Adaptability and Reconfiguration Automotive Embedded Systems

Modern vehicles have become increasingly computerized to satisfy the more strict safety requirements and to provide better driving experiences. Therefore, the number of electronic control units (ECUs) in modern vehicles has continuously increased in the last few decades. In addition, advanced applications put higher computational demand on ECUs and have both hard and soft timing constraints, hence a unified approach handling both constraints is required. Moreover, economic pressures and multi-core architectures are driving the integration of several levels of safety-criticality onto the same platform. Such applications have been traditionally designed using static approaches; however, static approaches are no longer feasible in highly dynamic environments due to increasing complexity and tight cost constraints, and more flexible solutions are required. This means that, to cope with dynamic environments, an automotive system must be adaptive; that is, it must be able to adapt its structure and/or behaviour at runtime in response to frequent changes in its environment. These new requirements cannot be faced by the current state-of-the-art approaches of automotive software systems. Instead, a new design of the overall Electric/Electronic (E/E) architecture of a vehicle needs to be developed. Recently, the automotive industry agreed upon changing the current AUTOSAR platform to the “AUTOSAR Adaptive Platform”. This platform is being developed by the AUTOSAR consortium as an additional product to the current AUTOSAR classic platform. This is an ongoing feasibility study based on the POSIX operating system and uses service-oriented communication to integrate applications into the system at any desired time. The main idea of this thesis is to develop novel architecture concepts based on adaptation to address the needs of a new E/E architecture for Fully Electric Vehicles (FEVs) regarding safety, reliability and cost-efficiency, and integrate these in AUTOSAR. We define the ASLA (Adaptive System Level in AUTOSAR) architecture, which is a framework that provides an adaptive solution for AUTOSAR. ASLA incorporates tasks-level reconfiguration features such as addition, deletion and migration of tasks in AUTOSAR. The main difference between ASLA and the Adaptive AUTOSAR platform is that ASLA enables the allocation of mixed critical functions on the same ECU as well as time-bound adaptations while adaptive AUTOSAR separates critical, hard real-time functions (running on the classic platform) from non-critical/soft-real-time functions (running on the adaptive platform). To assess the validity of our proposed architecture, we provide an early prototype implementation of ASLA and evaluate its performance through experiments. Keywords: AUTOSAR, E/E architecture, Runtime adaptation, Real-time systems