Architecture and Quality of Cloud Simulators

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Abstract: Cloud simulators are complex programs that can simulate a cloud infrastructure and applications running on that infrastructure. Such simulators are often used to evaluate new algorithms for cloud resource management and software deployment optimization. However, the implementation of such algorithms in a cloud simulator is a challenging task that may lead to erosion of the architecture of the simulator, and even to faults in the implementation. Using appropriate abstractions, a clear separation of concerns can be achieved.

Keywords: Cloud computing; cloud simulator; architecture; software quality

1 Introduction

Modern cloud infrastructures offer the opportunity to deploy software components quickly in virtual machines that can be flexibly managed during operations. This allows for example automatic scaling of the resources used by the software, so that it can react automatically to workload changes, while other important metrics like energy consumption can be optimized [Ma15, BM15]. Cloud simulators are programs that can simulate a cloud infrastructure (e.g., servers, virtual machines) and applications running on that infrastructure. Such simulators are often used to test new algorithms for cloud resource management and to empirically compare different algorithms with each other [MS17]. The empirical evaluation of these algorithms is very important as their performance is typically not guaranteed theoretically. Simulation is the natural method to evaluate the performance of algorithms in many different system configurations. Cloud simulators have usually high complexity, must support extensibility, and allow experiments to be run efficiently. These expectations pose strict requirements on the architecture of cloud simulators.

2 Approach and results

In our original paper, the architecture of two cloud simulators (CloudSim and DISSECT-CF) is investigated, in particular regarding the extension of the simulators with new resource management algorithms and with experiments to evaluate the algorithms [Ma18]. Beside

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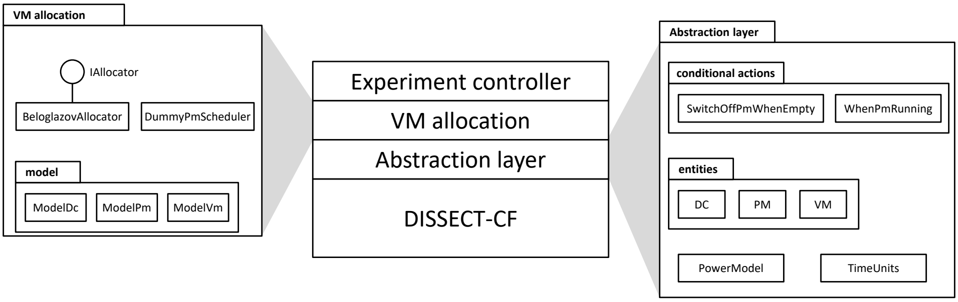

Fig. 1: Layered architecture featuring abstraction and decoupling

similarities and differences in the architecture of the two simulators, it is shown that a not sufficiently careful implementation of algorithms and experiments can lead to architecture erosion, which may result in unclear code and even faults. As a consequence, running the same algorithm in the two simulators with the same workload may lead to different results in metrics like overall energy consumption.

To avoid these problems, the paper shows how loose coupling and clearly defined interfaces between the simulator, the algorithms, and the experiments can be achieved by the introduction of additional abstractions (see Fig. 1). This way, a clear separation of concerns can be obtained, leading to code with improved quality. Furthermore, the paper demonstrates how the choice of simulator influences both the effort needed to implement an algorithm and the measured performance metrics. In particular, the API of CloudSim offered a higher level of abstraction than DISSECT-CF, but this could be bridged by extending DISSECT-CF with an appropriate abstraction layer. DISSECT-CF has a considerable advantage in execution time over CloudSim, even with the overhead added by the abstraction layer.

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References

[BM15] Bartók, Dávid; Mann, Zoltán Ádám: A branch-and-bound approach to virtual machine placement. In: Proceedings of the 3rd HPI Cloud Symposium "Operating the Cloud". pp. 49–63, 2015.

[Ma15] Mann, Zoltán Ádám: Modeling the virtual machine allocation problem. In: Proceedings of the International Conference on Mathematical Methods, Mathematical Models and Simulation in Science and Engineering. pp. 102–106, 2015.

[Ma18] Mann, Zoltán Ádám: Cloud simulators in the implementation and evaluation of virtual machine placement algorithms. Software: Practice and Experience, 48(7):1368–1389, 2018.

[MS17] Mann, Zoltán Adám; Szabó, Máté: Which is the best algorithm for virtual machine placement optimization? Concurrency and Computation: Practice and Experience, 29(10):e4083, 2017.