Software has become the driving force in the development of self-optimzing mechatronic systems. Such systems include hard-realtime coordination, which is realized by software, at the network level between distributed componentes as well as controllers which are more and more implemented by software. The communication goes beyond the use of system and environmental data from controlers. If necessary, complex status information about appropirate protocols and communication channels are exchanged, which themself can massively influence the underlying behavior of the individual components. This development leads to extremely complex hybrid (discrete / continuous) software. In addition, self-optimizing mechatronic systems are often used in safety-critical environments. This enforces the use of formal verification techniques to ensure the correctness of specified properties. In the context of this thesis new concepts and methods for the modelling and verification of these mechatronic systems are introduced and formally described. The new approach is based on the Mechatronic UML approch, developed in the Collaborative Research Center 614, which already supports a compositional verification approach for the pure real-time behavior of mechatronic systems. In order to enable an efficient verification for such mechatrinic systems, techniques like abstraction, decomposition as well as rule-based modelling are introduced. Here, these non orthogonal techniques are skillfully combined. One aim is to handle all models specified by all different domains. The new approach for the model-based verification of mechatronic systems is massively characterized by the integration of efficient verification techniques for the different domains, based on their domain specific model-based knowledge.