Advanced Prognostic and Health Management (PHM) and Model Based Prognostic Useful Life Remaining Capabilities for Aircraft Tactical Information and Communication Systems

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PROBLEM STATEMENT

The advanced next generation strike fighter aircraft CNI (Communications, Navigation and Identification) is an integrated system that provides more than 40 functions for the advanced next generation strike fighter aircraft CNI utilizes software defined radios (SDRs) and integrated software architecture to support critical capabilities and future network-centric operations. Featuring minimized size and weight, the system will greatly enhance the performance of the F-35 aircraft.

CNI comprises Identification Friend and Foe (IFF) Transponder; Ultra High Frequency (UHF)/ Very High Frequency (VHF) receive and transmit voice and data; Intercom Audio allows communications between the pilot, ground crew or in-flight refueling aircrew without radio frequency transmissions; Radar Altimeter; and Backup Radio provides voice communications in emergency events.

Because of the critical functions performed by the CNI it is essential that its components and subsystems remain operational during flight operations. Failure of any part of the CNI can result in degraded mission capability putting the crew and aircraft at greater vulnerability to catastrophic failure or hostile action.

To provide better health management information for the CNI system it is necessary to develop technologies that supply information that will indicate the current condition and a prediction as to the remaining useful/performance life of the system.

WHO CAN BENEFIT?

While the advanced next generation strike fighter aircraft program is the primary sponsor and the initial transition target for the technology there are a number of other programs that could benefit from its integration into their avionics suites. These programs include Manned and Unmanned Maritime Surveillance Aircraft, Tilt Winged Aircraft and other fixed and rotary wing aircraft.

BASELINE TECHNOLOGY

Current technology for determining the health state of avionic components, including that used for the most sophisticated integrated avionics systems still relies on built-in test/diagnostics. This methodology gives notice after a fault has occurred eliminating the opportunity for proactive operational adjustments or maintenance action.

TECHNOLOGY DESCRIPTION

ProMONITOR is a software application that provides sensory updating prognostics and health monitoring for processor based avionics components and subsystems.

Using the OSA-CBM architecture ProMONITOR uses data that is available from the existing monitoring equipment and will provide the end user with the current health state, notification of incipient faults and a prediction of the remaining useful/performance life of the monitored component.

Whereas existing maintenance intelligence is an indication that a fault has already occurred, ProMONITOR will provide information on impending faults and a prediction on when these faults will lead to system failure.

ProMONITOR is an enabling technology that will help fulfill the promise of CBM+. By using this technology Maintenance, Operations and Logistics functions will be provided valuable intelligence that will enhance their capabilities and allow them to provide better and faster support to the warfighter.

Table 1: Features, Advantages, and Benefits

Features	Advantages	Benefits
Uses existing health monitoring data.	Does not require adding additional sensors.	No system modification.
Provides pre-BIT health indication.	Gives notice of incipient faults.	Provides intelligence on performance degradation prior to physical degradation
Provides continuous degradation timeline.	Shows when a fault begins and the rate of progression.	Allows for pre-failure planning.
Provides Remaining Useful Life estimation.	Gives forewarning of system failure.	Allows for pre-failure planning.

CURRENT STATE OF DEVELOPMENT

Global Strategic Solutions with the Georgia Institute of Technology executed a Phase I project to determine the feasibility of developing a methodology to predict and manage impending failures mechanical components The results of the effort produced a methodology that provides the foundation for the development of a degradation model to detect, diagnose and predict impending failures in CNI components. A predictive algorithm for rotating machines was developed and demonstrated in a laboratory environment as part of the project. (TRL 3)

The base period Phase II effort focused on model and algorithm development and the development of an initial software application for monitoring the health of processor based avionic components resulting in a demonstration of a system prototype. The upcoming/current Phase II option period is focused on additional data acquisition for further model and algorithm development with eventual testing and validation in an operational/high fidelity lab environment. Rockwell Collins will provide domain expertise as the project progresses.

Conclusion of option periods for the Phase II effort will result in a full PHM application for processor based CNI components tested in an operational environment.

STTR Phase II	Technical Objective	Milestone	TRL	TRL Date
Base Period	• Model and algorithm development • Prototype system demonstrator	Model Enhancement & Validation of Prognostic Modeling Technique	4-5	12/2009
Option 1 yr 2	• Develop Methodology for Predicting System Performance Life Remaining Based on Materiel Condition Assessment	Proof of Concept Demonstration Test	5-6	02/2011
Enhancement Option yr 3	• Demonstrate/evaluate prototype prognostic application in operational maintenance environment	Operational End User Assessment Tests	6-7	02/2012

REFERENCES

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ABOUT THE COMPANY

Global Strategic Solutions LLC (GSS) was founded in October of 2005 with the mission to develop and market predictive software for aircraft and industrial applications. The company's focus is on providing unique, dual-use prognostics software that predicts the aircraft systems' remaining useful life using sensor data from condition monitoring systems. To further its research efforts GSS collaborates with equipment OEMs, Systems Integrators and public research institutions and has established working relationships with industry leaders such as Boeing, Hamilton Sundstrand and Rockwell Collins as well as research institutions including the Georgia Institute of Technology and the University of Tennessee. GSS has also conducted applied research and development efforts related to the application of virtual and synthetic instrument technologies to address maintenance of shipboard electronic systems and aircraft avionics at Organizational Level (O-Level), as well as conducting applied research and development efforts which address the principal contributing factors that lead to the significant investment costs during automatic test system (ATS) modernization efforts.