

# ***Abstract: Combining UML and Formal Notations for Modeling Cyber Physical Systems***

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## **Abstract**

The modeling of cyber physical systems presents many challenges because of their complexity, distribution, real-time and strong fault-tolerance requirements. UML, aspect-oriented programming, and formal notations are three hot research areas that have been around for several years now. As the standard of object-oriented analysis and design modeling language, UML has a wide range of applications and has been considered as de facto standard in software development. Aspect-oriented programming can effectively solve the crosscutting problem by adopting aspect to encapsulate the crosscutting concerns and therefore improves the system's reusability. Formal methods are promising approaches for proving the correctness of software. In this paper, we present how these three paradigms can be put together in the context of a new software development method and show how they can complement each other at different stages in the development life-cycle of cyber physical systems. The proposed approach combines UML and a formal design framework, which is based on a multi-set transformation language and coordination language, for modeling cyber physical systems. Models are written in UML. Non-functional aspects such as distribution, real-time, and fault-tolerance can be expressed in different formal notations separately from the functional aspect. The functional and non-functional aspects can be woven into cyber physical system by using state charts. In this way, developers can exploit the advantages of formal notations while skipping the complex formal modeling phase. The proposed approach can facilitate specification-driven design. At the same time, enable design reuse, and formal validation at the requirement specification level. An application example of elevator system depicts how the approach can be used.

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