Object-oriented Framework Architectures for Embedded Systems

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The tutorial presents how software frameworks can be developed for embedded systems. The Software Research Lab has successfully completed an ambitious project under a research contract for the European Space Agency and Nokia Research. The resulting framework for satellite control systems is innovative in the methodology used to design it, in the architectural solutions it proposes, and in targeting a domain - that of embedded, mission-critical, hard real-time systems - that has been comparatively neglected in framework research so far. The tutorial advocates the view that frameworks are artefacts offering three types of constructs to application developers: abstract interfaces, domain-specific design patterns and components. It then proceeds to describe the architecture of the framework. Inspiration for its design was drawn from an analysis of Real Time Operating Systems (RTOS) taken as models for reusable components in the embedded field. It is argued that satellite control systems can be conceptualized as collections of functionality managers similar to RTOS's and that the framework can be seen as a domain-specific extension to the operating system. This analysis of the framework architecture shows that design patterns and abstract interfaces, rather than concrete components, are the true foundation of a framework. This insight was used to propose a design process for frameworks that hinges on the division of the framework into so-called framelets. Framelets are units of design that simplify framework development by partitioning the space of design-patterns and abstract interfaces. They are to frameworks what subsystems are to individual applications. The experience from using the framelet approach in the satellite control system project is also presented. Finally, the constraints imposed on the framework architecture by the real-time character of satellite systems are discussed and it is argued that the proposed framework separates the functional architecture from scheduling issues.

Wolfgang Pree is a professor of computer science at the University of Constance and currently visiting the Department of Computer Sciences at the University of California, Berkeley. He has worked for many years in various areas of software engineering, in particular focusing on object-oriented software development, software architectures, frameworks, and human-computer interaction. Wolfgang is the author of Design Patterns for Object-Oriented Software Development (Addison-Wesley, 1995) and co-author of an upcoming book on The UML-F Profile for Framework Architectures (Addison-Wesley, Pearson Education, 2001).

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