Service-Oriented Architectures for Complex Safety-Critical Embedded Systems: A Case Study on UAVs

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Embedded systems are computing systems that are part of a larger system. They provide a predefined set of tasks, normally dedicated to a particular real-time application, and present special requirements. In fact, they typically provide real-time monitoring and control for an entire system. These systems are considered to be safety-critical when failure events can lead to human life losses or high valued asset losses. In some applications, such as in aviation, safety-critical embedded systems must present failure rates as low as a serious fault every $10^6$ to $10^7$ hours of operation.

Service Oriented Architecture (SOA) are having a widespread use in enterprise computing applications, being Web Services the most common implementation. The use of SOA has also been proposed for embedded systems, although very little could be found in the literature on the use of SOA for Safety-Critical Embedded Systems.

The authors discuss whether Web Services are suitable or not for embedded systems. While the use of SOA in the business application domain is well established, several aspects must be considered in the embedded systems domain, mainly the availability of enough resources (processing power and memory size). Embedded systems are attached to the fast growth of the Internet, communication technologies, pervasive computing and portable consumer electronics. System sizes range from the tiny to the big, complex mc ulticore systems. In many of them there are not enough resources to make possible the use of Web Services.

This paper encourages the use of SOA in the normally bigger non-critical sections of complex safety-critical embedded systems. This provides a simple approach to the problem, allowing the use of different paradigms to solve different parts of a complex system, avoiding the disadvantages already mentioned.

As a case study, an UAS (Unmanned Aerial System) reference model is proposed. The system was modeled (a layered reference model), showing its critical and non-critical sections. Services and protocols between layers are under development. The advantages of the use of SOA are discussed, easing the implementation of many high-level functions.

SOA shows to be a promising approach to implement parts of this reference model, especially in what concerns the missions played by the aircraft.

This paper also proposed a framework KBF (Knowledge Based Framework) to allow the use of SOA in the non-critical parts of Safety-Critical Embedded Systems, helping the implementation of the SSI (Smart Sensor Interface) and SSP (Smart Sensor Protocol), as they are good first candidates for application of the ideas presented in this paper.

Index Terms— Safety-Critical Embedded Systems, Unmanned Aerial Vehicles, Service Oriented Architecture

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References


