Formal Modeling of Environmental Monitoring Systems Using Event-B: Challenges and Opportunities

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Abstract

Environmental monitoring systems are critical for detecting, analyzing, and responding to ecological changes, pollution events, and natural hazards. Ensuring their reliability, correctness, and safety is essential, especially when deployed in high-stakes scenarios such as water quality surveillance, air pollution tracking, or climate data acquisition. This paper explores the application of Event-B and the Rodin platform for the formal modeling and verification of environmental monitoring systems. We identify key challenges such as handling sensor uncertainty, modeling dynamic environmental interactions, integrating heterogeneous data sources, and maintaining scalability in formal specifications. Additionally, we examine opportunities for leveraging formal refinement to build trust in system behavior from specification to implementation. Through case studies and modeling examples, we demonstrate how Event-B can enhance system robustness, facilitate early detection of design flaws, and support compliance with regulatory frameworks. We conclude by outlining future directions for integrating formal methods into sustainable environmental technologies and decision support systems.