Towards Mediator Connectors for Application level Interoperability

Romina Spalazzese

Towards Mediator Connectors for Application level Interoperability

Romina Spalazzese
Dipartimento di Informatica
Università degli Studi dell'Aquila
Via Vetoio, 67010 Coppito (AQ), Italy
romina.spalazzese@di.univaq.it

ABSTRACT

My research work aims at overcoming the heterogeneity barriers that prevent networked systems to interoperate, thus enabling them to communicate responding to the continuously evolving networked environment. The thesis focusses on the concept of *mediator connector* as the key enabler for system interoperability.

The proposed work about mediator connectors is investigated in the scope of the CONNECT[1] European project.

Categories and Subject Descriptors

D.2.12 [**Software Engineering**]: Interoperability

General Terms

Design, Theory

Keywords

Mediator connectors, protocol interoperability

1. INTRODUCTION

Our everyday activities are increasingly dependent upon the assistance of digital systems that pervade our living environment. Key technologies such as the Internet, the Web, and wireless computing devices and networks are now calm technologies in the sense of Marc Weiser's definition [2]. They can indeed be qualified as ubiquitous, even if converged computing and networking technologies have still not reached the maturity envisioned by the ubiquitous computing and subsequent pervasive computing and ambient intelligence paradigms.

However, the current ubiquity of digital systems is technology-dependent. The efficacy of integrating and composing networked systems is proportional to the level of interoperability of the systems' respective behaviors, from application- down to network-layers. This leads to a landscape of islands of networked systems, although interoperability bridges may possibly be deployed among them. Further, the fast pace at which technology evolves at all abstraction layers increasingly challenges the lifetime of networked systems in the digital environment.

[1]http://connect-forever.eu/

ESEC-FSE Doctoral Symposium'09, Aug. 25, 2009, Amsterdam, The Netherlands.
ACM 978-1-60558-731-8/09/08.

My research work aims at overcoming the heterogeneity barriers that prevent networked systems to interoperate, thus enabling them to communicate responding to the continuously evolving networked environment. The next section further discusses the interoperability issue and the concept of mediator connectors as a possible solution. Section 3 briefly introduces the core concepts of the approach and Section 4 concludes summarizing the related challenges.

2. THE INTEROPERABILITY PROBLEM

Middleware positions itself as the architectural paradigm enabling to effectively network together heterogeneous systems, specifically providing upper layer interoperability. Middleware bridges the gap between application programs and the lower-level hardware and software infrastructure in order to coordinate how application components are connected and how they interoperate, especially in the networked environment. As a matter of fact, middleware is yet another technological block, which also creates islands of networked systems.

Interoperable middleware have been introduced to overcome middleware heterogeneity. However, the solutions remain rather static, requiring either the use of a proprietary interface or a priori implementation of protocol translators. In general, interoperability solutions solve protocol mismatch among middleware at the syntactic level, which is too restrictive. This is even truer when one considers the many dimensions of heterogeneity, including software, hardware and networks, which now arise in ubiquitous networking environments, and that require fine tuning of the middleware according to the specific capacities embedded within the interacting parties. Thus, interoperable middleware can at best solve protocol mismatches arising among middleware aimed at a specific domain. Indeed, it is not possible to a priori design a universal middleware solution that will enable effective networking of digital systems, while spanning the many dimensions of heterogeneity now arising in networked environments and which will also increase dramatically in the future.

Mediator then stands as a core architectural paradigm for today's and future systems that increasingly need be connected. The mediator concept was early introduced to cope with the integration of heterogeneous data sources [3, 4]. However, with the significant development of Web technologies and given abilities to communicate openly for networked systems, many heterogeneity dimensions shall now be mediated among which protocol mediation that is concerned with behavioral mismatches that may occur during interactions.

A key challenge for today's systems architectures is to embed the necessary support for automated mediation, i.e., the connector concept needs to evolve towards the one of *mediator connectors*. Indeed, the actual systems with which communications will take place cannot be anticipated at design time due to today's open networking and further continuous evolution of networked systems. As such, connectors not solely coordinate the interaction behaviors of connected systems but also mediate those behaviors to enable actual interactions.

Automated mediation of heterogeneous protocols basically relies on: (i) the adequate modeling of processes abstracting the behavior of the protocols to be bridged (ii) the definition of a matching relationship between the process models that sets the conditions under which protocol interoperability is supported (iii) the elicitation of an algorithm that computes an appropriate mapping between matching process models.

3. THE APPROACH

A number of solutions to automated protocol mediation have recently emerged. Although proposed algorithms manipulates formally grounded process models, most solutions are discussed informally, making it difficult to assess their respective advantages and drawbacks. They further remain rather vague on the definition of enforced matching relationship.

What is needed is a new and formal foundation for mediator connectors from which: protocol matching and associated mapping relationships may be rigorously defined and assessed. These relationships may be automatically reasoned upon, thus paving the way for on the fly synthesis of mediator connectors. To the best of my knowledge such an effort has not been addressed in the past.

The problem of protocols mediation concerns the interoperability between two protocols. To explain the problem, let us consider for example two instant messengers: Windows Messenger(W) and Jabber Messenger(J). With respect to protocol meditation we are interested to formalize: i) how to identify whether the messenger protocols share similar intent ii) how to synthesise the mediator connector that enables them to interoperate despite of mismatches. In more detail with "*protocols share similar intent*" we mean that given the interaction protocols P_W and P_J of W and J respectively, *part of their behavior* is *complementary* thus showing an interaction potentiality. Thus, we expect to find, at a given level of abstraction, similarities in the structure of the protocol representations. This leads to formally analyze such alike protocols to find, if it exists, a suitable mediator that allows the interoperability that otherwise would not be possible.

I assume to know the behavioral specifications B_W and B_J of the protocols P_W and P_J respectively and also to have an ontology mapping between the alphabets of the mismatching protocols that defines a common alphabet. The high level process that I am investigating to solve this problem is made by the following steps. The first one deals with the transformation of B_W and B_J into canonical forms, CB_W and CB_J respectively, in order to simplify them and reason on minimized protocols. The second step deals with the check of the compatibility between CB_W and CB_J. If they are compatible then one tries to synthesise the mediator connector to allow P_W and P_J to interoperate otherwise the interoperability is not possible.

The compatibility check (also called matching), if succeeds, singles out the parts of the structures of the protocols that are expected to be similar, i.e., the parts of actual communication between P_W and P_J. Then a mapping will build the behavioral representation for the *abstract* mediator for such part of protocols. The subsequent synthesis produces the *actual implementation* of the mediator.

To validate the proposed approach, being protocols rigorously defined, it can be formally proved the correctness and the completeness of the synthesised mediator.

4. CONCLUSION

With the networked environment being increasingly open and dynamic, the seamless composition and related connection of systems becomes a prime requirement. However, the openness of the environment comes along with great heterogeneity in the networked systems, which challenges their connection. Mediator connector then appears as a paradigm of choice to effectively overcome behavioral mismatches among the protocols run by the networked systems that need to coordinate. However, while the mediator paradigm has deserved much attention over the last few years, including research towards supported automated mediation, key principles remain loosely defined.

The proposed approach aims at formally characterizing the mediator connector problem. First results in this direction are presented in [1].

A set of challenges arise in the area of software systems engineering (that would be interesting for future work), from theoretical foundations to specify the interaction behavior of networked systems to run-time methods and tools to turn specifications into running protocols, and vice versa.

5. ACKNOWLEDGMENTS

The work is partly supported by: the project CONNECT No 231167 of the Future and Emerging Technologies (FET) programme within the ICT theme of the Seventh Framework Programme for Research of the European Commission and the Italian PRIN D-ASAP. I would also like to thank Scuola Superiore Sant'Anna and ISTI CNR for presently hosting me after the Earthquake.

6. REFERENCES

[1] R. Spalazzese, P. Inverardi, and V. Issarny. A formalization of mediating connectors: Towards on the fly interoperability. In *WICSA/ECSA 2009. IEEE Computer Society, Cambridge, United Kingdom, September 2009. To appear.*

[2] M. Weiser. The computer for the 21st century. *Scientific American*, pages 94–104, Sept. 1991.

[3] G. Wiederhold. Mediators in the architecture of future information systems. *IEEE Computer*, 25:38–49, 1992.

[4] G. Wiederhold and M. Genesereth. The conceptual basis for mediation services. *IEEE Expert: Intelligent Systems and Their Applications*, 12(5):38–47, 1997.