i2Map: An Approach to Model the Landscape of Federated Systems

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Abstract

The rapid advance of technologies like Web services enables solutions to exploit more and more of the potential of the Web in many ways, recently especially in the field of federating distributed systems within or between businesses. To sustain maintainability and cope with the evolving application life cycles, a global uniform view on all involved sub systems and underlying infrastructure is required. This can be provided by a model that serves as a map for the landscape of the overall system to act as a guide to evolution. In this paper, we introduce the i2Map as an approach to these modeling demands focused on federable Web-service-based applications.

1. Introduction

Web Engineering is an emerging discipline which focuses on applying systematic methodologies for constructing Web-based solutions [1]. The way such solutions are built has been influenced heavily by the rapid change of technology. The set of available protocols and standards has evolved over time, leading to new opportunities for more advanced applications. Whereas early systems relied on the exchange of simple HTML documents over HTTP, today’s state of the art offers a variety of programming models, e.g. based on components or XML. Recent progress has led to the propagation of the Web service concept as an instrument to build composite systems in the Web. Modern Web-based applications can now employ infrastructure solutions like UDDI, WSDL or WS-Security as well as federation standards for achieving business-spanning interoperability.

In this context, our work is concerned with linking together Web-service-based applications that are possibly controlled by different partners. Particularly, we are interested in scenarios where federations of these applications form the foundation for inter-organizational cooperation. Such federations do not only pose a challenge to design and implementation techniques, but also to the operations process. The scope of management extends over physically distributed services and applications. Within the context of federated scenarios, the limited control over autonomous elements of the overall system demands dedicated approaches. In addition to this horizontal dimension, effective operations methods must also span all vertical system layers, ranging from the physical network to the business processes to be supported. The affected layers are interrelated in various ways, e.g. by security restrictions that applications impose on the underlying network topology. This renders a separate treatment of individual layers ineffective and calls for a uniform and consistent support for managing the system on a global scale.

2. Related Approaches

Other approaches towards the modeling of distributed applications are often less directed towards federated scenarios. The Dynamic System Initiative (DSI) for example comprises models targeted at supporting the design, deployment and operation of distributed systems on Microsoft platforms [2]. Similarly, the DCML open industry initiative (Data Center Markup Language) aims at modeling IT infrastructures of individual companies [3]. By combining the fundamental ideas of these description languages with concepts from areas like Enterprise Application Integration (EAI) [4], the benefits from system models can be extended to support the operation of whole system federations across multiple organizations.

3. Modeling Federated Worlds

Our approach addresses the challenges described above by offering a set of connected semantic models that can be used to describe federated Web-service-based systems as a whole. We propose the Integrated Information Map (i2Map) as an orientation plan for federated systems at design- and at runtime. The objective of this map is to describe whole solutions from the hardware components up to the business processes.

To account for the various layers involved and sub problems to be addressed, we define an extendable set of interrelated models named System Description Framework (SDF). Their level of abstraction enables a platform-independent view on heterogeneous environments.
Although capable of describing arbitrary Web-service-based applications, they specifically target federated systems that follow certain principles, as e.g. a dedicated approach towards the distribution of data sources. The model instances can be specified in a formal and machine-readable format as well as with the help of graphical notations. Figure 1 depicts some important layers of a system described with the i2Map in a simplified manner.

The SDF does not consist of the four layers exclusively, but should rather be seen as an extendable collection of different viewpoints on the same landscape that can be combined to give an optimal overview. As opposed to a prescriptive methodology, the i2Map approach provides a scalable and flexible framework that can be adapted to describe any aspect of federations. Thus, the framework character pays tribute to the need for evolution.

The physical layer views the described system from a rather technical perspective. Its most important entities are the servers on which the software of the federated system is installed. Modelled properties include technical parameters that are important for the support of evolution. In addition to servers, this layer also contains other network elements (e.g. switches, routers …), symbols representing networks, and the network connections between all nodes. The overall topology can be partitioned into networks that are controlled by different parties and therefore enjoy different levels of trust.

On the service layer, the federated system is composed of Web services and Web applications. Between them, the connections are characterized by high-level protocols (i.e. application layer) like HTTP or SOAP and should rather be seen as directed use-relationships specifying which service is called by which application/service. Multiple applications and services can be grouped into a security realm that defines a common identity and access management context. On this level, federations can be realized by establishing trust between security realms [5].

Focusing on the data and its distribution within the context of federation, the data layer is only concerned with the information-carrying system parts. Its basic modelling artifacts are classes and relationships. These abstract concepts can partially be related to special Web services and as such support the developer in understanding the distributed nature of the federated information. On top of that, the i2Map is open to extensions with additional models. e.g. concerning business processes.

4. System Support

The i2Map approach requires every layer model to be supported adequately at design time and also by Web standards at runtime. Thus, the discussed layer models have been translated into more formal representations. Hence, operations can benefit from such models allowing the expression of layer-spanning statements and restrictions that can be interpreted by programs. Therefore, instead of choosing a data-centric format like e.g. XML schema, we decided to take an approach similar to the DCML initiative and use the Web Ontology Language (OWL) to profit from the additional value offered by semantic models.

At runtime, the system model is made available with the help of dedicated Web services, which can be used to query system information. In addition to the semantic model, system elements and tools can access further information sources, whose data models are also considered as components of the SDF. UDDI directory services, for example, can provide runtime information about the locations and capabilities of the federated system’s Web services. Currently, we work on a tool to assist developers and operators with creating and manipulating the semantic models of the layers.

5. References