Frequency Finder

A program for managing, assessing compatibility and presenting on a map frequency assignments for aeronautical communication and navigation systems

1.   Introduction

1.1   ICAO is developing the program Frequency Finder that offers a tool to assist ICAO Regional Offices and States to manage and coordinate aeronautical frequency assignments. This program combines the data base management functions for updating the ICAO COM lists, calculation of interference areas and a geographical interface for plotting of the frequency assignments, including any interference area, on a map (currently with Google Earth only). The graphical interface can be used to overlay frequency assignments on certain geographical areas such as ACC or FIR sectors, with air-routes and combined with other ICAO databases that are being developed.

1.2   The program has initially been developed to provide support to Regional offices that have a central role in the coordination of frequency assignment with focus on ICAO Regions outside Europe (and in North America: USA and Canada). The program is currently being modified to accommodate frequency assignment planning in Europe as well (in particular the use of 8.33 kHz frequency assignments).

1.3   Frequency Finder is built along different modules:

- VHF air/ground communications (DSB-AM, VDL Mode 2 and VDL Mode 4)
- VHF navigation (ILS, VOR, GBAS, VDL Mode 4)
- NDB
- HF air/ground communication
- SSR Mode S II code assignments

In addition, Frequency Finder has included applications that will allow for the plotting of FIR sectors and air-routes. Plotting of ACC sectors (as used in Europe) is in preparation.

1.4   The program is using FileMaker Pro (version 12) for data base management, calculation of interference contours, assessing compatibility between frequency assignments and for generating the files necessary to plot the frequency use and interference areas on a map (with Google Earth). The program is available in a full version (that requires the user to have FileMaker Pro installed on the local computer) and in a runtime version (which does not require FileMaker Pro).

1.5   The modules for NDB and HF frequency assignment planning are still to be developed. The module for the coordination of SSR Mode S Interrogator Identifier codes (only for using the codes 0 – 15) has been completed. The planning criteria for the coordination of these Mode S II codes have been reviewed by the Aeronautical Surveillance Panel this module will be incorporated in Frequency Finder shortly. The module for VHF navigation systems (ILS, VOR and DME has been completed using the [limited] frequency assignment planning criteria for these systems that are applied in the ICAO Regions outside Europe. This module is being modified to incorporate the planning criteria for ILS, VOR and DME as per Annex 10 (which are in line with those used in the EUR Region. The module for VHF air/ground communication planning has been completed, using both the current limited Regional frequency assignment planning criteria as well as those that comply with the provisions of Annex 10. The planning criteria for VHF air/ground communication systems are further described in detail in the ICAO *Handbook on radio frequency spectrum requirements for civil aviation, Volume II* (Doc. 9718).

1.5   Frequency Finder has been used to generate the ICAO global frequency assignment plans and has concatenated and harmonized the different ICAO Regional COM lists into a single data base, including a single format for the frequency assignments. This global frequency assignment plan is intended to facilitate interregional coordination of frequency assignment as well as to be used as part of the global eANP. The global frequency assignment plan will also be used to seek registration of frequency assignments that have been coordinated through ICAO with the International Telecommunication Union (ITU) in the ITU Master International Frequency Register (MIFR).

2.   Using Frequency Finder.

2.1   The module for VHF air/ground communications is completed. Frequency Finder includes the global database of frequency assignments for VHF air/ground communications and VHF Navaids (including DME).

Note: Frequency Finder currently includes for the VHF Navaids the frequency assignment planning criteria that are applied in Regions outside Europe. Working Group F of the Aeronautical Communications Panel is involved in developing harmonized criteria that should be applied on a global basis.

2.2   Management of the database is provided by typical data base functions such as:

- Querying the database – the database can be queried using specific parameters (Region, Country, Location, Frequency, Service or FIR (ACC) sector. The user can also manually select frequency assignments.
- Entering new frequency assignments – entering new frequency assignments can be done through a special window in the program
- Modifying existing frequency assignment - modifying an existing frequency can be done through a special window in the program
  Note: new frequency assignments or modifications to an existing frequency assignment can immediately be tested for compatibility with other frequency assignments; these frequency assignments can be saved as a "draft" or "temporary" assignment

- Exporting the data base (as FileMaker Pro, Excel or PDF file) in the format of the ICAO COM list

A screenshot of the (global) database is in Figure 1

Figure 1 – Screenshot of the (global) data base.

2.3   Mapping of frequency assignments.

The Designated Operational Coverage of frequency assignments can be plotted on a map, using Google Earth. The user can plot the DOC of a single frequency assignment or a selection (as result of a query) of frequency assignments. In case the frequency is linked to either an FIR sector (or for Europe an ACC sector) the plotted coverage is limited to the boundaries of the relevant sector.

Examples for plotting the coverage on a map are in Figure 2 and Figure 3.

Figure 2 – Designated operational coverage limited to the boundaries of the FIR Commodore Rivadavia in Argentina; (FIR-U on 118.100 MHz)

Figure 3 – Overview of all frequency assignments on the frequency 118.200 MHz in the SAM Region

2.4 Testing existing frequency assignments

2.4.1 Frequency Finder can test existing frequency assignments as well as (proposed) modifications or new frequency assignments. Frequency Finder tests compatibility of the selected frequency with all co-frequency and adjacent frequency assignments in a circle with a radius of 1020 NM. Frequency Finder calculates the minimum distance required between the stations as well as the actual distance and identifies if the frequency assignment planning criteria (minimum separation distances) are met.

2.4.2 The results of each of the co- and adjacent channel calculations can be examined. Figure 4 shows the co-frequency calculation details that are presented.
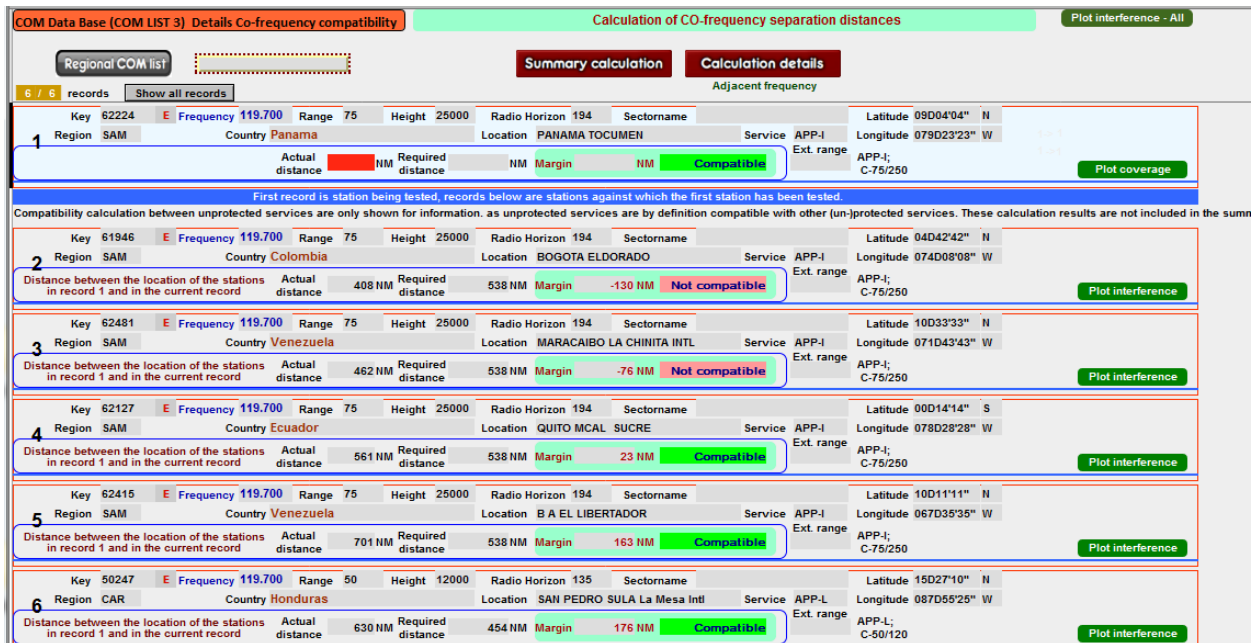
Figure 4 – Screenshot co-frequency calculation details

2.4.3 The calculation details shown in Figure 4 include all potential incompatibilities for station Tocumen in Panama (APP-I on 119.700 MHz). The areas where the frequency assignment planning criteria are not met (Nos. 2 and 3 in Figure 4) are identified as "not compatible" and can be plotted on a map with Google Earth. This window also identifies it the interference is air-to-air only or if also the desired ground station is interfered (i.e. can communicate with the undesired aircraft).

2.4.4 Figure 5 shows the coverage and the interference contours for Tocumen / Panama and the (interfering) stations in Columbia and Venezuela.

Figure 5 – Interference contours between Tocumen (Panama) and stations in Columbia and Venezuela

2.4.5　　　Figure 5 shows the frequency assignment that is being tested (Tocumen in Panama, Ghana; blue circle) and the interferers (Bogota Eldorado in Columbia and Maracaibo in Venezuela; orange circles). The white segments show the interfered area (at 45000ft. altitude above MSL).

2.4.6　　　The parameters for the tests are saved in the window "Summary Calculations" as shown in Figure 6. Tests can be re-evaluated later with the button "Redo calculations", taking into account any changes that have been made to the data base of frequency assignments at a later point in time.

Figure 6 – Summary of compatibility calculations.

2.5　　　　　　New frequency or modified frequency assignments.

2.5.1　　　　　In a special window "New/mod frequency", the user can modify an existing frequency assignment or introduce a new frequency assignment

2.5.2　　　　　Figure 7 shows the box used to enter modifications to an existing frequency assignment (in case a new frequency assignment is to be entered, this box is empty). After the parameters to be modified (or, for a new frequency assignment, the necessary details) are entered, the modified frequency assignment can be tested with regard to compatibility with the frequency assignment plan. The user will be informed if the modifications are compatible.

2.5.3　　　　　This box allows for insertion of the uniform designated operational coverage (DOC) of services as well as for tailoring the DOC to specific requirements.

2.5.4　　　　　After all details for a new or modified frequency assignment have been entered and tested the user can decide to keep the modified (or new) frequency assignment in the data base as a draft entry and start coordination with ICAO and/or States. Keeping the draft entry in the data base is necessary to secure that later modifications to the frequency assignment plan take into account the modified (or new) frequency assignment. Alternatively, the user can turn the "draft" frequency assignment into a permanent frequency assignment in the data base.

Figure 7 – Box for entering modifications to an existing frequency assignment.

2.6   Search for a new (or alternative) frequency.

2.6.1   Frequency Finder offers the user the option to search for either an alternative frequency (in case the frequency of an existing frequency assignment should be changed) or for a new frequency in case a new frequency assignment is to be added to the data base. Figure 8 shows the box that is to be used in this case.

2.6.1.1   In this box the user can select the frequency range within which the search for an alternative (or new) frequency assignment should take place or select from the allotment table which has been established by each Region.

2.6.2.2   The user can select the number (from 1 – 10) of alternative frequencies that Frequency Finder should attempt to find. After the search is completed, Frequency Finder shows the number of compatible frequencies from which the user can select. The margin (distance) to the nearest co-frequency (or adjacent frequency) assignment is also shown. For efficient frequency assignment planning, the user should select the frequency with the smallest margin (*** indicates that within the circle with a radius of 1020 NM around the station that is being tested no co-frequency (or adjacent frequency) assignments are recorded in the frequency assignment plan).

Figure 8 – Box in Frequency Finder to search for a new frequency assignment

2.7   Extended range stations

2.7.1   Station operating in an extended range configuration can be identified by entering in the database a name for the "family" of extended range stations as shown in Figure 8.

Key	Region	Frequency	Country	Ctry	Location	Latitude	Longitude	Service	DOC	FIR Sector	PolyID	Extended Range	Cat	Stat	Cond	R
60106	SAM	118.100	Argentina	ARG	CLORINDA	25D18'18" S	057D44'44" W	FIS-U	A-260/450			ER-ARG-1	NAT			
60160	SAM	118.100	Argentina	ARG	CURUZU CUATIA	29D46'46" S	057D59'59" W	FIS-U	A-260/450			ER-ARG-1	NAT			Re
60176	SAM	118.100	Argentina	ARG	EL DORADO	34D39'39" S	061D35'35" W	FIS-U	A-260/450			ER-ARG-1	NAT			Pri
60181	SAM	118.100	Argentina	ARG	EL TURBIO	51D37'37" S	072D13'13" W	FIS-U	A-260/450			ER-ARG-1	NAT			Re
60194	SAM	118.100	Argentina	ARG	GOB GORDILLO Chamical	30D20'20" S	066D18'18" W	FIS-U	A-260/450			ER-ARG-1	NAT			Ca
60196	SAM	118.100	Argentina	ARG	GOB GORDILLO Chamical	30D20'20" S	066D18'18" W	FIS-U	A-260/450			ER-ARG-1	NAT			
60197	SAM	118.100	Argentina	ARG	GOB GREGORES	48D47'47" S	070D10'10" W	FIS-U	A-260/450			ER-ARG-1	NAT			

Figure 9 – Identification of stations operating in an extended range configuration

These stations are not being tested for interference *between* each other. An example of the presentation of interference calculations involving extended range facilities is shown in Figure 10.
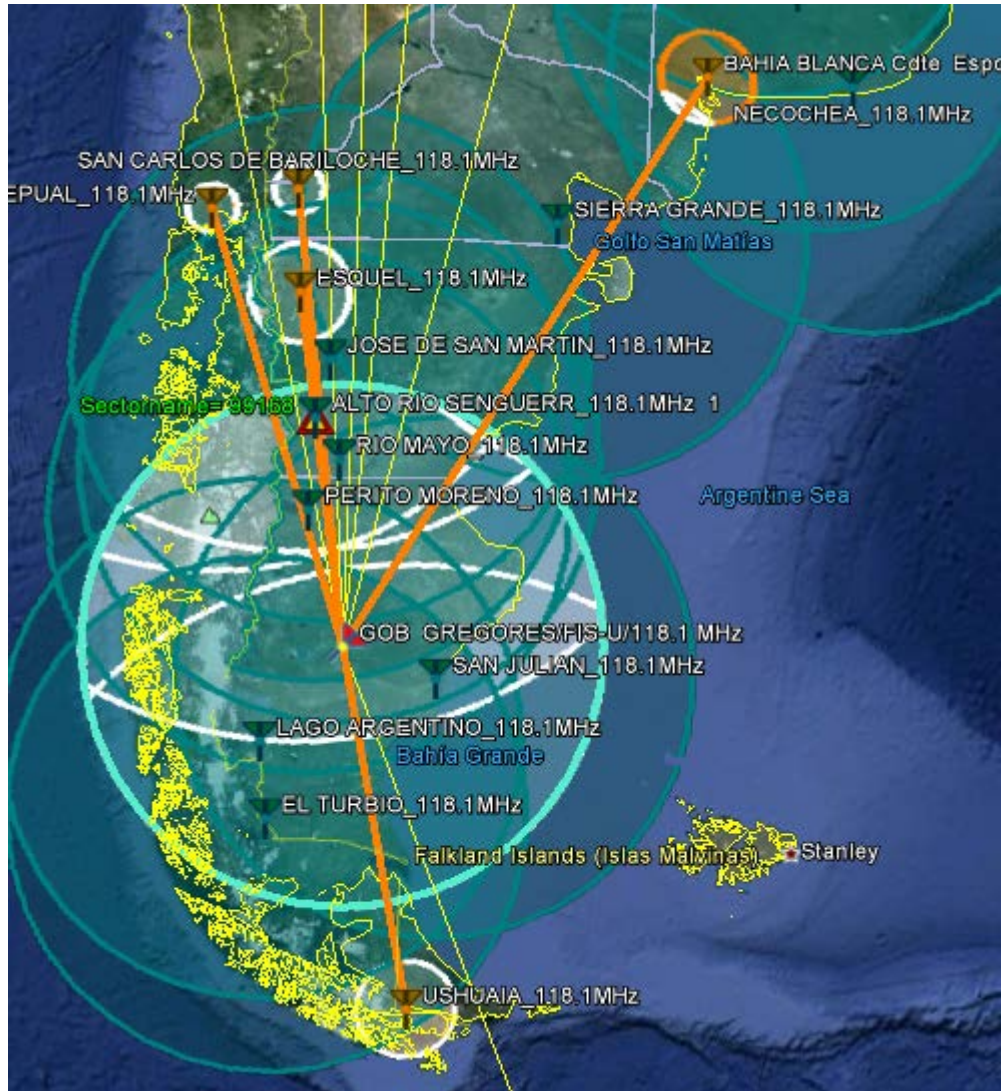

Figure 10 – Interference calculations involving extended range facilities.

In Figure 9 test results of the station Gob Gregores in Argentina are shown. Stations that are operating in an extended range configuration as identified in Figure 9 are not interfering with the station Gob Gregores and are plotted on the map with a dark green background. Other stations that operate on the same frequency but are not part of the extended range network are plotted and linked to the station Gob Gregores; an orange line indicates that interference is predicted. A yellow line indicates that no interference with the Station Gob Gregores is foreseen (but these stations may interfere with other stations in the extended range network.

2.8   Area services

2.8.1   Frequency Finder offers the option to plot the coverage of area services. In this case the overage is limited to the size of the area service (ACC or FIR). Calculation of interference considers the protection of the whole area. Figure 11 shows the actual coverage of the station Pucallpa in Peru (126.9 MHz) limited by the boundary of FIR Lima
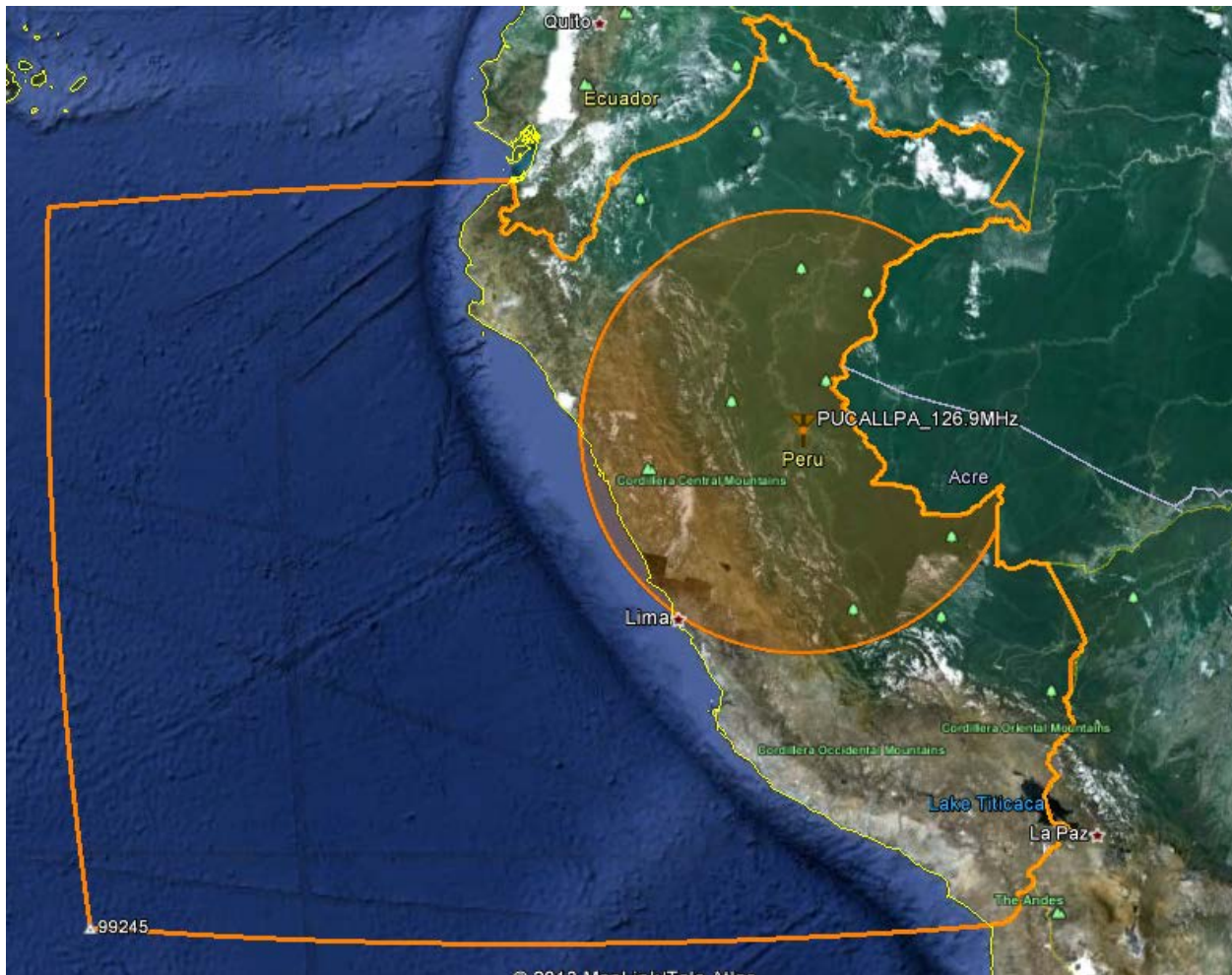

Figure 11 – Actual coverage of Pucallpa limited by the boundaries of FIR Lima

Figure 12 (below) shows the interference from station Salinas Gen Ulpiano Paez in Ecuador into the FIR Lima. The interfered area in FIR Lima is much bigger than the promulgated coverage of station Pucallpa.

One (or more) frequency assignments can be affiliated to an FIR sector. For this purpose, the Coordinates of all FIR sectors have been incorporated in Frequency Finder. These coordinates are from the ICAO program ICAOFIR13 and need to be updated from time to time. A mechanism to easily import this data is available.

For the EUR Region, the protection of area services also includes ACC sectors. This can be incorporated in Frequency Finder in case the geographical data for the ACC sectors is available.
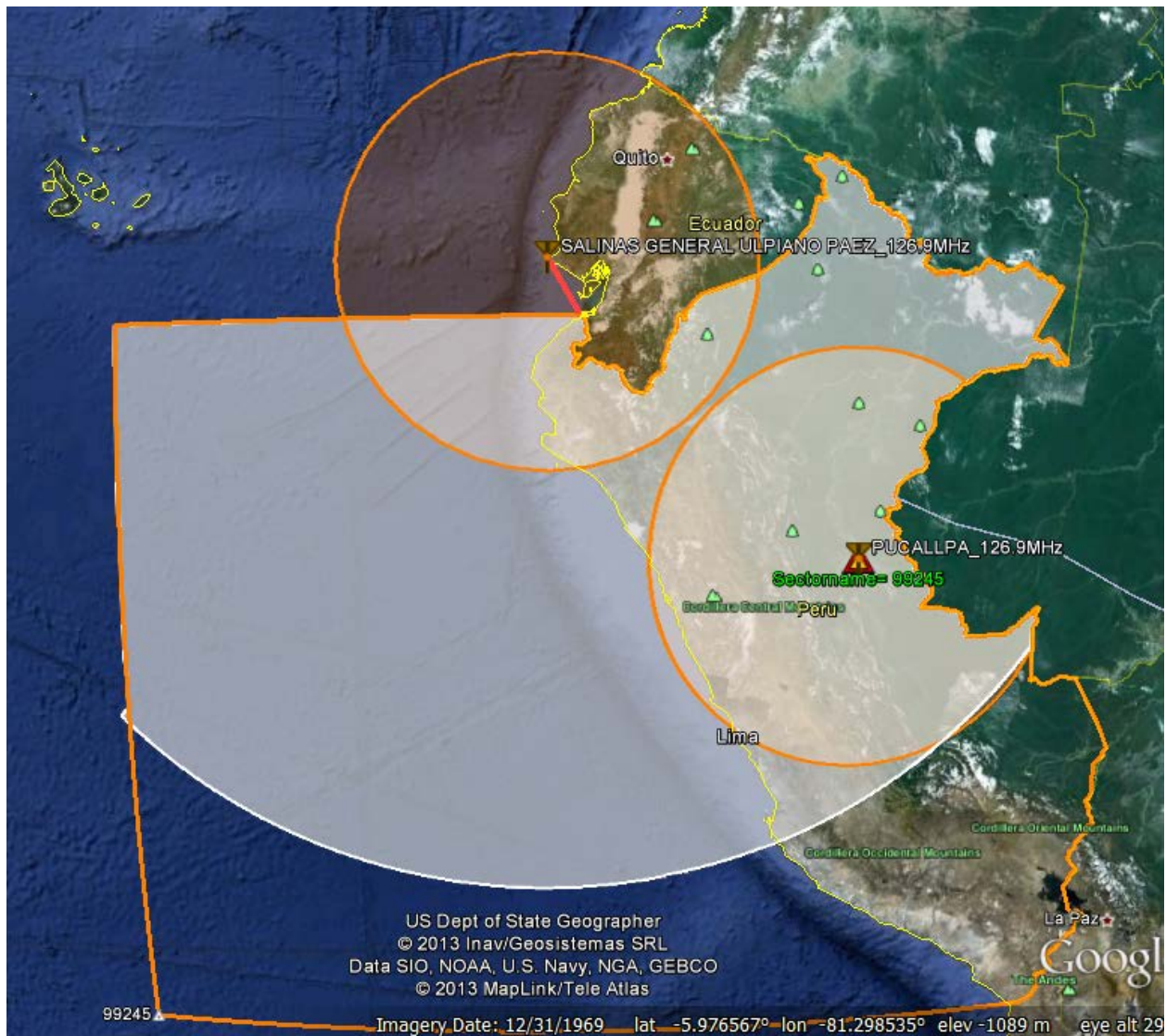

Figure 12 – Area of interference caused by station Salinas in Ecuador.

3.   **Use of Frequency Finder**

3.1   In its final format, Frequency Finder is intended to provide a tool for use by ICAO Regional Offices and ICAO Contracting States for the management and coordination of frequency assignments and to generate the ICAO global frequency assignment plan. The configuration that is currently foreseen is as follows and summarized in Figure 13:

a) The program resides on the local computer used by States and Regional offices
b) The global data base of frequency assignments resides on the ICAO website (HQ)
c) The global database can be downloaded from the ICAO website and imported in the local version of Frequency Finder to enable the user access to the most current version of the global database.
d) States and Regional Offices can use the global database to assess compatibility between current frequency assignments and with new or modified frequency assignments.
e) The local data base can be updated (either manually or automatically) with the current version of the global database.
f) **Only Regional Offices** can update the global database with modification to the database.

Note 1: the European database of frequency assignments, which is developed using different programs, will be imported in the ICAO global data base (and in the format of the global ICAO database) at regular intervals. Such updates can be effected automatically or through manual intervention.
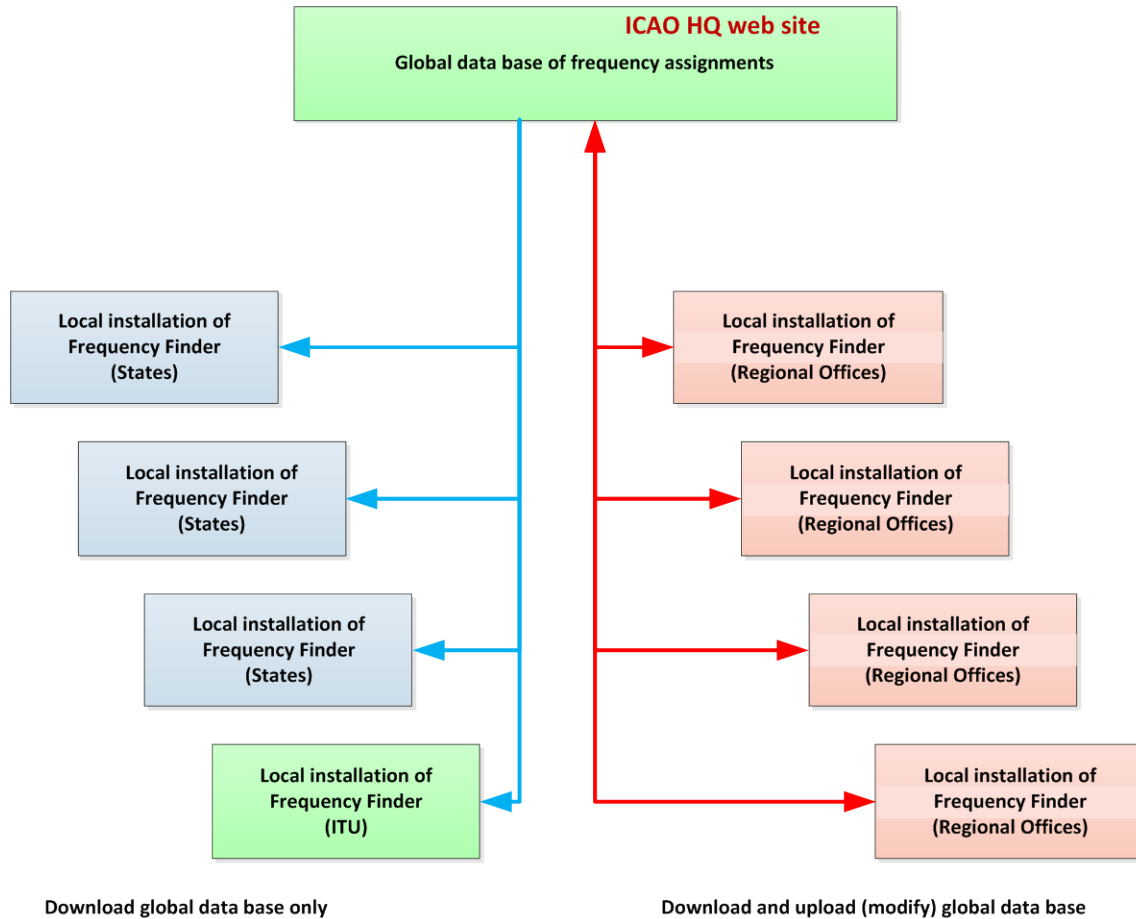
Figure 13 – Configuration for using Frequency Finder

Note 2: The above configuration is currently being developed.

4.   Further developments

4.1   VHF Air/Ground communication

4.1.1   Apart from modifications that may improving the user friendliness of Frequency Finder or removing bugs, further work concentrates on introducing the following functionality:

- Frequency planning for 8.33 kHz channel spacing (primarily for use in Europe)
- Identification of errors in current data base (all Regions)

4.1.2   Further work on the calculation of buffer zones for areas services (and for VOR/DME keyhole coverage areas) as well as introducing the use of terrain data to better visualize on the map the coverage of the VHF stations is necessary but cannot be completed with additional resources being available.

4.2   VHF Navigation systems

4.2.1   Frequency Finder currently includes the global data base of frequency assignments for VHF navigation systems (ILS, VOR, DME, GBAS). Frequency assignment planning is based on the planning criteria that are being used in the Regional Offices outside Europe.

4.2.2   In conjunction with developing for the ICAO *Handbook on radio frequency spectrum requirements for civil aviation (Volume II)* frequency assignment planning criteria for ILS, VOR, GBAS and VDL Mode 4 (in the frequency band 108 – 117.975 MHz), Frequency Finder is being updated to include these planning criteria. The use of Frequency Finder for frequency planning for VHF navigation systems will be aligned with the functions that have been introduced for the module for VHF air/ground communication systems.

4.3   LF/MF beacons and aeronautical HF bands

4.3.1   Initially, only the global data base for both LF/MF beacons (NDB and locator) as well as for HF air/ground communication frequencies will be introduced. At a later stage Frequency Finder will be updated with material that would enable using Frequency Finder for frequency assignment planning.

4.4   SSR Mode S Interrogator Identifier codes (SSR Mode S II codes)

4.4.1   Subject to agreement in the Aeronautical Surveillance Panel on planning criteria for SSR Mode S II codes, the module for that would enable Regions to coordinate and assign SSR Mode S II codes will be introduced in Frequency Finder.

4.5   eANP (electronic ANP) GIS Web Server mapping solution

4.5.1   Data from the frequency assignment plans that can be presented on maps is planned to be integrated in the development of the eANP GIS web server mapping solutions which are currently being developed in ICAO. Examples are the presentation of air routes (currently a provisional application for plotting on a map air routes has been inserted in Frequency Finder) and other data from the ICAO Regional Plans.

5. Coordination with the ITU (updating the Master International Frequency List)

5.1   ICAO is considering, at the request of the ITU, to align the ITU Master International Frequency Register (MIFR) with the ICAO global data base of frequency assignments. The Program Frequency Finder has been modified with the cooperation of the ITU and now includes a method to generate the necessary T12 and T13 notices that can be submitted to the ITU