A Coordination Mechanism for Self-Healing and Self-Optimizing Disciplines

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ABSTRACT
There is an increasing demand for autonomic systems, which offer controlling complexity through a decentralized, multi-discipline and policy-based paradigm. In practice, only one discipline is often taken into account, while having shared resources and policies, it is required to coordinate different disciplines. This research addresses the problem of coordinating self-healing and self-optimizing in autonomic elements by generic modelling of disciplines, and proposing a coordination mechanism.

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1. PROBLEM STATEMENT
Managing autonomic systems [3], is not possible without coordinating autonomic disciplines, so the IBM reference architecture [1] suggests system-level orchestrating within and across disciplines. These disciplines are self-configuring, self-healing, self-optimizing, and self-protecting. However, regarding the decentralized management principle in AC, coordination is better to be localized as much as possible due to the complexity at the global level. So there is a need for local coordination, by considering that any change in the context/self is sensed by all disciplines, and each one suggests an action plan. Now the problem is which combination of actions is optimal? This paper focuses on coordinating self-optimizing and self-healing, because they are most focused autonomic disciplines in the AC community.

2. COORDINATION MECHANISM
An autonomic element should be self and context aware, in order to take the right responses to changes. The generic model of such an autonomic element can be composed of six entities [4], namely: SD as State Diagram(s), DM as Dependency Model, A as Action set, PS as Policy Set, E as Event set and S as Sensor set. Each of these entities may be different for each autonomic discipline, because of representing different concerns. If an event $E_i^k$ (e.g. fault) occurs, the self-healing is the problem of finding an action sequence to recover the element to the previous or a new safe state by minimum cost, providing the above six entities and $H$ as history of actions. According to [5] planning has the best potential of use in self-healing to find the minimum expected cost for actions through continuous planning. Similarly, self-optimizing is the problem of finding an action sequence to optimize $U(.)$ (utility function), providing the model entities and $U(.)$. Policies play an important role in self-optimizing. Gilat et al. [2] define business objectives for self-optimizing in a simulated system. We use the similar idea for performing our experiment.

In a nutshell, we are facing with two questions for coordination. The first question is “what actions need to be coordinated?” Categorizing these adaptation actions into two classes of weak, for changing variables such as CPU share, and strong, often for changing the structure, provides us to answer this question. For coordination, weak adaptation actions can mostly be executed simultaneously for both disciplines, in contrary with strong ones. The second question is “at which phase of MAPE-K loop [3] the coordination can be occurred?”. Because monitoring and analyzing phases are related to detecting changes not planning actions, they are not appropriate joint-points. On the other hand, the joint point at planning phase needs to find two coordinated plans which is complex due to difference of the planning mechanism for self-healing and self-optimizing [5]. Finally, the joint-point at the execution phase mainly deals with the scheduling problem. It is more feasible to implement, due to focus on scheduling the actions regarding the impacts of each action and the policies.

3. EXPERIMENT
The experiment is performed on simple elements in a distributed system. The interested readers can find more details in [4]. The experiment deals with response of disciplines to an injected failure. Self-optimizing tries to compensate lack of the resource by provisioning (strong adaptation) while self-healing deals with recovery of the resource by restarting (weak adaptation). In case of execution coordinating, the element adapts itself by a less cost.

4. REFERENCES