

## Framework for application of innovative network technologies in building of Learning Support Environment

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**Abstract:** This paper presents a description of the ADO.NET Data Services Architecture and a Framework for application of network technologies and standards for e-learning. The developed framework may apply more generally in architecture for distribution systems and particularly for building of learning support systems. The framework includes a model for describing, structuring, organizing, and personalizing the learning objects located in LSE based on the standards and specifications for LMS.

**Key words:** ADO.NET Data Services, learning objects, LSE

### INTRODUCTION

The present research starts its developing from the concepts and principles of the innovative network technologies in the field of Internet programming as well as their current directions.

There has been published little work on the use of .NET technologies for Learning Support Environment (LSE). That's why the authors see major advantages in using network technologies as data services.

The purpose of the report is to offer a smart framework that interweaves key network technologies of Microsoft with the standards and specifications of Learning Management System (LMS), as Sharable Content Object Reference Model (SCORM), IMS Content Packaging, IEEE Learning Object Metadata (LOM), and Instructional Design Theory.

These standards need supplements in order to apply instructional design theory and personalized access to learning objects, which are achieved by the framework and program realization in LSE enclosed in the present report.

Applications demonstrated avoid the clumsiness of most of LMS built by very complicated software modules thanks to application of the ADO.NET Data Services architecture and concentrating the whole content in Learning Repository realized through Microsoft SQL Server.

### DESCRIPTION OF THE ADO.NET DATA SERVICES ARCHITECTURE

ADO.NET Data Services represents architecture that uses Representational State Transfer (REST) - style web services and provides architecture for consummating of resources in Entity Data Model through URI and relevant program code.

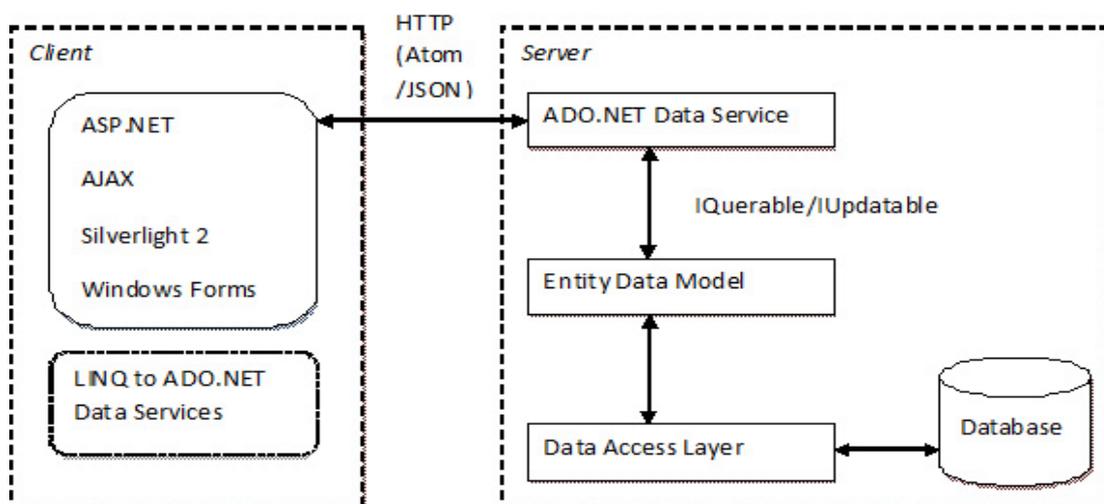


Fig.1 ADO.NET Data Services Architecture

The System.Data.Services.Client library provides clients' application with possibility of execution of Language INtegrated Query (LINQ) requests and to preserve changes in Learning Repository (Database) through ADO.NET Data Services.

Services use the ATOM and JSON formats for data representation. Services use URIs for location of the data.

ADO.NET Data Services provides the architecture to consume resources and map them into entities, expose an entire entity model via URIs, and customize the services by adding specialized service operations and the means to intercept service calls and perform business rules [4].

ASP.NET and Web services have been used in the initial application of the model for describing, structuring, and organizing the learning objects.

REST services differ from SOAP web services in that they use the HTTP verbs and the URI to describe the service operations (what a service can do). Therefore, REST services have no need for a WSDL to describe service operations. REST services use the verbs of HTTP to describe the action of the message in terms of Create, Read, Update, and Delete (CRUD) semantics [6].

Web services use approaches limiting the application of the new Model for describing, structuring, organizing, and personalizing the learning objects. Due to the specified reason the model is accomplished by applying the ADO.NET Data Services, ASP.NET 3.5 and Silverlight 2 technologies, and C#.

Some of the benefits realized from their experience are noted below:

- To promote reuse the developer has purposely not included any user interface (UI) components in the data services project. It is best practice to follow this approach and separate the UI and data services into their own projects.

This enables the data service to be easily consumed by multiple user interfaces such as .NET clients, Silverlight, and ASP.NET AJAX clients [6].

- The LearningObjects.svc data service that the authors create in these scenarios can be consumed by various clients.

- ADO.NET Data Services takes the best features of RESTful-style web services and makes them easier to implement over an entity model, and it provides features to account for authorization, business logic, and custom service operations [4].

- ADO.NET Data Services supports multiple data formats.

## **FRAMEWORK FOR THE APPLICATION OF NETWORK TECHNOLOGIES AND STANDARDS FOR E-LEARNING IN BUILDING OF LEARNING SUPPORT ENVIRONMENT**

Framework includes architecture for distributed systems and particularly for building of learning support system and model for describing, structuring, organizing, and personalizing the learning objects.

The architecture includes the following layers:

- Clients' application built through the Microsoft ASP.NET 3.5 and Silverlight 2 technologies

- Server application realizing data services through ADO.NET Data Services

- Database presented by Microsoft SQL Server

The software application of the framework has been achieved on Microsoft Windows Vista SP1, IIS 6.0/7.0, Visual Studio 2008 SP1, C#, SQL Server Express Edition, LINQ to ADO.NET Data Services, Microsoft .NET Framework 3.5 SP1, ASP.NET 3.5, Silverlight 2, Internet Explorer, and Fiddler2. ADO.NET Data Services is part of the ADO.NET 3.5 Service Pack 1 that resides in Visual Studio 2008 SP1.

Development of the RESTful service LearningObjects.svc includes the following stages:

1. Development of Entity Data Model (EDM) - LearningRepositoryModel.edmx based on the LearningObjectsRepository.mdf database.

The Entity Data Model - LearningRepositoryModel.edmx, shown in Figure 2, exposes some of the tables and entity relationships in the LearningObjectsRepository.mdf database. The association stage of entities is illustrated in the following figure:

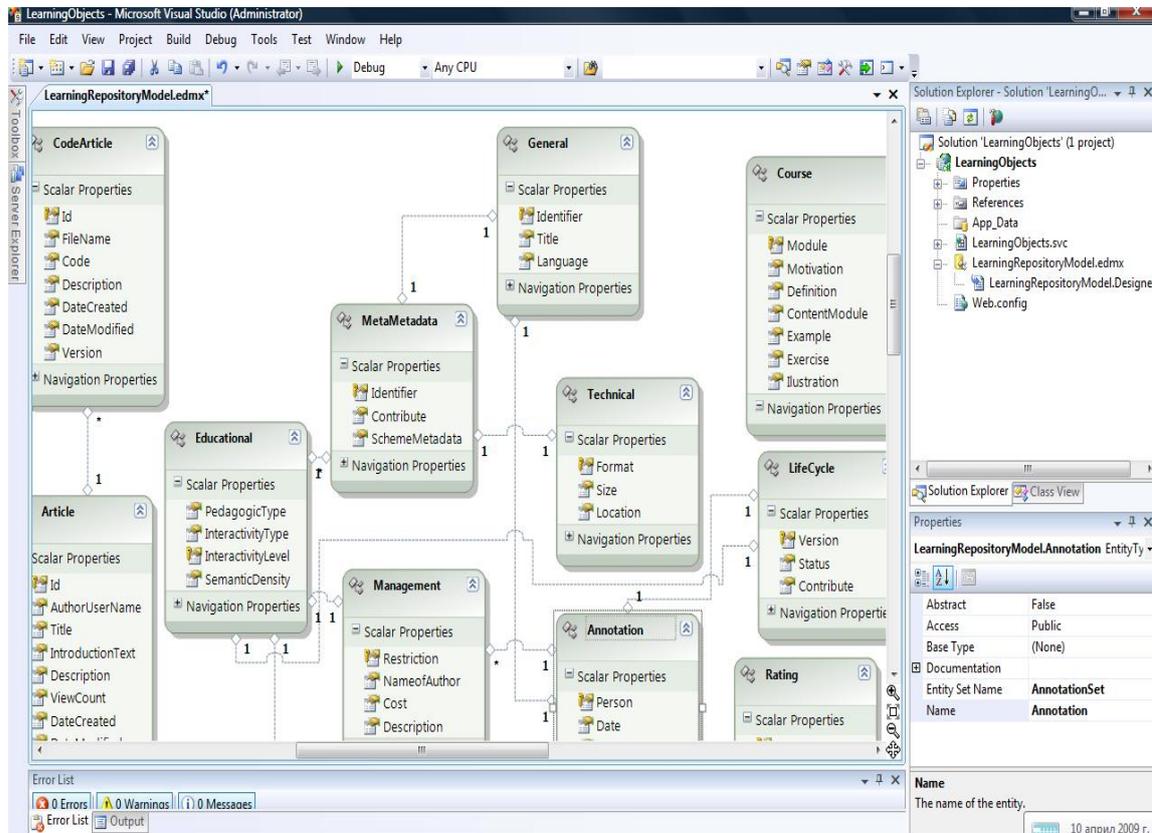


Fig.2 Learning Repository Model

All the tables and views have been mapped to strongly-typed objects.

The major benefit of EDM is to enable a developer to design an object-oriented system from the perspective of objects.

Access to an entity data model is made through ADO.NET Data Services to perform Create, Read, Update, and Delete (CRUD) operations, paging, and sorting, and to handle change tracking, implement transactions, and handle eager and delayed loading.

The magic of the EDM approach occurs with a set of XML documents that declaratively defines entities and how they map to the physical database.

## 2. Realization of connection of the service with the entity data model

It is executed as the service class inherits from `DataService<LearningObjectsRepositoryEntities>`, where `LearningObjectsRepositoryEntities` is the object context for the Entity Framework - generated model.

## 3. Access to the resources in EDM

When the developer specifies the security permissions, he/she has the option to change read/write security settings for individual entity sets that are exposed [6]. For this purpose the `InitializeService` method is used in the file `LearningObjects.svc.cs`

## 4. Testing the service with the help of IE.

## 5. Using the services by LSE created on ASP.NET and Silverlight 2.

Silverlight 2 and ASP.NET applications can issue LINQ queries to communicate with data service.

The home page of the data service lists all the entity sets that are exposed by it as shown in Figure 3:

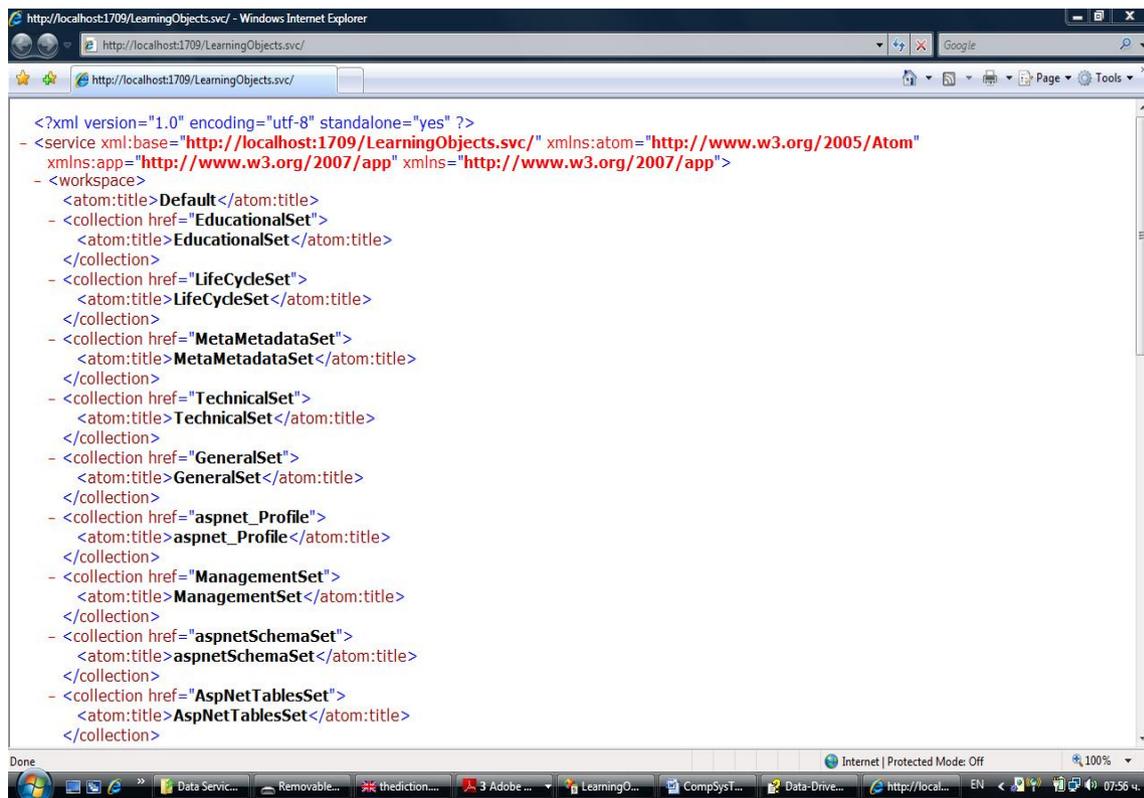


Fig.3 Using the service by LSE

The following types of resources are addressable in the ADO.NET Data Services protocol: Entity sets represent either an EntitySet or an AssociationSet. An EntitySet is a collection of instances of entity type. A relationship between entities is defined as an AssociationType [4].

An EntityType represents a useful element of data in the LSE, such as a CodeArticle, Article, Course, metaMetadata, Educational, LifeCycle, Rating, etc.

### MODEL FOR DESCRIBING, STRUCTURING, ORGANIZING, AND PERSONALIZING THE LEARNING OBJECTS

The basic principles for LSE development have been presented in the following modules of the model:

#### **Module 1:** Contents module

The contents module is the module of physical content organisation.

In conformity with the IMS Contents Packaging Information Model [8] the text files, the multimedia files, and all other physical files which can be used in a single learning environment are a combination of means defined as “contents”.

#### **Module 2:** Content package

The content package is an independent element of a LSE comprising a learning object suitably annotated by metadata and a manifest.

Its structure and organization allows the multiple use of the separate elements forming the learning object as well as their use in other learning objects.

The learning object is a learning resource that can be used for a unit of e-learning.

The common names for units of e-learning are: course, module, lesson, topic or learning content (multimedia content, instructional content, etc.)

Every learning object has an associated metadata record.

The metadata are used for describing the learning object and its characteristics in particular. The metadata also describe the elements included in the learning objects and their relations and give classified information of their status. For this purpose, Learning

Object Metadata Standard [9] offered nine categories: general, lifecycle, meta-metadata, technical, educational, rights, relation, annotation, and classification.

They are suitable for searching the learning objects in the database LearningObjectRepository.mdf of the server and the access to the Learning Repository is made through ADO.NET Data Service - LearningObjects.svc.

The manifest of each content package include the necessary information for defining adaptation rules which determine how learning objects should be selected for different learner profiles [5].

In conformity with the IMS Contents Packaging Specification [8] the content package in the environment includes two components – an XML file describing the course structure and the physical files forming the course structure.

Applying the new network technologies and particularly ADO.NET Data Services, ASP.NET, and Silverlight 2 the authors offer a new solution, in which learning objects and meta content will be presented in tables in MS SQL Server.

### **Module 3: Personalization module**

The personalization module constitutes collection of adaptation techniques that are intended to tailor a course for the individual learner. The intention is to optimize adaptive selection of alternative course material and characteristics/requirements.

Based on the selected learning design, which is essentially a hierarchy of learning activities, the module is able to bind specific learning objects to each activity using information from the learner's profile and it builds an intermediate representation of the learning experience [1].

The learning activity is a meaningful unit of instruction that provides a learning object to the learner or several sub-activities.

The sequence of launched content objects, for a given learner and content structure, provides a unique learning experience (learner interaction with content objects) [7].

The navigation rules define how different learning objects are selected for different learners and specify the matching between the learner profiles and learning content [5].

The module guides the construction of adaptive learning experiences and allows for the binding of appropriate learning resources at run-time according to the learner profiles. Representation of the course concepts and their semantic relations separated from the physical content allow for the binding of appropriate learning objects to the learning scenarios at run-time.

### **Module 4: Instructional design[11]**

The existing standards and specifications offer rules which do not follow any specific strategy of study. Therefore, the authors have used the instructional design theory.

Following this theory the following key processes for study using the Internet can be specified included in the learning support environment.

Modelling – the user is enabled to follow the accomplishment of a particular task step by step using the offered multimedia application in the environment, which facilitates the process of explanation and modelling.

Scaffolding and fading – these are learning technologies, where the assistance given by the environment slowly reduces and the responsibility of the user for developing an independent software application increases.

Articulation and reflection – the users need an analysis of their actions. One of the advantages of the developed learning environment is the possibility to record current activities and results for a subsequent analysis. After the user has mastered the respective course subjects, he/she is given “graded” tests for examining the acquired knowledge.

## **CONCLUSIONS AND FUTURE WORK**

Analyzing the most promising network technologies and the existing standards and specifications for the development of learning environments the report authors have achieved the framework development and have explained its application for the development of a single LSE.

In order to understand and reduce the complexity of the e-learning process, data storage, and application logic, the authors of the report propose the focus of the framework to be ADO.NET Data Services representing RESTful data.

Applying the new network technologies and particularly ADO.NET Data Services, ASP.NET 3.5 and Silverlight 2, the authors offers a new solution, in which learning objects and meta contents shall be presented in tables in MS SQL Server.

The personalized web-based environment allows execution of publishing, search, exchange and multiple uses of the learning objects. Each learner has access to the material that meets his requirements, interests and skills.

One of the most important advantages of the developed environment is that the user interface and data services are realized in independent projects in order to be possible different user interfaces to be used in case of future changes in the environment the adoption of another type of interface to be easier.

Proposed realization of the framework may be applied in its entirety or partially in learning support environments that may be adjusted by the teachers themselves without the interference of development teams.

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