GENERAL DYNAMICS
Canada

Data Management Complexity Simplified

Managing Information Overload More Effectively on Fixed- and Rotary-Wing Aircraft

Abstract

The multiple independent sensors on board today's fixed- and rotary-wing platforms deliver more useful information to operators continuously and in real time. Therefore, operators must be able to view all the information in real time to make tactical assessments and provide accurate and useful situational awareness intelligence to in-field personnel and commanders. Adding displays or increasing the number of operators is often not feasible and partially integrated systems create additional complications. A fully integrated solution built around common workstations that leverage information layering techniques provides operators with complete control of intelligence information.

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Information Overload on Fixed- and Rotary-Wing Aircraft

Sensors on fixed- and rotary-wing aircraft have become more sophisticated and increasingly sensitive over the past ten years. Today's sensors can see farther, cover a greater area, and collect more detailed information than ever before. Radar sensors, for example, are able to take advantage of improved power transmission and receiver sensitivity to provide greater detection capability over older systems.

The capabilities of other sensors have been improved in much the same way. More powerful hardware and more capable software have significantly enhanced the ability of these sensors to collect, process and deliver information to operators. And this trend is expected to continue as it keeps pace with ongoing innovations and advancements in electronic hardware and the software. This continuing evolution presents both benefits and challenges to military organizations.

On one hand, more powerful sensors can collect and deliver more detailed situational awareness information. Operators can now look farther and cover more ground to develop a more accurate assessment of a mission environment, and provide more accurate intelligence to commanders. On the other hand, the sheer volume of information these sensors generate has created a proportional increase in operator workload. To develop an accurate situational awareness assessment, operators must now process, review and analyze a continuous stream of video, and a variety of data inputs from deployed and onboard sensors that identify the location, bearing, distance and type of target the sensor has detected.

Compounding the problem is the fact that operator information systems on today's platforms include more than just what the platform's sensors can see. They also deliver information feeds from command centers and other aircraft, which operators must process and analyze to develop an accurate picture of the entire field of operation. As a result, operators are now faced with a more complex data management challenge.

In the past, operators developed situational awareness by switching between different sensors, which delivered information either on the same screen or on different screens. In effect, operators switched their attention from one sensor feed to another. This was a time and attention sharing activity, which was not ideal. If an operator was not switched to a specific sensor he or she was not getting the information that sensor was capable of delivering.

Now, because sensors are more sensitive, they are providing more useful information continuously and in real time. Therefore, operators must be able to view all the information in real time to make accurate assessments. This is important on current platforms because sensor systems are designed to match the capabilities of advanced weapons systems, which are now more effective at longer ranges. The capabilities of these systems can only be leveraged if sensor operators can process sensor data quickly to provide accurate situational awareness information to commanders. In addition, operators must be

able to counteract the sensor capabilities of opposing platforms, which are also equipped with advanced sensors and systems.

To deal with the digital information tsunami from sensors and other inputs more efficiently, the data management process must be simplified. A fully integrated data management system will allow operators to process and assess situational awareness intelligence in real time, and make it easier to determine which information is important for onboard commanders and command and control centers.

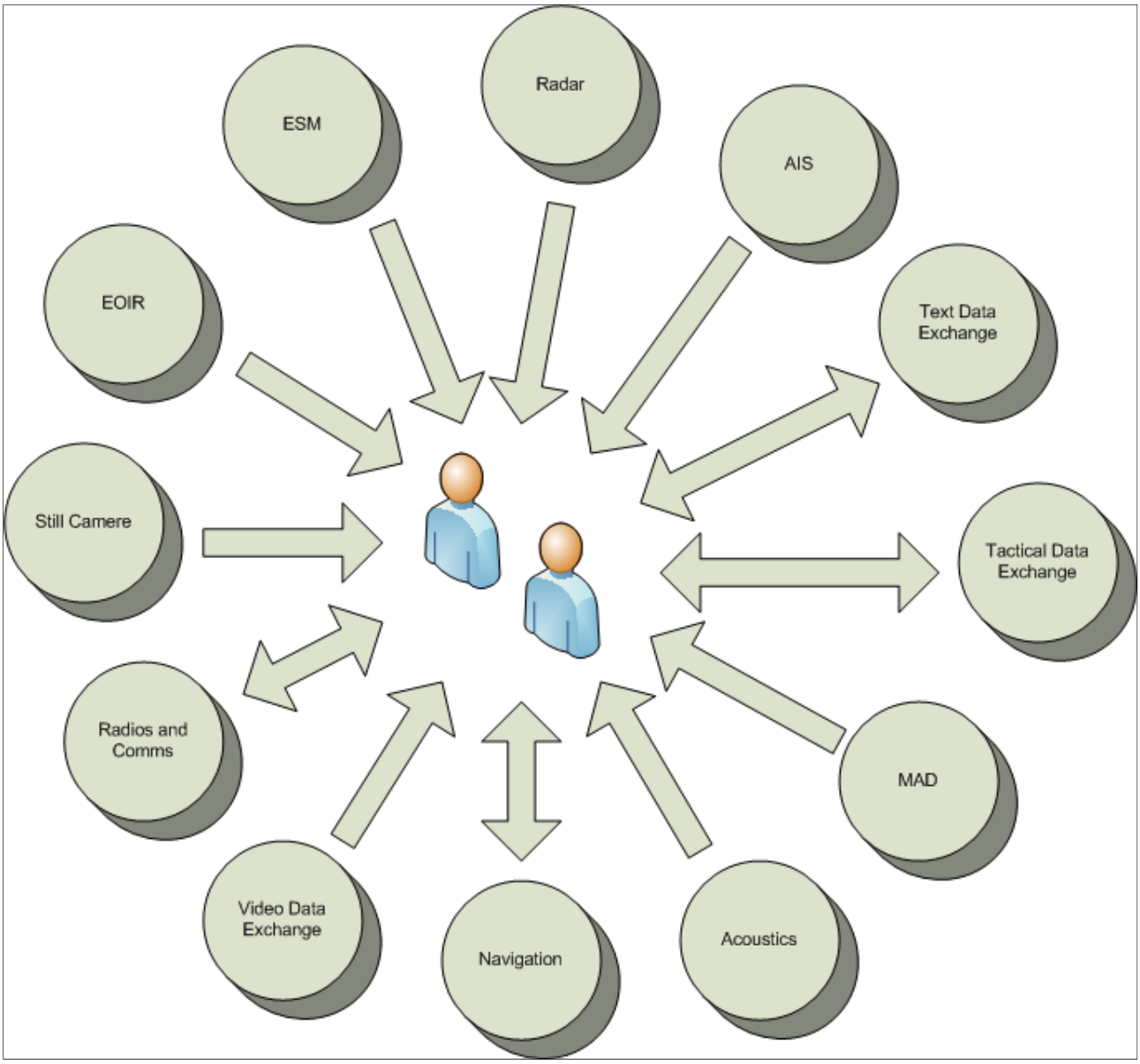
Managing the Information Tsunami

Effective command and control of in-field operations can only be achieved with accurate intelligence, surveillance and reconnaissance (ISR) information. Therefore, the advanced technologies employed by military organizations worldwide are designed to provide commanders and in-field personnel with detailed ISR information about everything from the status of assets in the field, to weather conditions, and the placement of opposing forces. As a key element of any operation, fixed- and rotary-wing aircraft are equipped to collect information with a variety of sensors engineered to support efforts to develop air superiority and full spectrum dominance.

A typical, fully-equipped ISR platform, for example (Figure 1), will include:

- **Radar systems**, for detection of surface targets, including very small targets, such as submarine periscopes
- **Electro-optic/Infra-red (EOIR) systems**, for classification of targets detected by other sensors
- **Electronic Support Measures (ESM) systems**, for detection of opposing radar and communications systems operating in the RF spectrum
- **Acoustic Sensor Systems**, for detection of sub-surface targets trying to hide among many noisy surface targets
- **Magnetic Anomaly Detector (MAD) systems**, for sub-surface detection of other platforms using variations in the Earth's magnetic field
- **Automatic Identification System (AIS)**, for location and identification of other vessels through the electronic exchange of data with other nearby platforms and AIS base stations
- **Tactical Data Exchange (TDE)**, for communication with other platforms and command and control centers via radio wave or cable data links

Figure 1: Multiple sensors provide independent real-time feeds



Sensor systems are not integrated

On most air platforms, all these sensor systems provide independent real-time feeds of critical information that can affect a strategic or operational initiative. There is no integration and the separate feed from each sensor is presented to operators on a dedicated display.

Given the extremely limited space on fixed- and rotary wing aircraft, having multiple independent systems presents significant size, weight and power (SWaP) challenges for system integrators who must find ways to cram all the required hardware and cabling into a very confined cabin. But it does make long term maintenance and support easier. If a display malfunctions, replacement is straightforward.

Likewise, displays can be easily replaced to accommodate improvements in the size and resolution of the information delivered by a specific sensor, thereby reducing the impact of the upgrade on system operations.

Unfortunately, this doesn't help operators who must manage the information tsunami created by multiple independent systems. With so many disparate sources of critical data, an operator must divide his attention among all the displays, correlate, analyze and process the information presented, and synthesize it all into a concise and coherent tactical overview for in-field personnel and commanders. This is inefficient and ineffective.

Traditional solutions are inefficient

One way to address this inefficiency is to have multiple operators, each focused on processing the information from one sensor system and passing that independent data to commanders and field personnel. Although this may work in large fixed wing aircraft, it will not work in smaller fixed- and rotary wing aircraft where cabin space is limited. There are simply too many bodies that must be accommodated in a very confined space, which exacerbates SWaP challenges. In addition, it makes the command and control process more difficult. Sensor information management is fragmented, operators can't see their sensor's data within the context of that delivered by other systems, and no one operator can develop and present a complete integrated ISR analysis to commanders. This affects the ability of a mission team to react to ISR reports in real time, and the effectiveness of the entire operation.

Another approach is to partially integrate sensors and functions (Figure 2). Sensors are configured to feed collected data into one or more systems designed to present information to operators. Usually, these systems are not engineered to manage the enormous load of information produced by advanced sensors, so operators use independent hardware, such as notebook computers, to supplement information management efforts. As a result, operators see a primary operational picture on the main system and a secondary operational picture on supplementary hardware. This creates complications and is extremely limited. Because the main system is unable to manage all the information produced, another application must be added when a new view of sensor data is required. And every time another view is added, another piece of hardware may also be needed to support that view, which further compounds the SWaP problem associated with cramped cabin space. Most importantly, operators are once again left with the burden of assessing and processing data on multiple displays to develop an integrated situational awareness analysis for command and control.

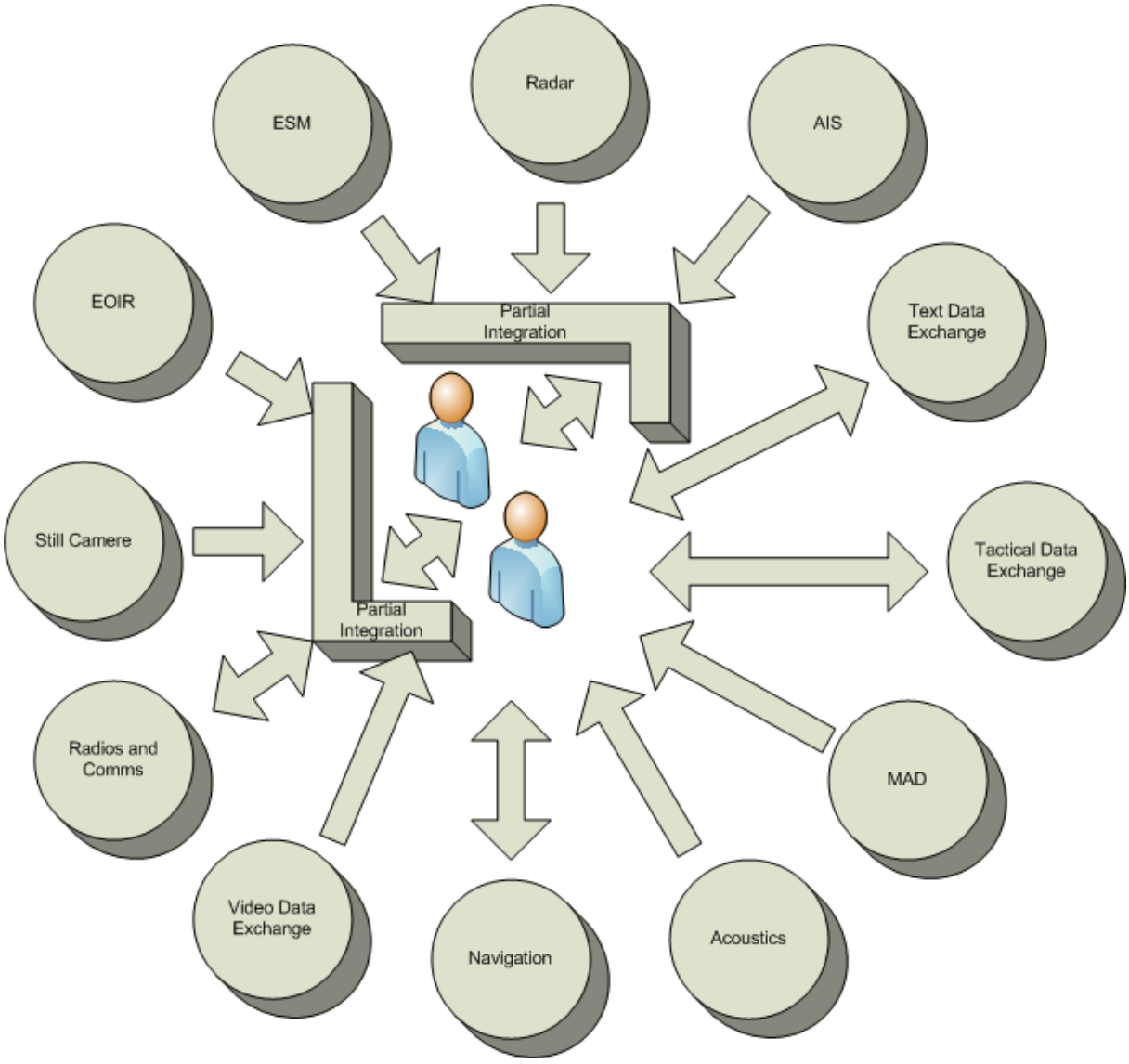


Figure 2: Partially integrated solutions feed data into one or more systems

Simplifying Data Management

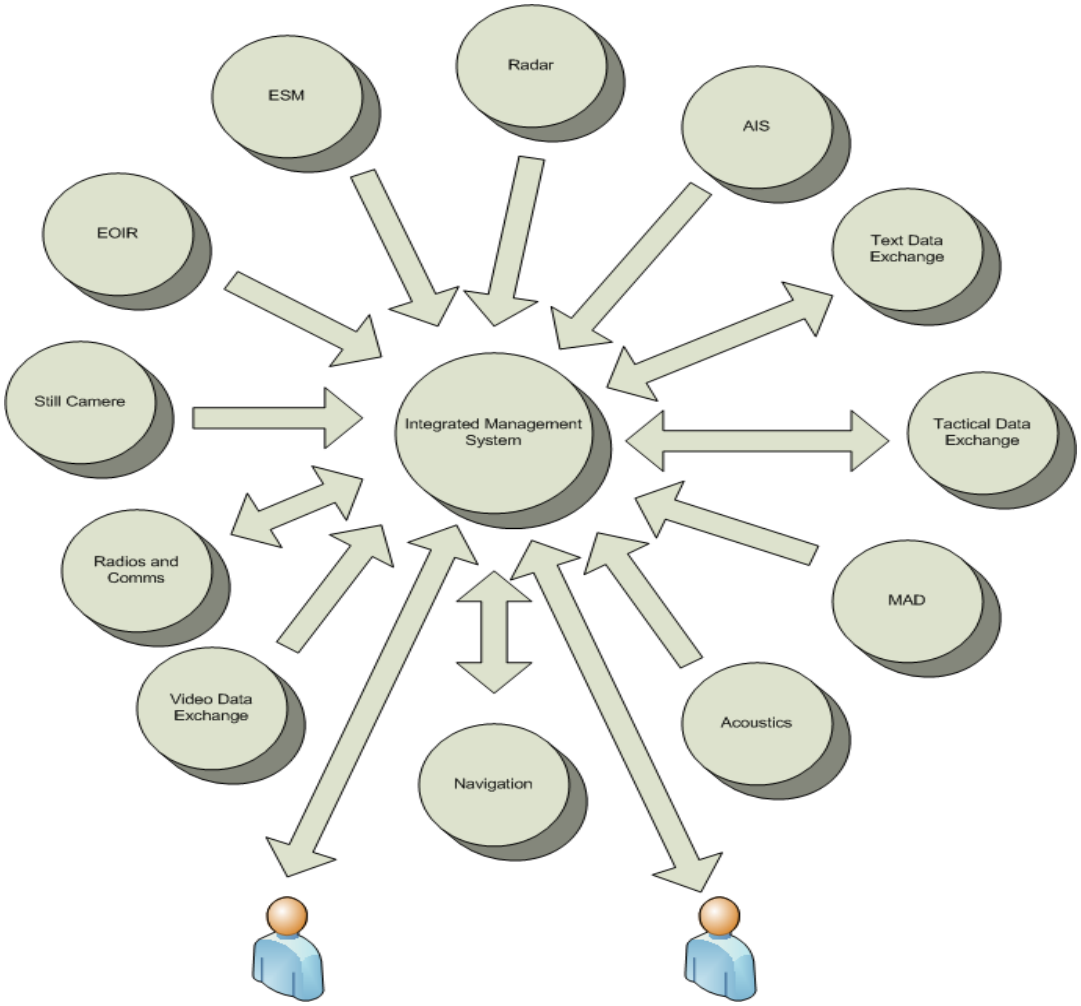
To deal with the digital information tsunami from sensors and other inputs more efficiently, operators need a more simplified data management process. The ideal solution should be built around workstations that enable operators to access any information at any time, and also allow operators to de-clutter their displays by eliminating the information that is not of tactical significance to a given situation. This includes information from onboard sensors as well as from cooperating platforms. The solution should also allow operators to tailor their view of information to fit a specific requirement at a specific point in time — whether that is overall situational awareness or a more focused task. Most

importantly, it should be able to present all sensor information in the geographic context within which it is being collected, such as coastlines, bodies of water, and underwater land masses.

Functionally, the solution must be easily accessible by operators. To meet operational requirements, it must be fully ruggedized. It must have high availability and reliability, and it must be easy to maintain and support. Finally, given the limited cabin space available on most aircraft, and the precious nature of weight on an air platform, the solution must also be SWaP-optimized to reduce hardware and cabling wherever possible.

A fully integrated data management solution best addresses all operator and aircraft requirements (Figure 3).

Figure 3: A fully-integrated solution should be configured and programmed to accept continuous input from multiple on-board and off-board sensors, coordinating platforms, and units



Creating a fully integrated solution

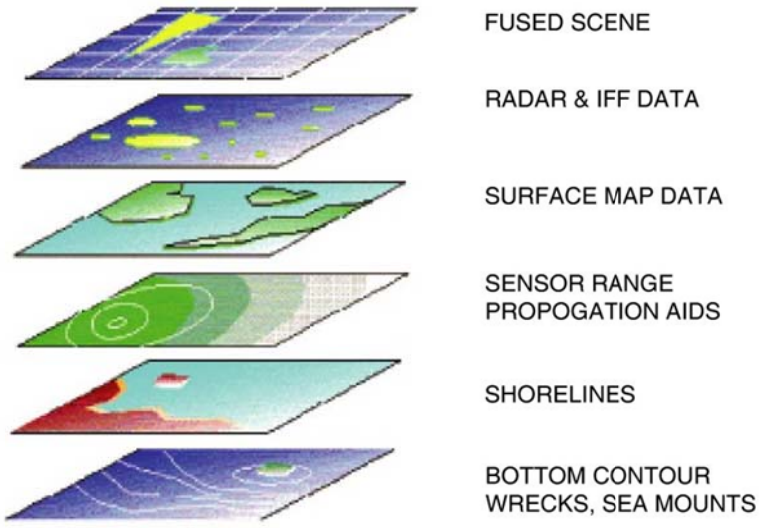
To reduce costs and ensure availability and reliability, a fully integrated solution should be built with field-proven, highly-ruggedized commercial off-the-shelf (COTS) components. This approach also guarantees the solution will be easy and less costly to maintain because there will be more parts available over an extended in-service lifecycle. Costs can be further reduced by integrating components into a modular design, which makes maintenance and support easier when required because it allows maintenance crews to immediately diagnose and isolate a problem and replace faulty modules rather than the entire system.

Operationally, the system should be configured and programmed to accept and process continuous input from multiple on-board and off-board sensors, coordinating platforms, and units and provide a complete and common situational awareness picture to operators. Efficiency and effectiveness can be increased by providing operators with complete control over all information inputs at all times, and allowing operators to monitor and manage sensors to ensure they are working as intended.

Improving operator efficiency with information layering

Ultimately, operator efficiency will be determined by how the information collected is displayed. Complete control and maximum flexibility can be achieved by layering all sensor information and tactical data (Figure 4) and delivering the complete picture to operators as a single fused plot, which contains sensor data, target data from external communications and digital map data.

Figure 4: Display layering improves operator efficiency



With information layering, each operator in an aircraft can be presented with a complete, integrated view of all tactical information. And each operator can select range scale, map content and data de-cluttering independently from other workstations in the system to fit specific tasks.

For example, the radar data plot may be displayed individually or removed from the display as a first level of de-cluttering of the main graphical area. Likewise, data from other sensors can be selectively included or excluded, as required. Conversely, selecting a layer for display adds it to a fused scene that depicts the mission area in the form of sensor data, communications data, environmental data and tactical data.

As a result, the information layering capabilities of the system reduce operator workload by reducing the number of sensor- or data-specific windows that have to be navigated. At the same time layering increases each operator's situational awareness by presenting a fused view of a situation plot.

Enabling complete control

Finally, to ensure complete control over all information, operator interactions must be optimized to leverage the information layering capabilities of the system. By including a combination of on-screen controls in the information or tableau area, pop-up menus in the main graphical area, and a QWERTY keyboard, the operator’s workstation can provide multi-functional control capability to match the tasks of each operator. Additional controls, such as console-mounted fixed or programmable key sets, or screen bezel controls, can be tailored to the physical limitations imposed by specific aircraft installation requirements.

The layering of sensor data on the display combined with workstation controls eliminates the need for operators to change their display to access subsystem control menus. In addition, operators can display and monitor multiple information screens simultaneously and perform control functions on any of the subsystems without reconfiguring the display.

General Dynamics Canada Data Management System

An integrated data management system designed based on this criteria will make operators more efficient and effective in any mission environment. It will enable operators to process and assess situational awareness intelligence in real time and make it easier for them to determine which information is important for onboard commanders and command and control centers.

The General Dynamics Canada Tactical Integrated Sensor Information System (TISIS) was engineered with these criteria in mind. It is designed to address the unique data management needs of fixed- and rotary-wing aircraft by enabling operators to manage the information tsunami collected by onboard sensors, cooperating platforms, and in-field resources.

Based on COTS components, the system has been engineered to provide powerful data management in a cost-effective design. This has enabled General Dynamics Canada to customize TISIS to provide data management on a variety of aircraft and integrate it with other sensors to provide a complete, integrated system for the global airborne surveillance market.

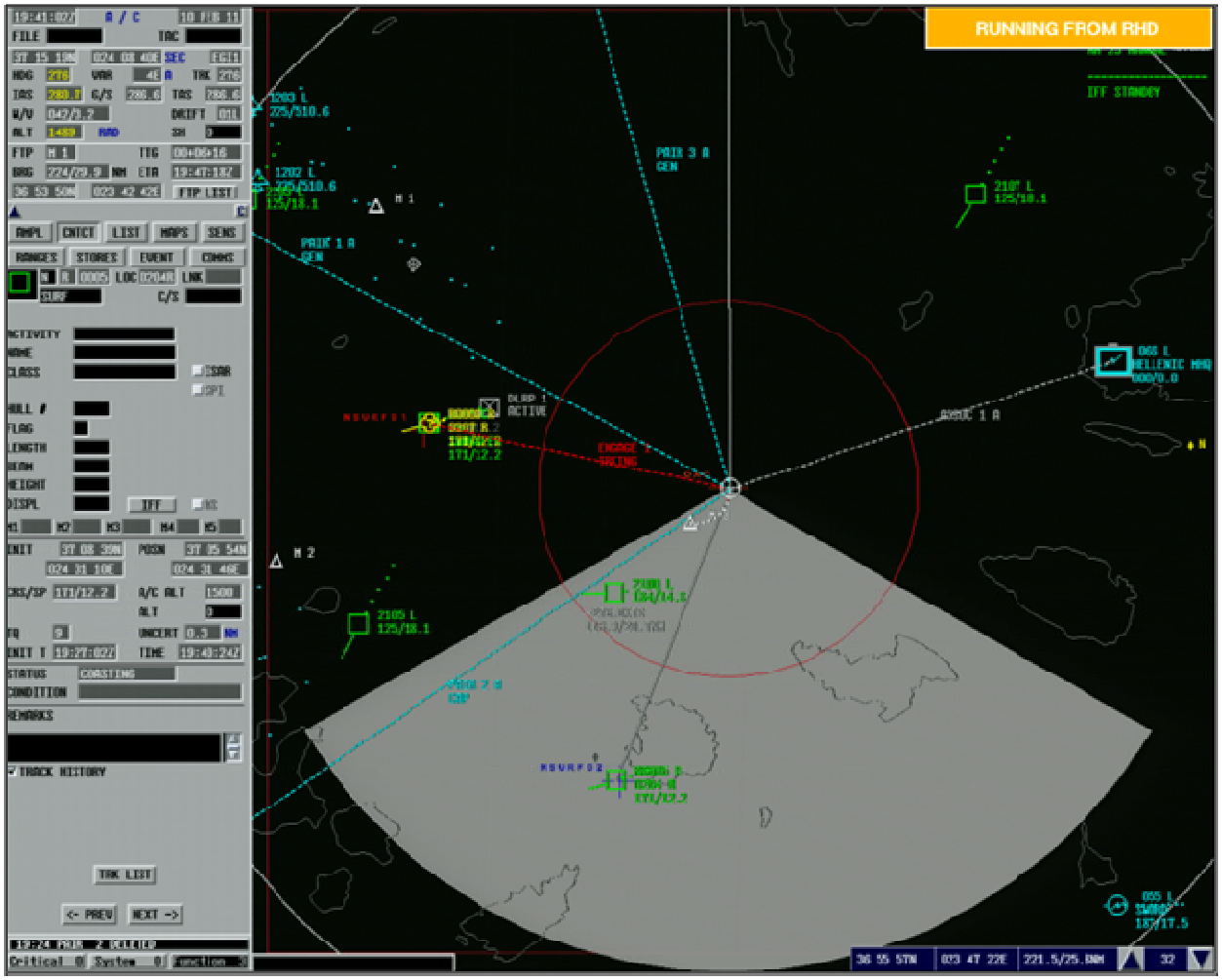
Advanced display layering and data processing

TISIS is the heart of fully integrated, universal data management workstations specifically engineered by General Dynamics for fixed- and rotary wing aircraft. The workstations allow operators to access all the capabilities of TSIS and the integrated mission sensors that feed it.

To enable more efficient data management, the fully integrated workstations present situational awareness information as a single, layered Tactical Situation Display (TSD), which includes data layers from all sensors, cooperating platforms, and resources. Operators have complete control over the layered information and can add or remove critical sensor data to the display as required.

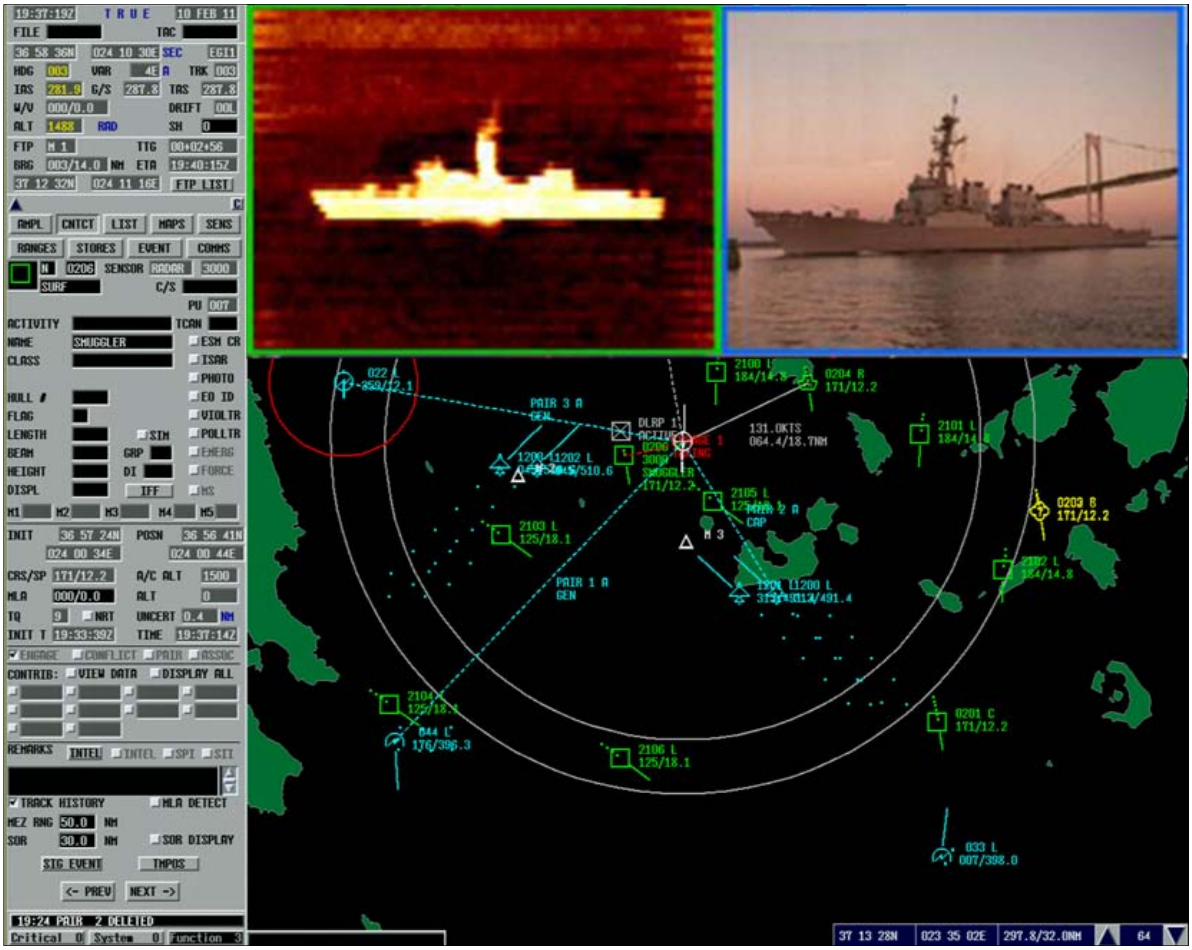
Situational awareness information collected and processed by TSIS can be displayed as a representation of the current tactical situation (Figure 5), a sensor video display, or a text presentation.

Figure 5: General Dynamics Canada integrated data management system operator display



The information area is an advanced Graphical User Interface (GUI) where operators can perform functions, edit data on-screen and manage the window with on-screen controls. In addition, window display and management is totally autonomous at each operator workstation, thereby enabling operators to configure the display to suit specific sensor inputs (Figure 6).

Figure 6: Operator display for EO/IR video



Data integrity is assured because all data is collected and processed by a central tactical database, which serves as the repository for:

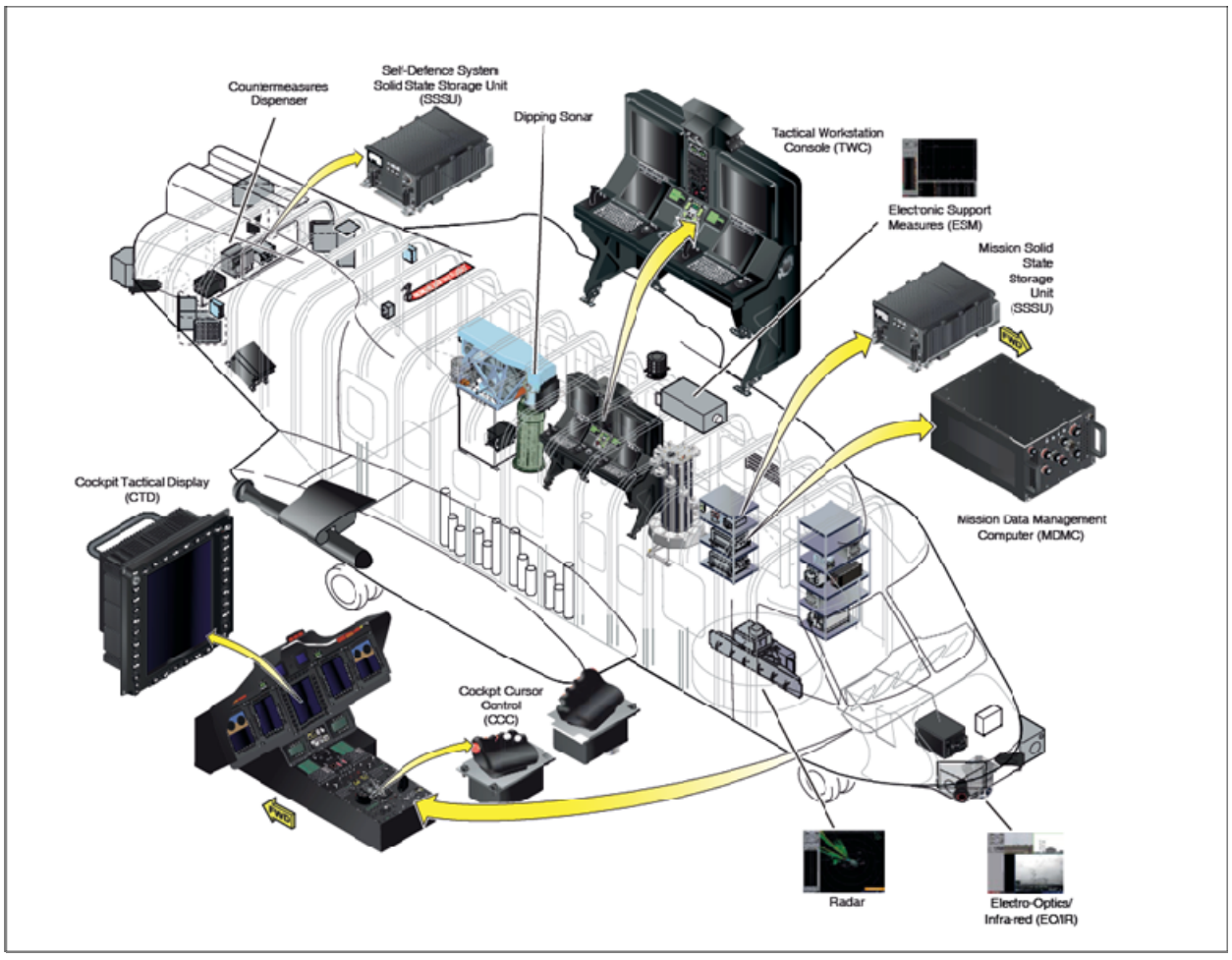
- Own aircraft data
- Platform data (contacts, fixes and tracks)
- Tactical areas
- Tactical positions
- Tactical aids
- Environmental data
- Support data (libraries, notes, briefing data)

With complete control of this database, the system can create a common operational picture for all operators. Any operator can access any piece of information at any point in time, and any changes made by one operator are automatically processed for all workstations. This simplifies the data management process and ensures all operators are always working with the most current data set.

SWaP-optimized for extended service

This fully integrated data management solution is engineered to reduce SWaP on all air platforms. By eliminating the need for multiple independent displays, integrating the information from multiple sensors into one database, and streamlining operations through an enhanced workstation, the General Dynamics Canada solution reduces the hardware and cabling that must be installed in the limited space available on fixed- and rotary-wing platforms (Figure 7).

Figure 7: Data management complexity simplified with the General Dynamics Canada integrated mission system



In addition, the solution is backed by a complete In-service Support (ISS) program, which includes:

- **Weapons System Engineering Management (WSEM),** which is structured to comply with ISO/IEC 15288 System Engineering Life Cycle Processes guidelines and provide a management framework within which all technical and engineering support functions are delivered
- **Technical Problem Management (TPM),** which is tied directly to a performance-based availability program and monitored for performance associated with all technical problem solving support system projects within the ISO/IEC 15288 framework
- **Engineering Support Services (ESS),** which include all systems, hardware and specialty engineering disciplines to provide cost-effective, leading edge technical support
- **Software Support Services (SSS),** which provide fast turnaround problem solving, bug fixing and technical investigation, and ensure customers are fully connected with change processes through regular releases of an operational software suite
- **Supply Chain Management Services (SCMS),** which leverage the latest SCM tools and services to ensure that spare components are always available and deployable
- **Training Support Services (TSS),** which provide reliable, easy-to-use training systems and training
- **Technical Air Worthiness Support (TAWS),** which ensures that the flight integrity of air platforms is maintained

Conclusion

The information tsunami created by multiple independent sensors and systems creates significant challenges for operators on fixed- and rotary-wing platforms. Today's sensors deliver more useful information all the time and in real time. Therefore, operators must be able to view all the information in real time to make tactical assessments and provide accurate and useful situational awareness intelligence to in-field personnel and commanders. Adding displays, or increasing the number of operators is impractical and partially integrated systems create additional complications.

A fully integrated solution built around a universal workstation that leverages information layering techniques provides operators with complete control of intelligence information. It allows operators to declutter their displays by eliminating the information that is not of tactical significance to a given situation. And it allows operators to tailor their view of information to fit a specific requirement at a specific point in time — whether that is overall situational awareness or a more focused task.

The fully, integrated General Dynamics Canada data management solution is engineered to address the unique data management needs of fixed- and rotary-wing aircraft. It ensures that all sensor information is always at an operator's fingertips. And it enables operators to manage the information tsunami collected by onboard sensors, cooperating platforms, and in-field resources quickly and efficiently.

Acronyms

Term	Definition
AIS	Automatic Identification System
COTS	Commercial off-the-shelf
EOIR	Electro-optic/Infra-red
ESM	Electronic Support Measures
ESS	Engineering Support Services
GUI	Graphical User Interface
ISR	intelligence, surveillance and reconnaissance
ISS	In-service Support
MAD	Magnetic Anomaly Detector
SCMS	Supply Chain Management Services
SSS	Software Support Services
SWaP	size, weight and power
TAWS	Technical Air Worthiness Support
TDE	Tactical Data Exchange
TISIS	Tactical Integrated Sensor Information System
TPM	Technical Problem Management
TSD	Tactical Situation Display
TSS	Training Support Services
WSEM	Weapons System Engineering Management

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