

SHADOWS

Scope

As computing systems become more powerful, pervasive, and interconnected, the resources involved in their development and management grow at an alarming rate and their reliability deteriorates. The growing magnitude and complexity of IT infrastructure are threatening to undermine the very benefits provided by the software itself. The software complexity crisis carries painful costs for the IT industry in terms of quality and management costs. It further affects IT consumers by imposing significant increases to IT total cost of ownership.

The Shadows project aims to systematically address the challenge of growing software complexity and its detrimental impact on software manageability, reliability, and productivity. Shadows technologies enable the development of complex software systems of high and durable quality, with lower development and maintenance costs. The project introduces a new **paradigm for the development of self-healing software systems**. The notion of self-healing, as defined and pursued by Shadows, is the capability of a software system to automatically diagnose and heal the root causes of its failures and performance problems, and prevent them from reappearing. Shadows self-healing technologies discover problems and potential problems, analyze them, and then apply modifications to the software system, to its operating parameters, or to its run-time environment, to fix the system or keep it functioning properly.

The Shadows project targets large and heterogeneous software systems with multiple dimensions of complexity, such as distribution and intricate interdependencies, dynamicity (reconfiguration and evolution), legacy system constraints, complex hardware, and possibly incomplete or missing specifications and source code. Such systems can be found in many important application domains including, but not limited to, industrial control systems, e-commerce enterprise applications, service-based architectures, and telecommunication systems.

Advances

The Shadows project addresses self-healing of complex software systems and extends the state-of-the-art in several ways. It introduces pioneering technologies to enable systematic self-healing of classes of failures that are not solved by other approaches. One of its main innovations is the integration of technologies that work on different system and software tiers, addressing different classes of problems, and sharing a common solution framework.

The project will deliver a widely applicable methodology and an integrated set of tools that provide capabilities for the self-healing of system failures during system

development and production. The tools are tested and validated in several industrial application domains. Initial results already show improvements in system development productivity and system robustness.

The Shadows project integrates several new technologies into a coherent framework, making the power of self-healing system design and management accessible to software developers, system administrators, and users of IT systems at large.

Positioning in global context

Shadows is a leading research project in the field of software self-healing. Drawing on its partners' research competence and the proven technologies they have brought to the project, Shadows has developed several novel self-healing technologies and successfully demonstrated their applicability to multiple application domains. Via its industrial partners, Shadows transfers innovative research results into software development tools and software production environments.

To facilitate wide adoption of its self-healing methodology and tools by IT personnel, the Shadows technologies are provided as Eclipse plug-ins and conform to the TPTP standard. At the end of the project, the technologies will all be accessible from a single, unified framework.

Shadows is at the forefront of software self-healing due to the technologies it has developed and their industrial validation position, not only at the research level, but in production environments as well. Thus, field deployment of Shadows technologies appears a realistic goal. The resulting acceleration in the development and improvement in the reliability of complex software systems should decrease software TCO.

Contribution to standardization and interoperability issues

The Shadows project aims at leveraging and contributing to emerging international standards: TPTP from the Eclipse Foundation and CIM from DMTF. Two Shadows members, namely, IBM and Scapa Technologies, are strategic members of the Eclipse Foundation with strong TPTP-related activity in Europe. Shadows uses TPTP as the platform for implementing its self-healing technologies. The Shadows project collaborates with the TPTP community, and has already proposed TPTP extensions which may be of general interest for the community. Additionally, two Shadows members—IBM and the University of Milano Bicocca—have close connections with DMTF. As a part of the Shadows project, these members have joined the DMTF “Common Diagnostics Model” and “Behavior and State” working groups. The project aims to influence these groups by

proposing a new or extended CIM schema for self-healing. Overall, Shadows's active involvement with emerging standards should provide for high levels of interoperability and integration, and for fair industrial acceptance of the project results.

Target users / sectors in business and society

Target users of Shadows technologies:

- Software and application developers will benefit from a shorter development process, improved software quality, and a decrease in the number of service calls.
- End-users and IT consumers will benefit from increased system reliability, reduced maintenance costs and total cost of ownership.
- Policy makers will use software self-healing standards and technologies to regulate and set requirements for quality of software products.

Overall benefits for business and society

Shadows provides self-healing methodology and tools to address software failures during development, testing, and production. Thus, we expect quantified and significant improvements in system design productivity, system robustness, maintainability, and quality, and the ability to provide reliable services. Such improvements should, in turn, significantly augment the competitiveness of the European software industry. The success of the project will be evaluated using a set of case studies, which will measure the effectiveness of the new technologies and the competitive benefits provided by the project to the European industries.

It is estimated that the Shadows solution yields a positive increase in system reliability as measured by (1) a reduction of at least 20% in the number of functional errors, by (2) a reduction of 15%-20% in the average number of performance problems and of 20% in network traffic related to performance problem detection, and by (3) a reduction of 20% in the number of concurrency-related errors. These measures are based on early experiments performed by the partners. The relative improvement is measured in comparison with systems in which the Shadows self-healing solutions are not implemented.

Examples of use

Shadows technologies are evaluated via a set of case studies, using sounding boards provided by the industrial partners. Specifically, the project employs cases including the following types of application domains:

- Embedded and real-time systems: Shadows technologies provide automated determination of normal ranges of operation and of error-prone concurrent use of resources. These determinations allow rapid testing and increase the robustness of critical systems.
- Telecommunication and E-commerce systems: Shadows technologies allow automated identification and resolution of client and server congestion.

Achievements

The project has generated the following results, and will continue to improve and generate them:

- A generic self-healing framework, named Panacea, to be used by software developers (alpha)
- TPTP extensions for self-healing, to be used in conjunction with the framework (some mature, some in the planning stages)
- A self-healing methodology (in progress)
- Eclipse plug-ins for specific self-healing technologies (ready for use)
- Guidelines for developers (some already available, some in development)
- Multiple self-healing patents, filed and in progress
- Multiple publications in fora of relevance
- Lessons learned will be delivered towards the end of the project.



title

A self-healing approach to designing complex software systems

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type of project

Specific Targeted Research Project

contact point

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3 120 000 €

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36