The SPES modeling framework allows seamless, model-based development of complex embedded software. It defines structures, content, and concepts used in artifacts. One major challenge when engineering embedded systems is to consider the synchronization between different engineering disciplines at the process and artifact level in a coherent manner. In this chapter, we present an extension for the SPES modeling framework supporting the close integration of systems engineering based on ISO/IEC 15288 with software engineering based on ISO/IEC 12207 and software-related engineering disciplines by using the core concepts of the SPES modeling framework as the foundation for a general engineering philosophy for the architectural design of embedded systems.
5.1 Introduction

A multitude of disciplines are involved in the engineering of embedded systems. One major challenge here is to consider the synchronization between different engineering disciplines at the process and artifact level in a coherent manner. Process standards address this challenge by defining a transition between the activities involved from the disciplines but they do not provide sufficient support with respect to the corresponding artifacts and their relationships. The missing artifact-oriented integration of the engineering disciplines (e.g., electrical engineering, software engineering, and mechanical engineering) within the systems engineering process leads to error-prone and cost-intensive synchronizations.

Existing standards which aim to integrate engineering disciplines at the systems and software engineering process level — such as ISO/IEC 12207 [ISO/IEC 12207], ISO/IEC 15288 [ISO/IEC 15288], and ISO/IEC 29148 [ISO/IEC/IEEE 29148] — typically try to achieve integration by proposing activities and corresponding relationships between them within the related disciplines. This means that for each activity, we define which other activities need to be performed as a prerequisite because these activities provide necessary input (see also Section 3.3). Typically, existing process approaches that also consider artifacts for describing the input and output of the activities do this only at an abstract level (e.g., V-Model_XT [Rausch et al. 2005]). On the other hand, artifact-oriented models that are defined in a formal way (e.g., [Gausemeier et al. 2007, Braun et al. 2010]) lack support for a recursive system structure as defined in ISO/IEC 15288. Furthermore, these approaches typically focus only on relationships between some specific artifact types from different disciplines.

In this chapter, we present an approach that enables close integration between the different engineering disciplines based on standard processes using the core concepts of the SPES XT modeling framework. The underlying artifact model of the SPES XT modeling framework facilitates the seamless integration of the corresponding systems and engineering processes. The explicit concept of viewpoints and granularity layers combined with the artifact model enables the SPES XT modeling framework to also support the required recursive engineering of embedded systems.