The Semantic Web Conceptual Solution and Working Ontology for Tourism Ecosystem

Ramona Markoska*, Aleksandar Markoski*
** Faculty of ICT, University St. Kliment Ohridski Bitola, Republic of Macedonia
ramona.markoska@fikt.edu.mk
aleksandar.markoski@fikt.edu.mk

***Abstract*—Tourism is one of the highly dynamic areas which already extensively are using the available Internet technologies. The Semantic Web as the next generation web, gives opportunity of having background knowledge about the meaning of web sources stored in a machine-readable way using appropriate ontologies. Several publicly available tourism ontologies already exist today. However, information management solutions for tourism are still at an early stage from a semantic point of view. Concept of tourism "ecosystems" gives opportunity to implement successful tourism sector strategy and address the system-level challenges that lead to build up the institutions that support tourism and solving the problems which includes inadequate physical and social infrastructure and insufficient attention to environmental issues. Based on previous principles authentic tourism ecosystem ontology is created and presented in this paper. Open source software OWLGrEd was used for ontology creation and a set of mutually compatible software tools for creating and implementation of semantic solutions, such as WAMP server, ARC2, PHP, MySQL, and SPARQL. Proposed conceptual solution can be used for development of the next generation tourism information systems.**

I. INTRODUCTION

Today, actual trends on data processing on the web are focused on reorganizing those web data according the new requirements of semantic web. Following the activities in this area, it can be noted that there are many theoretical researches and recommendations, but unfortunately, lack of practical realization. Generally, the ontology is the formal naming and definition of the types, properties and relationships of entities that are common parts in a particular domain of discourse, in this case, the domain of tourism ecosystem. The chosen area of tourism ecosystems is widespread as a search field on the internet, providing the financial impact in e-business branch, and any particular improvement on query processes could be significant.

The main idea of the semantic web is to create internet communication and issues, understandable to machines, which means to the servers and network computers. Unlike that, the former concept of the web, was realized to be much close with the logic and cognitive processes of the humans. The semantic web is a more effective way to work with different data and give the opportunities to make some conclusions, and perceptions can be realized through many different approaches that lead to better business effects. Previous notes emphasize the importance of organizing data in ontologies and the need to restructure toward semantic solutions. In this work, authentic tourism ecosystem ontology is created using the open source software OWLGrEd. This is initial condition to create semantic database, which need also, special condition and adapted software services. Therefore, the last part of this paper describes a set of mutually compatible software tools for creating semantic solutions, such as, WAMP server, ARC2, PHP, MySQL, and SPARQL.

II. SEMANTIC WEB TECHNOLOGIES FOR TOURISM

The Semantic Web paradigm needs special adaptations of standardized solutions for data and database organization, used on previous working versions of Web and internet. For this purpose it needs to make standardization and reorganize following forms of data use. These efforts are starting point to develop semantic software solutions.

Reference [1] is detecting two extremes in current tourism information systems. On the one side there are well-structured information repositories, mostly from large providers of touristic packages, travel or lodging arrangements. Virtually all of these providers offer easy access to their systems via the World Wide Web, but they are mostly isolated from each other and they rarely include detail information.

On the other side, however, there is the World Wide Web as a whole with its many small, detailed pieces of information, e.g. about opera festivals, and touristic offers in market niches, in particular regions or regional style lodging.

Because of the vastness of the Web there lies a heavy burden on the user for accessing the latter kind of information, as well as for interpreting it and connecting it to the offers made by the large providers.

In [1] also are described few Application Scenarios: Semantic Search Engine for Tourism, Browsing Topic Portals, Semantics-based Electronic Markets, and Web Services for Tourism where the Semantic Web can solve the detected problem. The scenario one would like to have is that one gives some preferences about maximum budget and minimum of comfort, let your software find out about the constraints (including e.g. your personal datebook) and propose a complete package to you that considers the information given on the web page.

Different Application scenarios and using the Semantic Web solutions for tourism are presented in [2], [3] and [4].

III. TOURISM ONTOLOGIES

As described in [5], in tourism domain, there already exist different taxonomies and catalogues which are designed and used internally by tourism agents to help them to manage heterogeneous tourism data. Efforts are made to generate global standards to facilitate inter and intra tourism data exchange. List of available ontologies are also described in [6], [7], [8] and [9].

Harmonise Ontology within the EU Project Harmonise It is specialized to address interoperability problems in the area of tourism (e-tourism) focusing on data exchange, supporting tourism organizations in exchanging data and information without changing their local data structures and information systems.

Mondeca Tourism Ontology which includes important concepts of the tourism domain which are defined in the WTO thesaurus (www.world-tourism.org) managed by the WTO (World Tourism Organization). The concepts given are object profiling, tourism packages, multimedia content related to tourism and description of archeological objects along with other concepts.

QALL-ME Ontology developed in the frame of EU-funded project covers several aspects of tourism sector which are covered in other ontologies as well. It includes accommodation, toursm sites, events, transportation etc. The ontology is mapped with two foundational ontologies – WordNet and SUMO.

HiTouch Ontology developed mainly by Mondeca and was a part of IST/CRAFT European program aiming to develop software tools to be used by travel agents to cater the needs and expectations of prospective tourist.

GETESS: The German Text Exploitation and Search System is a BMBF financed project aims at retrieving the tourism related information through tourism websites. This information can be queried by users through natural language processing techniques. GETESS is an intelligent agent that gathers tourism related information from the web and generate answers to human queries in a user friendly way.

OnTour Ontology was developed by DERI (Digital Enterprise Research Institute). In addition to normal tourism concepts (location, accommodation…) it also includes concepts that describe leisure activities and geographic data.

OTA Specification (OpenTravelAlliance) members are organizations that represent all segments of the travel industry, along with key technology and service suppliers, corresponding to events and activities in various travel sectors.

TAGA Travel Ontology works on the platform compliant to Foundation for Intelligent Physical Agent (FIPA). TAG defines two domain ontologies for its working, one covers the basic concepts related to travelling like travel routes, services needed, reservations etc, and the other is dedicated to auctions and its protocols.

e-Tourism Ontology. The goal of the ontology is to support tourism organizations with exchanging data and information without changing their local data structures and information systems.

Travel Itinerary Ontology is simple ontology for representing a travel itinerary.

General Geographic Ontology provides geographic location information for cities, airports, ports, and other facilities and includes name, country, lat/long, etc.

A Tourism Ontology developed by the University of Karlsruhe contains four different sub-ontologies for the tourism domain defining about 300 concepts and more than 100 relations.

IV. TOURISM ECOSYSTEM ONTOLOGY

All previously presented tourism ontologies are publicly available, they are showing the current status of the efforts, and may serve as a basis for development of problem specific tourism ontologies.

New ontology is developed using the Digital Ecosystems concept (Fig. 1), where all relevant factor are interconnected in many complex relations. In [10] Digital Ecosystems have been considered highly relevant especially in the case of highly fragmented sectors where a high number of SMEs are operating, as it is in the case of tourism.

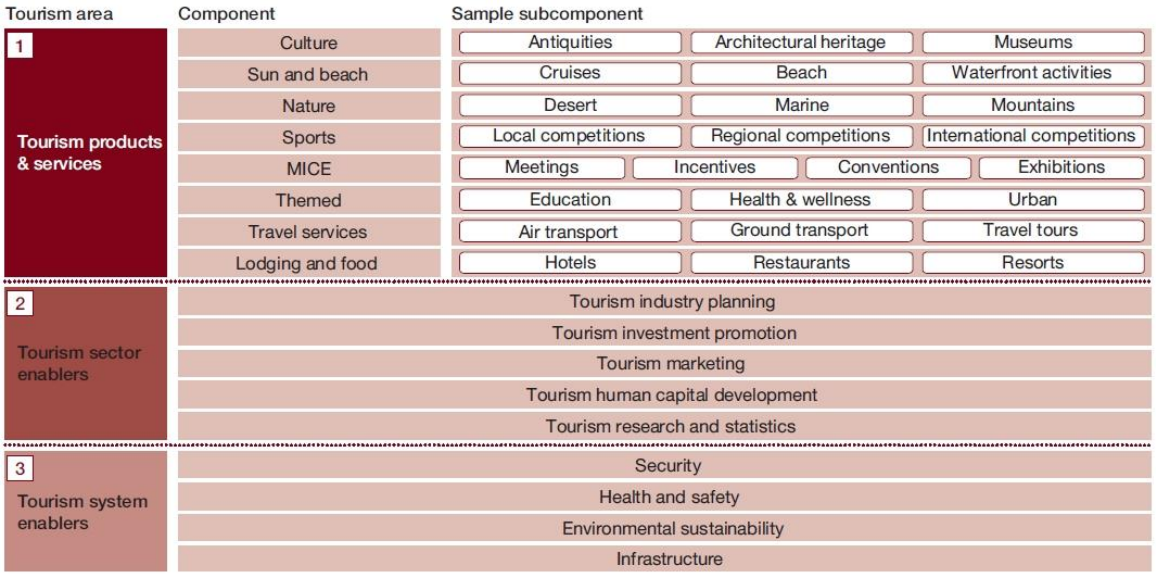

Figure1. Tourism ecosystem - key tourism areas and components

Ref. [11] presents a framework for development of a successful tourism sector strategy based on ecosystem concept presented at Fig. 1.

A. *Tourism ecosystem key areas*

In order to increase the number of tourists, countries must make changes to every part of their tourism "ecosystems". They must improve their most visible tourism products and services, build up the institutions that support tourism, and address the system-level challenges that lead to tourists being disappointed with their visit and not returning. These problems can include inadequate physical and social infrastructure and insufficient attention to environmental issues.

Reference [9] presents a framework to develop and execute a successful tourism sector strategy. It describes a three-step process, and the impact that a central tourism planning entity can have when it is refocused on the correct priorities.

As a result of analyzes, the best way to understand how countries compete for tourists is to think of tourism as an ecosystem composed of three parts: products and services, sector enablers, and system enablers shown in Fig.1.

Tourism products and services attract travelers to a country. In principle there are two types of travelers: business and leisure. Leisure travelers are more important, because they account for the largest share of total spending. Cultural and natural attractions, beaches and resorts, and sports events are all products that appeal to leisure travelers.

Tourism sector enablers support a country's physical attractions. They are activities that a country undertakes to build up its tourist industry and to formulate and execute a strategic plan, promote investment in its tourism sector and market to prospective tourists.

System enablers are the last part of the tourism ecosystem. System enablers are the quality of a country's infrastructure, security, health and safety, and environmental-sustainability practices. These are all elements of a country's larger systems. By making a country more appealing to tourists, the country makes itself better for its own citizens as well.

Other parts of the structure (components and subcomponents) are well known and more or less used in other, previously mentioned ontologies. This methodology goes beyond standard definition of tourism industry and includes physical and social infrastructure, and points attention to environmental issues as an integral part of providing quality for tourism products and services.

B. *Development of ontology for tourism ecosystem*

Ontology for the Tourism Ecosystem was created and visualized using open source software OWLGrEd [12], [13]. Data from Fig. 1. were adopted using the Semantic Web rules and protocols. All data are organized in standard semantic way: Classes, Data Properties, Object Properties and Individuals, (example in Fig. 2), and they are available in order to ensure interoperability with other sources of data.

Visualization of all main classes of the created ontology, using OWLGrEd software is shown at Fig.3.

```
<rdf:RDF
    <owl:Ontology rdf:about="http://www.mydomain.org/Tourism.owl"/>
      <!--
    //
    // Classes
     -->
    <!-- Air_transport -->
    <owl:Class rdf:about="Air_transport">
        <rdfs:subClassOf rdf:resource="Travel_services"/>
    </owl:Class>
    <!--
    //
    // Data properties
     -->
    <!-- location -->
    <owl:DatatypeProperty rdf:about="location">
        <rdfs:domain rdf:resource="Tourism products &amp;amp; services"/>
        <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#string"/>
    </owl:DatatypeProperty>
    <!--
    //
    // Object Properties
     -->
    <!-- partOfTour -->
    <owl:ObjectProperty rdf:about="partOfTour">
        <rdfs:domain rdf:resource="Travel tour"/>
        <rdfs:range rdf:resource="Hotel"/>
        <rdfs:range rdf:resource="Museum"/>
    </owl:ObjectProperty>
    <!--
    //
    // Individuals
     -->
    <!-- Gradishte_Beach -->
    <owl:NamedIndividual rdf:about="Gradishte_Beach">
        <rdf:type rdf:resource="Beach"/>
        <Tourism:hasName rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Gradishte Beach</Tourism:hasName>
        <Tourism:isAttraction rdf:datatype="http://www.w3.org/2001/XMLSchema#string">true</Tourism:isAttraction>
    </owl:NamedIndividual>
```

Figure 2. Part of the Tourism Ecosystem Ontology RDF/OWL file

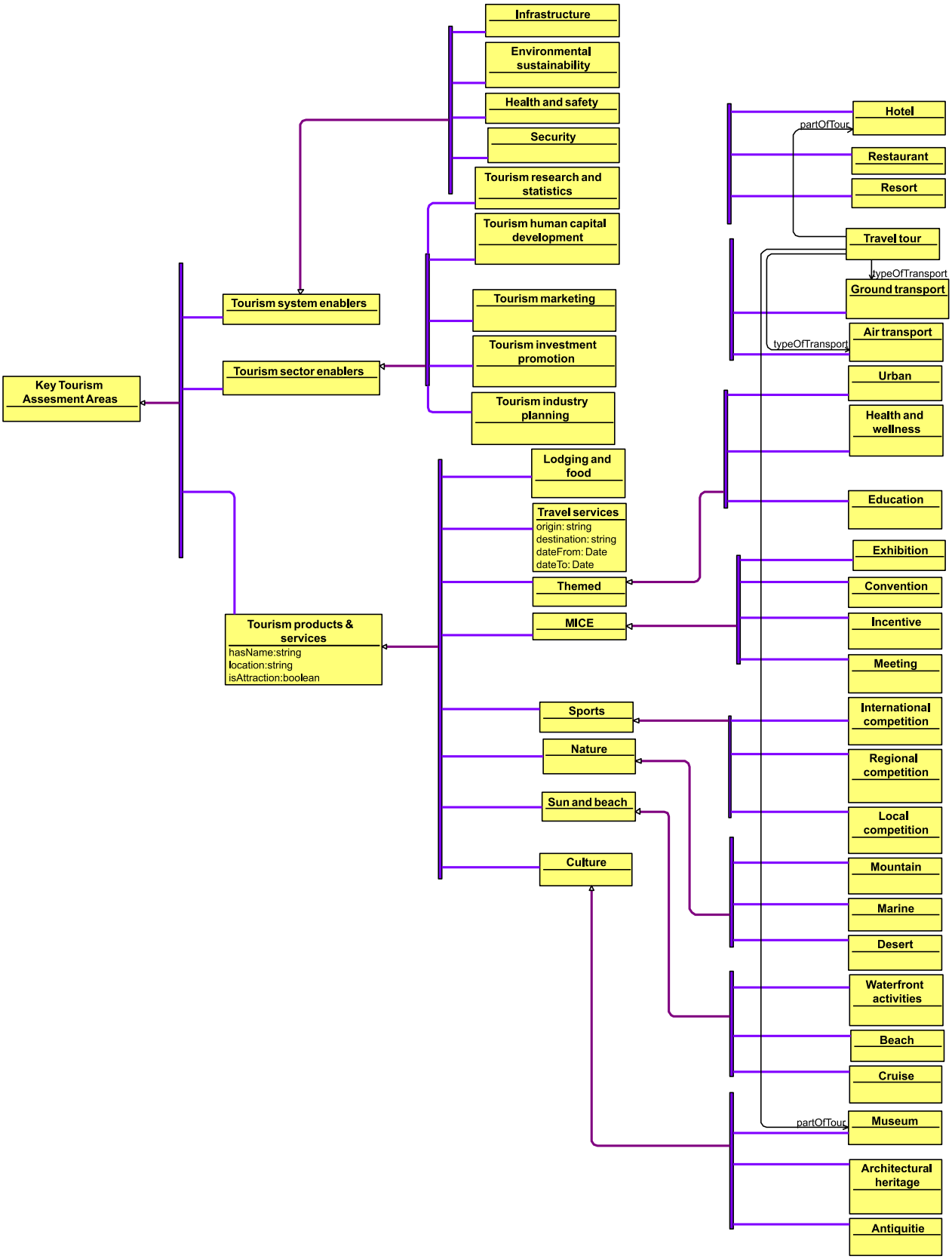

Figure 3. Tourism Ecosystem Ontology, created using OWLGrEd (basic, only main classes shown)

Basic Ontology can be expanded by adding the new individuals, (for example different members of Class Hotel) by adding few well known hotels in Ohrid, Macedonia as shown on Fig. 4,

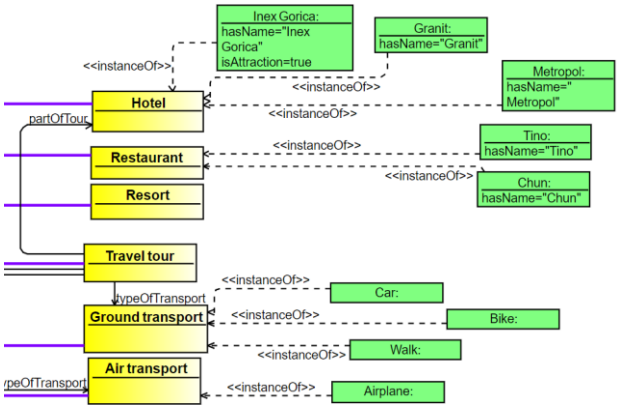

Figure 4. Part of a Tourism Ecosystem Ontology

or add a members of different classis which has the same property (isAttraction=true, Fig. 5.) for some well-known attractions in the vicinity of Ohrid Lake.

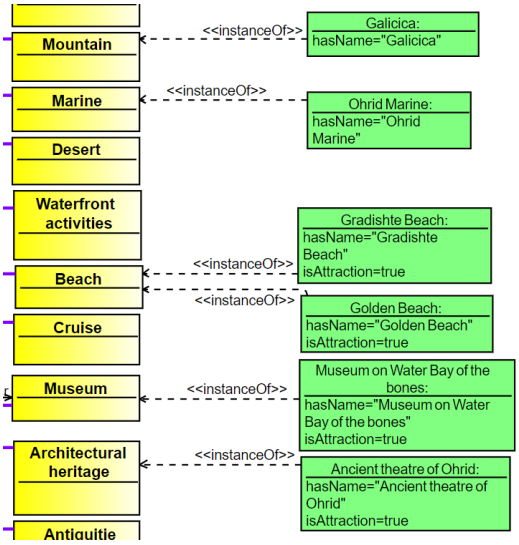

Figure 5. Idividuals with the same property isAttraction

Development of presented ontology is ongoing process, especially in the areas where existing ontologies are not applicable. In the future more attention will be paid to defining the appropriate Subclasses, Properties and Individuals for Tourism Enablers (both System and Sector).

Ontology can be used in order to develop proper Information Management System for further development of Digital Tourism Ecosystem concept. All efforts should lead to improvement of framework for development and executing a successful tourism sector strategy. It can help to maximize the impact that a central tourism planning entity can have when it is refocused on the correct priorities.

V. CREATING THE SEMANTIC DATABASE

According to previous analyzes of the semantic contents on the Internet, there is a serious lack of practical examples in all areas, including tourism, which leads to necessity for reconstruction of the classical Web contents in direction of the semantic web. In this paper, some theoretical recommendations are used as a starting point in realization of a real ontology. In a broad sense, ontology is a formal naming and definition of the types, properties and relationships between entities that are common parts in a particular domain of discourse, in this case, the domain of tourism ecosystem.

Previous notes emphasize the importance of organizing data in ontologies and the need to restructure toward semantic solutions.

Starting from theoretical description and some practical recommendations, an authentic ontology for Tourism Ecosystem is created, using open source visual ontology editor, OWLGrEd. The working ontology is based on RDF format. This is initial condition to create semantic database, which need also, special condition and adapted software services. According to personal practical experience and research from other authors (Ref. [14] and [15], it is possible to create complete working concept of semantic services, using open source software tools.

Therefore, the next part of this paper in brief describes use of mutually compatible software tools for creating semantic solutions, such as, WAMP server, ARC2, PHP, MySQL, SPARQL.

A. *Implementation steps*

The key steps for semantic information retrieval using WAMP server is as follows:

1. Installation of WAMP server
2. Installation of ARC2
3. Configure MySQL
4. Configure SPARQL Endpoint
5. Creating Ontology
6. Load ontology into MySQL database
7. Query using SPARQL in PHP

Steps from 1-3 are standard for implementation of semantic database using WAMP, and well documented and described step-by-step in [14]. Step 4 is specific for configuring SPARQL Endpoint, configuring read, update and backup options for the database Fig [6].

```php
<?php
include_once(dirname(__FILE__).'/arc/ARC2.php');
// SQL database configuration for storing the postings:
$arc_config = array(
  /* MySQL database settings */
  'db_host' => 'localhost',
  'db_user' => 'root',
  'db_pwd' => '',
  'db_name' => 'arc2test',

  'store_name' => 'tourism',   /* ARC2 store settings */

  'endpoint_features' => array(/* SPARQL endpoint settings */
    'select', 'construct', 'ask', 'describe', // allow read
    'load', 'insert', 'delete',               // allow update
    'dump'                                    // allow backup
  ),
);
?>
```

Figure 6. Configuration PHP code for the ARC2 Store and Endpoint

Step 5 was described in IV part of this paper, and as a result tourism.owl file was created, which contains all data for Tourism Ecosystem Ontology.

Loading ontology into MySQL database (step 6) was done by using code shown on Fig. 7.

```
<?php
include_once(dirname(__FILE__).'/arc/ARC2.php'); //

  /* ARC2 store settings */
'store_name' => 'tourism',
/* stop after 100 errors */
'max_errors' => 100, );

$store = ARC2::getStore($config);
if (!$store->isSetUp()) {
$store->setUp(); }
$store->query('LOAD
<file:///c:/wamp/www/t-ecosystem/tourism.owl>');
?>
```

Figure 7. Loading data from ontology file (tourism.owl)

Data from ontology now are stored in MySQL database, in RDF triplets format (Sybject, Property, Object) and can be queried by standard SPARQL commands, Fig [8], which fulfills standard requirements of the semantic web.

```
<?php
include_once("arc/ARC2.php");
include_once('config.php');
$store = ARC2::getStore($arc_config);
if (!$store->isSetUp()) {
$store->setUp(); /* create MySQL tables */
}
$q = '
SELECT DISTINCT ?subject ?property ?object WHERE {
?subject ?property ?object .
}
';
$rows = $store->query($q, 'rows');
$r = '';
if ($rows = $store->query($q, 'rows')) {
$r = '<table border=1>
<th>Subject</th><th>Property</th><th>Object</th>'."\n";
foreach ($rows as $row) {
$r .= '<tr><td>'.$row['subject'] .
'</td><td>'.$row['property'] .
'</td><td>'.$row['object'] . '</td></tr>'."\n";
}
$r .='</table>'."\n";
}
else{
$r = '<em>No data returned</em>';
}
echo $r;
?>
```

Figure 8. PHP code for basic SPARQL query

After finishing the 7 steps, remote data can be loaded into a local data store and we can run fast, local queries. For remote access ARC2 solves the problem with the concept of the Remote Data Store and ARC2 allows the remote store initialization, and still access the data in the same exact way as for local data and executing remote SPARQL queries.

CONCLUSIONS

In this paper we presented some early stage work on development of ontology for Touristic Ecosystems which extends the standard definition of tourism industry and includes physical and social infrastructure, and also points attention to environmental issues as an integral part of providing quality for tourism products and services and strategic refocusing on the correct priorities.

Ontology was developed using open source semantic tools, and semantic database was created using following software technologies and solutions: WAMP, ARC2, PHP, MySQL, SPARQL.

Proposed conceptual solution can be used for research, development and practical implementation in future generations of tourism information systems.

REFERENCES

[1] A. Maedche, S. Saab," Applying Semantic Web Technologies for Tourism Information Systems", Information and communication technologies in tourism 2002 : proceedings of the International Conference in Innsbruck, Austria, pp. 311-319, 2002,.

[2] D. Kanellopoulos and S. Kotsiantis, "A Semantic Based Architecture for Intelligent Destination Management System", international Journal of Soft Computing 2(1): pp. 61-68, 2007.

[3] J. Cardoso, "Developing Dynamic Packaging Systems using Semantic Web Technologies", Transactions on Information Science and Applications, Vol. 3(4), April 2006, pp. 729-736, ISSN:1970-0832

[4] D. Kanellopoulos, A. Alkiviadis and A. Panagopoulos, "Exploiting tourism destinations' knowledge in an RDF-based P2P network", Journal of Network and Computer Applications 31, pp. 179–200, 2008.

[5] K. Prantner, Y. Ding, M. Luger, Z. Yan, C. Herzog. "Tourism ontology and semantic management system: state-of-the-arts analysis", Proceedings of the IADIS International Conference WWW/Internet, Portugal, 2007.

[6] J.Cardoso, "Developing An Owl Ontology For e-Tourism". In: Cardoso J., Sheth A.P. (eds) Semantic Web Services, Processes and Applications. Semantic Web and Beyond, vol 3. Springer, Boston, MA, pp. 247-282, 2006.

[7] P.M.M Ortega, L.G. Ávila, J.M. Gómez, "Business Intelligence Taxonomy". In: Espin R., Pérez R., Cobo A., Marx J., Valdés A. (eds) Soft Computing for Business Intelligence. Studies in Computational Intelligence, vol 537. Springer, Berlin, Heidelberg, pp. 149-159, 2007.

[8] A. Mathur, K. Akshatha, A. Shastry, and J. Anitha, "A survey on existing tourism ontologies", IJRET: International Journal of Research in Engineering and Technology, pp. 20–23, 2015.

[9] W.V. Siricharoen, "Using Ontologies for E-tourism", Proceedings of the 4th WSEAS/IASME International Conference on Engineering Education, Crete Island, Greece, July 24-26, 2007.

[10] R. Baggio, and G. Del Chiappa, "Tourism destinations as digital business ecosystems", ENTER2013 20 International Conference on Information Technology and Travel & Tourism, Innsbruck Austria, 2013.

[11] R. Shedriac, A. Nasr, G. Elhassan, A. Klat, R.E. Khoury, V. Jambart et al., "Reinventing the Tourusm in GCC, Building the Tourism Ecosystem", https://www.strategyand.pwc.com/media/file/Strategyand_Reinventing-Tourism-in-the-GCC.pdf, report originally published by Booz & Company, 2013.

[12] K. Cerans, R. Liepins, A. Sprogis, J. Ovcinnikova, G. Barzdins, "Domain-Specific OWL Ontology Visualization with OWLGrEd" In: Simperl E. et al. (eds) The Semantic Web: ESWC 2012 Satellite Events. ESWC 2012. Lecture Notes in Computer Science, vol 7540. Pp. 419-424, Springer, Berlin, Heidelberg.

[13] R. Liepins, K.Cerans, A.Sporgios "Visualizing and Editing Ontology Fragments with OWLGrEd", Proceedings of the I-SEMANTICS 2012, pp. 22-25, 2012.

[14] A. McIntyre, E.E. Durham, "ARC RDF Store – Easy RDF and SPARQL for LAMP systems", CSC 8711 Project 4, (Topic Report/Manual), http://tinman.cs.gsu.edu/~raj/8711/sp11/presentations/ARC_RDF_Store_Presentation.pdf (2012).

[15] U. Meena, K. Baskaran, "Semantic information retrieval using WAMP server" , International Journal of Advanced Research in Computer Science and Software Engineering, Volume 2, Issue 11, pp. 302-306, November 2012.