DON'T GET MIXED SIGNALS

Performance analysis of CNS Systems along flight procedures

Carolina Ajates, telecommunication engineer and Javier San Juan, aeronautical engineer at Ineco

At present, both air traffic controllers and pilots need to receive and transmit accurate and reliable information to operate safely. To this end, Communication, Navigation and Surveillance Systems are used. These systems operate by transmitting and receiving modulated signals that travel in a direct path from the transmitter to the receiver (line-of-sight propagation). These signals provide the position of the aircraft and enables the air traffic controllers to guide them safely and efficiently to their destinations. The information provided by these systems is, therefore, essential to design flight procedures, which determine different manoeuvres with specified protection from obstacles in the environment and ensuring safe separations between aircrafts.

However, the presence of obstacles in the vicinity of these CNS systems may cause either constructive or destructive interference, amplifying or attenuating the transmitted signal power or distorting or corrupting the information it contained. In this regard, the important urban growth that areas surrounding airports have experienced in the past few decades have resulted in obstacles sprouting up close to the nearby air navigation systems. Due to this, the increase of the undesirable effects mentioned before seems to be a trend that will continue in the future.

Radioelectric impact studies analyse the distortion a transmitted signal may experience due to the presence of multiple obstacles encountered during its propagation before reaching the receiver. Nowadays this kind of analysis is of paramount importance, as it enables to clearly identify which obstacles are incompatible with the proper performance and operation of CNS systems, ensuring take-offs, en route operations and landings can be performed under proper and safe conditions.

Ineco is a company with an extensive experience in the field of CNS radioelectric impact studies, with over 3,000 different projects carried out for both domestic and international clients.

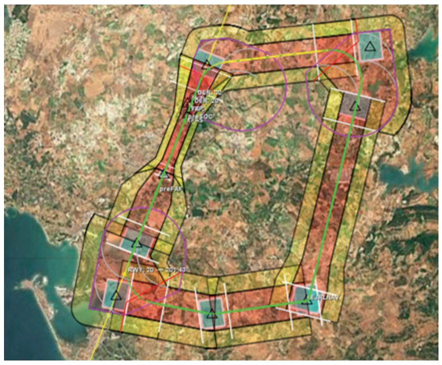


Figure 1: Importation of flight procedures from EOS (Navtools)

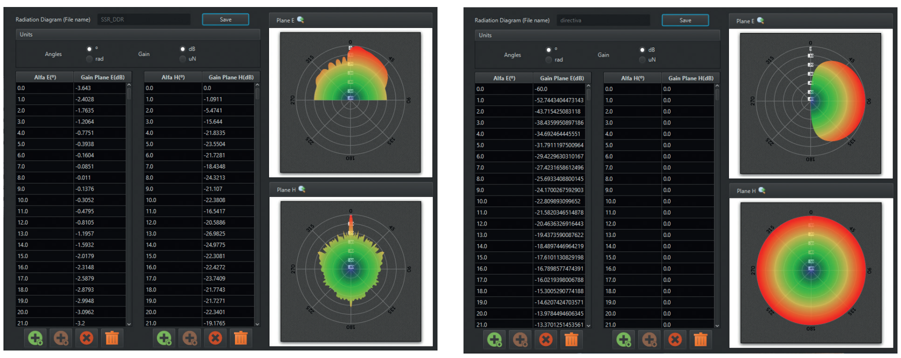


Figure 2: Implementation of radiation patterns for a SSR station (left) and for a directional DME station (right) (Navtools)

This is the context wherein the motivation for this internal R&D project arose. We identified in our staff a need for a software tool that would allow them to quantify, as faithfully as possible, the impact of both the terrain and the obstacles on the performances of CNS systems. These analyses enable not only to consider key factors when designing flight procedures, such as coverage, but also to determine whether the quality of the transmitted signals meet the requirements established by the international regulations regarding CNS systems.

Several years ago, as a first approach to this problem, Ineco developed IMPULSE (currently integrated into NAVtools Suite). This initial software tool allowed to perform qualitative analyses to evaluate the impact of new obstacles (for example, buildings) on pulsed signal systems (DMEs, Primary Surveillance Radars and Secondary Surveillance Systems).

However, thanks to the new R&D project developed in 2020, now a major step forward has been taken in NAVtools. The initial qualitative analyses have been replaced by accurate quantitative studies, where the actual transmitted and received signals are modelled both for airborne equipment and ground systems. From this moment on more precise studies can be conducted by taking into account the actual radiation patterns, simulating the modulation and demodulation of the signals and considering the multipath interferences caused by the terrain and obstacles. Furthermore, in the case of DME facilities, additional features have been incorporated in order to calculate the error in the distance measurement, power losses or possible reply – track losses

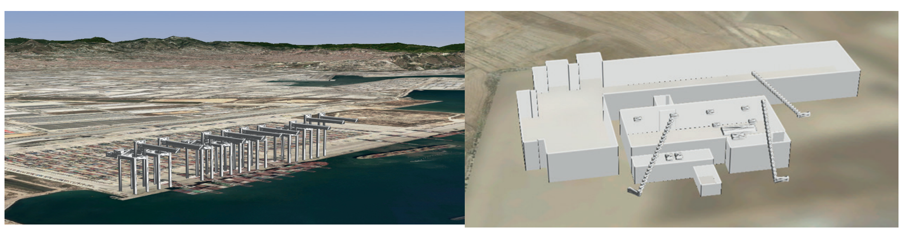
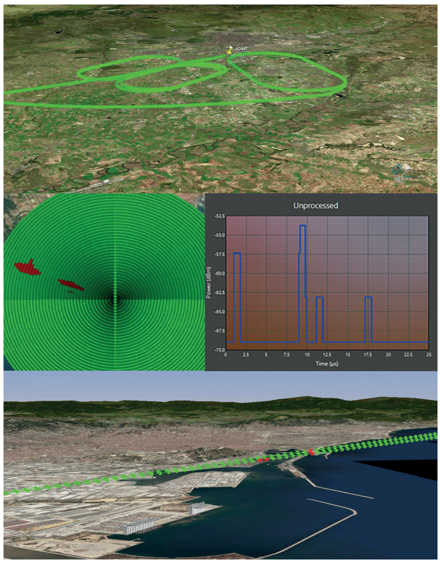


Figure 3: Example of obstacle modelling: cranes for containers in port of Barcelona (left) and new buildings and cranes (right)

(due to very low signal levels or strong multipath effects). These new features allow our staff to address problems with complex scenarios that so far could not be undertaken in an analytical way and were solved either qualitatively or using the experienced judgement of our experts. Besides, having such as powerful software tool marks a difference with respect to other companies in the sector, positioning Ineco as one of the leading corporations when conducting radioelectric impact studies or designing flight procedures.

Moreover, in order to have a better connection between procedures and radioelectric impact analyses, new functionalities have been also implemented in NAVtools to import new procedures, while they are still in the design phase, directly from EOS (Software tool developed by Ineco). Likewise, it is also possible to load current published flight procedures by means of an additional API which can connect with the database of the related Air Navigation Service Providers (ANSPs), provided that access is granted. Other useful information can be imported too, such as traffic sectors or facilities. All these automatizations greatly reduce the required study times, the expert's workload and the likelihood of human errors, avoiding the manual introduction of data.

In summary, this project has linked radioelectric impact studies and flight procedures. In this way, it is possible to protect current procedures (published by the ANSPs), preventing adverse effects on CNS facilities signals. Similarly, it is possible to facilitate the designing of future procedures using EOS, across areas where the optimal performance of CNS systems is ensured (including GNSS performances). ❖



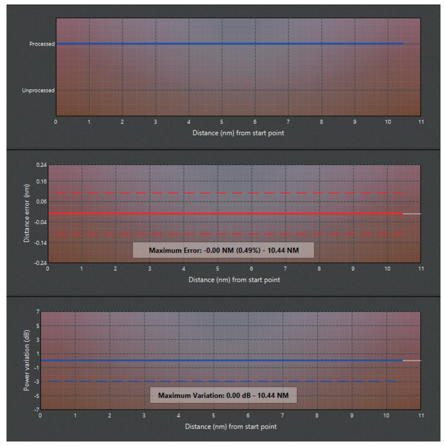


Figure 4: Example of radioelectric impact analyses on SSR stations (Navtools)

Figure 5: DME signal processing, distance error and power variation along a flight procedure (Navtools)