A Framework for Situation-Aware Adaptation of Service-Based Applications

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ABSTRACT

This work presents Situation Action Networks, a new framework for modeling Service-Based Application adaptation triggered by interesting or critical situations. The framework is based on a goal model able to track at runtime the fulfillment of goals. Situation Action Networks are tree-like hierarchical structures which enable goal decomposition into sub-goals and primitive actions in a recursive fashion which provides goal seeking execution plans, as a sequence of primitive actions. Situation Action Networks are dynamic and can evolve at runtime by using their inherent planning capabilities.

INTRODUCTION

Future Internet, an initiative emerged to bring together and interconnect services, objects and things of the real world to meet the changing global needs of business, is challenging the applications which need to consolidate various technologies such as Service-Oriented Architectures, Cloud Computing and Wireless Sensor Networks and handle dynamic and continuous changes propagated through the different technology stacks. This poses the challenge of application adaptation, the ability to reconfigure applications so as to support continuous, unimpeded augmentation of services in response to changing environmental circumstances.

The notion of adaptation has been extensively studied in the computer science domain as it is
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considered as one of the most desired functionalities of today’s highly dynamic, distributed and ubiquitous environments in the service-oriented environment (Kazhamiakin et al, 2010). Adaptation, the process of modifying a system or application in order to satisfy new requirements and to fit new situations, can be performed either because monitoring has revealed a problem or because the application identifies possible optimizations or because its execution context has changed.

Our work focuses on the discovery of critical or interesting situations of the environment that are not ordinary – so called ‘extraordinary’ situations – and we employ event processing as a means to detect and reason about situations. In event-driven architectures, services generate, consume and exchange events asynchronously, following the pub-sub paradigm. Events which are relevant to specific Service Based Applications (SBAs) (Hielscher et al, 2009) can provide a means to discover extraordinary situations. Event processing, a paradigm of choice in many monitoring and reactive applications, enables events to be propagated, filtered aggregated and composed into more complex events enabling detection of situations (Hinze et al, 2009). Our work aims to enhance the user’s experience when interacting with an SBA by adapting the system behaviour to situations. In this work, we present specific requirements for situation-aware adaptivity and outline Situation Action Networks (SANs), a modeling and execution framework for recommending SBA adaptations in response to extraordinary situations.

REQUIREMENTS FOR SITUATION-AWARE ADAPTATION

To describe the requirements for situation-aware adaptivity, we consider a crisis management scenario, which focuses on crisis situations related to a nuclear accident. Consider for example the case of a nuclear accident that caused radiation leakage and a grid of radiation sensors that monitors radiation levels in the area around the plant. The emergency plan prescribes that the Civil Protection Service subscribes to all sensors in a certain perimeter around the plant in order to detect the movement of the radioactive cloud. An extraordinary situation could be that in a short time after the accident, the wind increases and changes direction (e.g., North-West direction) while the weather forecast indicates that the wind direction will remain the same for the rest of the day. The ideal reaction to this situation, both in terms of cost and load processing, would be for the system to be subscribed at the right time only to events coming from sensors located south-east of the plant and are in a certain distance from it, which depends on the wind’s velocity or other weather conditions like humidity. Based on the information gathered from radiation sensors, authorities expect that certain cities south-east of the plant will be affected and need to inform people in these areas to follow some precautions or evacuate the area. This is normally done by transmitting TV and Radio messages, however, in the extraordinary situation in which there is a power loss, a proper reaction would be to deploy police forces and inform people using manual means such as speakerphones.

By studying similar scenarios identified within the PLAY FP7 ICT project (www.play-project.eu), we summarize the following requirements for situation-aware adaptivity (Table 1).

SITUATION ACTION NETWORKS

To address the specific requirements for situation-aware adaptivity, we need a mechanism able to model desired, meaningful SBA reactions to extraordinary situations without predefining all possible details at design time. The approach presented in this work starts from powerful models to enforce the fulfillment of goals by SBAs. It assumes the adoption of a goal model able to track the fulfill-