A Multi-Agent Friendly Microservices Architectural Style

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1 Introduction

Microservices architecture has emerged as a significant architectural style for implementing large scale distributed systems that are both reliable and scalable. There are many similarities between the underlying principles of Microservices and those of Multi-Agent Systems. Based on these similarities we have introduced the Multi-Agent MicroServices (MAMS) architectural style; an approach to integrating agent technologies seamlessly into microservices based architecture [1, 2].

Underpinning the integration strategy is the adoption of REpresentational State Transfer (REST), another architectural style that promotes the adoption of a resource-oriented view of distributed applications that is based on the Web Architecture [3]. Critically, REST models a system as a set of resources and supports interaction with resources using different types of representation that are accessible using the HyperText Transfer Protocol (HTTP). Critically, these representations are expected to not only expose the state of a request resource, but also to highlight related resources and operations that can be executed given the current state of that resource. These related resources and operations are specified through Hyperlinks and Hypermedia Controls (a generalised version of a HTML form) and together with the resource state lead to the principle of Hypermedia As The Engine Of Application State (HATEOAS).

REST is designed to be agnostic to the format of the resource representation that is used and a number of approaches have been proposed, such as the Hypermedia Application Language (HAL) [4, 5]. While HAL successfully provided good support for expressing Hyperlinks, it was less successful in representing Hypermedia Controls. In contrast, the emerging area of the Web of Things (WoT) was seen interesting work in the definition of Hypermedia Controls based on the notion of affordances [6]. This work, which builds on an emerging set of World Wide Web Consortium (W3C) standards[1] offers a powerful alternative for realising the REST/HATEOAS vision. These standards, which are built on the Resource Description Framework (RDF) developed for

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[1] http://w3c.org

the Semantic Web, provide support the representing not only the state of a resource, but also the associated Hyperlinks and Hypermedia Controls through ontologies such as the Hypermedia Controls ontology [7] and Hydra [8]. This fits closely with the Linked Data community and points at some of the original goals of the semantic web [9].

Our goal is to promote an approach to building distributed applications through the integration of Microservices Architecture, REST, Linked Data/RDF and ultimately Multi-Agent Systems. Individual microservices are modelled as collections of resources that are accessible through REST. Linked Data representations are used to define high-level relationships between resources in the form of hyperlinks and contextually relevant operations that can be applied to the resource via hypermedia controls. The hyperlink relations combine to form a distributed knowledge graph that connects data across the enterprise while the hypermedia controls provide the basis for self describing APIs. Together these features provide a knowledge rich environment that can is the natural domain of multi-agent systems where agents operate at the knowledge level, consuming resource representations and making decisions about what links / hypermedia controls to follow / execute. Such agents enable the implementation of behaviour into the fabric of the web.

References

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