Remote Maintenance for Flight Inspection Mission

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BIOGRAPHY

Captain Sérgio Corrêa: began his career in the Brazilian Air Force in 1989, when he became an electronic specialist after studying for two years. His experience in air traffic equipment began in 1991 on Santa Cruz Air Base in Rio de Janeiro, where he was responsible for the maintenance of High Frequency - Single Side Band Transceivers (HF-SSB, Transworld), Very High Frequency Omnidirectional Range (VOR) and Very High Frequency Aeronautic Transceivers (VHF-COM). In 2000 he was transferred to Afonsos Air Force Base, also in Rio de Janeiro, where he studied Non-Directional Beacon (NDB) and Instrument Landing System (ILS) maintenance courses and, after that, he participated in the ILS-AF (Model MARK 20) installation. He graduated in information technology (IT) in 2005 at Estácio de Sá University and in 2006 graduated in aeronautical telecommunications at the Aeronautical Instruction Centre in Belo Horizonte, Minas Gerais. Since then, he has worked at GEIV, the Brazilian Air Force Special Group for Flight Inspection, where he is responsible for the maintenance of the avionics and flight inspection systems used in Brazil. He has managed the UNIFIS3000/Hawker 800 XP aircraft project. He is also the adviser to the project technical manager for the EMBRAER Legacy 500 /UNIFIS 3000 equipped flight inspection aircraft program. Since 2010 he has been a Flight Inspection instructor.

ABSTRACT

Brazil has a territory larger than 8.5 million Km² with more than 900 aeronautical NAVAIDS. The Brazilian Department of Airspace Control (DECEA) - Brazilian Airspace Authority has searched for innovation that ensures the high safety level and reduces operational costs.
Essential to the necessary improvements are the Flight Inspection Special Group (GEIV), who are a part of DECEA, and responsible for flight inspection activities of NAVAIDS and air navigation procedures in Brazil. GEIV is developing a flight inspection method by remote maintenance. With appropriate software and installed data/communication networks, it is possible to keep the maintenance personnel operating the NAVAIDS configuration hundreds of kilometers from the site. This method will reduce the response time for maintenance actions in case of NAVAIDS failures and out of tolerance conditions, as well as high costs expended with staff displacement to sites that do not have permanent maintenance personnel, and promote the concentration of qualified technicians.

INTRODUCTION

Aviation technology has undergone constant changes aiming at the continuous improvement of the services provided to the air traffic users. We have seen the expansion of Communication Navigation Surveillance /Air Traffic Management (CNS/ATM) technologies in Brazil and the adaption of the air traffic management to these new demands, which have made air navigation increasingly agile and safer.
DECEA are responsible for the correct NAVAID functionality and the applicability and feasibility of navigation procedures, must be attentive to the technological development in the aeronautical context in order to constantly improve its services through application of new flight inspection methodologies to optimize the flight and guarantee the quality and reliability to this activity.[1]
In this context, DECEA has studied a methodology to mitigate the difficulties imposed by the large territorial extension under its responsibility. The use of the Remote Maintenance for Flight Inspection Mission aims to perform the whole routine of a periodic precision and non-precision NAVAIDS flight inspection, with the maintenance responsible located in a Supervision Control Center which by remote monitoring systems will have a view of operating status of the NAVAID and the possibility to

interact with the equipment, with the same resources and the situational awareness that he would have during a conventional flight inspection.
The use of this new methodology aims to eliminate logistical and technical problems that sometimes happen during a conventional flight inspection, such as the need to transport the maintenance responsible personal to the NAVAID. Therefore, the Remote Inspection could improve:

- Economy: Reducing expenses with travel and logistic costs;
- Quality of the technical intervention; During the NAVAID inspections, the actions will be made by technicians with greater expertise;
- Number of trained technicians: It will be necessary less technicians to support the same quantity of NAVAID.

To evaluate this new concept, DECEA ordered the GEIV to perform a proof of concept using the entire infrastructure already under DECEA administration. By that recommendation, GEIV planed two missions to test the remote maintenance for flight Inspection performance. First at Galeão airport, a structure close to flight inspection base, and then at Maceió airport, far from the flight inspection base.

OPERATIONAL SCENARIO

To ensure that Remote Maintenance for Flight Inspection can be performed transparently to the flight inspection aircraft crew, attention must be paid to all variables involved in this context, especially regarding communication with the maintenance team and the sending of commands for NAVAID adjustments.
For the communication, we must keep in mind that the interaction between the flight inspection crew and the maintenance team on ground should be constant, so the availability of this service is vital for the continuity of the inspection. Thus, when we envision the implementation of the Remote Maintenance for Flight Inspection, we must be sure that such methodology employs highly reliable communication systems.
Another factor that we should take care of the equipment status visualization and traffic rate sent to the NAVAID. For this activity, the network used must have Quality of Service (QoS) great enough to ensuring that the sent commands can be correctly delivered to the destination. Requirements such as low latency, noise immunity and high availability are essential for Remote Maintenance for Flight Inspection to occur properly and reliably.
Finally, thinking about economy and delimiting regions for better management, we intend to use the same NAVAID infrastructure existing today. In this way the maintenance responsible will interact with the NAVAIDS and flight inspection crew from the supervision control center installed in the integrated centers that will be best explained in this article. Each center will have control over the NAVAIDS within its management region.

AREAS AND RESPONSIBILITIES

To manage the entire infrastructure of Brazilian air navigation support, in 1972, the Brazilian Air Force started studies to implement the Air Defense and Air Traffic Control System, the result was the creation of the System Implementation Commission of Air Defense and Air Traffic Control.
In addition to technical and strategic responses to issues such as projections of the increasingly air traffic, alternatives were also sought that could handle resource limitations. The solution found was the integration of the same infrastructure to meet two needs: air defense and air traffic control. The integration of air traffic control and Brazilian air defense services was created.
In the early 1980s, the Integrated Centers for Air Defense and Air Traffic Control (CINDACTA) were created.
To fulfill its mission, the CINDACTA has subordinate organizations, the Airspace Control Detachment (DTCEA). In those organizations we found the resources, systems and equipment that support effective airspace control.

Technical and operational resources that can be found at DTCEA:

- Radio Detection and Ranging (RADAR) for air traffic control and/or Air Defense.
- Meteorology System – Meteorological Station connected to the National Center of Aeronautical Meteorology that elaborates weather forecasts for all Brazilian airspace.
- Telecommunications Systems – Networks using satellite communication techniques, microwave and HF, VHF, and UHF transceivers for operational and administrative communications needs.
- Air Navigation Aid System – composed by equipment as VOR, ILS, NDB, DME and PAPI installed along the routes, terminal areas and airports.

With the CINDACTA infrastructure operating, the Brazilian territory was divided in four large areas corresponding to the Flight Information Regions (FIR). After the division of Brazilian territory CINDACTA I became responsible for the FIR Brasília, CINDACTA II is responsible for the FIR Curitiba area, CINDACTA III is responsible for the FIR Recife area and CINDACTA IV is responsible for the FIR Amazônica area. A view of the areas and responsibilities can be seen in figure 1.

Figure 1 - Air traffic support infrastructure division

SUPERVISION CONTROL CENTER

In the Supervision Control Center (SCC) there will be data and communication infrastructure to provide remote access to the NAVAID. At the SCC, a specialist will be able to interact and make any adjustments requested by the flight inspection crew to the equipment under inspection.

Each Integrated Center should host a SCC to take care of its area since they have communication channels to the aid management; this makes the aircraft-maintenance communication feasible using existing resources. In addition, each Integrated Center has the most knowledge about the NAVAID under its care.[2]

In the Integrated Centers, there already exists an installed network connecting to almost every NAVAID infrastructure under its responsibility; more specifically they are located in their technical offices. Their equipment includes, among others, routers, gateways, MODEM's and, in specific locations, satellite links. All these systems are permanently monitored by local technicians, ensuring the correct operation and fast action in case of failures.

To carry out the Remote Inspection, the NAVAID must receive the necessary commands from the existing network and the inspection must happen transparently to the flight inspection crew.

In order to do this, the crew must be able to make adjustments as in a conventional periodic flight inspection, for which the aid must have a remote access interface by Internet Protocol (IP). Nowadays, only recently installed equipment in Brazil has this capability. This capability should be implemented for older equipment.

PROOF OF CONCEPT

To corroborate the proposed technical procedures for the use of the remote maintenance for flight inspection, a real Periodic Flight Inspection was performed for the Instrument Landing System (ILS), installed on runway 10 (ILS-ITB) at Galeão International Airport, in Rio de Janeiro. The procedure was divided in three distinct phases, Ground verification, Flight verification and ILS Periodic Flight inspection.

In the Ground verification phase, the Very High Frequency (VHF) communication and data communication were tested between ILS-ITB and the Supervision Control Center prototype, installed at Cajú in Rio de Janeiro. During the Flight verification phase, the communication was tested between the SCC and the flight inspection aircraft.
As the communications between the Maintenance responsible, located in the SCC, and the GEIV Crew has a fundamental importance for the accomplishment of the mission, in the Flight verification phase, the VHF channels and the switching of ILS ITB transmitters were tested. If there was a problem during the tests, the Local Technical Team could intervene immediately to ensure the correct ILS functionality.
One day before the Flight inspection phase, GEIV coordinated with ATM to determine the ideal time to perform the flight.
During the Flight inspection phase, all characteristic of the ILS (Cat II) operation were checked so that the remote maintenance for flight inspection could be evaluated.
The following parameters were checked: [3]

1) Identification;
2) Localizer (LOC) 1 and Glide Slope (GS) 1Structure;
3) LOC 2 and GS2Structure;
4) LOC 1 Width, Symmetry and Clearance;
5) LOC 2 Width, Symmetry and Clearance;
6) Marker Beacon (MKR) 1 Width measurement;
7) MKR 2 Width measurement;
8) Distance Measuring Equipment (DME) 1 and DME2Distance accuracy;
9) GS monitor for high angle alarm;
10) GS monitor for low angle alarm;
11) GS monitor for wide alarm;
12) GS 1 Angle, Width, Symmetry and SBP;
13) GS 2 Angle, Width, Symmetry and SBP.

In addition to checking the tolerance parameters, possible adjustments and changes of transmitters were tested.
A view of the architecture used in Galeão test can be seen in Figure 2.

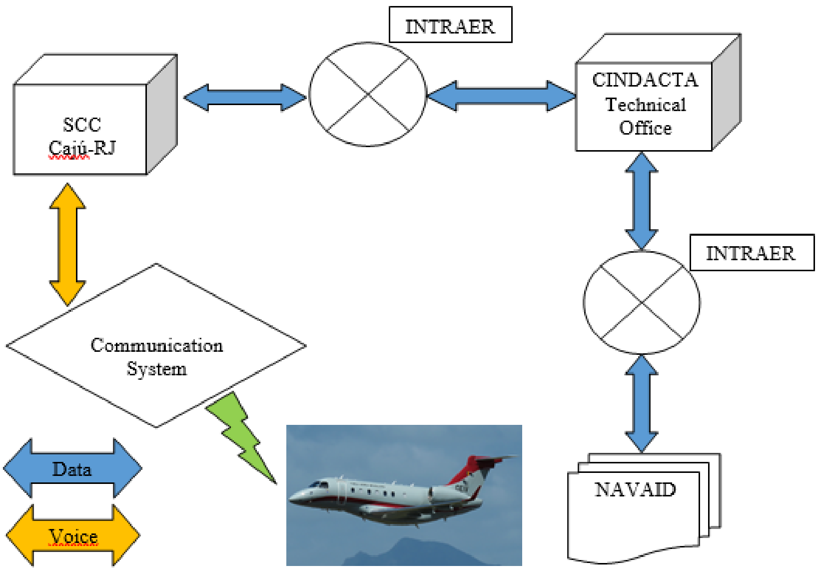

Figure 2–Galeão Basic Operation Diagram

After the tests performed at Galeão airport, despite the satisfactory results, we thought of performing another inspection with remote maintenance in the scenario that fomented this study. Therefore, we started to think about a test using SCC and ILS located in extreme points of the Brazilian territory.

For the new test, the ILS-IMC in the Maceió international airport, Alagoas state was chosen. After ground test phase, which confirmed the ability of the Aeronautical intranet (INTRAER) to support the connection for remote NAVAID assistance, we analyzed the best way of ensuring communication between the SCC at Galeão, Rio de Janeiro, and the aircraft carrying out the inspection at Maceió airport, a distance of 1100 nautical miles. As a solution for the test, the SCC was installed at the Galeão Air Base. From the SCC the High Frequency (HF) communication system installed at Santa Cruz Air Base, Rio de Janeiro, was operated remotely. A view of the architecture used can be seen in Figure 3.

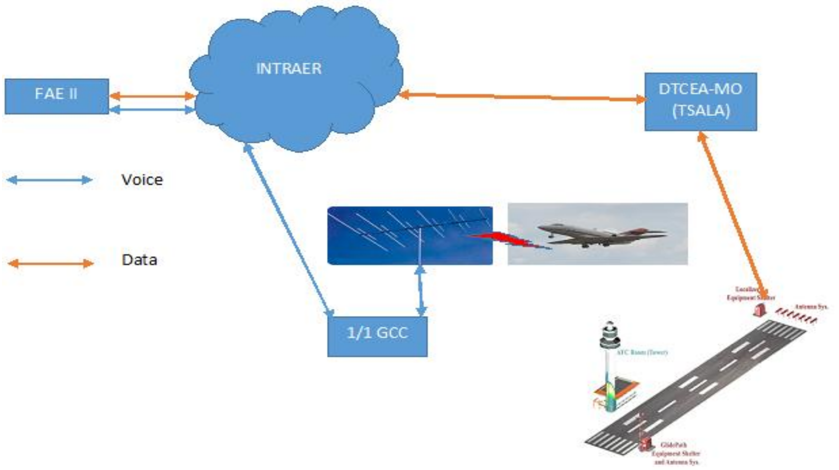

Figure 3–Maceió Basic Operation Diagram

At the end of the flight, it was possible to guarantee that the inspection occurred normally, and the remote maintenance was transparent to the flight inspection crew. Several commands were executed remotely, as requested by the Flight Inspector, from the exchange of transmitters to the modification of parameters provided during the ILS-IMC Periodic Inspection.

As a potential systemic vulnerability, it is worth mentioning the fact that the INTRAER network is required, both to receive and send information to remote stations and access link to the HF system at Santa Cruz Air Base.

CONCLUSION

The use of the remote maintenance represents an advance in the NAVAID flight inspection management, so that it gives time and economical gain. The structure used in the tests proved to be extremely effective, despite being a Proof of Concept, proving to be an excellent tool applicable to the Periodic Flight Inspections.

The connection of the equipment to the SCC in the CINDACTA will allow a constant access to the status of the NAVAID, giving a more efficient maintenance management and GEIV activation after maintenance that requires the flight inspection.

The preparation and coordination for flight inspection will be made easier because the resources required to assist the inspection in several NAVAIDS in the same region will be centralized in the same integrated center.

REFERENCES

[1] BRAZIL, 2011, DCA 351-2 - ATM Operational Conception

[2] BRAZIL, 2017, Remote Maintainers for Flight Inspection Mission Conception (DRAFT)

[3] BRAZIL, 2017, Flight Inspection Brazilian Manual