Real-Time Systems for Industrial Use: 
Requirements for the Future

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The current industrial use of real-time systems can be divided into two categories. High end systems, where commercial RTOS solutions have the main share, and low end systems, which are often driven by custom-built proprietary solutions based on a main program loop and interrupt handlers due to the traditionally restricted computing power of micro-controllers. The requirements for current industrial real-time systems are specific to the primary task of the device.

The power of micro-controller platforms has increased significantly in recent years, making a more general software architecture for real-time controllers attractive. Increased power also increases the motivation to extend the duties of these controllers with a broad range of functionality, including non-real-time aspects not supported by traditional RTOS platforms. In addition, the range of applications with real-time components is expanding as well, with audio and video streaming being obvious but not unique examples. All of these trends are helping to erode the familiar distinction between real-time and non-real-time systems, increasing the need for a new approach combining the abilities of general purpose OS platforms with the low-level resource control capabilities of existing RTOS platforms. No existing platform can satisfy all of these requirements.

Commercial providers are already extending the RTOS functionality by merging new functions including network connectivity, file systems, and graphic user interfaces into the real-time core. A different approach is the extension of a non-real-time OS with real-time functionality. WindowsCE is an example of an attempt to provide a limited set of real-time functionality on top of a multimedia centric general OS. Both of these approaches satisfy a limited audience because of their cost, and because they provide limited programming models.

On the other hand we see a rapidly growing use of Open Source Software (OSS), especially Linux. The main benefit of OSS in these industrial applications is increased control over the system, along with scalability and flexibility; lower cost is a secondary attraction. The attraction of OSS for research is the ability to publish solutions. However, the available real-time extensions for Linux have some major disadvantages, which create a set of constraints that need to be satisfied by researchers addressing emerging industrial real-time requirements within an OSS platform:

1. Scalability and portability
2. User selectable programming models
3. User selectable interrupt handling mechanisms
4. Design and modeling tools

A platform with these features would be useful for both industrial applications and academic research. It would also serve as an excellent path for transfer of research results into industrial practice. Use of a common platform would also increase the precision with which researchers and practitioners could discuss requirements and ideas. Scalability and portability are already features of Linux, but these properties must be preserved when adding real-time features and must be enhanced for embedded applications. A pluggable programming model should include the ability to select an existing scheduling algorithm or implement a new one, as well as the ability to select the API used by executing programs. This is necessary because the semantics of industrial applications varies widely, and because it will smooth the transition of current applications to the new platform. Design and modeling tools for selection of appropriate components and the prediction of their behavior would be an important area of interest of researchers and a benefit for all users.

The full paper will give a short overview of currently available approaches and discuss the requirements of current and future real world real-time applications. It will also consider the advantages of an OSS real-time platform for researchers and industrial users and point out the areas where researchers should pay more attention in order to build fully useful systems for industrial use.