Providing Tangible Benefits to Aircraft Operators from Onboard HUMS Systems to Ensure Greater Data Capture Rates

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Abstract

The ADF has recently acquired the ARH Tiger and MRH 90 helicopters, and both of these aircraft have been delivered with onboard systems for the collection of health and usage data. These systems have been developed and refined with the intent of collecting data to support high level engineering requirements.

Historically Health and Usage Monitoring Systems (HUMS) have been developed for the long term management of the aircraft without adequately considering the burden they impose on the operators who collect the data. The result of this is that the benefit in collecting this data is often lost to the operator and the capture rate suffers due to more immediate operational demands, as their priority is always flying the aircraft.

By designing a system that provides tangible benefits to the maintainers and engineering support organisations, the increased workload associated with the data collection is offset against the increased availability of information that aids in maintenance and engineering investigations. Reducing the workload of the operators and maintainers to operate the aircraft should be an important function of a HUMS system. But there are a number of factors that must be addressed in order to make this mutually beneficial situation a reality.

Introduction

In 2001 the Australian Defence Force (ADF) ordered from Australian Aerospace 22 ARH Tiger helicopters. This was followed, in 2004 with an order for 12 MRH 90 helicopters. In 2006 the MRH 90 order was expanded to a total of 46 aircraft. In addition to the provision of these two new aircraft types, Australian Aerospace also provides maintenance, logistics and engineering support that includes Aircraft Structural Integrity (ASI) management.

Central to the ASI programs for both the ARH Tiger and the MRH 90 are the use of on-board HUMS that capture important data for the long term management of the aircraft. The on-board HUMS systems capture data at a much greater frequency, higher accuracy and better resolution than can be reported by aircrew. However one potential drawback of these HUMS systems compared to the more traditional manual/paper based usage data collection systems is that they are more complicated and consequently they require more training and increased management effort on behalf of those that use the system and collect the usage data. Whilst the ADF and Australian Aerospace can find clear links to future savings in both time and money from the benefits of higher resolution and more accurate data for use in the ASI

program, the aircraft operators may be left to bear the additional workload with minimal apparent reward.

Organisation Priorities

The organisations associated with the operation of an aircraft fleet can be broken into three categories:

- Aircraft Operations (inc. Aircrew): Plan, fly and support aircraft operations.
- Flight Line: Ensure the aircraft is available for operations.
- Authorised Engineering Organisation (AEO): Focus on airworthiness and ensuring aircraft Availability through long term Engineering support.

The first two groups are focused on meeting the immediate needs of operating the aircraft and achieving a high rate of mission success. Generally, only a small consideration is given to long term support and availability. Systems such as an on board HUMS, whilst acknowledged by these groups as important are generally treated with lower priority as the time taken to collect this data can come into conflict with the needs of operating the aircraft and satisfying mission objectives.

The third group, the AEO, is concerned with providing engineering support in an airworthiness framework ensuring that the fleet operates within its certification basis and providing engineering solutions that maximise the life of type. The data collected via the HUMS is particularly important to areas such as structural integrity management where higher resolution is preferred.

ARH Solution

ARH Tiger

The Armed Reconnaissance Helicopter (ARH) Tiger is the Australian variant of the Eurocopter Tiger a tandem cockpit, twin engine military attack helicopter. The ARH Tiger has a predominantly composite fuselage and rotor blades, integrated avionics on a MIL-STD-1553 MILBUS, Electronic Self Protection Systems and Weapons Systems (30 mm Cannon, 70 mm Rockets and Hellfire Missiles).

Figure 1: Eurocopter ARH Tiger

HUMS History

The Eurocopter Tiger was not designed with an integrated on-board HUMS system. To meet the Australian Defence Forces (ADF) requirements for an onboard usage monitoring system, Australian Aerospace (AA) in conjunction with Eurocopter (EC) and Aerospace Monitoring and Systems (AMS – now part of SAAB) designed a usage monitoring system using commercial off the shelf components (COTS).

Design

The ARH Tiger usage monitoring system is a locally developed system that uses COTS components to collect usage data from the aircraft's flight control, navigation and onboard logistics systems. No other Tiger variant uses this system and therefore the issues surrounding it are unique to the ADF.

The ARH Tiger UM system consists of 4 components:

1. CAMM2 – The ADF authorised tool for the collection and storage of all data relating to aircraft maintenance and lifing
2. MMS-Ops – Collects 'Logistics' data from the aircraft – this identifies the aircraft, its configuration, fuel and combat loads

3. GME –MILBUS data is collected from the aircraft via a removable hard disk. The data is filtered through the GME into 'Usage Data' which relates to the flight profile flown by the ARH.
4. AIMS – Combines the Logistics Data from MMS-Ops and Usage Data from GME to produce a mission, manoeuvre and exceedance spectrum that is used to verify the structural integrity of the ARH Tiger.

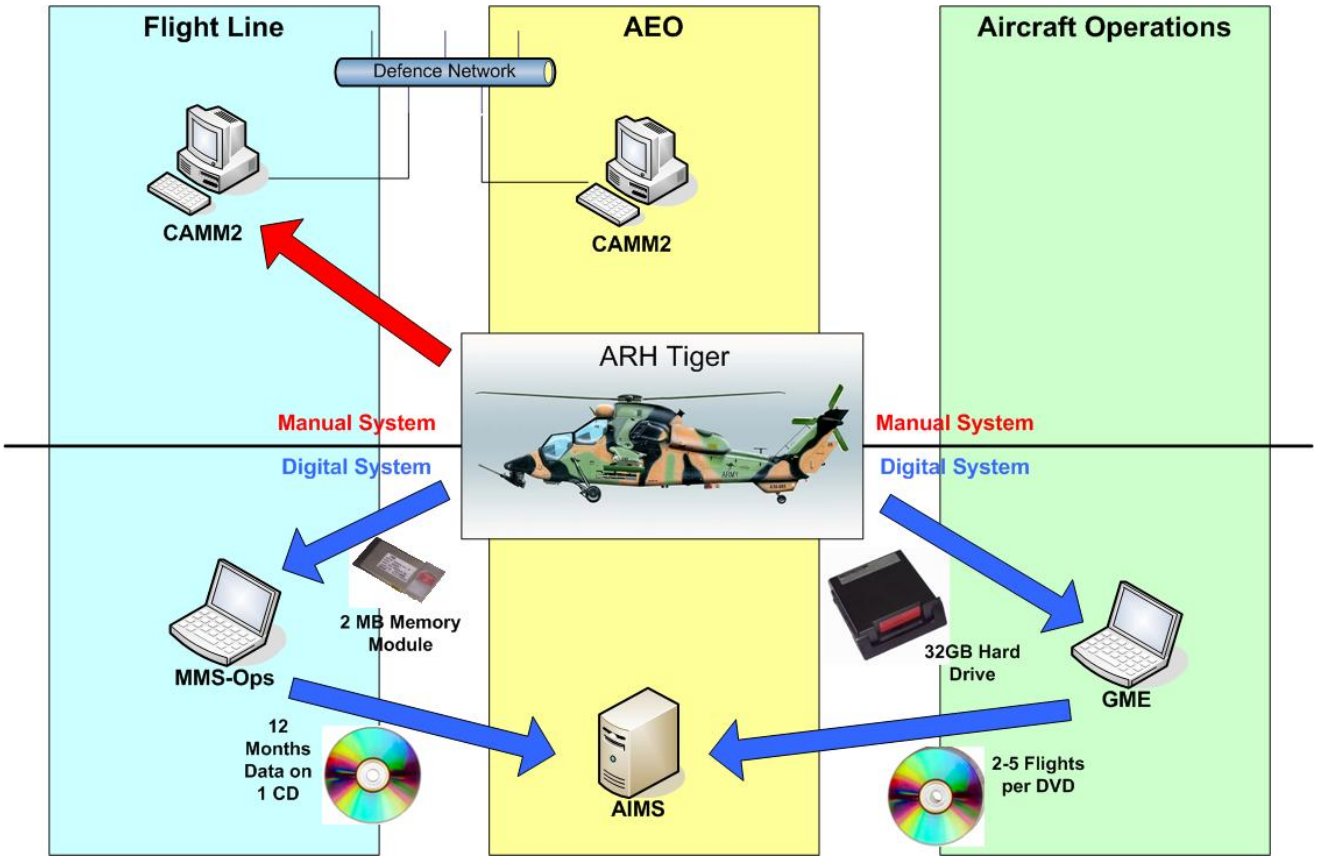

Figure 2: ARH Usage Monitoring Design Overview

Experience with the ARH HUMS

The challenges of the ARH Tiger UM system come from having to use already available data collection systems on the aircraft rather than a purpose build on-board data system. This has led to a more complex ground system to collect and organise the large quantities of data (starting from 2-3 GB per flight). In addition to this the system requires two different organisations to collect two separate data streams and recombine them using a third organisation. The result of this complexity is that human factors play a significant role in the capture rate of the usage data.

Capture Rates

Historically the usage data capture rate on the ARH has been lower than optimal, generally varying between 40% and 60% of flights when the volume of HUMS data captured is compared to the number of flights captured on CAMM2. This capture rate has been investigated by AA and human factors have been found to significantly contribute to lower than optimal rates as the HUMS data is not necessarily seen to contribute to the immediate availability of an aircraft. Therefore the collection and processing of the HUMS data can easily become a lower priority task particularly in the face of aircraft availability and operational schedule pressures.

MRH Solution

MRH 90

The MRH 90 is the Australian variant of the NH90 Troop Transport Helicopter (TTH), a European designed, twin engine, four blade main rotor design multi-role military helicopter. The Helicopter has a composite fuselage with twin side cabin doors and a rear ramp, composite rotor blades, modular avionics system integrated within a full glass cockpit, fly-by-wire control system with 4 axis auto-pilot and advanced mission flight aids, specific mission and role fit equipment, and an on-board monitoring and diagnostic system.

The MRH 90 will be operated by both the Army and the Navy and hence will be located at a number of bases around Australia.

Figure 3: NHIndustries MRH 90

HUMS Description

The requirement for a HUMS was included in the design of the NH90 from early in its development. The system that came from this requirement uses an on-board monitoring and diagnostic system (MDS) to collect the HUMS data. If needed, the aircrew or maintainers can use the MDS to present HUMS information relating to the most recent flight on screens in the aircraft cockpit. After each flight the HUMS data from the MDS is downloaded to the Ground Logistics Information Management System (GLIMS). GLIMS is a database that stores all of the historical HUMS data and allows trending of the HUMS data over the life of the aircraft.

The functionality built into GLIMS goes beyond HUMS and trending of HUMS data. As designed, GLIMS is capable of being a complete maintenance management system able to manage aircraft configuration and logistics, trigger technical events and aid the maintainers in trouble shooting faults on the aircraft. However, in the ADF context, it was determined early on that these functions were incompatible with the existing maintenance management system, Computer Aided Maintenance Management 2 (CAMM2) and so this functionality is not fully employed by the ADF.

Design

The MRH 90 on-board HUMS is a system specifically designed into the MRH 90 architecture and works with a ground station to collect, calculate and interpret the data. The MRH 90 HUMS consists of 2 components:

1. CAMM2 – The ADF authorised Maintenance Management System
2. GLIMS – Downloads the data from the MRH 90 on-board HUMS system for interpretation for engineering and logistics activities.

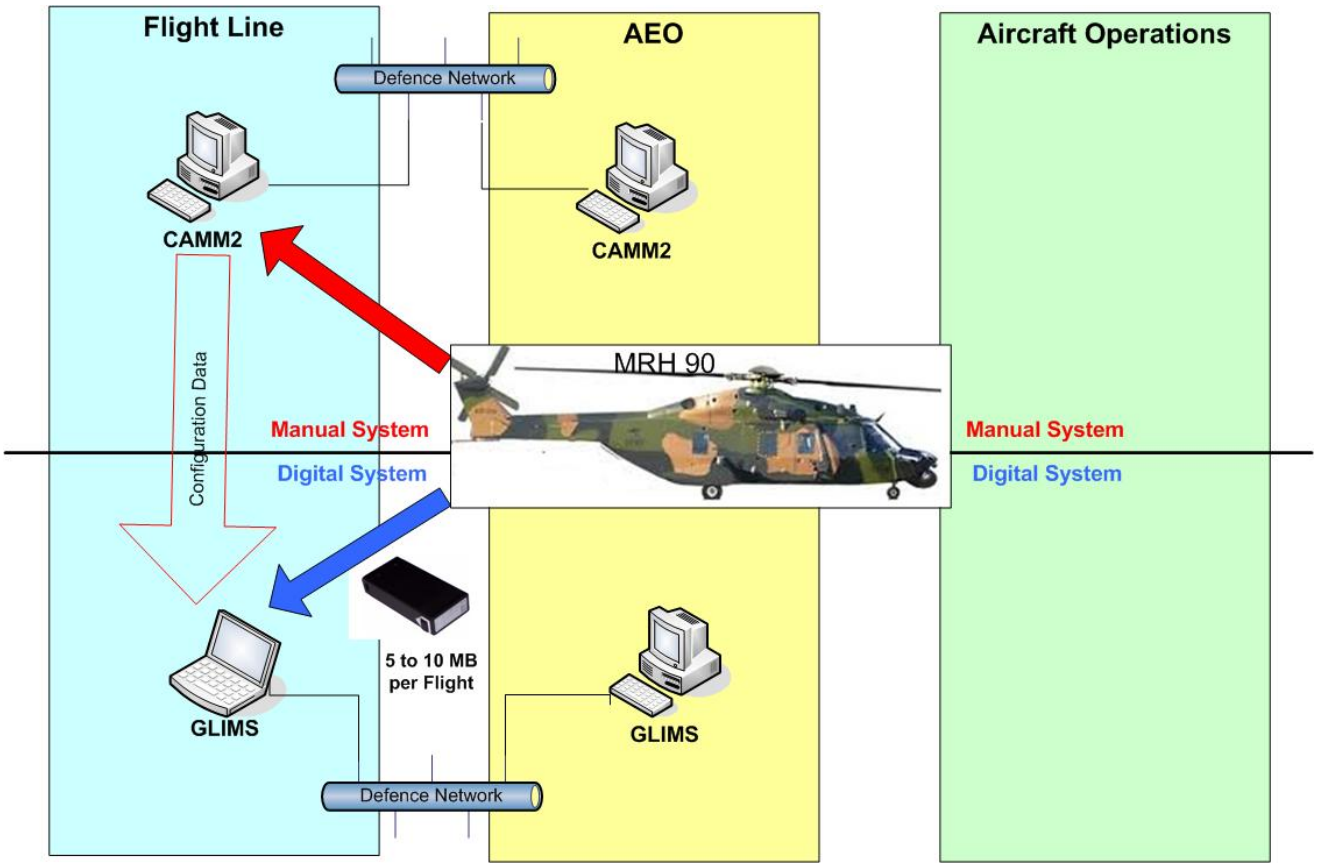

Figure 4: MRH 90 HUMS Design Overview

Experiences with the MRH HUMS

The MRH 90 HUMS has a number of challenges. These can be summarised as follows:

- GLIMS duplicates many of the functions of CAMM2 with no method of linking electronically. If all functions are to be available and HUMS data is to be collected at the highest resolution possible, then GLIMS can generate additional work relating to the management of the database for the Flight Line staff.
- GLIMS computers must be networked to work effectively. MRH 90 aircraft will be located at several bases around Australia and the architecture of the network solution is still being finalised.

Capture Rates

As the GLIMS is yet to be fully accepted for service by the ADF, and GLIMS stations are not available at all locations where MRH 90 aircraft are operated, the usage data capture rates have not been collected in detail. However an initial investigation of capture rates was carried out in the period from 1 December 2009 to 31 March 2010. This was based on the eight aircraft that operated for that entire period using GLIMS and indicated a provisional capture rate of better than 65%. Anecdotal evidence from operations since this time has indicated that

the capture rate has continued to improve as the operators have gained experience with GLIMS.

Impact of Design on Capture Rates

Experience gained by Australian Aerospace in operating the HUMS for both the ARH and MRH has indicated a strong correlation between the capture rates achieved by each platform and the utility of the HUMS to those tasked with collecting the data.

The ARH Tiger Usage Monitoring system is effective in collecting a large amount of data that will be of great use carrying out incident investigations as well as long term management of the fleet structural integrity. However, it is apparent that the information collected is not of immediate use to the aircraft Flight Line and Operations staff who are tasked with collecting it. Of particular impact is the fact that the usage data collection system requires two disparate sets of data to be collected and then combined to produce the usage data that can be used for analysis. This further dilutes the utility of the collected data as the neither of the groups tasked with its collection have visibility of the aggregate usage data. Additionally, as the operations staff do not, generally come from an aircraft maintenance background, the importance of the data can be lost amongst their more immediate priorities associated with ensuring that aircraft are operated on schedule.

By contrast, the MRH 90 Health and Usage Monitoring system design has basic features that reduce its potential to impact negatively on the capture rates as it collects a smaller volume of data, and only requires the involvement of a single group (Flight Line) who have a greater appreciation for the need to collect usage data to aid in long term fleet management. However, one significant challenge of the MRH 90 HUMS is that the staff associated collection of the data are also responsible for the basic administration and maintenance of the underlying database system. As the staff involved are not normally associated with such a role this requires additional training and has the potential to result in the perception of an overhead. This overhead is offset as the MRH HUMS also allows the Flight Line staff to access health data such as alarms, fault codes and vibration information all of which are relevant to the immediate operation of the aircraft. Consequently, the Flight Line staff collect and process the MRH 90 HUMS data for their own purposes and the fact that the data is available for the long term structural integrity management of the fleet is almost a by-product of normal Flight Line maintenance activities.

Improvements Identified

The experience gained from the introduction and on-going management of the ARH and MRH 90 HUMS has shown a link between the perceived effort associated with collection of the HUMS data and the capture rates achieved. This perception can derive from the fact that a HUMS system may require additional administrative effort to ensure that the associated databases are maintained and or it may come from the fact that the data being collected is not of immediate use to those associated with its collection.

The design of any system needs to take into consideration the needs of the operators even if the only need addressed is that the system does not impose additional workload without contributing comparable, tangible benefits to offset this workload. If this can be achieved then the usage data capture rate, often the primary focus of any usage monitoring program, will likely improve and be self-sustaining to the mutual benefit of the Flight Line staff and AEO.

This principle will be carried forward into the ongoing management and future upgrades to the HUMS systems and processes for the MRH 90 and ARH Tiger.

Conclusion

To manage the aircraft structural integrity and ensure it reaches its projected service life, sufficient data to represent the real-life flying of the aircraft is needed. To achieve this requires that a high percentage of the usage data is captured.

Whilst automatic HUMS systems remove the human limitations from types and accuracy of the HUMS data able to be collected there are still human factors that need to be considered in the management of the data. HUMS systems that provide a tangible benefit to aircraft operators can help to ensure a reduced burden on the operators of the system which has been seen to contribute to greater data capture rates. This will align the goals of the engineers supporting the aircraft long term with those who are supporting it in the short term.