

Domestic Priority data as claimed by applicant

This appln claims benefit of 62/358,437 07/05/2016

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.) - None.

Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 11/23/2016

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/352,255**

Projected Publication Date: 03/22/2018

Non-Publication Request: No

Early Publication Request: No

Title

Servicing Cell Selection in Air to Ground Communication Systems

Preliminary Class

455

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/352,255	11/15/2016	Heinz A. Miranda	32045/50990	7058
4743 7590 12/19/2017 MARSHALL, GERSTEIN & BORUN LLP 233 SOUTH WACKER DRIVE 6300 WILLIS TOWER CHICAGO, IL 60606-6357			EXAMINER HUYNH, NAM TRUNG	
			ART UNIT 2645	PAPER NUMBER
			NOTIFICATION DATE 12/19/2017	DELIVERY MODE ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

mgbdoCKET@marshallip.com



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United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
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Application No. : 15352255
Applicant : Miranda
Filing Date : 11/15/2016
Date Mailed : 12/19/2017

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Notice of Allowance Mailed

This application has been accorded an Allowance Date and is being prepared for issuance. The application, however, is incomplete for the reason below.

Applicant is given two (2) months from the mail date of this Notice within which to respond. This time period for reply is extendable under 37 CFR 1.136(a) for only TWO additional MONTHS.

The application is not in compliance with 37 CFR 1.46(c), as indicated in the attachment. The request under § 1.46(c)(1) to correct or update the name of the applicant or the request under § 1.46(c)(2) to change the applicant was improper and was mistakenly accepted by the Office.

If applicant fails to respond within the above-identified time period and in accordance with the attachment, the Office record will be changed to show the applicant information that was established prior to the filing of the request under § 1.46(c), a corrected application filing receipt showing the previously established applicant information will be sent to the applicant, and the previously established applicant information will be printed on the patent.

***A copy of this notice MUST be returned with the reply. Please address response to
"Mail Stop Issue Fee, Commissioner for Patents,
P.O. Box 1450, Alexandria, VA 22313-1450".***

/Anita Grimmage/
Publication Branch
Office of Data Management
(571) 272-4200

Application No. 15352255

**APPLICATION FILED ON OR AFTER SEPTEMBER 16, 2012,
NOT IN COMPLIANCE WITH 37 CFR 1.46(c)**

The § 1.46(c) request identified below was improper for the reason(s) indicated below and was mistakenly accepted by the Office. The corrected/updated applicant name or the change of applicant was mistakenly printed on the application filing receipt dated 11/25/2016.

The request filed under § 1.46(c)(1) to correct or update the name of the applicant or under § 1.46(c)(2) to change the applicant was improper for the reason(s) indicated below:

- ☐ No application data sheet under § 1.76 specifying the correct or updated name of the applicant in the applicant information section in accordance with § 1.72(c)(2) was filed.
- ☐ An application data sheet was filed but it did not comply with § 1.76(c)(2) in that underlining was not used for insertions and/or strike-through or brackets was not used for text removed.
- ☐ An application data sheet was filed but it was not signed.
- ☐ An application data sheet was filed and signed but it was not signed in accordance with § 1.76(e) and § 1.33(b).
- ☐ Other:

The request filed 06/27/2017 under § 1.46(c)(2) to change the applicant was improper for the reason(s) indicated below:

- ☒ No statement under § 3.73(c) was filed.
- ☐ A statement under § 3.73(c) was filed but it did not identify the assignee as required by § 3.73(c)(1).
- ☐ A statement under § 3.73(c) was filed but it neither provided documentary evidence of chain of title in accordance with § 3.73(c)(1)(i) nor provided a statement specifying the location (reel and frame number) in the Office's assignment records of such documentary evidence of chain of title.
- ☐ A statement under § 3.73(c) was filed but it did not include the statement as required by § 3.73(d)(1).
- ☐ A statement under § 3.73(c) was filed but it was not signed.
- ☐ A statement under § 3.73(c) was filed and signed but it was not signed in accordance with § 3.73(d)(2) or (d)(3).
- ☒ Other: In addition to providing the required statement, a corrected ADS is also required.

A timely response to this notice must include a compliant application data sheet and/or a compliant § 3.73(c) statement, and should also include a transmittal letter requesting that the Office continue to recognize the applicant information as printed on the above-identified application filing receipt and that the Office print the patent accordingly.

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Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT <i>(Use as many sheets as necessary)</i>				Complete if Known	
				Application Number	15/352,255-Conf. #7058
				Filing Date	November 15, 2016
				First Named Inventor	Heinz A. Miranda
				Art Unit	2645
				Examiner Name	N. T. Huynh
				Attorney Docket Number	32045/50990
Sheet	1	of	2		

[illegible]

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	Cite No. ¹	Foreign Patent Document	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T ⁶
		Country Code ³ Number ⁴ Kind Code ⁵ (if known)				
		WO-2004/023677-A2	03-18-2004	Boeing Co		

Examiner Signature		Date Considered	
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I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with 37 CFR § 1.6(a)(4).

Dated: January 2, 2018

Electronic Signature for Lilian Y. Ficht: /Lilian Y. Ficht #64,514/

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Sheet	2	of	2	Attorney Docket Number	32045/50990

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No. ¹	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
		International Application No. PCT/US2017/039634, International Search Report and Written Opinion, dated November 23, 2017.	

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- **Kitroser, Itzik**
Beer Sheva 84265 (IL)
- **Einsiedler, Hans Joachim**
13189 Berlin (DE)
- **Kadel, Gerhard**
64293 Darmstadt (DE)

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(71) Applicant: **Deutsche Telekom AG**
53113 Bonn (DE)

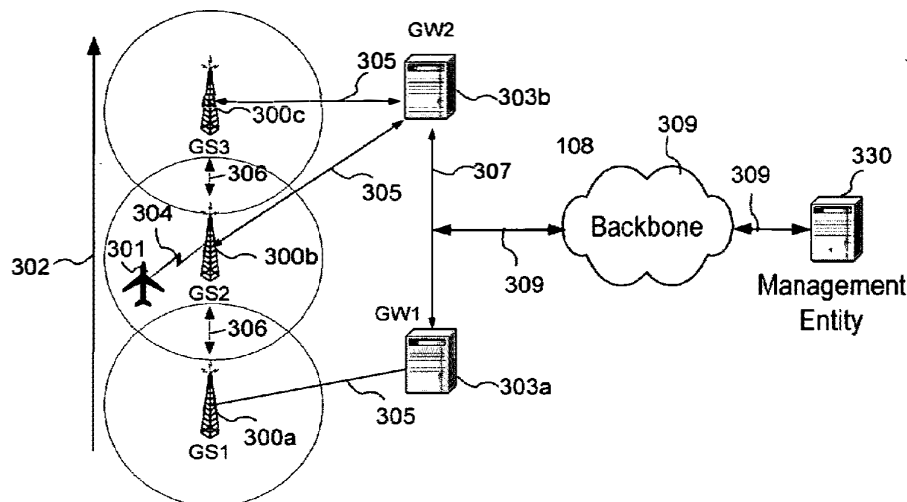
(74) Representative: **Flaccus, Rolf-Dieter**
Flaccus · Müller-Wolff
Patentanwälte
Bussardweg 10
50389 Wesseling (DE)

(72) Inventors:
• **Ben-Shimol, Yehuda**
Beer Sheva 84750 (IL)

(54) **System and method for enabling fast and seamless handover for air-to-ground communication**

(57) The invention is a method and system for performing seamless and fast handover in air-to-ground wireless communication networks. Handover is accomplished by means of maintaining an active group from a plurality of ground base stations along a known trajectory

(or flight plan) of an aircraft and synchronizing communication between all the ground base stations in the active group. Thus the system is designed such that the method is able to perform load balancing, i.e. to take into account that multiple aircraft may be in a particular geographic area at the same time.

**Fig. 3**

DescriptionField Of The Invention

5 **[0001]** The present invention relates to a handover process in wireless communication networks between ground base stations and aircraft. More particularly, the present invention relates to a system and method for enabling fast and seamless handover for Air-to-Ground communication systems.

Background of the Invention

10 **[0002]** Wireless communication networks in air-to-ground communication systems provide communication channels for passengers located onboard aircraft to enable standard Internet applications (such as voice, video and data) and email communications while the aircraft is moving along its flight plan from the originating airport to the destination airport.

15 **[0003]** Typically, as illustrated in Fig. 1, a wireless air-to-ground communication network may include an aircraft 101 flying along flight path 102, a plurality of ground base stations (GBS or BS) 100a, 100b and 100c, and plurality of gateway stations (GW) 103a, 103b and 103c. The aircraft 101 is in communication with the ground base stations through communication channel 104. Each gateway station may be connected to a plurality of ground base stations through communication channels 105 or to other gateway stations through communication channel 108 or 107. The different ground base stations can communicate with each other through communication channels 106. It is common that each ground base station covers a certain geographical area. When the aircraft is within the covered area of a particular ground base station, the aircraft connects to that ground base station through a channel 104 effected using a certain wireless terrestrial communication technology (radio or optical). For a specified Aircraft, the current ground base station, to which it is connected, is called the serving ground base station.

20 **[0004]** As in state of the art wireless technologies supporting mobility on the ground, the aircraft can move from a geographical area covered by a certain ground base station to a geographical area covered by another ground base station. The new ground base station towards which the aircraft is moving is named the target ground base station, and changing between a serving ground base station to a target ground base station is called "handover".

25 **[0005]** The air-to-ground wireless communication network includes aircraft moving at a high velocity (generally in excess of 500 mph); and, this means that handover events, which occur when changing from the geographical area covered by one ground base station to another ground base station, can occur with high frequency and hence are required to be made in a timely manner. Unlike terrestrial communication systems, in air-to-ground communication systems, the trajectories of the aircraft moving from originating airports to destination airports are known in advance up to a certain precision level. This allows the communication system to know in advance all the ground base stations along the flight plan of a specific aircraft.

30 **[0006]** Fig.2 illustrates the situation when two aircraft 201a and 201b are moving along different flight plans (or trajectories) 202a and 202b. As can be seen, aircraft 201b is moving along trajectory 202b and must switch (i.e. handover) between three geographical areas (203c, 203d and 203e), while aircraft 201a is moving along trajectory 201a and must switch between five geographical areas (203c, 203a, 203d, 203b and 203e).

35 **[0007]** The problem is to perform fast and seamless handover in order to have service continuity to the passengers onboard the aircraft using the communication system for Internet-based services and email communications, including, but not restricted to, voice, video and data communication services.

40 **[0008]** Some wireless terrestrial communication systems such as Institute of Electrical and Electronics Engineers (IEEE) 802.16e communication systems and 3GPP Long Term Evaluation (LTE) and LTE provide means of performing efficient and seamless handover procedures.

45 **[0009]** In IEEE 802.16e, a scheme of Fast Base Station Switching (FBSS) is defined, such that the mobile station maintains a group of base stations (BSs) called a Diversity Set. The mobile station exchanges signals only with one BS, which is named as an Anchor BS among the BSs in the diversity set. The mobile station may change the anchor BS using some selection scheme. The mobile station manages its relevant diversity set by using some criterion to exclude a BS from the diversity set or by using some criterion to add a new BS to the diversity set. In order to perform handover between different BSs in a diversity set, the BSs involved must be synchronized based on a common time source, must operate at the frequency channel and are also required to share or transfer Medium Access Control (MAC) context. Such context includes all of the information that the mobile station and the BS normally exchange during network entry.

50 **[0010]** In LTE, the means of providing efficient handover and reducing data lost during handover are defined. One such mechanism is bi-casting, where the serving gateway bi-casts or multi-casts data packets to a set of eNBs (E-UTRAN NodeB), including the serving eNB, which are candidates for being the next serving eNB. Another such mechanism is buffer forwarding. In buffer forwarding, once the handover decision is taken, the source eNB forwards buffered data for the user equipment to the target eNB.

55 **[0011]** Park (US Patent Publication 2007/0218842) is concerned with the handover from a serving base station to a

target base station for land based mobile phone users. In particular, it teaches a system and method for updating a diversity set between a serving anchor base station and a mobile station during handover in a communication system. The Base Station transmits a base station diversity set, or the base station diversity set and a base station recommended set to a Mobile Station, and generates a temporary base station diversity set including base stations which are included in the base station diversity set and the base station recommended set, thereby enabling handover even though a diversity set discrepancy between the Base Station and the Mobile Station occurs. It may be appreciated that standard automobiles travel at no more than about 60 mph and pedestrian mobile users move considerably more slowly. The Park method would not work for fast moving mobile users in an aircraft, which generally may be traveling more than ten times faster than an automobile and more than 200 times faster than a person on foot. For an aircraft a much faster handover is required. Any discrepancy in the diversity set results in a loss of communication, because the aircraft is traveling so fast.

[0012] Vesterinen (US Patent Publication 2008/0188223) is likewise concerned with the handover from a serving base station to a target base station for land based mobile phone users. It teaches a system for performing a handover of mobile equipment from a source network to a target network in a mobile telecommunication system. The specific problem raised by Vesterinen is downlink data information loss during the handover process due to detachment of the user from source network while moving to a target network. Specifically, this publication is concerned with scenarios of Inter-Network handover between 3GPP LTE/SAE and 3GPP 2G/3G (second generation/third generation) networks. Data, which may be transferred via the source network to the mobile equipment when it is linked to the source network, are buffered in a network element in case a need for a handover arises. The data buffered in the network element is forwarded from the network element to the target network for transferring them to the mobile equipment after it has been linked to the target network.

[0013] None of the known prior art involves a fast handover for fast moving mobile stations, like aircraft.

[0014] It is therefore a purpose of the present invention to provide a continuous communication channel when an aircraft is handed over from one ground base station to another.

[0015] It is another object of the present invention to address the problem of seamless and fast handover in air-to-ground wireless communication network by means of maintaining a plurality of ground base stations along a known trajectory (or flight plan) of an aircraft, such that all the ground base stations are synchronized.

[0016] It is another object of the present invention to define means of synchronization between ground base stations in terms of transmission buffers and protocol state.

[0017] Further purposes and advantages of this invention will appear as the description proceeds.

Summary Of The Invention

[0018] In a first aspect the invention is a method for fast and seamless handover in wireless communications between ground base stations and aircraft. The method comprises the steps of:

- a. identifying ground base stations along the flight path of the aircraft;
- b. defining a group of active ground base stations in a geographic area in which the aircraft is traveling;
- c. maintaining communications between a serving base station in the group of active ground base stations and the aircraft; and
- d. maintaining simultaneous communications between the active ground base stations.

[0019] Embodiments of the method of the invention further comprise the steps of

- a. identifying new target ground base stations when the aircraft approaches a new geographic area along the flight path;
- b. adding the newly identified target ground base stations to the group of active ground base stations; and
- c. deleting from the group of active ground base stations ground base stations that have already been passed on the flight path.

[0020] In embodiments of the method of the invention all active ground base stations are synchronized and all ground to air data is forwarded to all of the active ground base stations. The serving ground base station for a given aircraft can be selected from among the group of active ground base stations by either a gateway station or by a Management Entity.

[0021] In embodiments of the method of the invention the decision regarding ground base station selection per aircraft is made in advance in an "offline" manner based on the expected flight plans of all the aircraft expected to fly over a given geographical region. In other embodiments of the method of the invention online data concerning changes in trajectory or velocity are sent from the aircraft via the ground stations to the gateway computer and Management Entity, either of which is able to re-assign the aircraft to different ground stations.

[0022] In embodiments of the method of the invention the serving ground base station per aircraft is selected from an active ground base station that is serving the fewest other aircraft. A load balancing method can be used to select per aircraft a serving ground base station from the group of active ground base stations.

[0023] In a second aspect the invention is a system for fast and seamless handover in wireless communications between ground base stations and an aircraft. The system comprises the following entities:

- a. a Management Entity;
- b. a plurality of gateway stations along the flight path of an aircraft;
- c. a plurality of ground base stations along the flight path of the aircraft;
- d. communication links between the entities comprising the system.

[0024] According to the invention, a group of active ground base stations including a serving base station is located in a geographic area in which the aircraft is traveling and all ground to air data is forwarded by a gateway station to all ground base stations in the group.

[0025] All the above and other characteristics and advantages of the invention will be further understood through the following illustrative and non-limitative description of preferred embodiments thereof, with reference to the appended drawings.

Brief Description Of The Drawings

[0026]

- Fig. 1 is a diagram illustrating an example of a prior art network topology of an air-to-ground wireless communication system;
- Fig. 2 is a diagram illustrating two possible trajectories of an aircraft;
- Fig. 3 is a diagram illustrating an example of a network topology of an air-to-ground wireless communication system according to the present invention;
- Fig. 4 is flow chart illustrating the flow of handover and addition of a new ground base stations and synchronizing it with the aircraft;
- Fig. 5 is a diagram showing a network of ground base stations and multiple aircraft flight paths;
- Fig. 6 is a graph showing two aircraft and their trajectories;
- Fig. 7 is bi-partite graph showing solutions to the problem of load balancing for a particular set of aircraft and a set of ground base stations; and
- Fig. 8 is a flow chart illustrating the load balancing process according to an embodiment of the invention.

Detailed Description of Embodiments of the Invention

[0027] As contemplated by the herein invention, seamless and fast handover in a air-to-ground wireless communication network is accomplished by means of maintaining an active group from a plurality of ground base stations along a known trajectory (or flight plan) of an aircraft and synchronizing communication between all the ground base stations in the active group.

[0028] Fig. 3 is a diagram illustrating an example of a network topology of an air-to-ground wireless communication system according to the present invention. The wireless air-to-ground communication network may include an aircraft 301 flying along flight path 302, a plurality of ground base stations (GBS or GS) 300a, 300b, 300c, and ... 300n and a plurality of gateway stations (GW) 303a, 103b and ... 303n. At any given time, the aircraft 301 is in communication with one or more ground base stations through communication channel 304. The ground base stations can communicate with each other through communication channels 306. Each gateway station may be connected to a plurality of ground base stations through communication channels 305 or to other gateway stations through communication channel 307. The gateway stations can communicate with the Management Entity 330 through the operator's network (backbone) 309.

[0029] In particular at any given time, more than one ground base station will be synchronized with the aircraft along the trajectory or flight plan of the ground base station. Using Fig. 2 as an example, this means that for aircraft 201a all the ground base stations in geographical areas 203c, 203a, 203d, 203b and 203e may be synchronized and for aircraft 201b all the ground base stations in geographical areas 203c, 203d, and 203e may be synchronized.

[0030] Synchronization means that all ground to air data will be forwarded by the gateway to all currently active ground base stations for example by means of multicasting or a similar method known in the art. If needed, gateway stations will forward such data to other gateway stations and then to the relevant ground base station (e.g., GW1 or GW2 in Fig. 3). More particularly, as shown in Fig. 3, gateway stations 303a and 303b communicate along communication lines 307. Then, each gateway station communicates with each ground base station in its area by means of communications

channels 305. One of the gateway stations, for example GW1 (103a), communicates with the Management Entity 330 via backbone 309.

[0031] In addition, all MAC information, including MAC state machines such as ARQ (Automatic Repeat reQuest) and/or encryption state machines, will be synchronized between all ground base stations currently active.

[0032] When the handover event from one serving ground base station to the new serving ground base station along the flight path occurs, the old serving ground base station is excluded from the active group and the next ground base station along the trajectory or flight plan is added to the active group. In particular, since the flight plan is known, the various gateway stations and ground base stations along the route are necessarily also known. Initially, all the gateway stations and ground base stations along the initial route for a certain defined distance are deemed active and synchronized. Then, as each handover occurs, the gateway stations and ground base stations that were passed and are no longer in communication with the aircraft are removed from being active and synchronized, and replaced with the next group of gateway stations and ground base stations along the route. Thus, the active group includes ground base stations from more than one geographic area.

[0033] The specific procedure may be better understood from the flow chart in Fig. 4. After activation (step 400), the serving ground base station generates a handover indication or signal (step 402). For example, referring to Fig. 3, the serving ground base station GS2 generates a handover signal that it sends over communication channel 305 to GW 2. Thereafter, GW2 communicates via backbone 309 to the Management Entity 330 which identifies the next in line ground base station based on the flight plan or trajectory of the particular aircraft, (step 404). A message (or signal) is sent via backbone 309, GW2, and communication channel 305 to the new ground base station GS3 for it to join the active group of ground base stations (step 406). Current buffer and state machine status information is sent via communication channel 306 from the presently active ground base station GS2 to the new ground base station GS3 (step 408). The gateway GW2 is updated by Management Entity 330 to forward ground to air packets to the new ground target base station and the old ground base station GS1 is discontinued from the active group of ground base stations (step 410). As the aircraft travels along its route, steps 302 to 310 are continually repeated. The process is ended (step 412) when the aircraft arrives at its destination.

[0034] The embodiment of the network topology described above with reference to Fig. 3 and Fig. 4 is a simplified model meant to illustrate the handover procedure of the invention. Many variations of this model are possible. For example, the active group may comprise many more ground base stations and more gateway stations can be in communication with them. Gateway Stations, i.e. the components that perform the tasks of the gateway station, can reside within ground base stations or can be, as illustrated herein, in external entities that control more than one ground base station.

[0035] It should be appreciated that at any give point in time, there is usually not just a single aircraft in the air in a geographical region. Instead there are typically many, each of which has its own route and its own communications needs. Thus the system must take into account that multiple aircraft may be in a particular geographic area at the same time. For example, referring to Fig. 2, aircraft 201a and 201b may both be in geographic area 203c at the same time. Multiple aircraft may be utilizing the same ground base station and/or the same gateway station. Therefore, there is also a requirement for load balancing, so that the system does not overload any particular station, but, instead, spreads out the load over as many stations as is practical.

[0036] Fig. 2 illustrates a simplified situation in which the two aircraft are flying along parallel straight trajectories. Fig. 5 shows a more realistic two-dimensional situation. At the time shown five different aircraft are traveling with different trajectories across an area served by 36 ground base stations (dark dots in the figure). For purposes of the example, the coverage area of each of the ground stations (circles centered on each ground station) is equal. Based on Fig. 5 the concept of load balancing is now illustrated. By way of example, consider a set A of aircraft (AC) and a set N of ground base stations (BS). Each aircraft, AC(i), is moving along a given trajectory which is covered by an overlapping subset $N(i) \subseteq N$ of ground base stations. Several possible trajectories are shown for several aircraft. Deeply shaded regions in Fig. 5 are areas of overlapping coverage that can be served by more than one ground base station. Each aircraft needs to select a serving ground base station from the available set of ground base stations. As shown, each trajectory is converted to a set of non-overlapping time intervals of two types. Type I is a time interval with no option of ground base station selection (i.e. areas that are covered by a single ground base station). Type II is a time interval with selection options (i.e. areas covered by more than one ground base station). The arrows in Fig. 5 represent the trajectory of each aircraft with relation to a reference timeline. The tail of each arrow denotes the location of the aircraft at a reference time, and the body of each arrow denotes the expected present location of the aircraft, depending of its velocity. Two crossing arrows may represent the case where two different aircraft visit the same geographical location. Such crossing can be simultaneous, which means that two aircrafts are in proximity of each other at a certain instant of time, or such crossing is sequential, in sense that the aircraft visit the same geographical location in different instants of time.

[0037] To affect load balancing the time intervals of the second type (Type II) have to be determined for aircraft simultaneously crossing the same geographical region. For each aircraft there is a need to determine when to execute a handover and a need to determine which ground base station to select. The goal is to minimize the number of aircraft

that are simultaneously served by the same ground base station, thereby defining a maximal bandwidth for each aircraft. The decision regarding ground base station selection per aircraft can be made in advance in an "offline" manner. Such decisions can be made by the Management Entity in the gateway computer using information of the expected flight plans of all the aircraft expected to fly over a given geographical region supplied by the Management Entity. However, changes in trajectories may occur during the flight. In addition, the time of which the aircraft will enter the coverage area of a certain ground station may also change, e.g. due to change of scheduled departure time or the velocity of the aircraft. Such a time change will affect the coverage intervals timeline of the aircraft and can affect the GS selection previously made offline. "Online" data concerning changes in trajectory or velocity response are sent from the aircraft via the ground stations to the gateway computer, which is able to re-assign the aircraft to different GSs. Alternatively, the online data from the aircraft can be forwarded to the Management Entity, which performs the reassignment and forwards the new assignment to the appropriate gateway station and ground station.

[0038] The j -th coverage interval (CI) for an Aircraft $AC(i)$ is defined as the tuple $CI_j(i) = \langle t_j^i, t_{j+1}^i, N_j^i \rangle$ where $t_j^i < t_{j+1}^i$

and t_j^i and t_{j+1}^i are the start and end times of the coverage interval, respectively, and $N_j^i \subseteq N$ is a sub set of ground base stations which can serve Aircraft i during $t_j^i \leq t \leq t_{j+1}^i$. A Trajectory $Traj(i)$ for Aircraft i is defined as a sequence of consecutive coverage intervals as follows: $Traj(i) = \{ \langle t_1^i, t_2^i, N_1^i \rangle, \langle t_2^i, t_3^i, N_2^i \rangle, \dots \}$.

[0039] Trajectories of two aircraft are shown, by way of example, in Fig. 6. Type I coverage intervals are denoted by diagonal filling and Type II coverage intervals are denoted by solid filling. Between each two Type I coverage intervals, there must be at least one Type II coverage interval. In particular, the coverage areas of each two neighboring ground base stations overlap. In Fig. 6, the time axis is composed from the superposition of coverage intervals of the given trajectories. A decision point t_i is defined as the i -th event in which one of the aircraft is either entering or leaving a coverage interval. At each decision point, a new assignment of aircraft and ground base stations needs to be considered.

[0040] An aircraft $AC_i \subseteq A$ is defined to be active at time τ if $\exists CI_k(i) \{ CI_k(i) \in Traj(i) \wedge t_k^i \leq \tau \leq t_{k+1}^i \}$. If $AC(\tau)$ denotes a set of all aircraft which are active at time τ , then GS $n \subseteq N$ is defined to be active at time τ if $\exists CI_k(i) \{ CI_k(i) \in Traj(i) \wedge t_k^i \leq \tau \leq t_{k+1}^i \wedge n \in N_k^i \}$. If $N(\tau)$ denotes a set of all GSs which are active at time τ , then the assignment of aircraft to GSs at decision point t_j can be represented as an assignment problem on a $G_j = (A_j \cup N(t_j), E_j)$, where $A_j = AC(t_j)$, and

$$e = \{ AC_i, N_j \} \in E \Leftrightarrow \exists CI_k(i) \{ CI_k(i) \in Traj(i) \wedge t_k^i \leq t_j \leq t_{k+1}^i \wedge N_j \in N_k^i \}.$$

[0041] Wherein, G_j denotes a bi-partite graph whose vertices are the disjoint union of GSs and aircrafts that are active at decision point t_j and its edges set E_j represents all edges between the aircrafts and their active GSs, i.e. all GSs included within the coverage interval of each aircraft). Fig. 7 is an example of a G_j .

[0042] In addition a weight function w , which maps a real value to each edge $e \in E_j$ is defined. A weight $w(e)$ for the pair (edge) $e = \{ AC_i, N_j \}$ represents the desirability of assignment of AC_i to GS N_j .

[0043] Such a desirability function can represent, for example, continuation of connection to a GS which was connected with the AC at a preceding decision point or the fact that handing over the AC to a different GS will incur some system penalty, e.g. a delay in arrival time at the destination. Another example of the use of the weight function is the case where multiple GSs from different airline operators are associated with the coverage interval of the AC. In such case, the weight function can represent a preference to connect the AC to a GS belong to a certain operator.

[0044] A feasible solution of the assignment problem for a given G_j is a subgraph $G_j' = (A_j \cup N_j, E_j')$ where $deg(v) \leq 1, \forall v \in A_j$.

[0045] The weight of a feasible solution G_j' is defined as $\sum_{e \in E_j'} w(e)$. Naturally, a solution having maximal weight is sought.

[0046] In an embodiment of the assignment problem a load balancing requirement is represented by trying to equalize the degree of each vertex in N_j , which relates to the number of aircrafts that are served by each BS.

[0047] Fig. 7 is bi-partite graph illustrating solutions to the problem of load balancing for a particular set of aircraft and a set of ground base stations. The circles on the left edge of Fig.7 represent four aircraft and the circles on the right edge represent five ground stations. The arrows originating on a circle representing an aircraft and ending on a circle representing a ground station signify that, at the time represented by the graph, the aircraft is flying over the coverage area of that ground station. The numbers above each line are the weights assigned to the assignment of a specific aircraft to a specific ground station and the dark arrows are the solutions to the load balancing problem as determined by the computer of the Management Authority (or the computer of the gateway) following the above described procedure.

[0048] In the example of Fig. 7: AC₁ is flying over the coverage area of GS1, GS3, and GS5; AC₂ over GS2 only; AC₃ over GS1 and GS4; and AC₄ over GS5 only. The solution of the load balancing problem for AC₂ and AC₄ are obvious. Both AC₁ and AC₃ could be assigned to GS1 however the weight for AC₁ is higher; therefore AC₁ is assigned to GS1. AC₃ could be assigned to either GS1 or GS4 however since AC₁ has already been assigned to GS1 and since no aircraft have been assigned to GS4 then AC₃ is assigned to GS4. This assignment is made despite the fact that the weight for this assignment is less than that for the assignment to GS1. In other circumstances, for example when both GS1 and GS4 had no aircraft assigned to them, then the system would have assigned AC₃ to GS1, instead of to GS4 as in the present case.

[0049] Fig. 8 is a flow diagram showing the load balancing process carried out by the Management Entity. After initiating the process in step 800, a database that includes data such as flight number, time schedules, and trajectories of expected flights is entered into the processing unit of the Management Entity (step 802). For each plane, the time of flight is divided into decision intervals (see Fig. 6) and an assignment to a ground station is made for each plane for each interval (Fig.7) in step 804. The Management Entity distributes the assignment information to the appropriate Gateway Station via the system backbone (step 806). In step 808 the gateway stations receive online data related to their current speed and direction of travel from the aircraft and transmit this data to the Management Entity. In step 810 the Management Entity repeats step 804 using the online data to update the database and reassigns the aircraft that are not following their originally scheduled flight path to different ground stations if necessary. The reassignment information is transmitted to the gateways and steps 806 to 810 are repeated cyclically.

[0050] Although embodiments of the invention have been described by way of illustration, it will be understood that the invention may be carried out with many variations, modifications, and adaptations, without exceeding the scope of the claims.

Claims

1. A method for fast and seamless handover in wireless communications between ground base stations and aircraft, comprising the steps of:

- a. identifying ground base stations along the flight path of said aircraft;
- b. defining a group of active ground base stations in a geographic area in which said aircraft is traveling;
- c. maintaining communications between a serving base station in said group of active ground base stations and said aircraft; and
- d. maintaining simultaneous communications between said active ground base stations.

2. A method according to Claim 1, further comprising:

- a. identifying new target ground base stations when said aircraft approaches a new geographic area along the flight path;
- b. adding the newly identified target ground base stations to said group of active ground base stations; and
- c. deleting from said group of active ground base stations ground base stations that have already been passed on the flight path.

3. A method according to Claim 1, wherein all active ground base stations are synchronized and all ground to air data is forwarded to all of said active ground base stations.

4. A method according to Claim 1, wherein the serving ground base station for a given aircraft is selected from among the group of active ground base stations by either a gateway station or a Management Entity.

5. A method according to Claim 4, wherein the decision regarding ground base station selection per aircraft is made in advance in an "offline" manner based on the expected flight plans of all the aircraft expected to fly over a given geographical region.

6. A method according to Claim 5, wherein online data concerning changes in trajectory or velocity are sent from the aircraft via the ground stations to the gateway computer and Management Entity, either of which is able to re-assign the aircraft to different ground stations.

7. A method according to Claim 4, wherein the serving ground base station per aircraft is selected from an active ground base station that is serving the fewest other aircraft.

8. A method according to Claim 4, wherein a load balancing method is used to select per aircraft a serving ground base station from the group of active ground base stations.

9. A system for fast and seamless handover in wireless communications between ground base stations and an aircraft, comprising the following entities:

a. a Management Entity;

b. a plurality of gateway stations along the flight path of an aircraft;

c. a plurality of ground base stations along the flight path of said aircraft;

d. communication links between said entities comprising said system;

wherein a group of active ground base stations including a serving base station is located in a geographic area in which said aircraft is traveling and all ground to air data is forwarded by a gateway station to all ground base stations in said group.

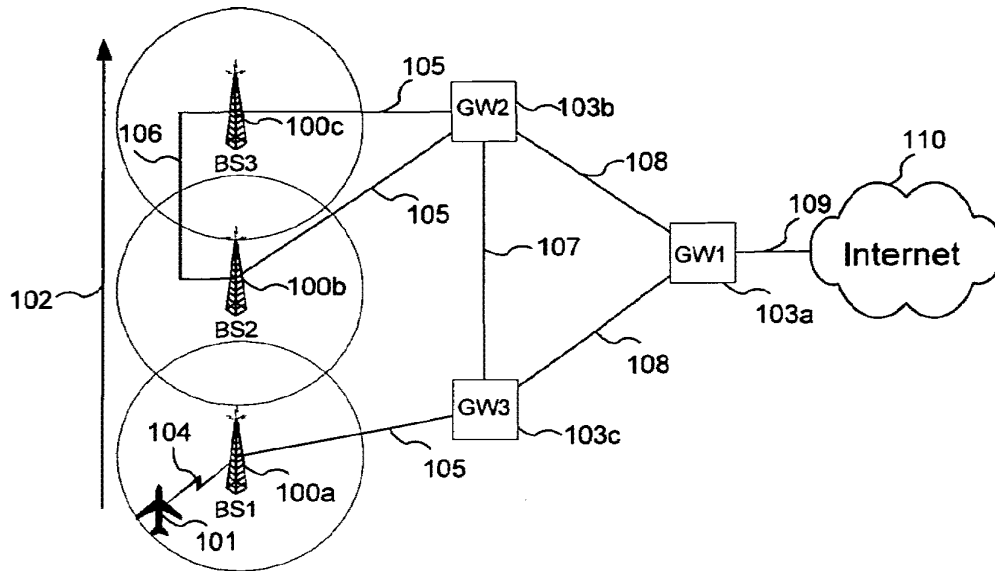


Fig. 1
Prior Art

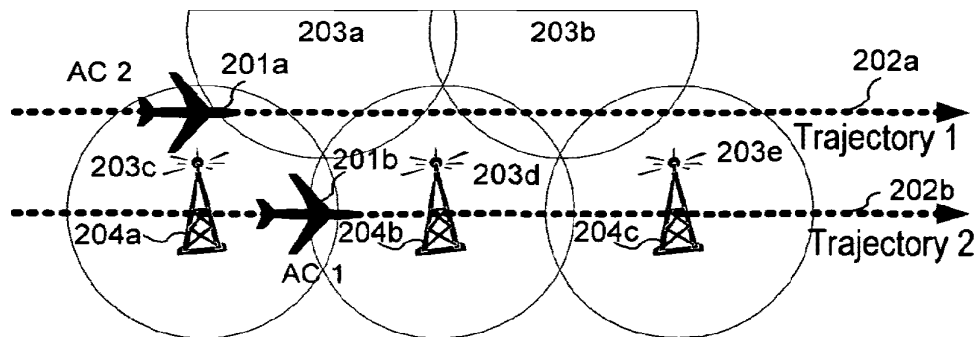


Fig. 2

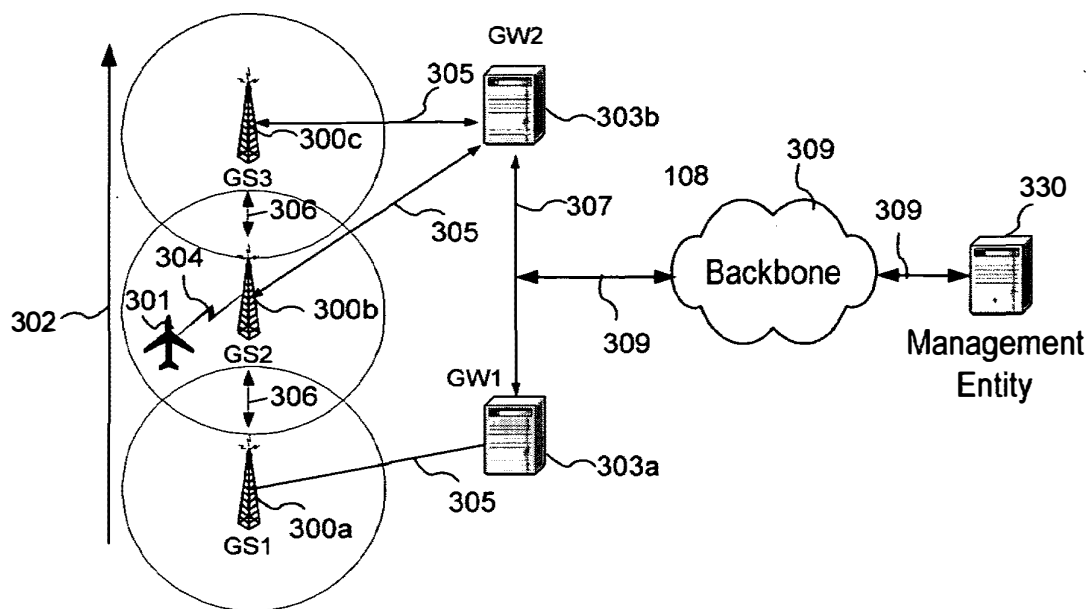


Fig. 3

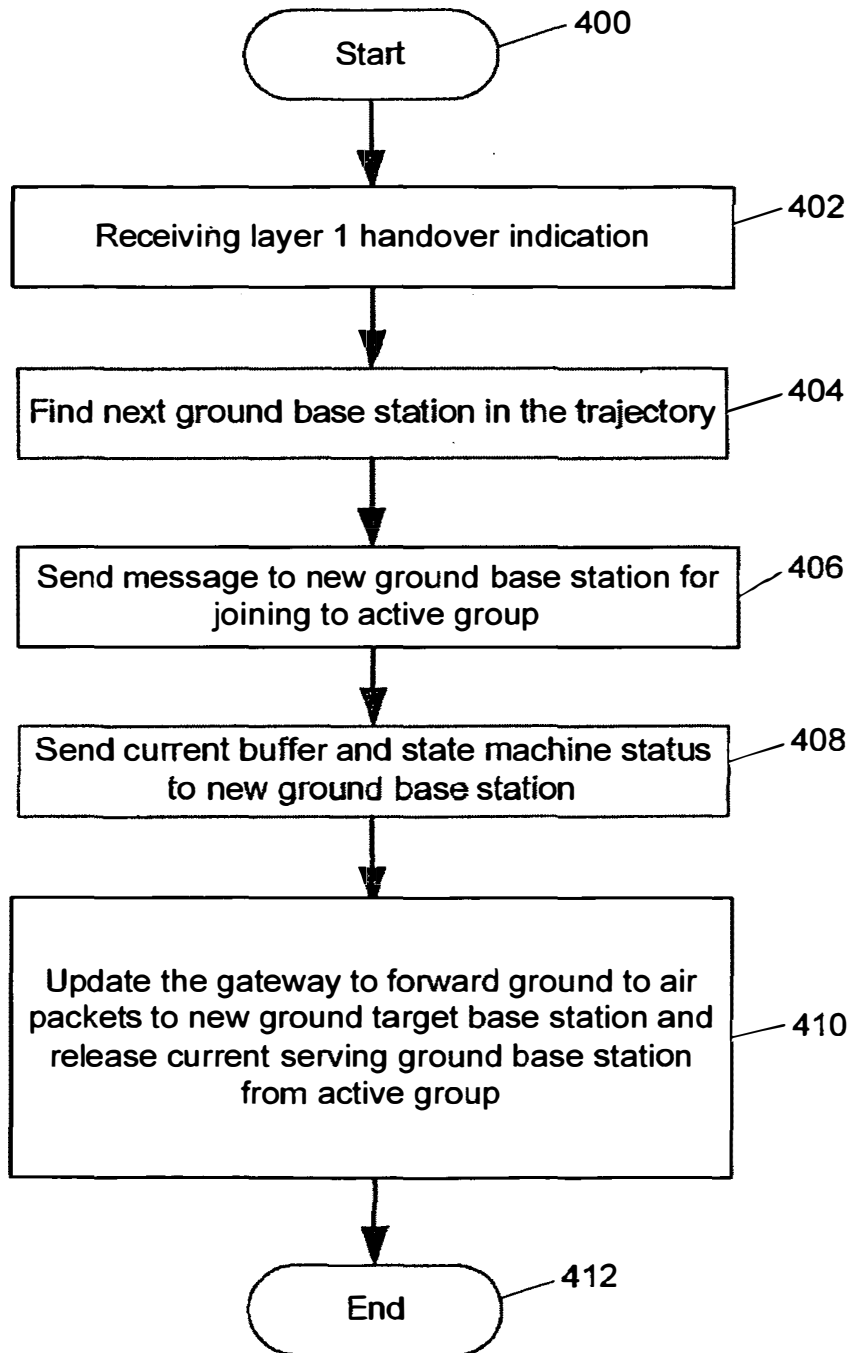


Fig. 4

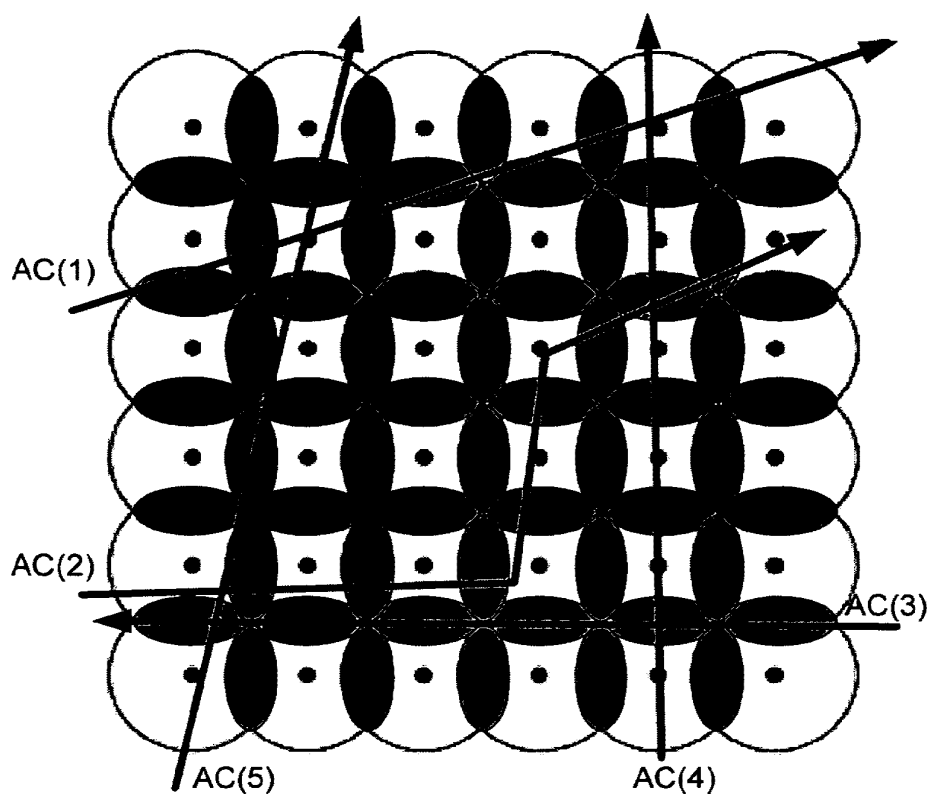


Fig. 5

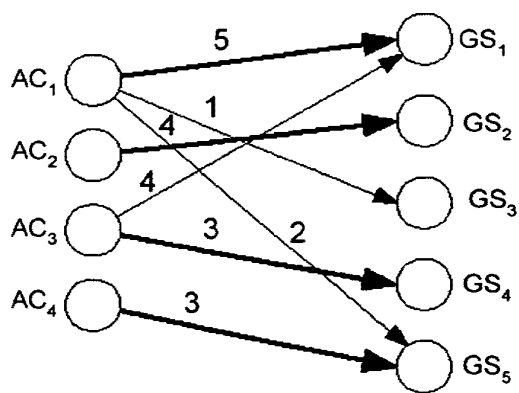


Fig. 7

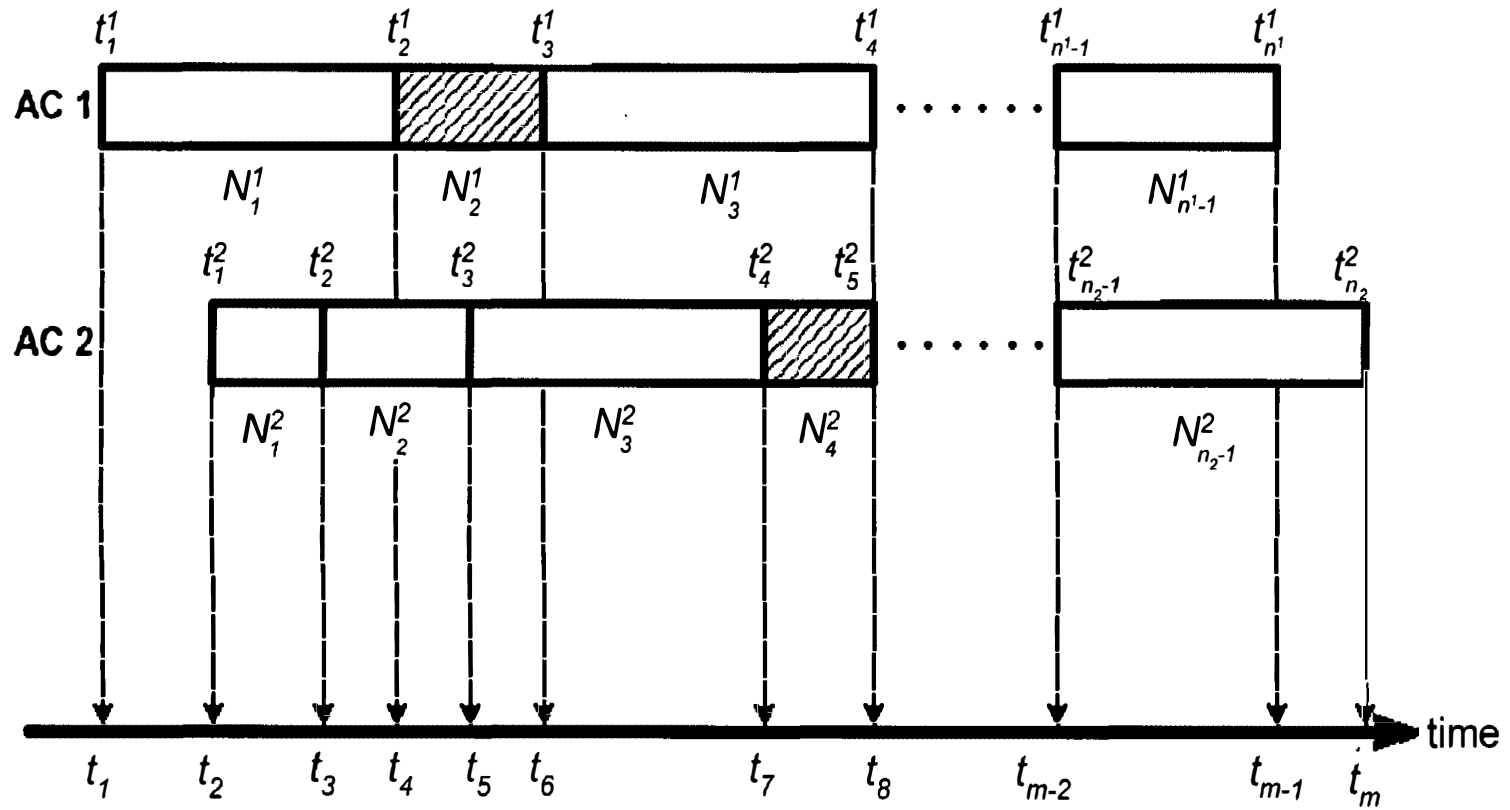


Fig. 6

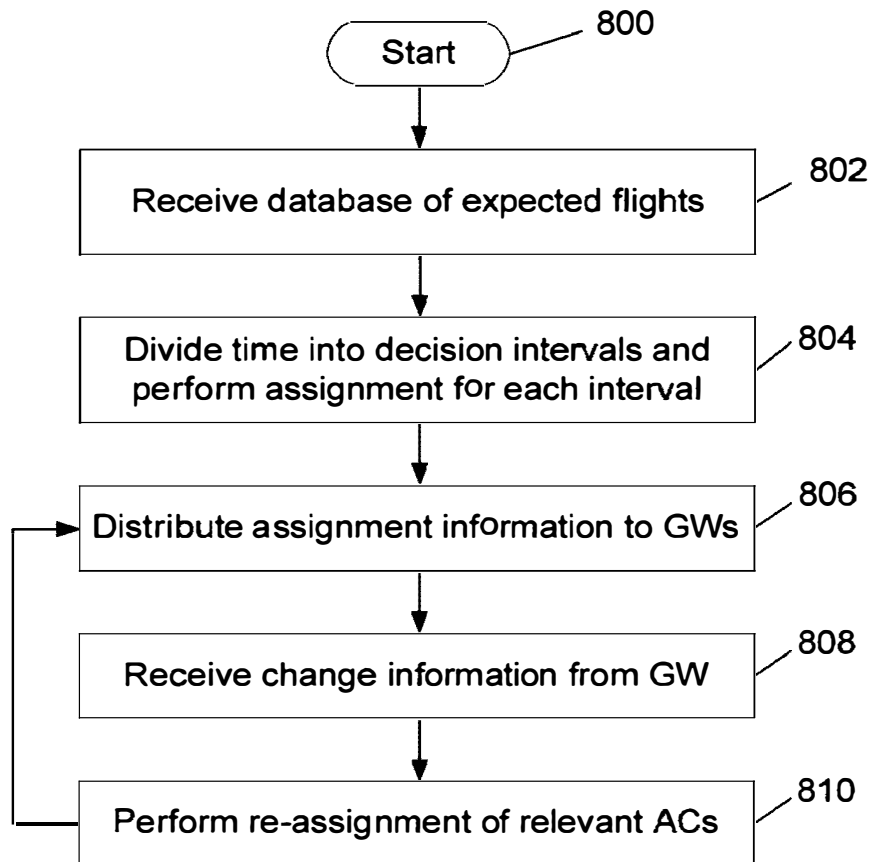


Fig. 8

REFERENCES CITED IN THE DESCRIPTION

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(74) Agent: **GALBRAITH, Ann, K.**; The Boeing Company,
P.O. Box 3707, M/C 11-XT, Seattle, WA 98124-2207 (US).

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(71) Applicant: **THE BOEING COMPANY** [US/US]; P.O. Box 3707, M/S 11-XT, Seattle, WA 98124-2207 (US).

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(72) Inventors: **HORTON, Edwin, T., Jr.**; 531 Shadow Ridge Drive, Wildwood, MO 63011-1707 (US). **MITCHELL, Timothy, M.**; 4608 SW Hudson Street, Seattle, WA 98116-4313 (US). **CAVANAUGH, Wayne, F.**; 25232 121st Place SE, Kent, WA 98031-6544 (US).

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(54) Title: SYSTEM AND METHOD FOR MANAGING COMMUNICATIONS WITH MOBILE PLATFORMS OPERATING WITHIN A PREDEFINED GEOGRAPHIC AREA

(57) Abstract: A system and method for providing communications within an airfield between an aircraft component located upon an aircraft and an airport data network. A control computer is used to select an optimal antenna substation from a plurality of antenna substations disposed about the airfield for the aircraft component to communicate with. The selection is based in part upon position information including the directional heading of the aircraft, determined using a suitable position detecting system, such as a Global Positioning System or a multi-lateration system, and in part upon the loading (i.e., RF traffic) being experienced by each antenna array. Determining the optimal antenna array for the aircraft to communicate with based on the directional heading of the aircraft and the real time usage of each of the antenna substations is advantageous as it decreases the number of times that the aircraft must initiate a new connection with a new antenna substation, and therefore decreases the transmission interruptions experienced due to the creation of new connections.

System And Method For Managing Communications With Mobile Platforms Operating Within A Predefined Geographic Area

CROSS-REFERENCE TO RELATED APPLICATIONS

5 **[0001]** This application claims priority from USSN 60/409,335; filed September 9, 2003, presently pending, and from USSN 60/408,846, filed September 6, 2002, presently pending.

FIELD OF THE INVENTION

10 **[0002]** The present invention generally relates to systems and methods for data transmission. In particular, the present invention relates to RF data transmission between mobile platforms, such as aircraft, and a plurality of antenna subsystems located at a controlled area, such as at an airfield, to more efficiently utilize the capacity of the antenna substations.

BACKGROUND OF THE INVENTION

15 **[0003]** In conventional wireless network architectures, the radio frequency (RF) connections made between mobile platforms, such as aircraft, and particular RF communication access points disposed about a controlled area, such as at an airfield, is typically accomplished using very high
20 frequency "line-of-sight" transmissions for modulating data between the aircraft and a ground-based control center in communication with the aircraft. Typically, frequencies in the range of about 2 GHz to about 6 GHz are employed for this purpose. Transmissions at such high frequencies facilitate extremely robust data transmission rates and provide excellent bandwidth for
25 transmitting very large amounts of data very quickly between the aircraft and the ground-based control center. Such high frequency, line-of-sight transmissions are often handled in accordance with well known 802.11a or 802.11b communications protocols.

30 **[0004]** However, a drawback with the use of such high frequency RF transmissions is the limited distance over which such signals may be transmitted. Typically, this distance is about 1000 yards (910 meters) or less

for such systems employed at airfields. Thus, when implementing a wireless, high frequency communications system at a controlled area such as an airport or airfield, where runways and taxiways may extend for significant distances and therefore define a relatively large, controlled area, a plurality of antenna substations must be employed. The antenna substations that are intended to communication with the aircraft as the aircraft taxis about the airfield, or is parked at various areas at the airfield for short or long periods, must be sufficient in number and strategically located at those areas around the airfield to ensure that communications can be maintained with an aircraft at all times during which the aircraft is present at the airfield.

[0005] With present day airfield traffic management systems the access to the antenna substations is also un-managed. By “un-managed”, it is meant that the decision as to which antenna substation a particular aircraft should communicate which is based upon which antenna substation provides the strongest RF signal to the aircraft, as detected by the RF equipment carried by the aircraft. During situations where many aircraft are accessing the antenna substations simultaneously, this may result in some antenna substations being utilized to capacity while others with a similar coverage area are underutilized, thus leading to network bottlenecks and inefficiency in the communications with the aircraft operating at the airfield or airport. An underlying cause of this problem is the lack of knowledge about each aircraft’s position, travel direction and speed, as well as a lack of consideration of the location, antenna type, orientation, and coverage area of the antenna substations.

[0006] An additional problem with un-managed, wireless communications systems for managing communications between aircraft and a ground based communications network stems from the transmission delay experienced when the network transfers an aircraft from one antenna substation to another at the airfield. Such delays are often experienced in signal strength based networks as such networks often transfer communications from one antenna substation to another due to the natural signal strength fluctuations experienced with RF transmissions. This can lead

to frequent transfers of communication between the aircraft and various antenna substations at the airfield as the aircraft taxis about the airfield. This, in turn, can produce frequent delays in passing important data from the ground based network to the aircraft. With present day systems that rely on signal strength as the means for selecting a particular antenna substation to communicate with, natural signal strength fluctuations can result in the aircraft making and breaking RF connections many times in a very short time period, even while the aircraft is parked at an airfield. This is because with some existing systems at certain airports, an aircraft would be able to detect a beacon signal from several antenna substations simultaneously. The naturally varying signal strengths will prompt the RF communications system on the aircraft to repeatedly make and break communications links with various antenna substations in an effort to maintain communication with the substation providing the strongest beacon signal. Since each interruption in communication can represent a time period of one or more seconds, a large amount of data transmitted to the aircraft can be lost each time an interruption in the communications link with an aircraft occurs.

[0007] Thus, there exists a need for an improved airport traffic management system that is capable of monitoring communications with a large number of aircraft on the ground at an airport and determining the optimal antenna substation to be used by each aircraft, in real time fashion, to even more efficiently manage communications between parked or taxiing aircraft at an airport and a ground-based central data network. Specifically, there is a need for a communications system that is able to determine the optimal access point to be used by ground based aircraft, which is not limited to the consideration of the signal strength of received RF beacon signals by the aircraft's RF communications system. This would reduce the frequency of changes by the aircraft in the specific access point with which it is communicating, and therefore reduce the number of instances where communication is lost between the ground based aircraft and the central data network due to the initiation of a new communications link with a different access point. Further, there is a need for a communications system that can

monitor and manage the number of aircraft that are communicating with a given access point at a given time to eliminate network bottlenecks and network inefficiencies.

5

SUMMARY OF THE INVENTION

[0008] The present invention overcomes the deficiencies of the prior art by providing an improved communications system for use in a controlled environment, such as within an airfield, between a mobile platform, such as an aircraft, and a centralized ground communications network, such as an airport central data network located at an airport or airfield. Specifically, the present invention provides for a control computer that selects the optimal antenna substation for the aircraft to communicate with from a plurality of antenna substations located about the airfield. The decision as to which antenna substation to select is based in part upon the directional heading of the aircraft that is determined using Global Positioning System (GPS) information from GPS satellites, and based in part upon the RF traffic being handled (i.e., loading) of each particular antenna substation. Determining the optimal antenna substation for the aircraft to communicate with based on the directional heading of the aircraft and upon the present usage of the different antenna substations is advantageous as it decreases the number of times that the aircraft must initiate a new connection with a different antenna substation. It also decreases the transmission interruptions experienced due to the initiation of new RF connections.

[0009] In an alternative preferred embodiment, the aircraft's position at an airfield at any given time is determined by multi-lateration techniques instead of by GPS information. Positional information concerning the aircraft is then used, together with additional information concerning the direction of travel of a moving aircraft and its speed, by a control computer to determine the appropriate access point for a given aircraft.

[0010] Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, are

intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

5 **[0011]** The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0012] Figure 1 is a block diagram generally illustrating a communications system of the present invention, and specifically illustrating an aircraft component and a ground based component, and where the ground
10 based component includes a plurality of antenna substations disposed about an airfield that are used to provide communication between the aircraft and a central data network;

[0013] Figure 2 is a top view of a portion of an airfield at which the communications system of Figure 1 may be used; and

15 **[0014]** Figure 3 is a flow chart-like illustration of the communication steps performed by a control computer and the aircraft component of Figure 1, and the interaction between the control computer and the aircraft component in establishing a communications link.

20 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] The following description of the preferred embodiments is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses.

[0016] With initial reference to Figure 1, a communications system
25 in accordance with a preferred embodiment of the present invention is generally illustrated at 10. The communications system 10 is used in a controlled environment such as at an airfield 12. The system 10 includes an aircraft communications component 14 located onboard a mobile platform such as an aircraft 16 (Figure 2), and a ground based component 15. The
30 ground based component 15 includes a control computer 17. The ground based component 15 provides communication between the aircraft communications component 14 and a remote data network 18, which may be

part of the ground based component 15 or that may be a separate system accessed by the system 10. While the following description focuses on the application of communications system 10 to an airfield 12 with an aircraft component 14 of an aircraft 16, it will be appreciated that the system 10 may
5 be used in any controlled environment where a plurality of mobile platforms (e.g. motor vehicles, ships, etc.) need to simultaneously access a plurality of communications substations at a controlled area. Thus the description of the mobile platforms as aircraft 16 is only exemplary and the present invention is not limited to use only with aircraft operating within the confines of an airfield.

10 **[0017]** The aircraft communications component 14 will now be described in greater detail. The aircraft communications component 14 is generally comprised of an aircraft data network 20, a device for determining the location and heading of the aircraft 16 such as a global positioning system (GPS) 22, and an antenna array 24. The aircraft data network 20 represents
15 components that are pre-existing on each aircraft 16. The network 20 is comprised of an information display 26, a server 28, a video device 30 (possible as a wireless video device), and various other types of aircraft equipment 32. The different components of the data network 20 are interconnected through a local area network connection such as an Ethernet
20 connection 34.

[0018] The GPS 22 determines the location and heading of the aircraft 16 through communication with navigation satellites (not shown) using GPS antenna 36. The navigation information received from the navigation satellites is received and processed by a GPS receiver 38.

25 **[0019]** The navigation information of the GPS 22 and the data from the aircraft data network 20 is prepared for transmission and encrypted by firewall/computer subsystem 40. The firewall/computer subsystem 40 may comprise any suitable computer system which includes an encryption device capable of encrypting data to allow the data to be transmitted with a suitable
30 degree of security.

[0020] The antenna array 24 may comprise any suitable number and types of RF antennas, but in one preferred form is comprised of four

separate RF antennas 42. It will be appreciated, however, that the aircraft communications component 14 could incorporate only a single RF antenna. Providing a plurality of antennas 42, however, provides added flexibility to the system 10.

5 **[0021]** The antennas 42 include a 2.4 GHz port side antenna 42a, a 5.8 GHz port side antenna 42b, a 2.4 GHz starboard side antenna 42c, and a 5.8 GHz starboard side antenna 42d. Port side antennas 42a and 42b are located toward the port side of the exterior of the aircraft 16 while starboard antennas 42c and 42d are located on an exterior surface toward the starboard
10 side of the aircraft. The use of antennas for operating at two different frequencies further ensures that if RF traffic on one frequency is very high, that a second frequency is available for use.

[0022] The antenna array 24 transmits the encrypted data of the GPS 22 from the aircraft component 14 to the control computer 18 by way of
15 a series of antenna substations 43a, 43b and 43c. Each antenna substation 43 includes an antenna array 44 that is located at a predetermined location at the airfield 12. The encrypted data may be transmitted in a variety of different formats but is preferably transmitted using well known 802.11a or 802.11b protocols. The data from the aircraft data network 20 may also be transferred
20 via antenna array 24, however, the transmission of data from the aircraft data network 20 is not the principal purpose for the invention.

[0023] In Figure 2, the antenna substations 43 are illustrated at various predetermined locations at the airfield 12. The airfield 12 is comprised of at least one runway 46, at least one taxiway 48, a terminal 50,
25 and a control tower 52. While Figures 1 and 2 illustrate three antenna substations 43a, 43b, and 43c, it must be realized that any suitable plurality of antenna substations 43 may be incorporated. The antenna substations 43 are located about the airfield 12 at those locations sufficient to provide communication with an aircraft at any area where the aircraft might be
30 required to taxi or might be parked.

[0024] All of the antenna substations 43 transmit a "beacon" signal from their respective antenna array 44 that identifies the source of the beacon

signal and an SSID (Service Set Identification), which is a unique identifier exclusive to the system 10. Antenna arrays 44 in close proximity are on different frequencies to further help prevent self jamming. The aircraft data network 20 knows the SSID and scans the frequencies associated with the antenna arrays 44 looking for a beacon signal. If it detects only one, then it will commence communications at that frequency and with that particular antenna array 44 associated with the received beacon signal. If it detects more than one beacon signal, then the signal having a stronger received signal strength will be selected and locked onto by the aircraft data network 20.

[0025] As seen in Figure 1, each antenna array 44a, 44b and 44c is preferably comprised of at least four antennas. Antenna array 44a includes an omnidirectional antenna 44a₁ tuned to 2.4 GHz, a 2.4 GHz directional antenna 44a₂, and two 5.8 GHz directional antennas 44a₃ and 44a₄. Antenna arrays 44b and 44c similarly include antennas 44b₁-44b₄ and 44c₁-44c₄, respectively. Each antenna of each antenna array 44 is coupled to one of a plurality of access points 56. Thus, antennas 44a₁-44a₄ are coupled to access points 56a₁-56a₄. Antennas 44b₁-44b₄ are similarly coupled to access points 56b₁-56b₄, and antennas 44c₁-44c₄ are similarly coupled to access points 56c₁-56c₄. The access points 56 form RF transceivers that convert the received RF data to electrical signals suitable for transmission through a land-based transmission line. Preferably, the received data is converted to a suitable IP protocol to permit transmission through fiber optic lines 58.

[0026] The directional antennas 44a₂-44a₄, 44b₂-44b₄ and 44c₂-44c₄ are used to beam RF signals down the runway 46 and taxiway 48. Accordingly, the various ones of these directional antennas are orientated so that their beams are directed away from each other, and more preferably such that the antennas of array 44a transmit beams at 180 degrees from one another (i.e., in opposite directions) along runway 46. The directional antennas of arrays 44b and 44c are similarly positioned to cover the full length of taxiway 48. The omnidirectional antenna 44a₁, 44b₁ and 44c₁ of each antenna array 44 is used to serve areas not covered by its associated

directional antennas. The use of directional antennas 44a₂-44a₄, 44b₂-44b₄ and 44c₂-44c₄ provide greater range and help to reduce self jamming. Self jamming is reduced because the RF signal from one of the directional antennas 44a₂-44a₄, 44b₂-44b₄ and 44c₂-44c₄ is reduced in level when
5 received by the other one of the adjacent directional antennas. This is because of the signal rejection characteristics of each of the directional antennas. This effectively improves the signal-to-jamming margin of each directional antenna.

[0027] Each antenna of antenna arrays 44a, 44b and 44c is in
10 communication with an associated fiber hub 60a, 60b and 60c. The fiber hubs 60 are in turn coupled to a fiber switch 62. The data received by fiber switch 62 is de-crypted by any suitable data de-crypting device, such as a firewall/computer subsystem 64. The data is transferred to and from
15 Firewall/computer subsystem 64 also performs an authentication of each aircraft 16 accessing the ground based component 15 to thus control access by the aircraft to the system 10. It will be appreciated that while fiber optics are utilized to handle the transmission of data between the antenna substations 43 and the fiber switch 62, that other suitable data transmission
20 means could be incorporated in lieu of a fiber optic system.

[0028] From the firewall/computer subsystem 64, the received data is directed to various subsystems by a hub or switch 68. The subsystems in receipt of the received data preferably include the control computer 17, the airport data network 18, and an information display 70 for visually displaying
25 various operational parameters of the system 10, such as the location and heading of the aircraft 16 and which antenna array 44 the aircraft 16 is in communication with. While the control computer 17 is illustrated as being separate from the airport data network 18, it should be realized that the control computer 17 may be part of the airport data network 18. The control
30 computer 17, information display 70, and airport data network 18 are interconnected by fiber optic lines 58 or any other suitable signal transmission means.

[0029] The decision as to which antenna substation 43 aircraft communications component 14 is to connect with in order to communicate with the airport data network 18 is made by control computer 17. The use of control computer 17 to determine which antenna substation 43 the aircraft communications component 14 is to communicate with will now be described in detail. As illustrated in Figure 3, the control computer 17 is activated at step 71 and waits to receive an incoming data signal from aircraft communications component 14 of a given aircraft 16, as shown at step 72. Once aircraft communications component 14 is activated at step 73, the aircraft communications component 14 performs a roaming operation at step 74 to detect a beacon signal from any one of the antenna arrays 44a, 44b, 44c. Once it detects such a signal it establishes a communications link with the antenna substation 43a, 43b, 43c providing the beacon signal, and then makes a connection with the control computer 17, as shown at step 72.

[0030] After the aircraft communications component 14 connects with one of the antenna arrays 44a, 44b, 44c, the aircraft component 14 transmits a unit identification number (e.g., a tail number) and its position, as determined by GPS 22, to the control computer 17, at step 76. Alternatively, multi-lateration could be used in place of a GPS system to determine the position of the aircraft 16. This position detecting technique will be discussed in connection with an alternative preferred embodiment of the invention.

[0031] The unit identification number and position data are received by the control computer at step 78. Once the control computer 17 receives the identification number and position data at step 78, and authenticates the aircraft 16 as an aircraft authorized to access the system 10, the control computer 17 computes a list of antenna arrays 44 that are within the coverage range of the aircraft communications component 14, as at step 80. The list of antenna arrays 44 that is generated by the control computer 17 is modified at step 82 based on antenna array load balancing considerations and the direction of travel of the aircraft 16 to determine the optimal antenna array 44 with which aircraft 16 is to communicate with. For example, Figure 2 illustrates aircraft 16 as being closest to antenna array 44b. However, if

antenna array 44a is presently operating at capacity with respect to the number of aircraft it is in communication with, then the control computer 17 will select a different antenna array 44 which represents the next optimal antenna array. Further, if the aircraft 16 is closest to antenna array 44b but
5 the data from the GPS 22 indicates that the aircraft 16 is traveling away from the antenna array 44b of antenna substation 43b and toward the antenna array 44c of substation 43c, the control computer 17 will select antenna array 44c as the optimal antenna array 44 for the aircraft component 14 to communicate with. This is done to minimize the number of times that the
10 aircraft component 14 must initiate a new connection with antenna arrays 44 as the aircraft traverses the airfield 12, and thus minimize the communication delays associated with establishing new communications links.

[0032] Once the optimal antenna array 44 is selected by control computer 17, the details of the optimal antenna array 44 are transmitted to the
15 aircraft communications component 14 at step 84 and received by the aircraft communications component 14 at step 86. The aircraft communications component 14 connects to the optimal antenna array 44 as indicated at step 88. If the aircraft communications component 14 successfully connects to the antenna array 44 selected by the control computer 17 at step 89, the
20 operation of the aircraft communications component 14 proceeds to step 76. At this step the unit identification number and the heading of aircraft 16 are again transmitted to the control computer 17 to allow the control computer 17 to continuously update its decision as to which antenna array 44 is the optimal antenna array for the aircraft 16 to communicate with. If the aircraft
25 communications component 14 is unable to connect to the preferred antenna array 44 at step 89 the operation of the aircraft component 14 proceeds to step 74 where the aircraft communications component 14 of the aircraft 16 connects with any available antenna array 44 until the component 14 is able to connect to the optimal antenna array 44 as selected by control computer
30 17.

[0033] An additional advantage to using "sectorized" (i.e., spaced apart) antennas is that it allows a system to be designed with a near optimum

frequency plan incorporating frequency reuse. Since omnidirectional antennas transmit in all directions, a frequency can be reused at a different antenna station only if the distance between the omnidirectional antennas is great enough to avoid interference. Sectorized antennas restrict the RF pattern, so frequency reuse in close proximity is possible as long as it is in a sector that does not overlap with a sector on the same frequency.

[0034] In an alternative preferred embodiment, the technique of multi-lateration is used to provide the needed positional information of each aircraft 16 located at an aircraft. In this embodiment, the aircraft 16 includes an RF transponder 100 as part of its communications component 14, as shown in Figure 1. It will be appreciated that when multi-lateration is used, the GPS subsystem 22 will not be required.

[0035] Briefly, and with reference to Figure 2, multi-lateration is a well known technique involving the use of multiple, non-rotating RF receivers 102 disposed at various locations about the airfield 16. The RF receivers 102 are used to capture pulses being transmitted from the RF transponder 100 of each aircraft 16. From these pulses, an external processing system associated with the RF receivers 102 extrapolates the position of the aircraft 16 at any given instant. Multi-lateration differs from a GPS based system because a GPS based system uses a single receiver (i.e., on the aircraft 16) to capture signals transmitted from a plurality of widely spaced satellites. One manufacturer of a multi-lateration system suitable for use with the present invention is Senesis Corporation of DeWitt, NY. The receivers 102 could be located at the antenna substations 15 or at other areas about the airfield 12. Since they are physically small components, they are easily mounted on other support structures or pre-existing buildings at the airfield 12. The resolution of the position information extrapolated from the receivers 102 is limited principally by the number of receivers 102 employed. Accordingly, the greater the number of receivers 102 located about the airfield 12 the greater the precision with which each aircraft's 16 location can be pinpointed at any given time.

[0036] Thus, the present invention discloses an improved communications system 10 for providing communications in a controlled environment, such as within the airfield 12, between a mobile unit, such as the aircraft component 14 of aircraft 16, and a remote network, such as the airport data network 18. Specifically, the present invention provides for a control computer 17 that selects the optimal antenna substation 43 from a plurality of antenna substations disposed about an airfield for the aircraft 16 to communicate with. This determination is based in part upon the position, direction of travel and speed of the aircraft 16, calculated using suitable position information, and in part upon the current load (i.e., number of aircraft) being handled by each antenna substation 43. Determining the optimal antenna substation 43 for aircraft component 14 to communicate with based on the directional heading of the aircraft 16 and the real time usage of each antenna substation 43 is advantageous as it decreases the number of times that aircraft communications component 14 must initiate communication with a new antenna array 44, and thus decreases the transmission interruptions experienced due to the creation of new connections.

[0037] The description of the invention is merely exemplary in nature and, thus, variations that do not depart from the gist of the invention are intended to be within the scope of the invention. Such variations are not to be regarded as a departure from the spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. A system for managing communication between a mobile platform operating within a pre-defined geographic region and a communications station, the system comprising:

a control system for managing communications within said geographic region;

a mobile platform communications component located on said mobile platform for communicating with said control system;

a plurality of antennas located at spaced apart locations within or adjacent said geographic region, each of said antennas being in communication with said control system; and

wherein said control system uses an operating characteristic of said mobile platform as said mobile platform operates within said geographic region to inform said mobile platform as to which one of said antennas to communicate with to maintain a communications link between said mobile platform and said control system while reducing a frequency with which said mobile platform is required to switch between different ones of said antennas as said mobile platform moves within said geographic region.

20

2. The system of claim 1, wherein said operating characteristic comprises real time position information of said mobile platform.

3. The system of claim 1, wherein said operating characteristic comprises real time information relating to a direction of travel of said mobile platform.

25

4. The system of claim 1, wherein said operating characteristic comprises real time information relating to a speed of travel of said mobile platform.

30

5. The system of claim 1, wherein said control system uses information relating to a loading of each of said antennas in determining which one of said antennas said mobile platform is to use for communication purposes.

5

6. A system for managing communications with a mobile platform operating within a pre-defined geographic region, comprising:

10 a mobile platform communications component located on said mobile platform for determining a location of said mobile platform while said mobile platform is operating within said pre-defined geographic region;

at least one antenna located on said mobile platform;

a ground based component including:

15 a plurality of antennas located at spaced apart locations about said pre-defined geographic region;

a control system in communication with said antennas; and

20 wherein said control system analyzes location information received by at least one of said antennas and selects a specific antenna with which said mobile platform communications component is to use for communicating with a network disposed at said pre-defined geographic region, said selection being made based at least in part on real-time location information for said mobile platform.

25

7. The system of claim 6, wherein said location information is provided to said control system by said mobile platform.

8. The system of claim 6, wherein said location information is
30 derived by said control system through multi-lateration techniques.

9. The system of claim 7, wherein said location information is derived from Global Positioning Satellite information and supplied to said control system by said mobile platform communications component.

5 10. The system of claim 6, wherein said selection is further made in consideration of a speed of travel of said mobile platform.

11. The system of claim 6, wherein said selection is further made in consideration of a loading of at least a pair of said antennas.

10

12. The system of claim 6, wherein each said antenna comprises an antenna substation comprised of at least one directional antenna and an omni directional antenna.

15

13. The system of claim 6, wherein said ground based component further includes a hub for facilitating communication between said antennas and said control system.

20

14. The system of claim 6, wherein each said antenna transmits a unique beacon signal, and wherein said mobile platform communications component initially selects one of said beacon signals having the strongest signal strength to establish a communications link with said ground based component.

25

15. The system of claim 6, wherein said control system further uses information relating to a speed of travel of said mobile platform to make said selection.

30

16. The system of claim 6, wherein said control system uses information related to a direction of travel of said mobile platform to make said selection.

17. A system for managing communications between a mobile platform operating within a pre-defined terrestrial, geographic region, in a manner to minimize interruptions to a communications link established between the mobile platform and a communications center at the geographic region, the system comprising:

5 a communications component disposed on said mobile platform, said communications component including a system for providing real time location information;

a ground based component including:

10 a plurality of antenna stations disposed at pre-determined locations about geographic region for providing radio frequency (RF) communications with said mobile platform at any location within said geographic region;

a control system in communication with each of

15 said antenna stations; and

wherein said control system uses said location information and a direction of travel of said mobile platform to determine which of said antenna stations to communicate with and to instruct said mobile platform to switch from one

20 of said antenna stations to another in a manner to minimize a number of changes between said antenna stations while said mobile platform travels within said geographic region, and while maintaining an optimal RF communications link between said mobile platform and said ground component.

25

18. The system of claim 17, wherein said mobile platform includes first and second RF antennas each operating at a different frequency.

30 19. The system of claim 17, wherein each said antenna station includes first and second antennas operating at different frequencies.

20. The system of claim 17, wherein the control system uses information concerning a loading of at least a pair of said antenna stations in determining which said antenna stations to instruct said mobile platform to use.

5

21. The system of claim 17, wherein said location information comprises real-time information obtained from a Global Positioning Satellite system.

10

22. The system of claim 17, wherein a speed of travel of the mobile platform is used by the control system to select and switch between ones of said antenna stations.

15

23. The system of claim 17, wherein at lease one of said antenna stations is used to inform said mobile platform as to which specific one of said antenna stations to communicate to switch to using.

20

24. The system of claim 17, wherein each said antenna station includes:

a directional antenna;

an omni directional antenna; and

wherein said directional antennas of said antenna stations are directed such that an associated antenna beam of each is directed away from one another.

25

25. The system of claim 17, wherein each said antenna station transmits a beacon signal identifying it to said communications component.

26. A method for managing communications within a pre-defined geographic area between a mobile platform operating within the geographic area and a control system, comprising:

- 5 a) using a plurality of ground-based antenna stations, each disposed at fixed locations within the geographic area, to each transmit an identification;
- b) using a communications component located on said mobile platform to receive said beacon signals and to select an initial one of said antenna stations to establish a communications link with said control
10 system as said mobile platform operates within said geographic region;
- c) using said control system to communicate with each of said antenna stations and to monitor at least one of speed of travel and direction of travel of said mobile platform within said geographic region;
- d) using said control system to analyze information obtained at
15 step c) to determine when said mobile platform should switch from communicating with said initial one of said antenna stations to a different one of said antenna stations to maintain an optimal communications link while moving within said geographic region; and
- e) instructing said communications component, in real time, as
20 to which one of said antenna stations to use to maintain said communications link in a manner which reduces a frequency with which said communications component is required to switch from one said antenna system to another.

25 27. The method of claim 26, wherein said communications component continuously supplies location information obtained from a Global Positioning Satellite system to said control system via said antenna stations.

30 28. The method of claim 26, wherein said control system uses multi-lateration to periodically determine at least an approximate direction of travel of said mobile platform.

29. The method of claim 26, wherein said control system uses both of said directional of travel and speed of travel of said mobile platform in determining which one of said antenna stations to instruct said
5 communications component to switch to so as to maintain said communications link.

30. The method of claim 26, wherein using said antenna stations comprises using antenna stations that each comprise a directional
10 antenna aimed in different directions.

31. The method of claim 26, wherein using said antenna stations further comprises using at least one directional antenna and one omni directional antenna.

32. The method of claim 26, further comprising using information pertaining to a loading of at least a pair of said antenna stations in determining which one of said antenna stations said communications component is to be instructed to use.

5

33. A method for managing communications within a pre-defined geographic area between a mobile platform operating within the geographic area and a control system, comprising:

10 locating a plurality of ground-based antenna stations, each disposed at fixed locations within the geographic area;

using at least one of the ground-based antenna stations to transmit an identifying signal;

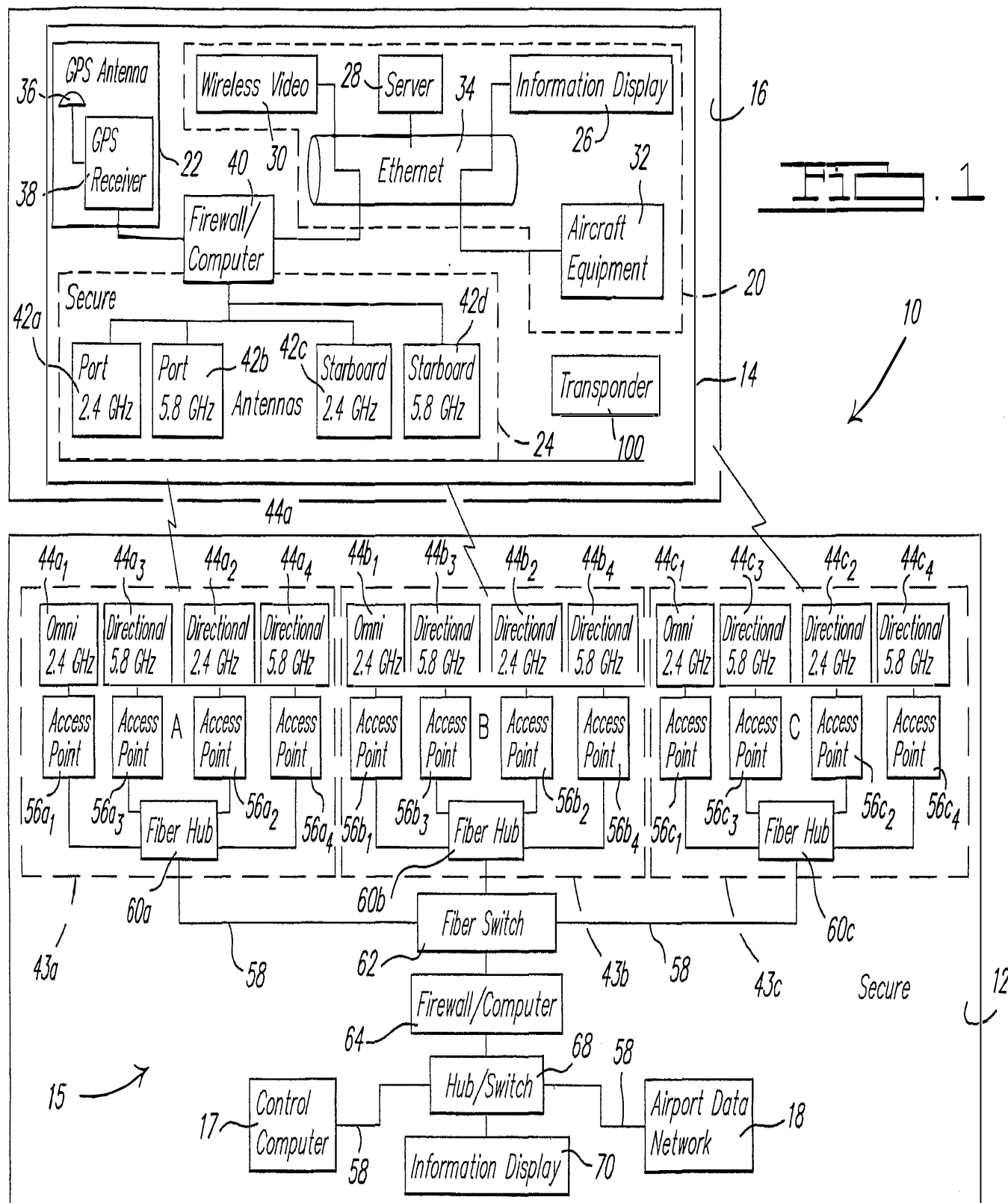
15 using a communications component located on said mobile platform to receive said identifying signal and to establish a communications link with said control system via said one of said antenna stations as said mobile platform travels within said geographic area;

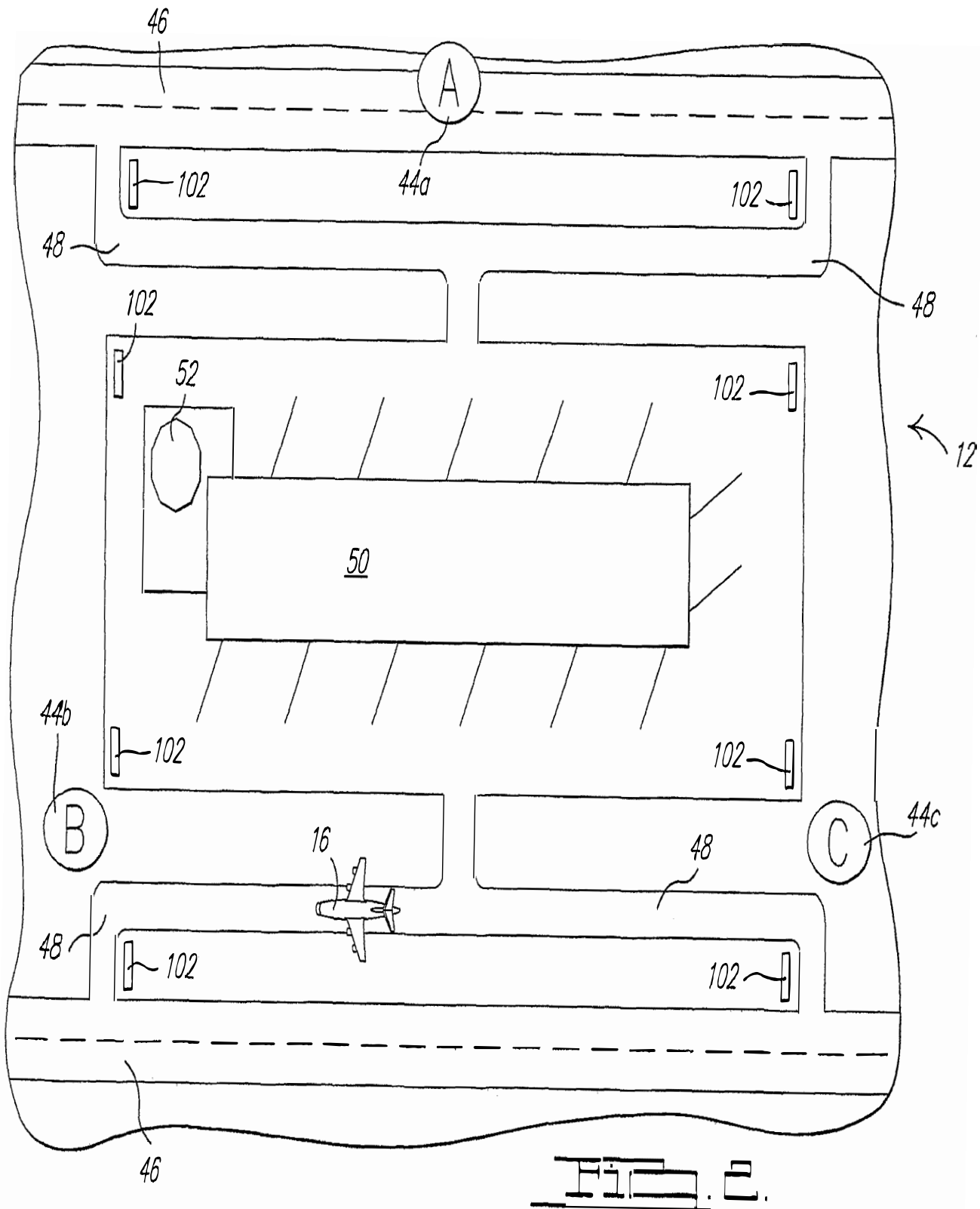
using said control system to analyze position information relating to said mobile platform as said mobile platform moves within said geographic area;

20 using said control system to determine when said communications component should switch from said one antenna station to a different one of said antenna stations to maintain an optimal communications link with said communications component while minimizing a number of times that switching between different ones of said antenna stations occurs; and

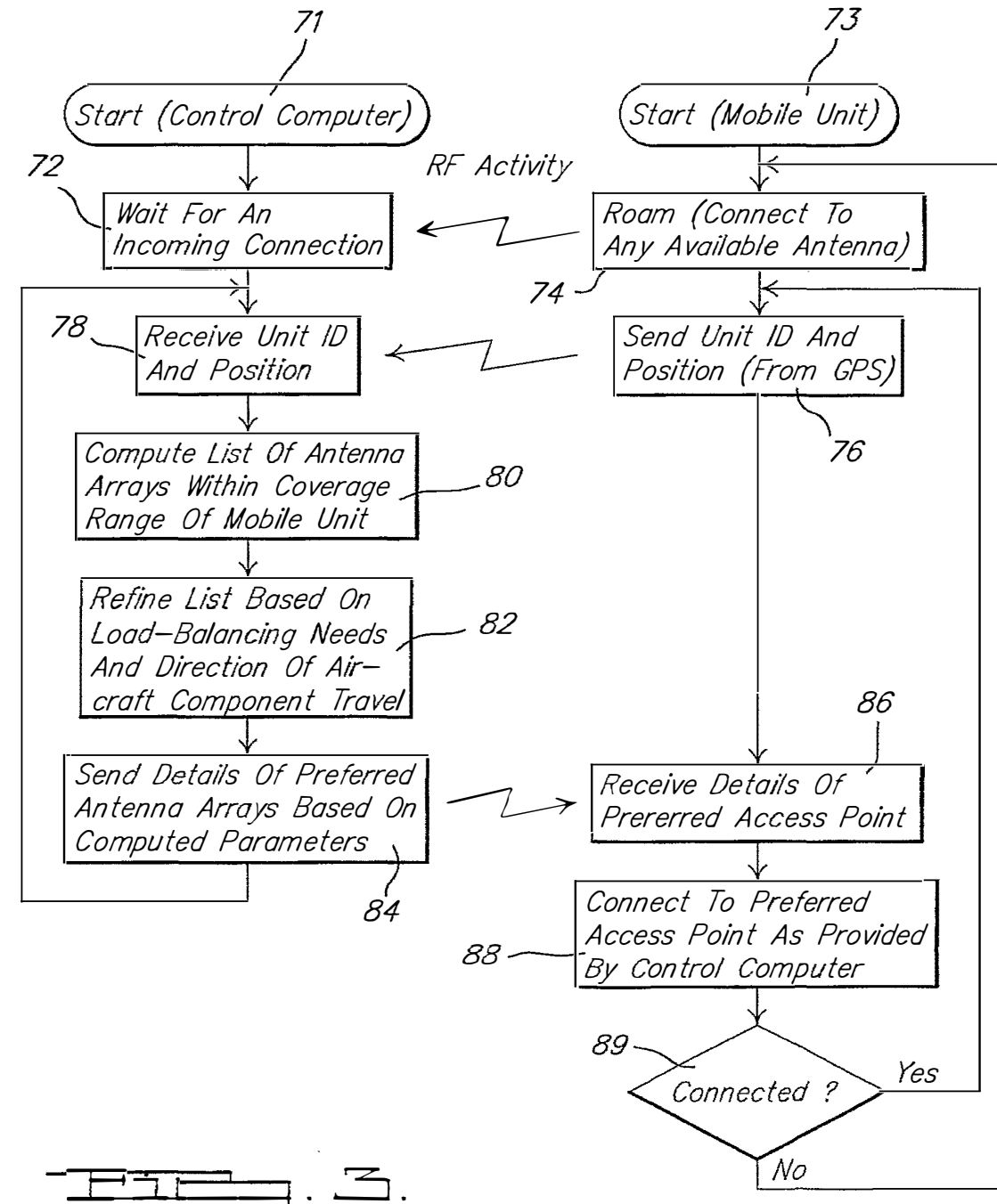
25 using the control system to inform said communications component, via at least one of said antenna stations, which of said antenna stations to switch to so as to maintain said communications link.

34. The method of claim 33, further comprising using said control
30 system to determine a loading of at least a pair of said antenna stations and using said loading in determining which one of said antenna stations to instruct said communications component to switch to.





3/3



PATENT COOPERATION TREATY

NOV 28 2017

MARSHALL GERSTEIN

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

To:

Rueth, Randall G
MARSHALL, GERSTEIN & BORUN LLP
233 South Wacker Drive
6300 Willis Tower
Chicago, Illinois 60606-6357
ETATS-UNIS D'AMERIQUE

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL SEARCH REPORT AND
THE WRITTEN OPINION OF THE INTERNATIONAL
SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

	Date of mailing (day/month/year) 23 November 2017 (23-11-2017)
Applicant's or agent's file reference 32045/50990/PC	FOR FURTHER ACTION See paragraphs 1 and 4 below
International application No. PCT/US2017/039634	International filing date (day/month/year) 28 June 2017 (28-06-2017)
Applicant GOGO LLC	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

Filing of amendments and statement under Article 19:

The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

When? The time limit for filing such amendments is normally two months from the date of transmittal of the International Search Report.

How? Directly to the International Bureau of WIPO, 34 chemin des Colombettes
1211 Geneva 20, Switzerland, Facsimile No.: (41-22) 338.82.70

For more detailed instructions, see PCT Applicant's Guide, International Phase, paragraphs 9.004 - 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.
3. ☐ **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:
- ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with any applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.
- ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

The applicant may **submit comments on an informal basis on the written opinion of the International Searching Authority** to the International Bureau. These comments will be made available to the public after international publication. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established.

Shortly after the expiration of **18 months from the priority date, the international application will be published** by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90*bis*.1 and 90*bis*.3).

Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for **entry into the national phase** before those designated Offices. In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months. For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

Within **22 months from the priority date, the applicant may request that a supplementary international search be carried out** by a different International Searching Authority that offers this service (Rule 45*bis*.1). The procedure for requesting supplementary international search is described in the *PCT Applicant's Guide*, International Phase, paragraphs 8.006-8.032.

Name and mailing address of the International Searching Authority  European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040 Fax: (+31-70) 340-3016	Authorized officer BETTIOL, Brigitte Tel: +31 (0)70 340-3901
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PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 32045/50990/PC	FOR FURTHER ACTION see Form PCT/ISA/220 as well as, where applicable, item 5 below.	
International application No. PCT/US2017/039634	International filing date (<i>day/month/year</i>) 28 June 2017 (28-06-2017)	(Earliest) Priority Date (<i>day/month/year</i>) 5 July 2016 (05-07-2016)
Applicant GOGO LLC		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 6 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of:

- ☒ the international application in the language in which it was filed
☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (See Box No. II)

3. ☒ **Unity of invention is lacking** (see Box No. III)

4. With regard to the **title**,

- ☒ the text is approved as submitted by the applicant
☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

- ☒ the text is approved as submitted by the applicant
☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority

6. With regard to the **drawings**,

- a. the figure of the **drawings** to be published with the abstract is Figure No. 1
☐ as suggested by the applicant
☒ as selected by this Authority, because the applicant failed to suggest a figure
☐ as selected by this Authority, because this figure better characterizes the invention
b. ☐ none of the figures is to be published with the abstract

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/039634

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 all searchable 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.:

2, 3, 5, 9, 10, 14, 15(completely); 1, 4, 7, 8, 11(partially)

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.

IPR2025-00672

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2017/039634

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04B7/185

ADD.

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)

H04B H04W

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 practicable, search terms used)

EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	WO 2004/023677 A2 (BOEING CO [US]) 18 March 2004 (2004-03-18) abstract paragraph [0002] paragraph [0005] paragraphs [0007] - [0008] paragraphs [0029] - [0032] paragraph [0036] figure 3 claims ----- -/--	1-3,5,7 4,8-11, 14,15



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

"E" earlier application or patent but published on or after the international filing date

"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)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"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

"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

"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

"&" document member of the same patent family

Date of the actual completion of the international search

25 September 2017

Date of mailing of the international search report

23/11/2017

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

Dejonghe, Olivier

IPR2025-00672

Petitioner's Exhibit 1004

page 1 of 2 Page 159 of 214

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2017/039634

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 2 278 732 A2 (DEUTSCHE TELEKOM AG [DE]) 26 January 2011 (2011-01-26) abstract paragraphs [0018] - [0024] paragraph [0035] paragraphs [0035] - [0037] figures claims -----	1-5, 7-11, 14, 15
A	US 8 688 101 B1 (HAYES GERARD JAMES [US] ET AL) 1 April 2014 (2014-04-01) abstract column 1, lines 51-65 column 3, lines 48-62 column 5, line 23 - column 6, line 62 column 11, lines 18-61 column 12, lines 24-55 figures claims -----	1-5, 7-11, 14, 15
A	US 2012/063522 A1 (FUSS TIM [DE] ET AL) 15 March 2012 (2012-03-15) the whole document -----	1-5, 7-11, 14, 15

IPR2025-00672

Petitioner's Exhibit 1004

Page 160 of 214

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2017/039634

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 2004023677	A2	18-03-2004	AU 2003268474 A1	29-03-2004
			EP 1537687 A2	08-06-2005
			US 2004132495 A1	08-07-2004
			WO 2004023677 A2	18-03-2004

EP 2278732	A2	26-01-2011	EP 2278732 A2	26-01-2011
			ES 2595229 T3	28-12-2016
			HR P20161253 T1	18-11-2016
			HU E028543 T2	28-12-2016
			PL 2278732 T3	31-01-2017
			PT 2278732 T	14-11-2016

US 8688101	B1	01-04-2014	EP 2885939 A1	24-06-2015
			US 8688101 B1	01-04-2014
			US 8825033 B1	02-09-2014
			US 2016029370 A1	28-01-2016
			WO 2014168742 A1	16-10-2014

US 2012063522	A1	15-03-2012	CA 2758992 A1	11-11-2010
			CN 102625979 A	01-08-2012
			DE 102009019995 A1	11-11-2010
			EP 2427972 A1	14-03-2012
			RU 2011141717 A	10-06-2013
			US 2012063522 A1	15-03-2012
			WO 2010128083 A1	11-11-2010

IPR2025-00672

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 2, 3, 5, 9, 10, 14, 15(completely); 1, 4, 7, 8, 11(partially)

Optimizing forward link user capacity for communication between an aircraft and the ground

2. claims: 6, 12, 13(completely); 1, 4, 7, 8, 11(partially)

Minimizing return link noise for communication between an aircraft and the ground

Information on Search Strategy - Pilot phase (see OJ 2015, A86)

The type of information contained in this sheet may change during the pilot for improving the usefulness of this new service.

Application Number

PCT/US2017/039634

TITLE:

APPLICANT: GOGO LLC

IPC CLASSIFICATION: H04B7/185

EXAMINER: Dejonghe, Olivier

CONSULTED DATABASES: WPI, EPODOC, XPI3E, XFULL, COMBI, ANSERA

CLASSIFICATION SYMBOLS DEFINING EXTENT OF THE SEARCH:

IPC:

CPC: H04B7/18506, H04W84/005, H04W48/20, H04W84/06, H04B7/18506/LOW,
H04W36/00/LOW, H04W36/0083

FI/F-TERMS:

KEYWORDS OR OTHER ELEMENTS FEATURING THE INVENTION:

PATENT COOPERATION TREATY

RECEIVED

NOV 28 2017

From the
INTERNATIONAL SEARCHING AUTHORITY

MARSHALL GERSTEIN

PCT

To:

see form PCT/ISA/220

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (PCT Rule 43bis.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.
PCT/US2017/039634

International filing date (day/month/year)
28.06.2017

Priority date (day/month/year)
05.07.2016

International Patent Classification (IPC) or both national classification and IPC
INV. H04B7/185

Applicant
GOGO LLC

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☒ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☒ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1 bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA:



European Patent Office
P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk - Pays Bas
Tel. +31 70 340 - 2040
Fax: +31 70 340 - 3016

Date of completion of
this opinion

see form
PCT/ISA/210

Authorized Officer

Telephone No. +31 70 340-0



IPR2025-00672

Petitioner's Exhibit 1004
Page 164 of 214

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/US2017/039634

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:
 - ☒ the international application in the language in which it was filed.
 - ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).
2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))
3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:
 - a. ☐ forming part of the international application as filed:
 - ☐ in the form of an Annex C/ST.25 text file.
 - ☐ on paper or in the form of an image file.
 - b. ☐ furnished together with the international application under PCT Rule 13ter.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
 - c. ☐ furnished subsequent to the international filing date for the purposes of international search only:
 - ☐ in the form of an Annex C/ST.25 text file (Rule 13ter.1(a)).
 - ☐ on paper or in the form of an image file (Rule 13ter.1(b) and Administrative Instructions, Section 713).
4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
5. Additional comments:

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/US2017/039634

Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non obvious), or to be industrially applicable have not been examined in respect of

- ☐ the entire international application
- ☒ claims Nos. 6, 12, 13(completely); 1, 4, 7, 8, 11(partially)

because:

- ☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international search (*specify*):
- ☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):
- ☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed (*specify*):
- ☒ no international search report has been established for the whole application or for said claims Nos. 6, 12, 13(completely); 1, 4, 7, 8, 11(partially)
- ☐ a meaningful opinion could not be formed without the sequence listing; the applicant did not, within the prescribed time limit:
- ☐ furnish a sequence listing in the form of an Annex C/ST.25 text file, and such listing was not available to the International Searching Authority in the form and manner acceptable to it; or the sequence listing furnished did not comply with the standard provided for in Annex C of the Administrative Instructions.
- ☐ furnish a sequence listing on paper or in the form of an image file complying with the standard provided for in Annex C of the Administrative Instructions, and such listing was not available to the International Searching Authority in the form and manner acceptable to it; or the sequence listing furnished did not comply with the standard provided for in Annex C of the Administrative Instructions.
- ☐ pay the required late furnishing fee for the furnishing of a sequence listing in response to an invitation under Rule 13ter.1(a) or (b).
- ☐ See Supplemental Box for further details

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/US2017/039634

Box No. IV Lack of unity of invention

1. ☒ In response to the invitation (Form PCT/ISA/206) to pay additional fees, the applicant has, within the applicable time limit:
- ☐ paid additional fees
 - ☐ paid additional fees under protest and, where applicable, the protest fee
 - ☐ paid additional fees under protest but the applicable protest fee was not paid
 - ☒ not paid additional fees
2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose not to invite the applicant to pay additional fees.
3. This Authority considers that the requirement of unity of invention in accordance with Rule 13.1, 13.2 and 13.3 is
- ☐ complied with
 - ☒ not complied with for the following reasons:
see separate sheet
4. Consequently, this report has been established in respect of the following parts of the international application:
- ☐ all parts.
 - ☒ the parts relating to claims Nos. 2, 3, 5, 9, 10, 14, 15(completely); 1, 4, 7, 8, 11(partially).

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	<u>9, 10, 14, 15(completely); 4, 8, 11(partially)</u>
	No: Claims	<u>2, 3, 5(completely); 1, 7(partially)</u>
Inventive step (IS)	Yes: Claims	<u>9, 10, 14, 15(completely); 4, 8, 11(partially)</u>
	No: Claims	<u>2, 3, 5(completely); 1, 7(partially)</u>
Industrial applicability (IA)	Yes: Claims	<u>2, 3, 5, 9, 10, 14, 15(completely); 1, 4, 7, 8, 11(partially)</u>
	No: Claims	

2. Citations and explanations

see separate sheet

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/US2017/039634

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item IV

Lack of unity of invention

The search authority found multiple (groups of) invention in this application, as follows:

Group I: Claims 1-15 whereby the retrieved information relates to forward-link user capacity (option (i) in claim 1)

Group II: Claims 1-15 whereby the retrieved information relates to return-link noise (option (ii) in claim 1)

In particular:

Group I relates to optimizing forward link user capacity for communication between an aircraft and the ground

Group II relates to minimizing return link noise for communication between an aircraft and the ground

Claim 1 comprises two distinct options:

The first option of claim 1 (option (i)) reads as:

A system comprising one or more processors and/or transceivers configured to:

retrieve a forward-link user capacity matrix comprising a plurality of forward-link user capacity estimates each associated with a respective location on the ground;

determine, based on the forward-link user capacity matrix, a candidate serving cell that is disposed on the ground; and

command a directional antenna and a particular transceiver to transmit or receive data between the airborne aircraft and the candidate serving cell.

The second option of claim 1 (option (ii)) reads as:

A system comprising one or more processors and/or transceivers configured to:

retrieve a return-link noise matrix comprising a plurality of reverse-link noise estimates each associated with a respective azimuth and elevation with respect to a current location of an airborne aircraft;
determine, based on the reverse-link noise matrix, a candidate serving cell that is disposed on the ground; and
command a directional antenna and a particular transceiver to transmit or receive data between the airborne aircraft and the candidate serving cell.

Each group of claims contains a number of technical features defining its subject-matter.

The only features common to the two identified groups is:

the system being configured to:

determine a candidate serving cell that is disposed on the ground; and

command a directional antenna and a particular transceiver to transmit or receive data between an airborne aircraft and the candidate serving cell.

These features are a priori well known to the person skilled in the art and do not represent any contribution to the prior art (see e.g. US2012063522). Therefore they cannot be considered as special technical features.

The remaining features being a priori considered as special technical features are the following:

Group I: retrieve a forward-link user capacity matrix comprising a plurality of forward-link user capacity estimates each associated with a respective location on the ground; the determination of the candidate serving cell is based on the forward-link user capacity matrix.

Group II: retrieve a return-link noise matrix comprising a plurality of reverse-link noise estimates each associated with a respective azimuth and elevation with respect to a current location of an airborne aircraft; the determination of the candidate serving cell is based on the reverse-link noise matrix.

These features are not the same nor corresponding, that is they have different technical effects and are related to different technical problems.

In fact the special technical features of group I solve the objectively determined problem of optimizing forward link user capacity

The special technical features of group II solve the objectively determined problem of minimizing return link noise

Thus, these 2 groups of inventions do not have any special technical features in common, nor they have any corresponding special technical features, as they relate to different solutions of different objectively determined problems. Hence, the search authority considers that the subject-matter of the application contains 2 subjects that are not so linked as to form a single general inventive concept.

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 Reference is made to the following documents:

- D1 WO 2004/023677 A2 (BOEING CO [US]) 18 March 2004 (2004-03-18)
- D2 EP 2 278 732 A2 (DEUTSCHE TELEKOM AG [DE]) 26 January 2011 (2011-01-26)
- D3 US 8 688 101 B1 (HAYES GERARD JAMES [US] ET AL) 1 April 2014 (2014-04-01)
- D4 US 2012/063522 A1 (FUSS TIM [DE] ET AL) 15 March 2012 (2012-03-15)

- 2 As a result of the non-unity objection raised above, claims 1 and 7 of the first non-unitary subject read as follows:

Claim 1:

A system comprising one or more processors and/or transceivers configured to:

retrieve a forward-link user capacity matrix comprising a plurality of forward-link user capacity estimates each associated with a respective location on the ground;

determine, based on the forward-link user capacity matrix, a candidate serving cell that is disposed on the ground; and

command a directional antenna and a particular transceiver to transmit or receive data between the airborne aircraft and the candidate serving cell.

Claim 7:

The system of any one of the previous claims, wherein at least one of the plurality of forward-link user capacity estimates is associated with a plurality of communication channels.

- 3 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 1 is not new in the sense of Article 33(2) PCT.

Document D1 discloses:

A system comprising one or more processors and/or transceivers configured to:

retrieve a forward-link user capacity matrix comprising a plurality of forward-link user capacity estimates each associated with a respective location on the ground (§31: "control computer 17 computes a list of antenna arrays 44 that are within the coverage range of the aircraft communications component 14, as at step 80. The list of antenna arrays 44 that is generated by the control computer

17 is modified at step 82 based on antenna array load balancing considerations and the direction of travel of the aircraft 16 to determine the optimal antenna array 44 with which aircraft 16 is to communicate with");

determine, based on the forward-link user capacity matrix, a candidate serving cell that is disposed on the ground (§31: "determine the optimal antenna array 44 with which aircraft 16 is to communicate with"); and

command a directional antenna and a particular transceiver to transmit or receive data between the airborne aircraft and the candidate serving cell (§32: "The aircraft communications component 14 connects to the optimal antenna array 44" & §25: " As seen in Figure 1, each antenna array 44a, 44b and 44c is preferably comprised of at least four antennas.

Antenna array 44a includes an omnidirectional antenna 44a1 tuned to 2.4 GHz, a 2.4 GHz directional antenna 44a2, and two 5.8 GHz directional antennas 44a3 and 44a4. Antenna arrays 44b and 44c similarly include antennas 44b1-44b4 and 44c1-44c4, respectively").

- 4 Dependent claims 2, 3, 5 and 7 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty, for the following reasons:

- the additional features of claims 2, 3, 5 and 6 are not considered as technical features of the system of claims 1 but merely relate to the state of certain parameters of the system (noise level above or below a threshold, distance between an aircraft and a candidate serving cell, distance between an aircraft and an alternative serving cell, ...). These parameters vary and the states indicated in these dependent claims will be reached at different times during the functioning of the system.

Therefore, the subject-matter of claims 2, 3, 5 and 6 does not meet the requirements of the PCT in respect of novelty.

- The additional technical feature of claim 7 is already disclosed in D1 (see fig. 1; §25: "each antenna array 44a, 44b and 44c is preferably comprised of at least four antennas. Antenna array 44a includes an omnidirectional antenna 44a1 tuned to 2.4 GHz, a 2.4 GHz directional antenna 44a2, and two 5.8 GHz directional antennas 44a3 and 44a4. Antenna arrays 44b and 44c similarly include antennas 44b1-44b4 and 44c1-44c4, respectively").

- 5 The combination of the features of dependent claims 4, 8-11, 14, 15 is neither known from, nor rendered obvious by, the available prior art.

Re Item VII

Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in D1 is not mentioned in the description, nor is this document identified therein.

Independent claims are is not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the prior art D1 being placed in the preamble (Rule 6.3(b)(i) PCT) and the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).

The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

Re Item VIII

The application does not meet the requirements of Article 6 PCT, because claims 2,3 and 7 are is not clear.

Claim 1 aims at a system. Claims 2, 3 and 7 are dependent on claim 1 and should therefore be defined in terms of technical features of a system, and not in terms the state of certain parameters of the system (noise level above or below a threshold, distance between an aircraft and a candidate serving cell, distance between an

aircraft and an alternative serving cell, ...). These parameters vary and the states indicated in these dependent claims will be reached at different times during the functioning of the system. These features are therefore not technical features of a system and therefore are not considered as limiting the scope of the claims.

Possible steps after receipt of the international search report (ISR) and written opinion of the International Searching Authority (WO/ISA)

General information

For all international applications, the competent International Searching Authority (ISA) will establish an international search report (ISR) accompanied by a written opinion of the International Searching Authority (WO/ISA). The WO/ISA may be responded to by

- filing informal comments with the **International Bureau of WIPO (IB)** (where no demand for international preliminary examination (**demand**) is filed)
- filing amendments under Art. 19 PCT (this can be done whether or not a **demand** is filed)
- filing amendments under Art. 34 PCT and/or formal observations in response to objections raised in the **WO/ISA** (where a **demand** is actually filed)

This document explains these possibilities.

Filing informal comments

After receipt of the **ISR and WO/ISA**, the applicant may file informal comments on the **WO/ISA**, **directly with the IB** (see International Search and Preliminary Examination Guidelines 2.15). These will be communicated to the designated/elected Offices, together with the International Preliminary Report on Patentability (**IPRP**) at 30 months from the priority date.

Amending claims under Art. 19 PCT

The applicant may file **amended claims** under Art. 19 PCT, **directly with the IB** by the later of the following dates:

- 2 months from the date of mailing of the **ISR** and the **WO/ISA**
- 16 months from the priority date

However, any such amendment received by the **IB** after the expiration of the applicable time limit shall be **considered to have been received on time** by the **IB**, if it reaches it **before** the technical preparations for international publication have been completed (the 15th day prior to the date of publication, see PCT Applicant's Guide, International Phase, 9.013).

For further information, please see Rule 46 PCT as well as form PCT/ISA/220.

Please also note that, when filing amended claims under Art. 19 PCT, such amendments shall be **accompanied by a letter** identifying the amendments made and also the basis for the amendments in the application as originally filed (Rule 46.5(b) PCT). Where a **demand** is filed, failure to comply with this requirement may result in the amendments being ignored in the International Preliminary Examination Report (**IPER**), see Rule 70.2(c-bis) PCT.

**Filing a demand
for international
preliminary
examination**

In principle, the **WO/ISA** will be considered to be the written opinion of the International Preliminary Examining Authority (**IPEA**). Where the **WO/ISA** issued by the **EPO** as **ISA** gives a positive opinion on the international application and the invention to which it relates, filing a **demand** with the **EPO** as **IPEA** would normally be unnecessary, since a positive IPRP would anyway be established by the **IB** based on the **WO/ISA** (see also further below).

If the applicant wishes to file a **demand** (for example, to allow him to argue his case in international preliminary examination with regard to objections raised in a negative **WO/ISA** before the **IPEA** issues an **IPER**), this must be done before expiration of **3 months after the date of mailing of the ISR and WO/ISA or 22 months after priority date**, whichever expires later (Rule 54*bis* PCT). Amendments under Art. 34 PCT can be filed with the **IPEA**, normally at the same time as filing the demand (Rule 66.1(b) PCT) or within the time limit set for reply to any written opinion issued during international preliminary examination by the **IPEA**.

If a **demand** is filed at the **EPO** as **IPEA** and no comments/amendments have been received by the time the **EPO** starts drawing up the **IPER** (Rule 66.4*bis* PCT), the **WO/ISA** will be transformed by the **IPEA** into an **IPER** (also called the **IPRP (Chapter II)** which would merely reflect the content of the **WO/ISA** (OJ 10/2011, 532). The **demand** can still be withdrawn (Art. 37 PCT).

Please also note that, when filing amendments under Art. 34 PCT, such amendments shall be accompanied by a letter which identifies the amendments made and also the basis for the amendments in the application as originally filed (Rule 66.8(a) PCT). Failure to comply with this requirement may result in the amendments being ignored in the **IPER (IPRP (Chapter II))**, see Rule 70.2(c-*bis*) PCT.

**Filing a request
for supplementary
international
search**

The applicant may, with the **IB**, file a request for **supplementary international search** under Rule 45*bis*.1 PCT. The present **ISR** and **WO/ISA** may also be taken into account in the execution of that supplementary international search, provided that these are available to the Authority charged with this task before it starts the supplementary search (Rule 45*bis*.5 PCT).

This kind of request **cannot be filed specifying the ISA** who did the **international search**.

More information on this topic can be found in the **PCT Applicant's Guide**, Chapter 8 (<http://www.wipo.int/pct/en/guide/ip08.html>).

**End of the
international
phase**

Where no **demand** is filed, at the end of the international phase, the **IB** will transform the **WO/ISA** into the **IPRP** (PCT Chapter I) (Rule 44*bis* PCT), which will then be transmitted together with possible informal comments to the designated Offices. Where a demand is filed, the **WO/ISA** is not transformed into an **IPRP (Chapter I)** by the **IB**, but rather the **IPEA** will establish an **IPER**, (the **IPER** is the same as the **IPRP** (PCT Chapter II), see Rule 70.15 PCT).

Electronic Patent Application Fee Transmittal

Application Number:	15352255			
Filing Date:	15-Nov-2016			
Title of Invention:	Servicing Cell Selection in Air to Ground Communication Systems			
First Named Inventor/Applicant Name:	Heinz A. Miranda			
Filer:	Lilian Y. Ficht/Yvonne Hernandez			
Attorney Docket Number:	32045/50990			
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
Total in USD (\$)				180

Electronic Acknowledgement Receipt

EFS ID:	31385407
Application Number:	15352255
International Application Number:	
Confirmation Number:	7058
Title of Invention:	Servicing Cell Selection in Air to Ground Communication Systems
First Named Inventor/Applicant Name:	Heinz A. Miranda
Customer Number:	4743
Filer:	Lilian Y. Ficht/Yvonne Hernandez
Filer Authorized By:	Lilian Y. Ficht
Attorney Docket Number:	32045/50990
Receipt Date:	02-JAN-2018
Filing Date:	15-NOV-2016
Time Stamp:	18:13:56
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$ 180
RAM confirmation Number	010318INTEFSW18150000
Deposit Account	132855
Authorized User	Yvonne Hernandez

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	Information_Disclosure_State ment.PDF	18995	no	2
			5a5ee74a8ac491b040c0c71d85eed38d8f343c69		
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	IDS_Citation_by_Applicant_5_References.PDF	35692	no	2
			02b809671517d678f05a365701dd4d283cfd6b296		
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Foreign Reference	EP2278732A2.PDF	678209	no	15
			83939d3987c84a0fd70586c68254807dc6b274b8		
Warnings:					
Information:					
4	Foreign Reference	WO2004023677A2.PDF	1188127	no	25
			d3e46e135741ff0030167548a3401c0f76226ebf		
Warnings:					
Information:					
5	Non Patent Literature	50990ISRwritop.PDF	1010190	no	22
			7c011f289933a0fe339b5bfe4115251292a130c7d		
Warnings:					
Information:					
6	Fee Worksheet (SB06)	fee-info.pdf	30316	no	2
			f9ce75e9bf8aa1cf1ee25d0243bd710a463e976b		
Warnings:					

Information:	
Total Files Size (in bytes):	2961529
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.	

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with 37 CFR § 1.6(a)(4).

Dated: January 2, 2018
Electronic Signature for Lilian Y. Ficht: /Lilian Y. Ficht #64.514/

Docket No.: 32045/50990
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Heinz A. Miranda et al.

Allowed: December 7, 2017

Application No.: 15/352,255

Confirmation No.: 7058

Filed: November 15, 2016

Art Unit: 2645

For: Servicing Cell Selection in Air to Ground
Communication Systems

Examiner: N. T. Huynh

INFORMATION DISCLOSURE STATEMENT (IDS)

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Pursuant to 37 C.F.R. §§ 1.56, 1.97, and 1.98, the attention of the United States Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08. It is respectfully requested that the information be expressly considered during the prosecution of the above-identified application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

This Information Disclosure Statement is filed after the mailing date of a Notice of Allowance under 37 C.F.R. § 1.311, but on or before payment of the Issue Fee (37 C.F.R. § 1.97(d)).

Pursuant to 37 C.F.R. § 1.97(e)(1), each item of information contained in this Information Disclosure Statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this Information Disclosure Statement.

In accordance with 37 C.F.R. § 1.98(a)(2)(ii), copies of U.S. patents and U.S. patent application publications are not submitted. Submitted herewith are copies of foreign patents and non-patent literature in accordance with 37 C.F.R. § 1.98(a)(2).

In accordance with 37 C.F.R. § 1.97(g), the filing of this Information Disclosure Statement shall not be construed as a representation that a search has been made. In accordance with 37 C.F.R. § 1.97(h), the filing of this Information Disclosure Statement shall not be construed to be an admission that the information cited in this Information Disclosure Statement is, or is considered to be, material to the patentability as defined in 37 C.F.R. § 1.56(b).

It is submitted that the Information Disclosure Statement is in compliance with 37 C.F.R. § 1.98, and the Examiner is respectfully requested to consider the listed references.

Our Credit Card has been charged in the amount of \$180.00 covering the fee set forth in 37 C.F.R. § 1.17(p). The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 13-2855, under Order No. 32045/50990.

Dated: January 2, 2018

Respectfully submitted,

Electronic signature: /Lilian Y. Ficht #64,514/
Lilian Y. Ficht
Registration No.: 64,514
MARSHALL, GERSTEIN & BORUN LLP
233 S. Wacker Drive
6300 Willis Tower
Chicago, Illinois 60606-6357
(312) 474-6300
Agent for the Applicant

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with 37 CFR § 1.6(a)(4).

Dated: January 3, 2018
Electronic Signature for Lilian Y. Ficht: /Lilian Y. Ficht #64,514/

Docket No.: 32045/50990
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Heinz A. Miranda et al.

Application No.: 15/352,255

Confirmation No.: 7058

Filed: November 15, 2016

Art Unit: 2645

For: Servicing Cell Selection in Air to Ground
Communication Systems

Examiner: N. T. Huynh

RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION PAPERS

MS Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the Notice to File Corrected Application Papers – Filing Date
Granted mailed December 19, 2017 regarding the above-referenced patent application,
Applicant respectfully submits a Corrected Application Data Sheet and Statement under 37 CFR
3.73(c) verifying that the Applicant and Assignee of the application is GOGO LLC.

Applicant believes no fee is due with this response. However, if a fee is due,
please charge our Deposit Account No. 13-2855, under Order No. 32045/50990 from which the
undersigned is authorized to draw.

Dated: January 3, 2018

Respectfully submitted,

By: /Lilian Y. Ficht #64,514/
Lilian Y. Ficht
Registration No.: 64,514
MARSHALL, GERSTEIN & BORUN LLP
233 S. Wacker Drive
6300 Willis Tower
Chicago, Illinois 60606-6357
(312) 474-6300
Patent Agent for Applicant

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)Applicant/Patent Owner: GOGO LLCApplication No./Patent No.: 15/352,255 Filed/Issue Date: November 15, 2016Titled: Servicing Cell Selection in Air to Ground Communication SystemsGOGO LLC, a Limited Liability Company
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☒ The assignee of the entire right, title, and interest.
2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):
- ☐ The extent (by percentage) of its ownership interest is _____ %. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.
- ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (e.g., bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

- A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.
- B. ☒ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: Heinz A. Miranda To: GOGO LLC
The document was recorded in the United States Patent and Trademark Office at
Reel 040342, Frame 0305, or for which a copy thereof is attached.
2. From: Michael H. Baker To: GOGO LLC
The document was recorded in the United States Patent and Trademark Office at
Reel 040342, Frame 0305, or for which a copy thereof is attached.

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STATEMENT UNDER 37 CFR 3.73(c)3. From: James P. Michels To: GOGO LLCThe document was recorded in the United States Patent and Trademark Office at
Reel 040342 , Frame 0305 , or for which a copy thereof is attached.4. From: Yong Liu To: GOGO LLCThe document was recorded in the United States Patent and Trademark Office at
Reel 040342 , Frame 0305 , or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
Reel _____ , Frame _____ , or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
Reel _____ , Frame _____ , or for which a copy thereof is attached.☐ Additional documents in the chain of title are listed on a supplemental sheet(s).☒ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Lilian Y. Ficht #64,514/
SignatureJanuary 3, 2018
DateLilian Y. Ficht
Printed or Typed Name64,514
Title or Registration Number

[Page 2 of 2]

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with 37 CFR § 1.6(a)(4).

Dated: January 3, 2018

Electronic Signature for Lilian Y. Ficht: /Lilian Y. Ficht #64,514/

Corrected Application Data Sheet

Inventor Information

Inventor Number::	1
Given Name::	Heinz
Middle Name::	A.
Family Name::	Miranda
City of Residence::	Cary
State or Province of Residence::	IL
Country of Residence::	US
Street of mailing address::	208 Foxford Drive
City of mailing address::	Cary
State or Province of mailing address::	IL
Country of mailing address::	US
Postal or Zip Code of mailing address::	60013
Inventor Number::	2
Name Prefix::	Mr.
Given Name::	Michael
Middle Name::	H.
Family Name::	Baker
City of Residence::	Elmhurst
State or Province of Residence::	IL
Country of Residence::	US
Street of mailing address::	375 S. Mitchell Avenue
City of mailing address::	Elmhurst

State or Province of mailing address:: IL
Country of mailing address:: US
Postal or Zip Code of mailing address:: 60126

Inventor Number:: 3
Name Prefix:: Mr.
Given Name:: James
Middle Name:: P.
Family Name:: Michels
City of Residence:: Lake Zurich
State or Province of Residence:: IL
Country of Residence:: US
Street of mailing address:: 1050 Westberry Ct
City of mailing address:: Lake Zurich
State or Province of mailing address:: IL
Country of mailing address:: US
Postal or Zip Code of mailing address:: 60047

Inventor Number:: 4
Given Name:: Yong
Family Name:: Liu
City of Residence:: Schaumburg
State or Province of Residence:: IL

Country of Residence::	US
Street of mailing address::	1817 Altoona Court
City of mailing address::	Schaumburg
State or Province of mailing address::	IL
Country of mailing address::	US
Postal or Zip Code of mailing address::	60194

Correspondence Information

Correspondence Customer Number::	04743
----------------------------------	-------

Application Information

Application Number::	15/352,255
Filing Date::	11/15/16
Application Type::	Regular
Subject Matter::	Utility
CD-ROM or CD-R?::	None
Sequence submission?::	None
Computer Readable Form (CRF)?::	No
Title::	Servicing Cell Selection in Air to Ground Communication Systems
Attorney Docket Number::	32045/50990
Request for Early Publication?::	No
Request for Non-Publication?::	No
Total Drawing Sheets::	6

Small Entity?:: No
Petition included?:: No
Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2:: No

Representative Information

Representative Customer Number:: 04743

Domestic Priority Information

Application::	Continuity Type::	Parent Application::	Parent Filing Date::	Prior Appl Status::
This Application	Claims benefit of provisional	62/358,437	07/05/16	Pending

Foreign Priority Information

Applicant Information

Applicant Number:: 1
Applicant Type:: Assignee
Organization Name:: GOGO LLC
Street of mailing address:: 111 North Canal Street
Suite 1500
City of mailing address:: Chicago
State or Province of mailing address:: IL
Country of mailing address:: US

Postal or Zip Code of mailing address:: 60606

~~Assignee Information Including Non-Applicant Assignee Information~~

~~Assignee Number::~~ ~~1~~

~~Organization Name::~~ ~~GOGO LLC~~

~~Street of mailing address::~~ ~~111 North Canal Street~~

~~City of mailing address::~~ ~~Chicago~~

~~State or Province of mailing address::~~ ~~IL~~

~~Country of mailing address::~~ ~~US~~

~~Postal or Zip Code of mailing address::~~ ~~60606~~

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Lilian Y. Ficht #64,514/	Date (YYYY-MM-DD)	2018-01-03
Name	Lilian Y. Ficht	Registration Number	64,514

Electronic Acknowledgement Receipt

EFS ID:	31399010
Application Number:	15352255
International Application Number:	
Confirmation Number:	7058
Title of Invention:	Servicing Cell Selection in Air to Ground Communication Systems
First Named Inventor/Applicant Name:	Heinz A. Miranda
Customer Number:	4743
Filer:	Lilian Y. Ficht/Yvonne Hernandez
Filer Authorized By:	Lilian Y. Ficht
Attorney Docket Number:	32045/50990
Receipt Date:	03-JAN-2018
Filing Date:	15-NOV-2016
Time Stamp:	18:47:53
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Miscellaneous Incoming Letter	Response_to_Notice_to_File_Corrected_Application_Papers.PDF	23168 92ad755a8c6b08fb578dc2dd94eb382e38e38b7d	no	1

Warnings:

Information:					
2	Assignee showing of ownership per 37 CFR 3.73	Statement_By_Assignee_to_Establish_Ownership_37_CFR_373c.PDF	34014 2be5f5b521f97aba62935253373318a12e6ccf63	no	2
Warnings:					
Information:					
3	Application Data Sheet	Corrected_Application_Data_Sheet.PDF	23298 1fb90356d9763a99b875f020e80d6953d3de8af4	no	5
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
Total Files Size (in bytes):			80480		
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					

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Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT <i>(Use as many sheets as necessary)</i>				Complete if Known	
				Application Number	15/352,255-Conf. #7058
				Filing Date	November 15, 2016
				First Named Inventor	Heinz A. Miranda
				Art Unit	2645
				Examiner Name	N. T. Huynh
				Attorney Docket Number	32045/50990
Sheet	1	of	2		

[illegible]

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	Cite No. ¹	Foreign Patent Document	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T ⁶
		Country Code ³ Number ⁴ Kind Code ⁵ (if known)				
		WO-2004/023677-A2	03-18-2004	Boeing Co		

Examiner Signature	/NAM T HUYNH/	Date Considered	01/10/2018
-----------------------	---------------	--------------------	------------

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. ¹ Applicant's unique citation designation number (optional). ² See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. ³ Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁶ Applicant is to place a check mark here if English language Translation is attached.

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with 37 CFR § 1.6(a)(4).

Dated: January 2, 2018

Electronic Signature for Lilian Y. Ficht: /Lilian Y. Ficht #64,514/

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Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT <i>(Use as many sheets as necessary)</i>				Complete if Known	
				Application Number	15/352,255-Conf. #7058
				Filing Date	November 15, 2016
				First Named Inventor	Heinz A. Miranda
				Art Unit	2645
				Examiner Name	N. T. Huynh
Sheet	2	of	2	Attorney Docket Number	32045/50990

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No. ¹	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
		International Application No. PCT/US2017/039634, International Search Report and Written Opinion, dated November 23, 2017.	

Examiner Signature	/NAM T HUYNH/	Date Considered	01/10/2018
-----------------------	---------------	--------------------	------------

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ Applicant's unique citation designation number (optional). ² Applicant is to place a check mark here if English language Translation is attached.

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with 37 CFR § 1.6(a)(4).

Dated: January 11, 2018

Signature: /Lilian Y. Ficht #64,514/
(Lilian Y. Ficht)

Docket No.: 32045/50990
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Heinz A. Miranda et al.

Allowed: December 7, 2017

Application No.: 15/352,255

Confirmation No.: 7058

Filed: November 15, 2016

Art Unit: 2645

For: Servicing Cell Selection in Air to Ground
Communication Systems

Examiner: N. T. Huynh

AMENDMENT AFTER ALLOWANCE UNDER 37 C.F.R. § 1.312

MS Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

INTRODUCTORY COMMENTS

Prior to issuance of the patent, Applicant respectfully requests entry of this amendment under 37 C.F.R. 1.312 for the above-captioned patent application.

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper.

Remarks/Arguments begin on page 8 of this paper.

AMENDMENTS TO THE CLAIMS

1. (Previously presented) A non-transitory computer readable medium, comprising processor executable instructions that when executed by a computer processor disposed within an airborne aircraft cause the computer processor to:

command a directional antenna installed on the aircraft and a transceiver disposed within the aircraft to measure a first signal-to-noise ratio of a first communication channel corresponding to a first location on the ground, the first communication channel configured to support transmissions to/from the airborne aircraft;

command the directional antenna and the transceiver to measure a second signal-to-noise ratio of a second communication channel corresponding to a second location on the ground, the second communication channel configured to support transmissions to/from the airborne aircraft;

calculate a first forward-link user capacity estimate using the first signal-to-noise ratio of the first communication channel;

calculate a second forward-link user capacity estimate using the second signal-to-noise ratio of the second communication channel; and

calculate a forward-link user capacity matrix using the first forward-link user capacity estimate and the second forward-link user capacity estimate,

wherein the forward-link user capacity matrix is utilized to select communication channels to utilize for transmissions between a plurality of ground stations disposed on the ground and the airborne aircraft.

2. (Previously presented) The medium of claim 1, wherein the first communication channel comprises a first center frequency and a first bandwidth, wherein the second communication channel comprises a second center frequency and a second bandwidth, and wherein the first communication channel does not overlap the second communication channel.

3. (Previously presented) The medium of claim 1, wherein the processor executable instructions, when executed by the computer processor, cause the computer processor to:

command the directional antenna and the transceiver to measure a short-term average of the first signal-to-noise ratio of the first communication channel;

command the directional antenna and the transceiver to measure a short-term average of the second signal-to-noise ratio of the second communication channel;

calculate the first forward-link user capacity estimate using the short-term average of the first signal-to-noise ratio of the first communication channel; and

calculate the second forward-link user capacity estimate using the short-term average of the second signal-to-noise ratio of the second communication channel.

4. (Previously presented) The medium of claim 1, wherein the processor executable instructions, when executed by the computer processor, cause the computer processor to:

command the directional antenna and the transceiver to measure a long-term average of the first signal-to-noise ratio of the first communication channel;

command the directional antenna and the transceiver to measure a long-term average of the second signal-to-noise ratio of the second communication channel;

calculate the first forward-link user capacity estimate using the long-term average of the first signal-to-noise ratio of the first communication channel; and

calculate the second forward-link user capacity estimate using the long-term average of the second signal-to-noise ratio of the second communication channel.

5. (Previously presented) The medium of claim 1, further comprising additional processor executable instructions that when executed by the computer processor cause the computer processor to command the directional antenna and the transceiver to transmit the forward-link user capacity matrix to a ground station controller using an out-of-band communication channel, the ground station controller disposed on the ground and in communicative connection with the plurality of ground stations.

6. (Previously presented) The medium of claim 1, further comprising additional processor executable instructions that when executed by the computer processor cause the computer processor to:

command the directional antenna and the transceiver to measure a third signal-to-noise ratio of a third communication channel corresponding to a third location on the ground, the third communication channel configured to support transmissions to/from the airborne aircraft;

calculate a third forward-link user capacity estimate using the third signal-to-noise ratio of the third communication channel; and

calculate the forward-link user capacity matrix using the first forward-link user capacity estimate, the second forward-link user capacity estimate, and the third forward-link user capacity estimate.

7. (Previously presented) A computer-implemented method, executed with a computer processor disposed within an air-to-ground communication ground station, comprising:

commanding, with the computer processor, a directional antenna installed at the ground station and a transceiver disposed within the ground station to measure a first noise power level of a first communication channel at a first elevation and a first azimuth from a current position of the ground station, the first communication channel configured to support transmissions between the ground station and airborne aircraft;

commanding, with the computer processor, the directional antenna and the transceiver to measure a second noise power level of a second communication channel at a second elevation and a second azimuth from the current position of the ground station, the second communication channel configured to support transmissions between the ground station and the airborne aircraft;

calculating, with the computer processor, a first reverse-link noise estimate using the first noise power level of the first communication channel;

calculating, with the computer processor, a second reverse-link noise estimate using the second noise power level of the second communication channel; and

calculating, with the computer processor, a reverse-link noise matrix using the first reverse-link noise estimate and the second reverse-link noise estimate,

wherein the reverse-link noise matrix is utilized to select communication channels to utilize for transmissions between a plurality of ground stations disposed on the ground and the airborne aircraft.

8. (Previously presented) The method of claim 7, wherein the first communication channel comprises a first center frequency and a first bandwidth, wherein the second communication channel comprises a second center frequency and a second bandwidth, and wherein the first communication channel does not overlap the second communication channel.

9. (Previously presented) The method of claim 7, further comprising:
commanding, with the computer processor, the directional antenna and the transceiver to measure a short-term average of the first noise power level of the first communication channel at the first elevation and the first azimuth;

commanding, with the computer processor, the directional antenna and the transceiver to measure a short-term average of the second noise power level of the second communication channel at the second elevation and the second azimuth;

calculating, with the computer processor, the first reverse-link noise estimate using the short-term average of the first noise power level of the first communication channel; and

calculating, with the computer processor, the second reverse-link noise estimate using the short-term average of the second noise power level of the second communication channel.

10. (Previously presented) The method of claim 7, further comprising:
commanding, with the computer processor, the directional antenna and the transceiver to measure a long-term average of the first noise power level of the first communication channel at the first elevation and the first azimuth;

commanding, with the computer processor, the directional antenna and the transceiver to measure a long-term average of the second noise power level of the second communication channel at the second elevation and the second azimuth;

calculating, with the computer processor, the first reverse-link noise estimate using the long-term average of the first noise power level of the first communication channel; and

calculating, with the computer processor, the second reverse-link noise estimate using the long-term average of the second noise power level of the second communication channel.

11. (Previously presented) The method of claim 7, further comprising commanding, with the computer processor, the ground station to transmit the reverse-link noise matrix to a ground station controller, the ground station controller disposed on the ground and in communicative connection with the plurality of ground stations.

12. (Previously presented) The method of claim 7, further commanding, with the computer processor, the directional antenna and the transceiver to measure a third noise power level of a third communication channel at a third elevation and a third azimuth from the current position of the ground station, the third communication channel configured to support transmissions between the ground station and the airborne aircraft;

calculating, with the computer processor, a third reverse-link noise estimate using the third noise power level of the third communication channel; and

calculating, with the computer processor, the reverse-link noise matrix using the first reverse-link noise estimate, the second reverse-link noise estimate, and the third reverse-link noise matrix.

13. (Currently amended) A computer system comprising one or more processors and/or transceivers configured to:

retrieve at least one of:

(i) a forward-link user capacity matrix comprising a plurality of forward-link user capacity estimates each associated with a respective signal-to-noise ratio measurement of a respective communication channel corresponding to a respective location on the ground; or

(ii) a return-link user capacity matrix comprising a plurality of ~~reverse~~return-link user capacity estimates each associated with a respective noise power level of a respective communication channel corresponding to a respective azimuth and elevation from a current location of an airborne aircraft;

determine, using at least one of (i) the forward-link user capacity matrix or (ii) the ~~reverse~~return-link user capacity matrix, a candidate serving cell that is disposed on the ground; and

command a directional antenna and a particular transceiver to transmit or receive data between the airborne aircraft and the candidate serving cell.

14. (Previously presented) The system of claim 13, wherein the one or more processors and/or transceivers are configured to

retrieve the at least one of (i) the forward-link user capacity matrix or (ii) the return-link user capacity matrix from an air-to-ground network controller disposed on the ground and in

communicative with a plurality of serving cells, the plurality of serving cells including the candidate serving cell.

15. (Previously presented) The system of claim 13, wherein the candidate serving cell comprises a respective noise power level above a threshold.

16. (Previously presented) The system of claim 13, wherein the one or more processors and/or transceivers are further configured to transmit the at least one of (i) the forward-link user capacity matrix or (ii) the return-link user capacity matrix using an out-of-band channel.

17. (Previously presented) The system of claim 13, wherein the forward-link user capacity matrix indicates a lower signal-to-noise ratio associated with the candidate serving cell than an alternative serving cell, and wherein the alternative serving cell is located at a distance from the airborne aircraft that is greater than a distance from the airborne aircraft of the candidate serving cell.

18. (Currently amended) The system of claim 13, wherein the ~~reverse~~return-link user capacity matrix indicates a higher noise power level associated with the candidate serving cell than a ~~[[power]]~~ noise power level associated with an alternative serving cell, and wherein the alternative serving cell is located at a distance from the airborne aircraft that is greater than a distance from the airborne aircraft of the candidate serving cell.

19. (Canceled)

20. (Previously presented) The system of claim 15, wherein the threshold comprises at least one of:

a short-term noise threshold that enables a serving cell selection decision among a plurality of serving cells; or

a long-term noise threshold that enables a future serving cell restriction decision.

REMARKS

Dependent claim 18 is amended to correct a reversal of words from “power noise level” to “noise power level.” Claims 13 and 18 are amended to correct antecedent basis, and support for which may be found, for example, in the specification at [0018]-[0020] and [0066]-[0073]. As such, no new matter is added by this amendment.

If it is determined that a telephone conference would expedite the prosecution of this application, the Examiner is invited to telephone the undersigned at the number given below.

In the event the U.S. Patent and Trademark Office determines that an extension is required, Applicant petitions for any required relief including extensions of time and authorizes the Commissioner to charge the cost of such petitions and/or other fees due in connection with the filing of this document to Deposit Account No. 13-2855 referencing docket no. 32045/50990/US.

Applicant believes no fee is due with this response. However, if a fee is due, please charge our Deposit Account No. 13-2855, under Order No. 32045/50990 from which the undersigned is authorized to draw.

Dated: January 11, 2018

Respectfully submitted,

By: /Lilian Y. Ficht #64,514/
Lilian Y. Ficht
Registration No.: 64,514
MARSHALL, GERSTEIN & BORUN LLP
233 S. Wacker Drive
6300 Willis Tower
Chicago, Illinois 60606-6357
(312) 474-6300
Patent Agent for Applicant

Electronic Acknowledgement Receipt

EFS ID:	31476031
Application Number:	15352255
International Application Number:	
Confirmation Number:	7058
Title of Invention:	Servicing Cell Selection in Air to Ground Communication Systems
First Named Inventor/Applicant Name:	Heinz A. Miranda
Customer Number:	4743
Filer:	Lilian Y. Ficht/Yvonne Hernandez
Filer Authorized By:	Lilian Y. Ficht
Attorney Docket Number:	32045/50990
Receipt Date:	11-JAN-2018
Filing Date:	15-NOV-2016
Time Stamp:	15:40:18
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		Amendment_After_Allowance _Under_37CFR1.PDF	48951	yes	8
			e379a9065cfebbba1725c9a4e0682ad39855 d17af		

IPR2025-00672

	Multipart Description/PDF files in .zip description		
	Document Description	Start	End
	Amendment after Notice of Allowance (Rule 312)	1	1
	Claims	2	7
	Applicant Arguments/Remarks Made in an Amendment	8	8
Warnings:			
Information:			
Total Files Size (in bytes):		48951	
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I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with 37 CFR § 1.6(a)(4).

Dated: January 11, 2018

Signature: /Lilian Y. Ficht #64,514/
(Lilian Y. Ficht)

Docket No.: 32045/50990
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Heinz A. Miranda et al.

Allowed: December 7, 2017

Application No.: 15/352,255

Confirmation No.: 7058

Filed: November 15, 2016

Art Unit: 2645

For: Servicing Cell Selection in Air to Ground
Communication Systems

Examiner: N. T. Huynh

AMENDMENT AFTER ALLOWANCE UNDER 37 C.F.R. § 1.312

MS Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

INTRODUCTORY COMMENTS

Prior to issuance of the patent, Applicant respectfully requests entry of this amendment under 37 C.F.R. 1.312 for the above-captioned patent application.

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper.

Remarks/Arguments begin on page 8 of this paper.

PART B—FEE(S) TRANSMITTAL

Complete and send this form, together with the applicable fee(s), to: **Mail**

**Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22314-1450
(571)-273-2885**

or **Fax**

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note Use Block 1 for any change of address)

MARSHALL, GERSTEIN & BORUN LLP
233 S. Wacker Drive
6300 Willis Tower
Chicago, Illinois 60606-6357

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

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I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, EFS-Web transmitted, or facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's Name)
(S-signature)
(Date)

APPLICATION NO	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO	CONFIRMATION NO
15/352,255	11/15/2016	Heinz A. Miranda	32045/50990	7058

TITLE OF INVENTION: Servicing Cell Selection in Air to Ground Communication Systems

APPLN: TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$960.00			\$960.00	03/07/2018

EXAMINER	ART UNIT	CLASS-SUBCLASS
N. T. Huynh	2645	

1. Change of correspondence address or indication of "Fee Address" (37CFR 1.363).
- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
- (1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
- (2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered attorney or agent. If no name is listed, no name will be printed
1. MARSHALL, GERSTEIN & BORUN LLP
2. Randall G. Rueth
- 3.

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

1a. NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

GOGO LLC

Chicago, Illinois

Please check the appropriate assignee categories (will not be printed on the patent):

☐ Individual ☒ Corporation or other private group entity ☐ Government

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- ☒ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies

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5. Change of Entity Status (from status indicated above)

- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
- ☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature

/Randall G. Rueth, Reg. No.: 45,887/

Date March 2, 2018

Typed or printed name

Randall G. Rueth

Registration No.

45,887

Electronic Patent Application Fee Transmittal

Application Number:	15352255			
Filing Date:	15-Nov-2016			
Title of Invention:	Servicing Cell Selection in Air to Ground Communication Systems			
First Named Inventor/Applicant Name:	Heinz A. Miranda			
Filer:	Randall George Rueth/Yvonne Hernandez			
Attorney Docket Number:	32045/50990			
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	960	960

IPR2025-00672

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				960

Electronic Acknowledgement Receipt

EFS ID:	31945529
Application Number:	15352255
International Application Number:	
Confirmation Number:	7058
Title of Invention:	Servicing Cell Selection in Air to Ground Communication Systems
First Named Inventor/Applicant Name:	Heinz A. Miranda
Customer Number:	4743
Filer:	Randall George Rueth/Yvonne Hernandez
Filer Authorized By:	Randall George Rueth
Attorney Docket Number:	32045/50990
Receipt Date:	02-MAR-2018
Filing Date:	15-NOV-2016
Time Stamp:	15:29:25
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$960
RAM confirmation Number	030518INTEFSW15312900
Deposit Account	132855
Authorized User	Yvonne Hernandez

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37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	Issue_Fee_Transmittal.PDF	33018	no	1
			a94aab3d209fc92ca d67cec9fe05b7a1f56t b11		
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30301	no	2
			aa429ffef22bba8d826468d33f018fc7816e2 b14		
Warnings:					
Information:					
Total Files Size (in bytes):			63319		
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/352,255	11/15/2016	Heinz A. Miranda	32045/50990

CONFIRMATION NO. 7058

PUBLICATION NOTICE



OC000000098228760

4743
MARSHALL, GERSTEIN & BORUN LLP
233 SOUTH WACKER DRIVE
6300 WILLIS TOWER
CHICAGO, IL 60606-6357

Title: Servicing Cell Selection in Air to Ground Communication Systems

Publication No. US-2018-0083692-A1

Publication Date: 03/22/2018

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently <http://www.uspto.gov/patft/>.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

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Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101



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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/352,255	04/24/2018	9954600	32045/50990	7058

4743

7590

04/04/2018

MARSHALL, GERSTEIN & BORUN LLP
233 SOUTH WACKER DRIVE
6300 WILLIS TOWER
CHICAGO, IL 60606-6357

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

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APPLICANT(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional applicants):

Heinz A. Miranda, Cary, IL;
GOGO LLC, Chicago, IL;
Michael H. Baker, Elmhurst, IL;
James P. Michels, Lake Zurich, IL;
Yong Liu, Schaumburg, IL;

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