

Embedded System Testing

Ensuring system safety & robustness
through automatic system testing.



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MAKING YOUR EMBEDDED SYSTEM SAFE, RELIABLE AND ROBUST

The increasing complexity and safety-integrity requirements of embedded components and systems are a real challenge for the mission-critical industries. With several highly-critical functions being controlled by embedded systems with complex software, the assurance of quality is a must.

To guarantee the necessary levels of safety, industry safety standards (e.g. DO-178C, EN 20126, IEC 61508) address the planning and development of safety-critical systems for each of the respective industries. The higher the Safety Integrity Level (or Design Assurance Level - DAL) of a specific system, the higher the complexity of the Verification & Validation (V&V) requirements. For the highest levels, up to 40% of the development effort easily goes into V&V and safety management activities.

Every year, problems with airplanes, trains or medical devices increase manufacturer' operational costs and cause significant brand damage. Getting embedded software systems right first time is crucial. The quality and safety of the end product is of the highest importance and time-to-market is critical.

OUR EXPERTISE

Our engineers are experts in hardware-in-the-loop (HIL), and software-in-the-loop (SIL) V&V techniques, compliant with the most

common industry standards (ARP 4754, DO-178, DO-254, EN 20126/8/9, IEC 61508, MIL-STD-882, IEC 62304, among many others).

Our capabilities include:

- Architecture, design and formal code reviews, with a particular focus on the optimisation of code structure and maintenance, memory and CPU budgets, functional safety and correct-by-design.
- Validation activities through HIL and SIL techniques, including open and closed-loop testing, using simulated target environments and/or the actual target hardware.
- Independent validation activities, focusing on stress-testing and robustness-testing using fault injection and our state-of-the-art in-house Xception tool.

When conducting system safety and reliability assessments, activities are tailored to the specific criticality level of the system. These usually include hardware, software and system-level formal analysis techniques aimed at mitigating risk.

Commonly referred to as 'RAMS', these include:

- Reliability Block Diagrams (RBDs)
- Fault Tree Analysis (FTAs)
- Failure Mode Effects and Criticality Analysis (FMECAs)
- Hazard Analysis (HA), and Hazard & Operability Studies (HAZOP)
- Risk Assessment and Management
- Hardware Software Interaction Analysis (HSIA)

With a strong culture and extensive hands-on experience of safety-critical projects, our engineers are knowledgeable in typical low-level embedded architectures including micro controllers, micro-processors and FPGAs.

OUR OFFER

Critical Software is able to:

- 1)** Design and deploy qualified validation solutions, tailored to the needs of our clients.
- 2)** Provide testing, verification & validation of complete embedded systems.
- 3)** Provide independent reliability & safety assessments, and independent verification and validation of systems, including robustness testing and fault injection.

How to guarantee an efficient and safe system integration?

How to improve the overall robustness, reliability and safety of systems?

How to deal with increasing complexity in a structured and systematic manner?

How to improve the time-to-market, while meeting all robustness goals?

How to improve efficiency and optimise resource usage?

How to reduce development and production costs, significantly improving overall competitiveness?

Hardware-in-the-loop system validation facility.

A case study in embedded system testing.

CHALLENGE | COST-EFFECTIVE FORMAL VALIDATION

Developing safety-critical and mission-critical software is costly, mainly due to the multiple levels of specification and the corresponding levels of verification. In addition, records of all activities must be duly produced and stored, ensuring the whole process is auditable. In the case of the most demanding standards, the formal verification and validation activities account for more than 40% of the total project effort. When done manually, verification is time consuming and prone to errors.

SOLUTION | AUTOMATED HARDWARE-IN-THE-LOOP VALIDATION FACILITY

Critical Software has developed an automated hardware-in-the-loop System Validation Facility (SVF), supporting fully-automated execution of test scripts and fully-automated checks, ensuring completely automated test campaigns, resulting in high productivity levels.

To address the various needs of the system under test, Critical Software's SVF is based on a highly-configurable and extendable base solution, providing the following interfaces out of the box:

- Analog IO – dozens of AC, DC and discrete inputs and outputs are available for testing, with variable ranges of voltages, currents and wave types.
- Digital IO – CAN, RS485, RS422, NTDS and ethernet, among many others.

Critical Software's SVF also

supports fault injection directly into the microprocessor of the system under test, allowing the stimulation of built-in tests without using instrumented software builds. By automatically coordinating the complete set of inputs and outputs, the SVF is able to verify timing requirements in the order of milliseconds.

RESULTS | PRODUCTIVE VALIDATION CAMPAIGNS FOR HIGH CRITICALITY LEVELS

Critical Software's SVF enables easy implementation and fast execution of test campaigns. Regression testing becomes much more efficient, allowing more aggressive and extensive test policies. This provides higher levels of confidence on the system under test. Regression testing effort and schedule demands are dramatically reduced when compared to manual or semi-automated testing.

In addition, since tests are automated they are not prone to manual execution errors, are deterministic and follow a pre-planned execution time. Automation allows the execution of larger regression test campaigns without extending testing effort and provides more accurate inputs for effort estimation.

TECHNOLOGIES & FEATURES

- Certification to the highest criticality level
- Automated hardware-in-the-loop testing
- Fault injection for safety integrity testing
- Highly-configurable reports





REAL ADDED VALUE

Critical Software can help your company build more robust embedded systems, faster. Either by allowing you to offload V&V tasks, as well as RAMS related activities, or by increasing your development team's capacity.

We offer fixed-price projects and tailored solutions, while maintaining flexibility. Our highly-specialised engineering team can integrate with client teams, or work standalone in our offices located throughout Europe. We can also connect directly with end-client locations, if required.

We are at the forefront of technological innovation in embedded systems. Our commitment allows us to go beyond our clients' initial expectations. We add value to our clients' products by focusing on our core V&V and RAMS capabilities, using our unique fault injection techniques and tools. We help by significantly increasing robustness and significantly decreasing the number of defects at delivery. Simultaneously, we possess detailed knowledge about embedded systems from a developing point of view.

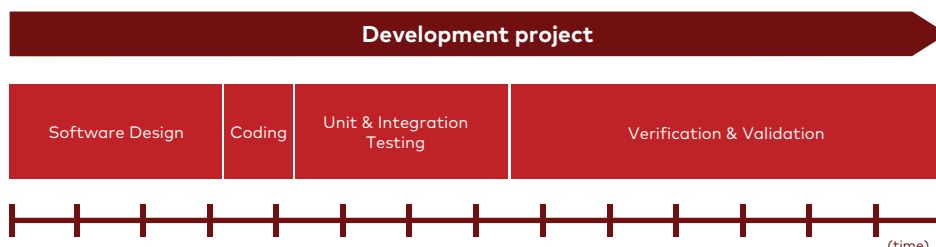
We enable the development of more efficient end-products, reducing production and evolution costs, helping our clients to gain a sustainable competitive advantage.

ABOUT CRITICAL SOFTWARE

Critical Software provides systems and software services for safety, mission and business-critical applications. We work closely with our clients, helping them to meet the most demanding standards for performance and reliability.

We were founded in 1998, with NASA our very first client. Today, we work across many international industries and have offices across the globe.

Shortening development time without compromising on quality.



We combine software development with V&V and RAMS analysis to improve quality and reduce time to market, with a significant positive impact on the overall life cycle.