



# CASE STUDY: AGUSTAWESTLAND HELICOPTER TOUCH SCREEN DISPLAY

VxWorks 653 and Presagis VAPS XT-178 Power Safety Critical  
Avionics Display Systems

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This case study presents an AgustaWestland state-of-the-art safety critical touch screen avionics display system that has been developed for a military helicopter upgrade programme, using a standards-based approach based on ARINC 653 and ARINC 661, with the Wind River® VxWorks® 653 real-time operating system (RTOS) and Presagis VAPS XT-178 DO-178B/C-qualifiable human machine interface (HMI) tool suite. This approach helps to overcome hardware obsolescence and contributes towards reducing operational and through-life costs.

## **DESIGNING FOR EVOLUTIONARY UPGRADE**

Avionics displays have often been developed as bespoke systems to meet the requirements of a specific deployment platform. While this approach has been very successful, systems that have been developed using a monolithic software architecture often don't provide sufficient flexibility to enable the implementation of additional functionality to meet new operational requirements. This approach also can incur significant development and recertification costs.

AgustaWestland is an Anglo-Italian helicopter company owned by Italy's Finmeccanica, which has extensive experience in the development of civil and military rotorcraft and their mission systems. The company adopted an innovative approach for the development of a new safety critical avionics display for a military helicopter upgrade programme. This involved the use of an industry-standards-based software architecture based on ARINC 653 and ARINC 661, and an extensible open architecture-based hardware platform.

## TOUCH SCREEN DISPLAY UNIT ARCHITECTURE

The military helicopter had previously used avionics display control units within the cockpit and cabin of the aircraft. These units used a text-based HMI to control multiple avionics systems, as shown in Figure 1. There was a limit to the number of options that could be displayed concurrently, due to the space used by text-based menus and the limited physical size of the display. These limitations resulted in a hierarchical menu system of significant depth, which took a long time for the aircrew to navigate. Thus, a goal of the upgrade programme was to optimize the usability of the avionics display control unit by exploiting available technologies. There was also a requirement to reduce the impact of obsolescence and the through-life costs of the helicopter avionics display systems. This encompassed development costs, testing and safety certification, operational use through minimizing spares, and reducing future upgrade and certification costs.

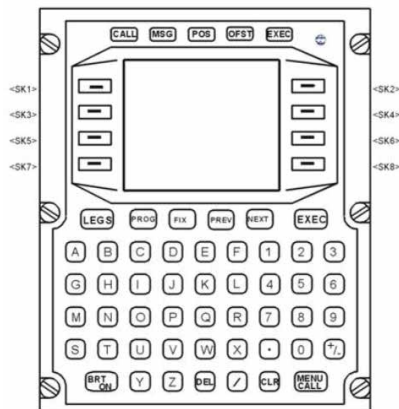


Figure 1: Military helicopter multifunction display prior to upgrade  
Image: © AgustaWestland

In order to implement these capabilities in a new touch screen unit (TSU) to be used in a dual cockpit and dual mission systems configuration in a military helicopter, AgustaWestland selected Barco's MFD-2108 state-of-the-art touch screen LCD display. This display utilises Barco's MOSArt (modular open system architecture for real-time avionics) and is integrated with the Wind River VxWorks 653 real-time operating system, which implements ARINC 653 partitioning of applications. This open, extensible architecture has enabled AgustaWestland to configure the display to its specific requirements and to integrate its applications into the display system using a modular approach, which differs from the turnkey black-box solutions approach used by traditional suppliers.

## EXTENSIBLE DISPLAY ARCHITECTURE USING VXWORKS 653

During the design phase, AgustaWestland further exploited the capabilities of ARINC 653 partitioning by decomposing the TSU application into modular components to minimise the impact of change to TSU requirements. To do so, AgustaWestland used the following software architecture:

- The *ARINC 661 Cockpit Display System (CDS)* partition contains the Presagis ARINC 661 Compliant Kernel and Widget Library and Barco OpenGL stack, which are used to generate all the graphical output for the display.
- The *Master User Application (UA)* partition contains functionality to control the unit and is likely to change as a result of changes in requirements, minimising the impact of change on the other software.
- The *Physical Interface Handler* partition contains functionality responsible for the communication with other avionics systems via dual-redundant networks. The unit relies on other aircraft systems to provide the data for display, as it has no knowledge of what data is being displayed.
- The *Health and System Management* partition contains software to manage the built-in test (BIT) functionality.

The resulting software architecture (shown in Figure 2) has achieved a balance between minimising design complexity and minimising the impact of change to TSU requirements in terms of the burden of retesting and requalification for flight. The TSU was developed using a role-based development approach according to the RTCA DO-297 (EUROCAE ED-124) standard, with Barco undertaking the role of platform supplier, and AgustaWestland development teams undertaking the roles of application suppliers, systems integrator, and certification applicant.

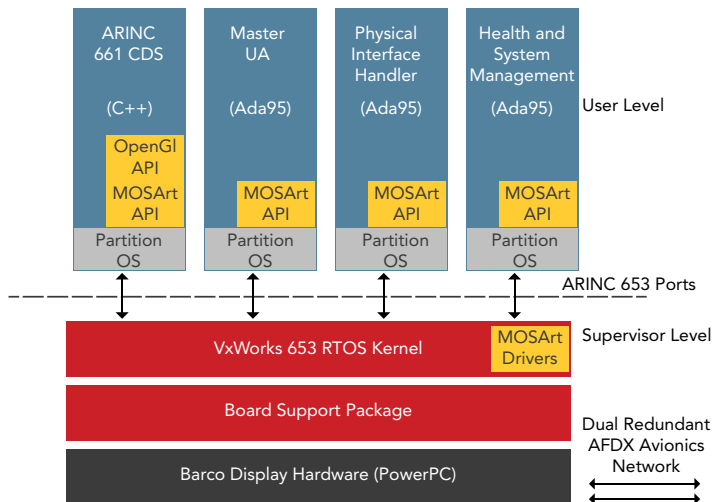


Figure 2: TSU software architecture

### RAPID PROTOTYPING AND DISPLAY MODELING USING ARINC 661

AgustaWestland needed to implement a flexible graphical user interface which could be easily adapted to support different configurations and interfaces and control of other avionics systems. For these reasons, AgustaWestland selected the Presagis VAPS XT-178 DO-178B/C-qualifiable HMI tool suite for the development of the displays for the

touch screen unit. VAPS XT-178 was used to create displays containing visual objects and symbols, known in ARINC 661 as *widgets*. The displays also use ARINC 661 *layers*, which are areas of the display with an associated set of widgets displayed at the same level on a window and with properties that can be controlled, such as whether it is visible or invisible, or enabled or disabled.

The TSU top-level display is shown in Figure 3. The top row of the display contains a persistent layer containing critical system messages and widgets for buttons to return to the top-level display and to enable the aircrew to step backward from the most recent selection. The blue circle widgets enable the aircrew to select the menus for the corresponding helicopter subsystems, and the red cross widgets allow the aircrew to enter input selections and parameters.



Figure 3: TSU top-level display  
Image: © AgustaWestland

### APPLICATION DEVELOPMENT WORKFLOW

AgustaWestland wanted to be able to simulate the graphical display system in a host development environment in order to be able to undertake rapid prototyping and accelerate the design process for the display layout and menu hierarchies. The modeling and simulation capabilities of Presagis VAPS XT-178 were used to undertake this rapid prototyping, and this early visualisation capability enabled the development team and their colleagues responsible for ergonomic design to collaborate closely and accelerate the design process.

In addition, AgustaWestland has augmented this desk-based layer modeling process with a training and simulation environment which uses touch-sensitive glass panels to perform mission simulation and gain early customer feedback. This approach enables the display layers to be refined before porting to real display hardware.

During the design phase, AgustaWestland used Atego's Artisan Studio to perform UML modeling of the Master UA, Physical Interface Handler, and Health and System Management applications. The integration between Artisan Studio and VxWorks 653 enabled AgustaWestland to move seamlessly from the design phase to the implementation phase by performing autocode generation of the application frameworks in Ada95 and definitions of the ARINC 653 communication ports for inter-partition communication. This implementation framework was automatically imported into Wind River Workbench to enable AgustaWestland to undertake the development on VxWorks 653. The applications were developed in Ada95 using the AdaCore Zero Footprint Profile (ZFP), which is included in the GNAT Pro High Integrity Edition. This provided a good technical match between TSU application requirements and certification demands.

### TESTING, INTEGRATION, AND CERTIFICATION

To meet the requirements of DO-178B/ED-12B objectives for requirements-based testing and code coverage testing, a three-stage testing process was undertaken using Vector Software's DO-178B-qualified VectorCAST testing suite:

1. Host-based unit testing of each of the ARINC 653 partitions separately
2. Integration testing of the combined system with all ARINC 653 partitions
3. System testing of the deployment configuration and final binaries on the target hardware

The decision made in the design phase to decompose the TSU application into modular components within ARINC 653 partitions provided additional benefits in the testing phase, enabling unit testing of the CDS, Master UA, and other applications to occur independently. This approach will also provide additional benefits by reducing certification costs associated with potential future system upgrades to meet new operational requirements.

These efficiencies were achieved by using independent payload streams rather than a traditional monolithic system image load for the platform. This design and build separation enables the TSU application to be updated in the future without rebuilding and retesting the other system binaries. The payload stream was created by the DO-178B-qualified tool, VerlMAx (which was developed by Wind River certification partner Verocel). This tool also checked that the XML definitions and XML files were mutually consistent. The ARINC 653 Partition OS also performed an additional run-time check during initialization to verify that the XML version number matched the expected configuration version. This approach ensured that incompatible versions of images within the payload stream could not be used in a deployed system.

## PROGRAMME RESULTS

The ARINC 653 and ARINC 661 standards-based approach has been successfully used for the development of a safety critical touch screen avionics display, which has provided improved HMI navigation and achieved the operational requirements for a military helicopter upgrade programme.

The use of ARINC 661 and display simulation has provided a faster iterative development approach, enabling customer feedback to be gained more rapidly and incorporated into design iterations, and so reducing the risk of the final deployment configuration not meeting customer expectations. The use of ARINC 661 layers to separate the configuration data from the application provides a flexible framework that enables the display layout and configuration to be changed frequently without impacting the application code, thereby reducing the impact on certification effort. This method will also provide the ability to support new requirements and different deployment configurations for other customers.

The use of VxWorks 653 provides an open foundation for modular and incremental certification. The TSU application architecture could be enhanced by AgustaWestland to exploit these capabilities in subsequent upgrades and future TSU variants. This approach would contribute to a further reduction in future certification costs.

## FUTHER INFORMATION

A more detailed account of the helicopter upgrade programme is provided in the conference paper "Development and Certification of a Safety-Critical Touch Screen Avionics Display using Open Standards", to be presented at the 22nd Safety-critical Systems Symposium, 4–6 February 2014.

