Chapter 4.7
Consistency and Modularity in Mediated Service–Based Data Integration Solutions

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ABSTRACT

A major aim of the Web service platform is the integration of existing software and information systems. Data integration is a central aspect in this context. Traditional techniques for information and data transformation are, however, not sufficient to provide flexible and automatable data integration solutions for Web service-enabled information systems. The difficulties arise from a high degree of complexity in data structures in many applications and from the additional problem of heterogeneity of data representation in applications that often cross organisational boundaries. The authors present an integration technique that embeds a declarative data transformation technique based on semantic data models as a mediator service into a Web service-oriented information system architecture. Automation through consistency-oriented semantic data models and flexibility through modular declarative data transformations are the key enablers of the approach.

INTRODUCTION

A major aim of the Web service platform is the integration of existing software and information systems (Alonso et al., 2004). Information and data integration is a central aspect in this context. Traditional techniques based on XML for data representation and XSLT for transformations between XML documents are not sufficient to provide a flexible and automatable data integra-
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tion solution for Web service-enabled information systems. Difficulties arise from the high degree
of complexity in data structures in many business
and technology applications and from the problem
of heterogeneity of data representation in applica-
tions that cross organisational boundaries.

The emergence of the Web services platform
and service-oriented architecture (SOA) as an ar-
chitecture paradigm has provided a unified way to
expose the data and functionality of an informa-
tion system (Stal, 2002). The Web services platform
has the potential to solve the problems in the data
integration domain such as heterogeneity and interopera-
bility (Orriens, Yang and Papazoglou, 2003; Haller, Cimpian, Mocan, Oren and Bussler,
2005; Zhu et al., 2004). Our contribution is an in-
tegration technology framework for Web-enabled
information systems comprising of

• Firstly, a data integration technique based
  on semantic, ontology-based data models
  and the declarative specification of trans-
  formation rules and
• Secondly, a mediator architecture based on
  information services and the construction
  of connectors that handle the transforma-
tions to implement the integration process.

A data integration technique in the form of
a mediator service can dynamically perform
transformations based on a unified semantic data
model built on top of individual data models in
heterogeneous environments (Wiederhold, 1992).
Abstraction has been used successfully to address
flexibility problems in data processing (Rouvel-
lou, Degenaro, Rasmus, Ehnebuske and McKee,
2000). With recent advances in abstract, declara-
tive XML-based data query and transformation
languages (Zhu et al., 2004) and Semantic Web
and ontology technology (Daconta, Obrst and
Smith, 2003), the respective results are ready to
be utilised in the Web application context. The
combination of declarative and semantic speci-
fication and automated support of architecture
implementations provides the necessary flexibil-
ity and modularity to deal with complexity and
consistency problems. Two central questions to
the data integration problem and its automation
shall be addressed in this investigation:

• How to construct data model transforma-
tion rules and how to express these rules in
a formal, but also accessible and maintain-
able way is central.
• How integration can be facilitated through
  service composition to enable interoper-
  ability through connector and relationship
  modelling.

We show how ontology-based semantic data
models and a specific declarative data query and
transformation language called Xcerpt (Bry and
Schaffert, 2002) and its execution environment can
be combined in order to allow dynamic data trans-
formation and integration. We focus on technical
solutions to semantically enhance data modelling
and adapt Xcerpt and its support environment
so that it can facilitate the dynamic generation
of Xcerpt query programs (in response to user
requests) from abstract transformation rules.

BACKGROUND

Information integration is the problem of com-
bining heterogeneous data residing at different
sources in order to provide the user with a unified
view (Lenzerini, 2002). This view is central in
any attempt to adapt services and their underlying
data sources to specific client and provider needs.
One of the main tasks in information integration
is to define the mappings between the individual
data sources and the unified view of these sources
and vice versa to enable this required adaptation.
Figure 1 shows two sample schemas, which might
represent the views of client and provider on a
collection of customers, that require integration.
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