



safety is critical.

Whether building commercial or military airplanes, safety is the first concern for every phase of production. There is no margin of error; precision is absolutely critical.

The standards governing the development cycle of any software embedded in airborne equipment are among the most stringent for software development in the world. Every line of code embedded in any airborne system must be tested and verified and must conform to rigorous standards of accuracy, consistency, verifiability, and compatibility. As a result, the certification processes associated with embedded code production lead to tremendous overhead for avionics developers.

The [VAPS Qualifiable Code Generator \(QCG\)](#) from Presagis answers the needs of avionics developers for more efficient and less expensive methods for certifying their code while still adhering to the rigorous demands of DO-178B standards. [Because safety is critical.](#)

© 2008 Presagis Canada Inc. All rights reserved.

Presagis and VAPS are trademarks of Presagis Canada Inc. and/or its subsidiaries or affiliated companies in Canada, United States and other countries. All other trademarks contained herein are the property of their respective owners.

WHAT IS DO-178B CERTIFICATION?

DO-178B is the standard that enforces the stringent and rigorous process guidelines governing the entire development life-cycle of embedded software in airborne equipment.

Set by the Radio Technical Commission for Aeronautics (RTCA), DO-178B ensures that every line of code in an embedded airborne system is verified and tested and that its requirements conform to strict standards of accuracy, consistency, verifiability, and compatibility with the target computer. With an emphasis on project management and Software Engineering, DO-178B focuses on development processes and their objectives.

In DO-178B, “software” pertains to all drivers, Board Support Package (BSP), real-time operating system (RTOS), libraries, graphics, and application software. Developing software for safety-critical certification applications involves considerably more documentation, up-front requirements-based design, requirements traceability, testing, and verification. Software testing means ensuring that the lowest level detailed requirements are accurately implemented, that paths are covered according to their criticality level, and that full traceability is provided.

In civil aerospace applications, certification is required for systems whose failure will put human life at risk. Both the Federal Aviation Administration (FAA) in the US and the Joint Aviation Authority (JAA) in Europe recognize DO-178B\ED-12B (Software Considerations in Airborne Systems and Equipment Certification) as an acceptable standard for the approval of software in airborne systems. Prepared and maintained by the RTCA and the European Organization for Civil Aviation Electronics (EUROCAE), these are the most stringent software certification standards in the world.



image courtesy of BARCO

In addition to focusing on the development process for airborne software, DO-178B\ED-12B also concentrates on the evidence required to demonstrate compliance with the various criticality levels. Producing this evidence, which includes test archives and traceability documentation, is very labor intensive and time consuming since every line of code that is produced under a DO-178B\ED-12B project must be traceable back to its original requirement.

THE EMERGING USE OF COTS TOOLS FOR DO-178B

Because the DO-178B\ED-12B certification process is both labor intensive and time-consuming, companies are looking for time-saving solutions. One option involves developing proprietary tools in-house or hand-coding; however, companies who have taken this approach are discovering that maintaining their in-house tools and/or custom code base significantly reduces any benefits associated with hand-coding.

Another option is to use Commercial-off-the-shelf (COTS) tools to automate the certification process. The main benefit of this COTS approach is that the company realizes significant cost and time savings, in part because it no longer bears the cost and responsibility of maintaining standard-conformance for the tools. Another benefit is that development artifacts for a specific platform configuration can be re-used across multiple projects sharing that same configuration, which can lead to further reductions in development time and certification effort.

Using COTS tools on either civil or military aerospace avionics developments leads to substantial cost savings that far outweigh the initial tool licensing investment, but the real dollar amount saved depends on the size of the development effort and on the level of certification desired. Many avionics and aerospace companies have made or are making the move towards COTS tools in order to take advantage of the substantial savings, especially when these savings are taken together with the other benefits of this approach that include a reduction in code maintenance and greater technology development.

LEVEL	MEANING	CONSEQUENCE	PROCESS OBJECTIVES
A	software whose anomalous behaviour would prevent continued safe flight and landing or loss of aircraft and/or occupants (e.g. failure of an engine control or flight computer software)	catastrophic failure	66
B	software whose anomalous behaviour would cause large reduction in safety margins, serious/fatal injuries to occupants, or higher crew workload (e.g. faults in software related to GPS)	hazardous/severe to major failure	65
C	software whose anomalous behaviour would result in significant reduction in safety, discomfort to occupants, or significant increase in crew workload (e.g. failure of a radio data link)	major failure	57
D	software whose anomalous behaviour does not significantly reduce aircraft safety and involves crew actions well within capability (e.g. changes in flight path schedule)	minor failure	28
E	software whose anomalous behaviour does not affect operational capability and does not result in an increase in crew workload	no effect	0

Figure 1. DO-178B Certification Levels. To further enhance safety critical avionics development, the FAA has issued a series of Technical Standard Orders (TSOs) to identify the required level of certification for each device type. This chart shows the different levels of certification that can be applied to software in an aircraft.

THE BENEFITS OF USING QUALIFIABLE TOOLS

Tools for DO-178B\ED-12B certification can be categorized as either (1) development tools that will produce code that will fly in the aircraft or (2) verification tools that will be used as part of the certification process to verify or check steps but will not produce code that will fly in the aircraft.

DO-178B\ED-12B states that the qualification of a tool is necessary when processes of DO-178B\ED-12B certification are eliminated, reduced, or automated. Tool qualification requires demonstrating a tool's conformance with DO-178B\ED-12B in the same way that the developer's end product is to be certified. Concerning the qualification of software development tools, DO-178B\ED-12B goes further to state that the development processes for such tools should satisfy the same objectives as the software development processes of airborne software. As a result, the software level assigned to the tool should be the same as the level for the airborne software that it produces.

Thus, the main advantage of using a qualified tool is that the user can automate or reduce the level of effort spent on certification, and these reductions can only be achieved by using "qualifiable" development tools. Non-qualifiable tools do not reduce the effort of final certification because the user is forced to undertake all of the documentation and testing as if no tool had been used, a process that is both time consuming and costly.



VAPS QCG OVERVIEW

VAPS® QCG The VAPS software tool suite from Presagis is a premier COTS solution for embedded software certification because it is both a qualifiable development tool as well as a qualifiable verification tool.

VAPS is recognized as the industry standard for the rapid prototyping, designing, testing, and deploying of aerospace Human Machine Interfaces (HMI). Used by teams to jointly design and test the look, feel, functionality, and behavior

of a particular embedded system or group of embedded display units, VAPS enables the development of dynamic, interactive, real-time graphical HMIs for safety critical embedded devices in aircraft. With the addition of the VAPS Qualifiable Code Generator (QCG) and VAPS DesignDoc, the VAPS tool suite is a qualifiable COTS tool that greatly reduces the cost of embedded software certification.

Qualifiable to RTCA DO-178B level A, VAPS QCG is a code generation solution for deploying VAPS applications to a safety critical embedded system, including aircraft cockpit display systems. Since VAPS QCG is coupled with the VAPS graphical design environment, this tool enables graphics software generated from a VAPS application to be certified with a minimum of effort. By greatly reducing the effort required within the software design, coding, and testing phases of the graphics display development lifecycle, VAPS QCG dramatically shortens the time required for developing certifiable embedded software products.

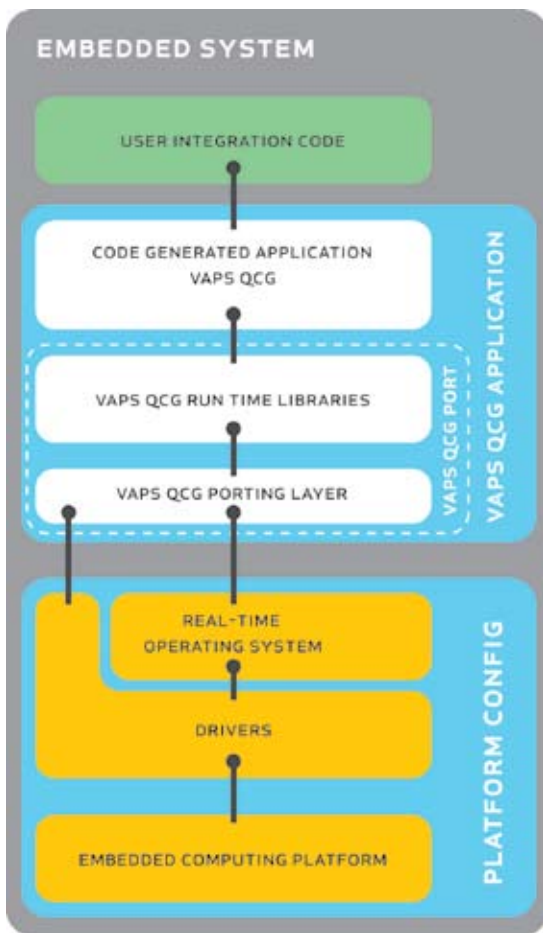


Figure 2. Embedded Systems using VAPS QCG

Porting Layer

The VAPS QCG Porting Layer is a thin layer of code that abstracts platform dependencies, thereby allowing VAPS QCG to be easily ported to arbitrary platforms. The porting layer can either be coded by the customer or by the Presagis Professional Services Group.

Run Time Libraries

The VAPS QCG Run Time Libraries contain the functions to implement generic VAPS behavior. These libraries have no dependencies on any external software other than the VAPS QCG porting layer, making them easily portable. The libraries are written and provided by Presagis and do not need to be modified.

Generated Code

This layer of code implements the functionality as defined by the VAPS model. The generated code is specific to each application.

User Code

User code typically performs I/O, any additional data processing, fills VAPS QCG channel buffers, and calls VAPS QCG to draw.

Designed to generate code in a consistent and reliable way, VAPS QCG eliminates the need for the manual coding of VAPS graphics, logic, and behavior. VAPS QCG may also be used to generate either desktop executables for review and prototyping purposes or highly optimized code for porting to embedded systems. The optimizations include reduced generated code size, reduced frame loading time, reduced run time transformations, and increased drawing speed. The entire process, from the creation of a VAPS model to a fully functional executable, can take just a few minutes. The result is a reliable process that saves significant amounts of time in both the design and verification phases of embedded development, as well as reduces dependencies for specialized internal skill sets.

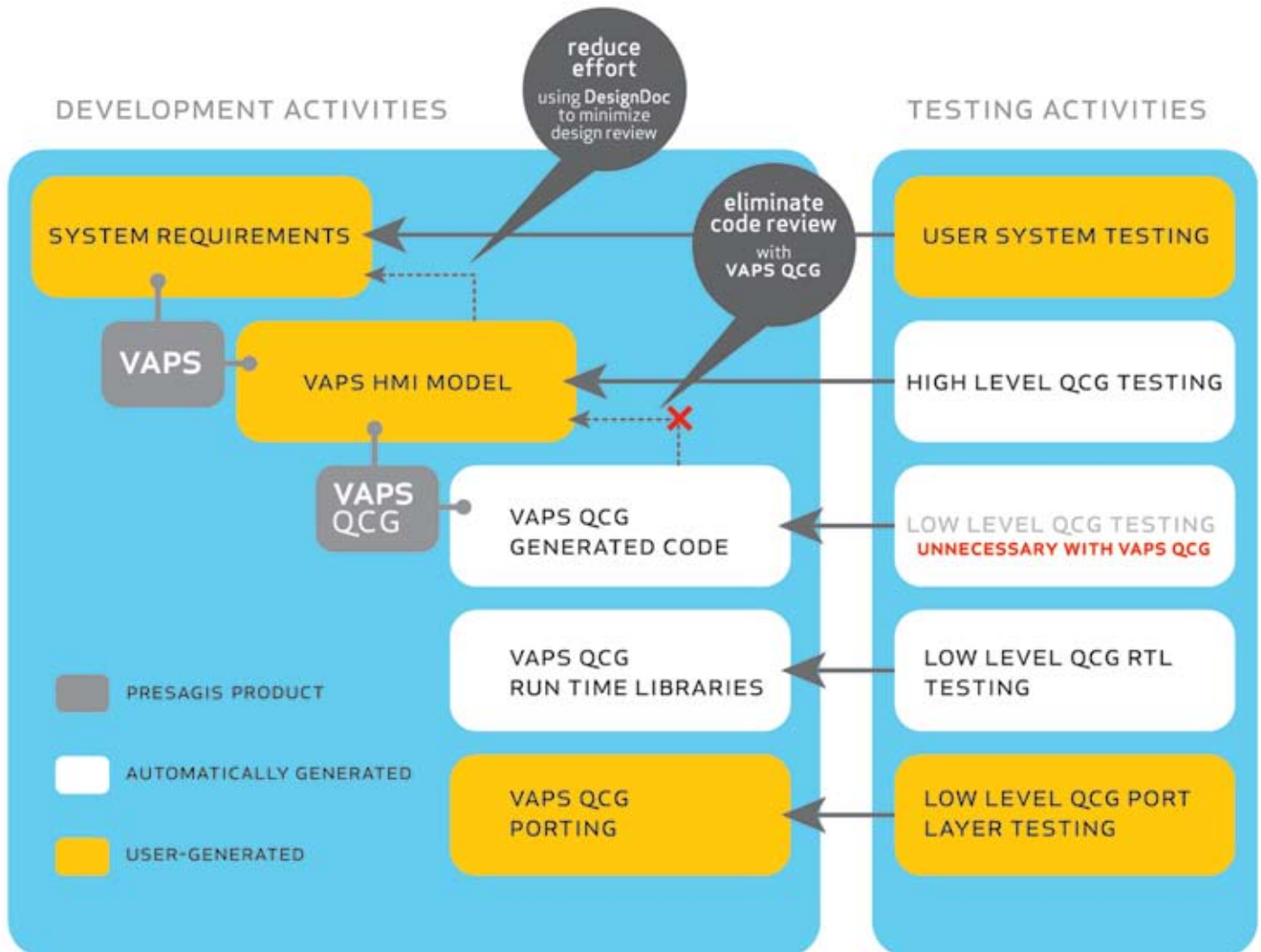


Figure 3. Realize time/cost savings by using VAPS to model graphics from the generation of system requirements through to the design phase of a project and by using VAPS QCG to generate code from design through to the implementation phase. In addition, reduce low level testing with the QCG and Run Time Libraries.

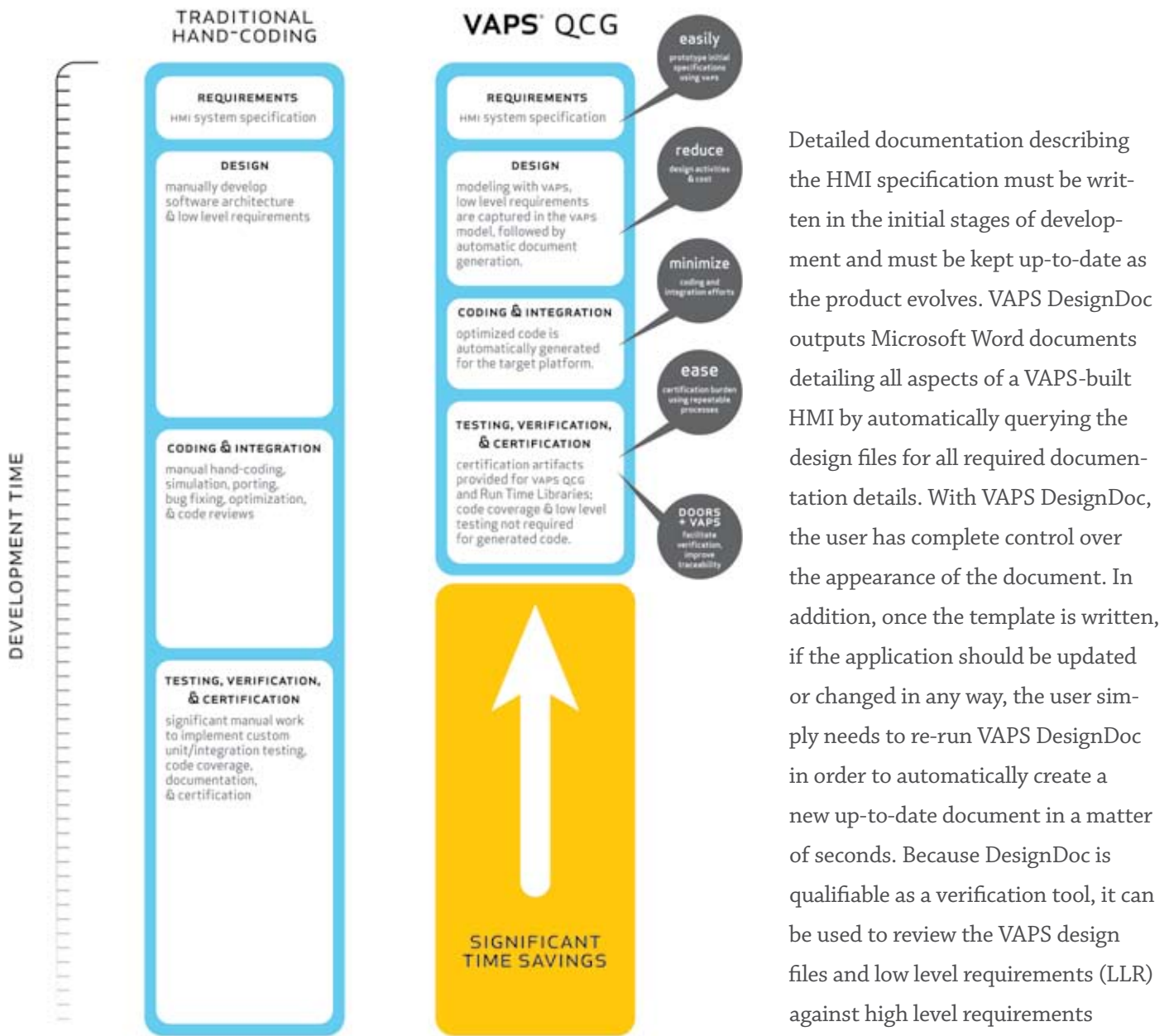


Figure 4. Traditional hand-coding and certification of embedded displays can result in delays and cost overruns in both the development and certification processes. Using VAPS QCG, together with repeatable, proven processes, reduces risk and facilitates better time to market.

Detailed documentation describing the HMI specification must be written in the initial stages of development and must be kept up-to-date as the product evolves. VAPS DesignDoc outputs Microsoft Word documents detailing all aspects of a VAPS-built HMI by automatically querying the design files for all required documentation details. With VAPS DesignDoc, the user has complete control over the appearance of the document. In addition, once the template is written, if the application should be updated or changed in any way, the user simply needs to re-run VAPS DesignDoc in order to automatically create a new up-to-date document in a matter of seconds. Because DesignDoc is qualifiable as a verification tool, it can be used to review the VAPS design files and low level requirements (LLR) against high level requirements (HLR).

When using Telelogic DOORS, the VAPS integration with DOORS allows the user to link DOORS requirement

IDs to VAPS objects. This allows the user to maintain traceability for the VAPS application within DOORS. As the DOORS requirement IDs are saved in VAPS as well, they are included in documents generated by DesignDoc, thus facilitating review.

VAPS QCG PACKAGING & TECHNICAL OVERVIEW

VAPS QCG includes the following elements:

Code Generator & Run Time Libraries

VAPS QCG is a code generator that generates embeddable C-code directly from VAPS Metafiles for applications requiring DO-178B level A or ED-12B certification.

VAPS Developer License

VAPS Developer is used to model HMI applications for embedded avionics systems.

Telelogic DOORS™ interface license

This interface integrates VAPS with DOORS, the most popular requirement traceability product, to enhance users' control of their deliverables by providing a link between the original product requirements and the end product.

VAPS QCG Certification Kit (optional):

DO-178B Artifacts

- Plan for Software Aspects of Certification (PSAC)
- Software Accomplishment Summary (SAS)
- Software Configuration Index (SCI)
- VAPS QCG Run Time Design documents
- VAPS QCG High Level Run Time behavior test cases
- Access to complete VAPS QCG development artifacts

VAPS DesignDoc

The certification kit provides all of the necessary certification artifacts in support of a customer's certification efforts. Presagis DesignDoc is a "verification" tool included in the VAPS QCG Certification Kit that facilitates the review of VAPS design files against original high level customer design requirements as part of the necessary

certification process. DesignDoc is qualifiable as a verification tool under DO-178B in support of these programs.

Target Platform Support

VAPS QCG supports virtually all embedded target platform configurations through a porting layer, including – but not limited to – combinations of the following popular products:

Real-time Operating System Support

- Wind River VxWorks AE653
- Green Hills Integrity-178

Drivers Support

- Seaweed Systems SeaWind/178 Certifiable Graphics Software
- Alt Software DO-178B drivers

Embedded Computing

- GE Fanuc
- Curtiss Wright

Code Language

Both the QCG generated code and Run Time Libraries are a subset of ANSI C in accordance with Motor Industry Software Reliability Association (MISRA) guidelines.

Downward compatibility

Applications developed for VAPS QCG may also be code generated using the following Presagis code generators:

- VAPS C-code Generator (CCG)
- VAPS CCG Lite

VAPS Qualifiable "Mode"

The Qualifiable "Mode," an additional time saving feature in VAPS, allows users to validate that the VAPS application is QCG 'compliant' before using VAPS QCG to generate the code. The validation process ungroups, removes, or changes invalid VAPS objects, files, and channels found in the VAPS application. While manually validating an application containing hundreds or even thousands of files would be a tremendously time-consuming process, any VAPS application can be quickly and automatically validated by using the VAPS Qualifiable mode. Once the validation process has been completed, the user can proceed with VAPS QCG code generation.

PROFESSIONAL SERVICES & DO-178B CONSULTING

Look to Presagis Professional Services for further time and cost savings

The following professional services packages from Presagis can help to both shorten development time-to-market and reduce the cost of safety-critical embedded display projects:

Program Start Up

“Program Start Up” is targeted to customers who are undertaking a new project, are currently lacking sufficient tool experience, are under strict deadline, or are eager to show early proof of concepts. A perfect complement to both our training courses and award-winning documentation, the “Program Start Up” package gives users the opportunity to learn about their Presagis products directly from an expert who will also properly install and configure these tools. Using “Program Start Up” can dramatically improve quality while accelerating development. It can also help users to reduce both ramp-up time and business risk through the efficient and focused configuring of the Presagis products required for their project.

Expert Help

Presagis maintains some of the top embedded and simulation talent in the world. With over ten years of experience helping customers to successfully accelerate their programs, Presagis consultants have the necessary skills and expertise to lower costs and reduce business risk. During the initial planning stages, “Expert Help” provides Evaluation Assistance for customers interested in evaluating the technology before investing in the products. During development, customers use the “Expert Help” service as a resource to complement their own staff; Presagis consultants are developers and subject matter experts who help to reduce the costs associated with training staff in seldom used skill sets and with extended ramp-up times.

Content Creation

Presagis Professional Services offers customers the opportunity to outsource their embedded and simulation content creation needs to experienced and qualified Presagis consultants. With the “Content Creation” service package, Presagis consultants ensure that customer specifications are properly specified and then develop high quality content either on site or remotely. The outsourcing option provided by this service package is a perfect solution for customers concerned about meeting program deadlines or requiring critical path assistance. The package is also an ideal way to reduce business risk and to save on having to hire or develop in-house specialized skill sets since content creation is done by subject matter experts.

CASE STUDY

The following is a high level description of a typical Original Equipment Manufacturer (OEM)/Supplier relationship within the development of an avionics display system. While this Case Study explains the uses of VAPS QCG within a particular workflow, the various roles of the supplier and OEM could differ from this example.

The first step involves the OEM creating a detailed system specification that includes the following:

- HMI specifications, including VAPS design files.
- Software architecture requirements, including the real-time operating system selection.
- Hardware parameters.
- Many other relevant system details.

...continued

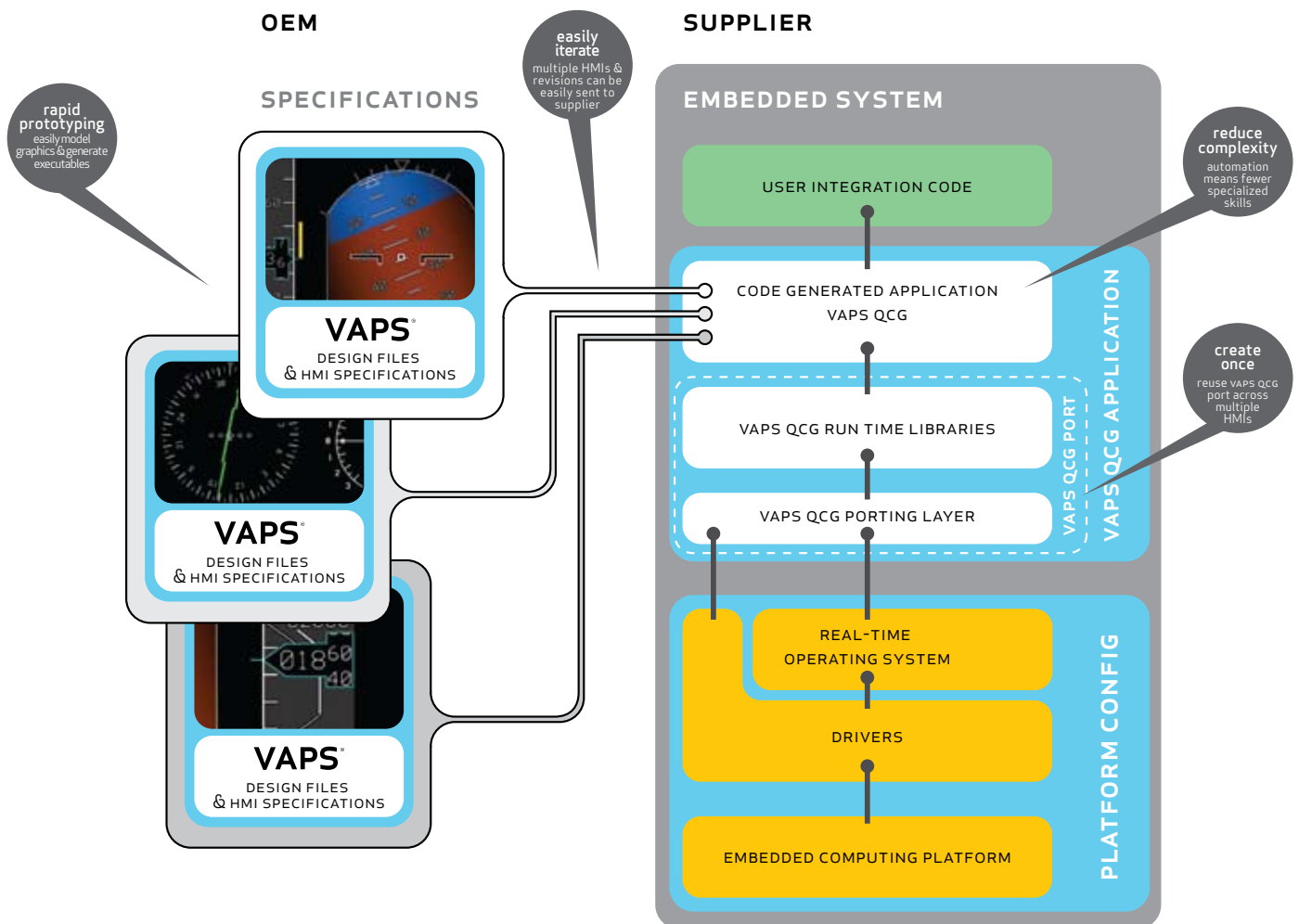


Figure 5. Using VAPS QCG, the OEM can easily communicate design requirements to the supplier, allowing the supplier to make modifications and to communicate the results back to the customer—often within minutes. Customers also save additional time and money by re-using the underlying platform architecture and porting layers on subsequent projects.

Then, the supplier uses the system specification document as a primary guideline for the development of the system. To begin, the supplier develops the integrated hardware and driver platform and then integrates and optimizes the RTOS for the target hardware. The supplier then ports the VAPS QCG Run Time Libraries to the target RTOS/Hardware platform, resulting in a platform that does not need to be modified for each subsequent HMI application and system. This porting activity can also be accomplished by the Presagis Professional Services group.

Next, the supplier code generates the VAPS Design Files for the target platform by using VAPS QCG. Changes to the HMI specification can now be immediately deployed to the target system using VAPS QCG automatic code generation.

In the final step, the system is certified DO-178B jointly by the OEM and the supplier. Since VAPS QCG is a qualifiable tool to be used under DO-178B, this must be declared in the end-user system PSAC. The supplier performs the low level verification of the porting layer, which can, in turn, be used across multiple projects. In addition, verification of the VAPS HMI is performed as part of the complete system validation and testing. At this point, DesignDoc automatically generates detailed documents, including display formats, that are extremely useful for verification activities.

The benefits for the OEM of using the VAPS QCG approach are as follows:

- The OEM has complete control and ownership of the display format and resulting Intellectual Property (IP).
- Changes to the VAPS display format can be easily communicated to the supplier and implemented in a matter of minutes without any modification to the underlying platform.
- Development artifacts used in a VAPS QCG port for a specific platform configuration can be re-used across multiple projects sharing that same configuration, thereby leading to important reductions in development time and certification effort.
- New HMI applications can be developed and have code generated to the target platform as well, resulting in additional time/cost savings.
- The use of COTS tools provides the OEM with the option to take more control of the project by choosing to perform the VAPS QCG porting work without the need for specialist knowledge.
- The use of VAPS QCG on subsequent projects greatly reduces risk because VAPS QCG will have been recognized as certifiable on previous projects.

The VAPS approach also provides the supplier with the following benefits:

- Fewer programming and specialized skill sets required.
- Faster time to market, greater reliability, and overall better service to the OEM.

FAQ

When was VAPS QCG first launched?

VAPS QCG was launched in 2000 with international customer involvement, including Eurocopter, Barco, Smiths, and Elbit.

How does the VAPS/DOORS integration save time in verification?

The VAPS/DOORS interface enhances the user's control of deliverables by providing a link between the original system requirements and the implementation. The interface provides the capability to assign a DOORS requirement ID to VAPS objects, making it simpler to track changes for hundreds, or even thousands, of objects. The requirements and objects are reusable from project to project, thereby further reducing time and cost.

Which is the proper term used to describe VAPS QCG – qualifiable or qualified?

VAPS QCG has been developed to conform to DO-178B as a development tool and is thus qualifiable. As per DO-178B, tools can only be qualified on a given project. VAPS QCG has been qualified on a number of projects using the Certification Kit 'off-the-shelf'.

How many programs has VAPS QCG been qualified on?

Today there are more than 15 programs using VAPS QCG, with more being added every month. Ask your sales representative for a complete list.

Does Presagis plan to continue supporting VAPS QCG for years to come?

Absolutely. DO-178B certification is becoming increasingly important to customers, and Presagis will support VAPS QCG for as long as necessary in order to support its growing user base.

How does DesignDoc automatically generate documentation for verification?

VAPS DesignDoc uses a proprietary technology to output Microsoft Word documents detailing all aspects of a VAPS-built HMI by querying the design files for all the required details. Because DesignDoc is qualifiable as a verification tool, it can be used to review the VAPS design files and low level requirements (LLR) against high level requirements (HLR). When using Telelogic DOORS, the VAPS integration with DOORS allows the user to link DOORS requirement IDs to VAPS objects. This allows the user to maintain traceability for the VAPS application within DOORS. As the DOORS requirement IDs are saved in VAPS as well, they are included in documents generated by DesignDoc, thus facilitating review.

Do I have access to the full set of certification artifacts for VAPS QCG?

The full set of artifacts is available, providing that the VAPS QCG Certification Kit was purchased.

How much time and cost savings can I realistically expect to achieve using this product?

Time and cost savings are tightly linked to several factors, including the number of engineers working on the project, user experience, and the complexity

of the actual application being built. Specific users have indicated that 70-80% time savings across an entire project is not an unrealistic metric. It is advisable to speak with your sales representative in order to help you work through a sample project in order to get an accurate estimate for your specific deliverable.

I am concerned about performance. Are there metrics available for final systems developed using VAPS QCG?

Performance will be dictated largely by the target platform and the complexity of the application; however, with VAPS QCG, users can expect excellent performance for most mainstream avionics applications. VAPS QCG has met or exceeded embedded refresh targets on some of the most demanding customer applications. Speak with your sales representative for specific platform/application metrics examples.

I have a proprietary target platform requirement for my embedded system. Can I still use VAPS QCG?

Yes. The porting layer allows VAPS applications to be ported successfully to any embedded target, even proprietary ones.

Are Presagis VAPS QCG engineers available in order to help me through my certification project if necessary?

Yes. The product architect and the VAPS QCG engineering team are available and have helped many customers with certifications in the past. Additionally, Presagis Professional Services team is always available for any special or custom work that may need to be done on your project.

VAPS QCG CUSTOMERS

THALES Avionics

Project: Helicopter Projects

DATEL

Project: Pilatus PC21

ELBIT

Project: Eurocopter Tiger

BAE Systems

Project: Eurofighter Typhoon

GALILEO

Project: Fast Jet Programmes

BARCO

Project: Eurocopter Super Puma

SMITHS

Project: Helicopter Projects

BARCO

Project: Pilatus PC21

EADS

Project: Aircraft Program

BARCO

Project: Saras (Indian Aircraft)

LOCKHEED MARTIN (Owego)

Project: US101 (Presidential Helicopter)

LOCKHEED MARTIN (Marietta)

Project: C5 Amp

CMC ELECTRONICS

Project: Military Aircraft Program



talk to us.

Your feedback is important to us.

At Presagis, we want to ensure that our solutions meet our customers' needs. With the integration of object-oriented menus, 2D moving maps, 3D, and live-video into commercial and military cockpits, safety-critical standards will now apply to a whole new generation of technology.

By working to keep [VAPS QCG](#) at the forefront of innovation, Presagis ensures that our qualifiable code generator will help avionics developers to certify their software efficiently for all current and future elements of their embedded system.

We welcome the opportunity to discuss how VAPS QCG can help you to meet your project's certification needs.

sales offices

PRESAGIS WORLDWIDE

4700 de la Savane, Suite 300
Montréal (Québec)
H4P 1T7 Canada

+1 514 341-3874
+1 800 361-6424
+1 514 341-8018

PRESAGIS USA

1301 W. George Bush Freeway
Suite 120
Richardson, TX 75080 USA

+1 972 943-2400
+1 469 467-4563

PRESAGIS UNITED KINGDOM

St. Mary's House, 40 London Road
Newbury, Berkshire
RG14 1LA U.K.

+44 (0) 1635-262-724
+44 (0) 1635-528-701

PRESAGIS FRANCE

41 bis, Avenue de L'Europe
78140 Vélizy
France

+33 (0) 1-34-63-02-46
+33 (0) 1-34-63-02-48