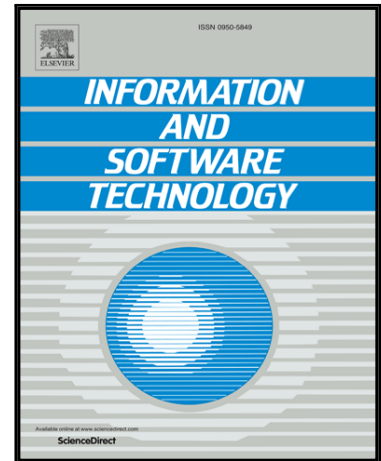


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Analyzing and Visualizing Information Flow in Heterogeneous Component-Based Software Systems

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Abstract

Context: Component-based software engineering is aimed at managing the complexity of large-scale software development by composing systems from reusable parts. To understand or validate the behavior of such a system, one needs to understand the components involved *in combination with* understanding how they are configured and composed. This becomes increasingly difficult when components are implemented in various programming languages, and composition is specified in external artifacts. Moreover, tooling that supports in-depth system-wide analysis of such heterogeneous systems is lacking.

Objective: This paper contributes a method to *analyze and visualize information flow* in a component-based system at various levels of abstraction. These visualizations are designed to support the comprehension needs of both safety domain experts and software developers for, respectively, certification and evolution of safety-critical cyber-physical systems.

Method: We build system-wide dependence graphs and use static program slicing to determine all possible end-to-end information flows through and across a system's components. We define a hierarchy of five abstractions over these information flows that reduce visual distraction and cognitive overload, while satisfying the users' information needs. We improve on our earlier work to provide interconnected views that support both systematic, as well as opportunistic navigation scenarios.

Results: We discuss the design and implementation of our approach and the resulting views in a prototype tool called FlowTracker. We summarize the results of a qualitative evaluation study, carried out via two rounds of interview, on the effectiveness and usability of these views. We discuss a number of improvements, such as more selective information presentations, that resulted from the evaluation.

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