New Model for Integration of Geolocation Services and Internet Technologies

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Summary

Geolocation services are one of the leading trends in the new developments of the information technology. Their impact could be seen in the different sectors of economy. Very closely connected to the new paradigm of mobility, detecting the user locations is becoming one of the most important point for the different industries. Contrary to isolated use of GPS and/or Geolocation service in specific issues related with user locations, there is a need to formulate the integrated approach - the new framework.

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Key words:

WSWAN, Geolocation, Model, GPS, Integration

1. Introduction

The world is changing from the industrial age to the information age. The rise of information technology marks a more complex relations between space and time. Location, as a expression or concretization of the space, plays a key role in determining the type and nature of human activity Location is correlated with, if not a determinant of users' information needs and product or service choices. From this perspective, an individual map is not the objective. According to Berry [3] it is how maps change as the different scenarios are tried that becomes information. It is important to note, location as furthered by this renewed Internet industry has seemingly extended the influence of the 'social' as a driver of contemporary Internet innovations. In this sense, Geolocation services are not just merely about location and can be read as technologies of mobility. As Cresswell [4] writes, mobility is "the entanglement of movement, representation, and practice".

Many previous papers from various fields have discussed the usage of geolocation information in day-to-day applications ([5], [6], [10]).

However, as location-aware technologies progress and spread across the globe, the more questions are arising. Which technologies are the most efficient and flexible for creating location-aware applications? Are Geolocation services only related with smart devices? Is GPS necessary part of any device to use Geolocation services? Is it the permanent connection to Internet one of the prerequisites for Geolocation services?

It therefore becomes apparent there is need to work towards the definition of the new framework for the integration of Geolocation services and Internet technologies.

2. Native or HTML5

The executable files which are copied and stored locally to the device (PC, tablet, mobile) are called native applications. Once it is initialized, the native application interfaces directly with the operating system (OS). Open access to all of the Application programming interface (API) that are made accessible by the operating system vendor is one of the main advantages of the native applications. However, with desktop or mobile, native software has to be released for each OS individually using the different programming languages, like Apple iOS (Objective-C), Google Android (Java), Windows Phone/8 (.NET). These differences between operating systems result in disadvantages of the native development approach - code written for one operating system cannot be used on another.

Contrary to native applications, web application based on HTML (stands for HyperText Markup Language) language, does not require any installations on the device (PC, tablet, smart mobile phone). It uses a web browser as a client, which is on all the devices, most of the time, already pre-installed. The ability to update and maintain web applications without distributing and installing software on potentially thousands of devices (PC, tablet, smart mobile phone) is a key reason for their popularity, as is the inherent support for cross-platform compatibility. With the growing ubiquity of mobile devices, people are now accustomed to accessing the Web on-the-go using phones, tablets, and other devices. What used to be a desktop-only activity is now a 24/7 anytime, anywhere possibility - the real web activity. Before HTML5, native application were the only option for mobile applications. But today, with the help of HTML5, developers can use the Web as both a desktop and a mobile platform.

DOI : 01.IJIS.2014.1.1

There are four (4) types of location data which could be programmatically accessed:

- Cached GPS. The last recorded GPS location.
- Cached Network. The devices can also store the last known location as determined by the cellular carrier's or other network location provider.
- Real-time GPS. This is the raw information that is streamed off the GPS.
- Real-time Network. This is the raw network location provider information returned by the cellular carrier, such as Vodafone in Malta or other network location provider.

Below is the snippet of the code of Java native application to get real-time GPS.

```
public void locationGetUpdated(LocationProvider provider, Location location) {
        if (location != null && location.isValid()) {
          QualifiedCoordinates qc =
                location.getQualifiedCoordinates();
          try {
            _latS = Double.toString(qc.getLatitude());
                _longS = Double.toString(qc.getLongitude());
            info.setText(
                "Lat: " + qc.getLatitude() + "\n" + "Lon: " + qc.getLongitude() + "\n"
                + "Alt: " + qc.getAltitude() + "\n" + " ") ;
          } catch (Exception e) {
            e.printStackTrace();
          } finally {
            try {
              } catch (Exception io) {
                io.printStackTrace();
            }
          }
        }
      }
```

DNS resolution was probably the first source for Geolocation information. In 2002 Spring et al. [8] used DNS names to improve location information as part of the Rocketfuel project. However, DNS

suffers from several problems: many interfaces do not have a DNS name assigned to them, and incorrect locations are inferred when interfaces are misnamed [12]. As well, as with devices, configuration of a specific domain name or location information is only accurate as long as the residential gateway does not move. [11] Another type of Geolocation services emerges from universities and research institutes. These services tend to use measurements alone or combined with other methodologies to improve Geolocation data quality. [9] However, the main problem was the inconsistent development for the different platforms without the common standards.

HTML5 introduced Geolocation API. HTML5 Geolocation API is completely separating the implementation of getting location with underlying hardware. There are several methods which are used including GPS, IP address, cell IDs, Wifi access points etc.

The following is the current status with the browsers and Geolocation service:

- Chrome = Google Location Services.
- Firefox on Windows = Google Location Services.
- Firefox on Linux =s GPSD -
- Internet Explorer 9+ = the Microsoft Location Service.
- Safari on iOS =Apple Location Services for iPhone OS 3.2+.
- Opera = Google Location Services.

In order to work it requires HTML5 and JavaScript support in the browser. HTML5 Geolocation requires an Internet connection. It's important to note that HTML5 in order to access a device GPS the optional enableHighAccuracy property must be set in the code. It can use this property with both the getCurrentPosition() and watchPosition() functions.

```
// Current position
navigator.geolocation.getCurrentPosition(prcsGeolocation,geolocError,
{
timeout: 0,
enableHighAccuracy: true,
maximumAge: Infinity
}
);
//Tracking position
Id = navigator.geolocation.watchPosition(prcsGeolocation,geolocError,
{
timeout: 0,
enableHighAccuracy: true,
maximumAge: Infinity
}
);
```

The variety of location solutions discussed in the previous section provides a wealth of location information available for Internet location-based services. However, the challenge is that none of these services provides high-quality location information for the whole Internet; even a single host might be better located by different services at different times. [2]

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Applications using HTML5 Geolocation typically have different requirements than native applications. Each platform has its advantages and disadvantages and it all comes down to requirements, budget, timeframes and skill sets:

- Ability to re-use existing JavaScript and HTML5 skills to build a high-accuracy mobile application.
- Don't have or have the access to native platform developers or skillets on Android, iPhone and/or Windows Phone.
- Need a cross-platform stand-alone web app or specialized application for concrete device and OS
- Quickly locate the user/consumer within a reasonable expectation of accuracy.
- The application that does not have extremely high accuracy requirements (e.g. < 10 meter) or
- application must have the high accuracy requirements (e.g. < 1 meter))

3. Data-interchange format - XML or JSONn

Today, the Extensible Markup Language (XML) is one of the most widely-used formats for sharing structured information: between programs, between people, between computers and people, both locally and across networks. Contrary to some data-interchenge format which is limited with the set of the tags defined by proprietary vendors, XML as a simple text-based format for representing structured information has no restriction. However, one of the major disadvantage might be the performance inefficiency.

JSON (JavaScript Object Notation), as a lightweight data-interchange format, is based on a subset of the JavaScript Programming Language and built on two structures: a collection of name/value pairs and an ordered list of values. The main advantage of JSON is the data model matches the data. However, JSON, by being so simple can only represent given data in a few plausible ways, which might be the limitation.

Geolocation data might be the different in two ways:

- The number and the structure of the attributes representing geolocation data
- The size of data itself

To compare the size element the simply test is done. The benchmark reproduces a very common scenario in web development: serializing a big set of business data, a set of one million coordinates. Here are the different representations of the coordinates entity in XML and JSON.

XML:

```
< Coordinates>
  <Longitude>%d</Longitude>
  <Latitude>%d</Latitude>
</ Coordinates>
```

JSON:

```
{ Longitude:%d, Longitude:"%d"}
```

The benchmark:

- Generate a set of random coordinates
- Generate the XML and JSON representations of this set
- Compare the sizes of the documents
- Generate the compressed versions of the XML and JSON documents
- Compare the sizes of the compressed documents and the time it took to compress

Table 2: Compare XML and JSON

Text	Normal	Compressed	Duration
XML	90.78M	18.70M	3.36s
JSON	48.78M	17.01M	2.71s
XML overhead	84.33%	9.61%	21.2%

Source: Authors

As expected for both the text and zipped versions XML has a size overhead but while this overhead is really important with the text version: 84%, almost twice as big, it becomes less significant, less than 10%, when gzipped. But to obtain this gain in size it had to consume some additional CPU time: it takes more than 20% more time to gzip the XML document than the JSON document.

If the data format and size is critical the similar tests must be performed to make the best choice for geolocation data.

4. Services - PHP or MCF

Service Orientation is the result of the natural evolution of current development models. Object-oriented models were used in the 80s, then they were replaced by the component-based development models in the 90s. Service orientation retains the benefits of component-based development (self-description, encapsulation, dynamic discovery and loading), but there is a shift in paradigm from remotely invoking methods on objects, to passing messages between services. As Aydin [1] stated the service Oriented Architecture (SOA) recognizes this and tries to construct a distributed, dynamic, flexible, and reconfigurable service system over Internet that can meet

DOI : 01.IJIS.2014.1.1

information and service requirements of many different users.

According to Sayar [7], SOA concept has three key components:

- Service provider publishes services to a registry and makes it available on the Internet for the requests of the consumers.
- Service requester (client) performs service discovery operations on the service registry in order to find the needed service; then accesses services.
- Service registry helps service providers and service requesters to find each other by acting as a registry of the services.

The implementation of service oriented architecture could be done in the different languages/platforms, like PHP or MCF.

PHP is a general-purpose scripting language that is especially suited to server-side web development where. Due to open source and no licensing cost, PHP is one of the most used programming language on all websites whose server-side programming language is known, However, there some vulnerabilities which are linked to PHP. These vulnerabilities are caused mostly by not following best-practice programming rules.

Windows Communication Foundation (WCF) is a Microsoft framework for building service-oriented applications and includes the following set of features:

- Service Orientation
- Interoperability
- Multiple Message Patterns
- Service Metadata
- Data Contracts
- Security
- Multiple Transports and Encodings
- Reliable and Queued Messages
- Durable Messages
- Transactions
- AJAX and REST Support
- Extensibility

Windows communication foundation is not simple replacement of very popular Web services. It is important step further to established common features in many different scenarios for using service oriented architecture.

Table 1: Compare Web Services and WCF

Features	Web Service	WCF
Hosting	It can be hosted in IIS	It can be hosted in IIS, windows activation service, Self-hosting, Windows service
Programming	[WebService] attribute has to be added to the class	[ServiceContract] attribute has to be added to the class
Model	[WebMethod] attribute represents the method exposed to client	[OperationContract] attribute represents the method exposed to client
Operation	One-way, Request-Response are the different operations supported in web service	One-Way, Request-Response, Duplex are different type of operations supported in WCF
XML	System.Xml.serialization name space is used for serialization	System.Runtime.Serialization namespace is used for serialization
Encoding	XML 1.0, MTOM(Message Transmission Optimization Mechanism), DIME, Custom	XML 1.0, MTOM, Binary, Custom
Transports	Can be accessed through HTTP, TCP, Custom	Can be accessed through HTTP, TCP, Named pipes, MSMQ,P2P, Custom
Protocols	Security	Security, Reliable messaging, Transactions

Source: Authors

Given a components functionality into a WCF Service Contract, it's easy for clients of said component to use it in any of those scenarios as well. A drawback would be that, WCF is Microsoft's implementation of SOA and hence its APIs are solely controlled by MS which makes interoperability a bit difficult.

The new framework must be enough flexible to have booth options: PHP and MCF. The choice, which one to implement will be based on the use case of the specific project.

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5. Databases - SQL Server or MySQL

Contrary to some predictions, the relational databases are still the most popular way of organized collection of data in a way that supports processes requiring this information.

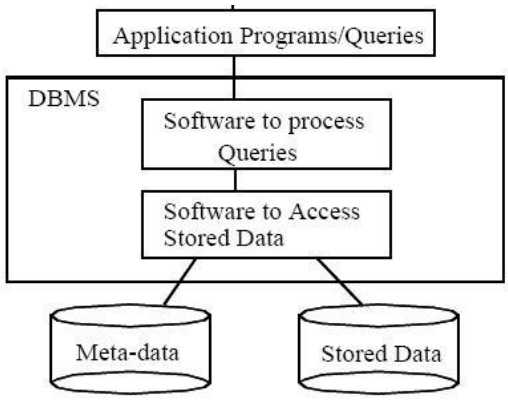

Figure 2 Overview of the organization of the relation database Source: Authors

SQL Server has Sybase-derived engine. All advanced features of a relational database are fully implemented. There is integration with Microsoft's .NET Framework and Visual Studio .NET. SQL Server has replication in a number of models: snapshot, transactional and merge. Regarding security SQL Server has been certified as C-2 compliant. It allows SQL Server to be used in government applications or any other similar level. However, all these features might have the negative impact and effect on performance. Very similar is the position with the licences. For use in a commercial environment, the SQL Standard Edition license needs to be purchased.

Contrary to SQL Server, MySQL is an open storage engine with the different possibility: InnoDb, BerkleyDB, MyISAM and Heap. Replication on MYSQL is simple process, mainly because all SQL statements that change data are stored and saved in a binary log. Regarding the cost of the licences, MySQLis free to use with the conditions of accepting GPL license rules. However, MySQL has a certain limitation in the security areas. It only supports basic security at the table level using the SQL command. At the moment there are indications that MySQL will continue to grow to the level of the full support of all the features of the relational database.
Choosing between a MySQL and SQL Server is a matter of the scale of the database application. For enterprise-level applications, SQL Server might be better option, especially in Windows environment. For lower-tier applications and non-Windows environment MySQL can offer the core functionality at a very low cost.

6. Integration

Previous models used different location positioning techniques, but they were never combined. In most cases it was used only GPS as a positional technology. Although GPS is still a major and one of the most accurate of location technology, it is not always possible. It is particularly problematic in poor weather conditions and in the interior of buildings (indoor environment) is not possible. New integration model is using all available positional technologies in a given environment and it combines them to obtain the best result.

Before this model, most of the location-based applications have been mainly developed for specific devices and platforms. Cross compatibility was either totally disabled or very expensive and therefore impractical. Because of the specificity of development in those circumstances it is somewhat acceptable. But today, it is almost impossible to limit the use of certain applications only for one device or another operating system .

It is one of the biggest advantages of this model to overcome these limitations and openness that tomorrow can add other options. The model allows operation located based services on a variety of devices (computer, tablet, smart mobile phones etc.) and different operating systems.

Prior to this model, most of the application did not clearly define 'boundaries, scope and applicability' of different applications as part of a location-based services. It clearly shows the necessity of analyzing the social and economic areas in which location-based services to be implemented. Selection of native applications (in Java) and HTML5 provides a wide range of possibilities for the development of specific building location-based applications. It is important to highlight, this model dismissed the dilemma and the debate on the use of either a native application or a HTML5 application .

Introduction and definition of data exchange formats (XML or JSON) as a de facto standard in today's Internet industry provides a clear separation between the client part of the application from the rest of the project. This is extremely important as it effectively enables the development of third-party software components as such and can be changed and tested without changing other parts of the system. Another important feature of the

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model is that in this way develops the code (parts or whole components) that can be reused in other.

The introduction of the service in the model is the separation of application logic (an essential part of the application) and client application (the so-called frontend) and databases (so-called backend). Despite the declarative expression, most of the former location-based applications did not separate above-mentioned logic, mainly by placing either the client part of the application or the server part of the application is closely connected to the database. Relocation of the logic provided by services gives the real form of the flexibility of the model .

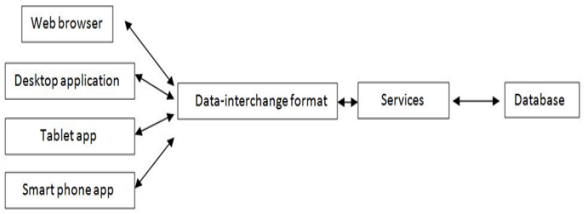

Figure 3: The new framework for the integration of Geolocation services and Internet technologies Source: Authors

This framework was successfully implemented in Research & Development project "Geocoding in Malta Using Handheld Devices". Three applications were developed.

The first one, was build for BlackBerry smart phones with the following functions:

- Using embedded GPS device
- Send GPS coordinates to server in XML format using SMS or Email
- Integration with Google maps
- SOA implemented in MCF
- SQL Server as database

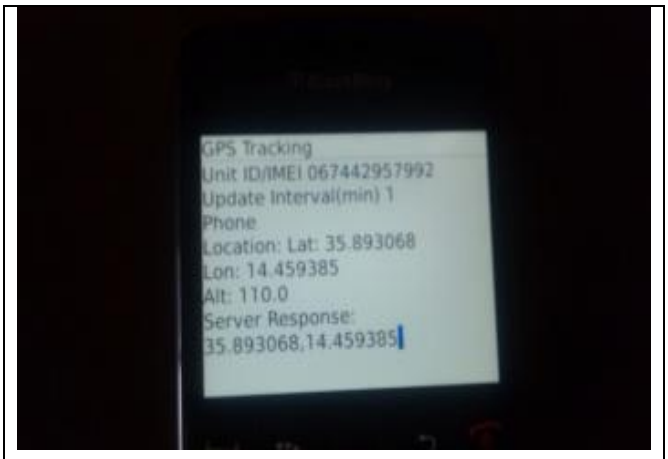

Figure 4: The native application for BlackBerry smart phones Source: Authors

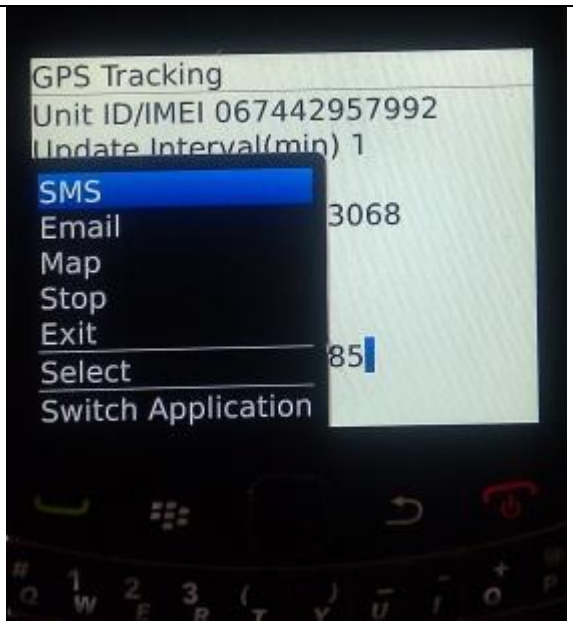

Figure 5: The native application for BlackBerry smart phones using different communications networks to send data Source: Authors

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Figure 6: The native application for BlackBerry smart phones, placing the position of the user using Google map Source: Authors

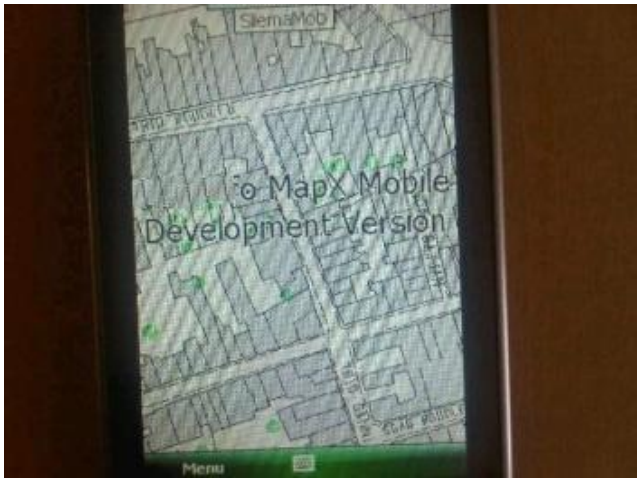

Figure 7: The native application for Windows smart phones, placing the first position of the user using base maps of Malta Source: Authors

The second one, was build for Windows mobile phone with the following functions:

- Using embedded GPS device as first positioning
- Integration with base maps of Malta
- Precise location using base maps of Malta
- SOA implemented in MCF
- SQL Server as database

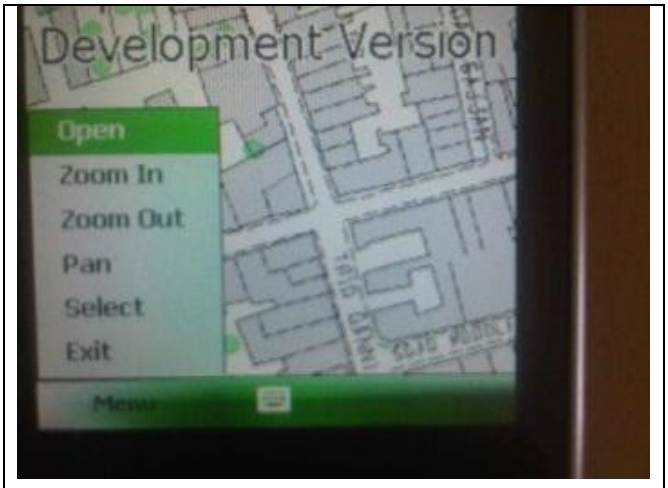

Figure 8: The native application for Windows smart phones, using the zoom functionality to get most accurate coordinates using base maps of Malta Source: Authors

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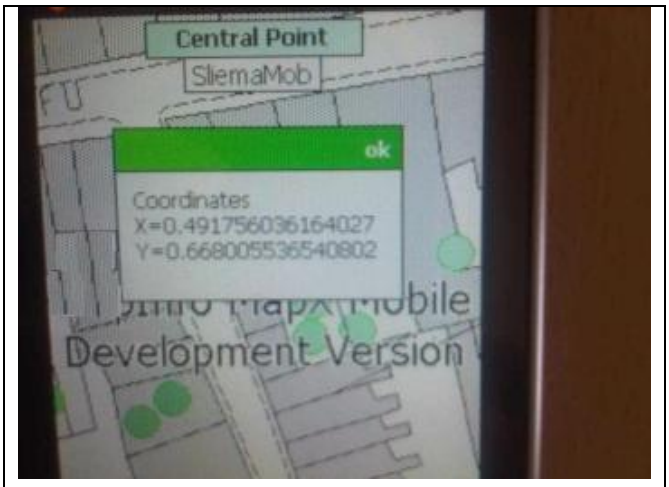
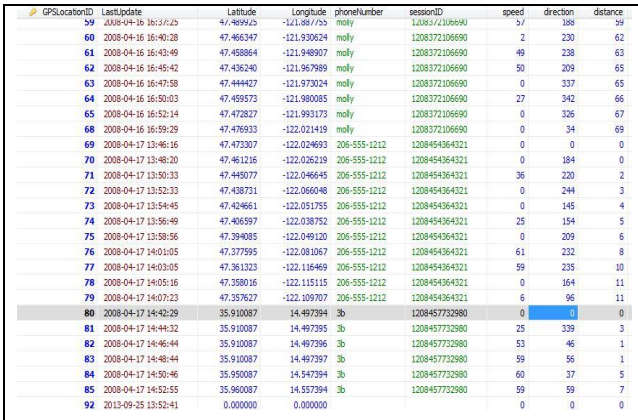


Figure 9: The native application for Windows smart phones, reading most accurate coordinates using base maps of Malta Source: Authors



GPSLocationID	LastUpdate	Latitude	Longitude	phoneNumber	sessionID	speed	direction	distance
59	2008-04-16 16:37:25	47.489925	-121.887755	molly	1208372106690	57	188	59
60	2008-04-16 16:40:28	47.466347	-121.930624	molly	1208372106690	2	230	62
61	2008-04-16 16:43:49	47.458864	-121.948907	molly	1208372106690	49	238	63
62	2008-04-16 16:45:42	47.436240	-121.967989	molly	1208372106690	50	209	65
63	2008-04-16 16:47:58	47.444427	-121.973024	molly	1208372106690	0	337	65
64	2008-04-16 16:50:03	47.459573	-121.980085	molly	1208372106690	27	342	66
65	2008-04-16 16:52:14	47.472827	-121.993173	molly	1208372106690	0	326	67
68	2008-04-16 16:59:29	47.476933	-122.021419	molly	1208372106690	0	34	69
69	2008-04-17 13:46:16	47.473307	-122.024693	206-555-1212	1208454364321	0	0	0
70	2008-04-17 13:48:20	47.461216	-122.026219	206-555-1212	1208454364321	0	184	0
71	2008-04-17 13:50:33	47.445077	-122.046645	206-555-1212	1208454364321	36	220	2
72	2008-04-17 13:52:33	47.438731	-122.066048	206-555-1212	1208454364321	0	244	3
73	2008-04-17 13:54:45	47.424661	-122.051755	206-555-1212	1208454364321	0	145	4
74	2008-04-17 13:56:49	47.406597	-122.038752	206-555-1212	1208454364321	25	154	5
75	2008-04-17 13:58:56	47.394085	-122.049120	206-555-1212	1208454364321	0	209	6
76	2008-04-17 14:01:05	47.377595	-122.081067	206-555-1212	1208454364321	61	232	8
77	2008-04-17 14:03:05	47.361323	-122.116469	206-555-1212	1208454364321	59	235	10
78	2008-04-17 14:05:16	47.358016	-122.115115	206-555-1212	1208454364321	0	164	11
79	2008-04-17 14:07:23	47.357627	-122.109707	206-555-1212	1208454364321	6	96	11
80	2008-04-17 14:42:29	35.910087	14.497394	3b	1208457732980	0	0	0
81	2008-04-17 14:44:32	35.910087	14.497395	3b	1208457732980	25	339	3
82	2008-04-17 14:46:44	35.910087	14.497396	3b	1208457732980	53	46	1
83	2008-04-17 14:48:44	35.910087	14.497397	3b	1208457732980	59	56	1
84	2008-04-17 14:50:46	35.950087	14.547394	3b	1208457732980	60	37	5
85	2008-04-17 14:52:55	35.960087	14.557394	3b	1208457732980	59	59	7
92	2013-09-25 13:52:41	0.000000	0.000000			0	0	0

Figure 11: The database MySQL with location data Source: Authors

The third one, was build as HTML5 application (tested on tablets and PC) with the following functions:

- If exists using embedded GPS device
- If there is no GPS device or cannot be used - using HTML5 Geolocation services
- Integration with Google maps
- Send coordinates to server in JSON format
- SOA implemented in PHP
- MySQL as database

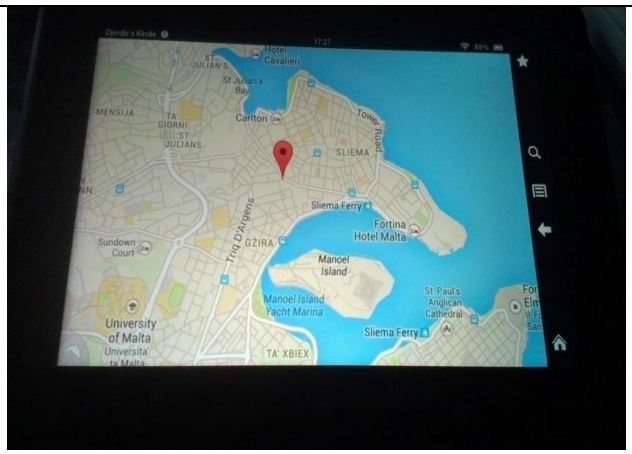


Figure 10: The HTML5 application Source: Authors

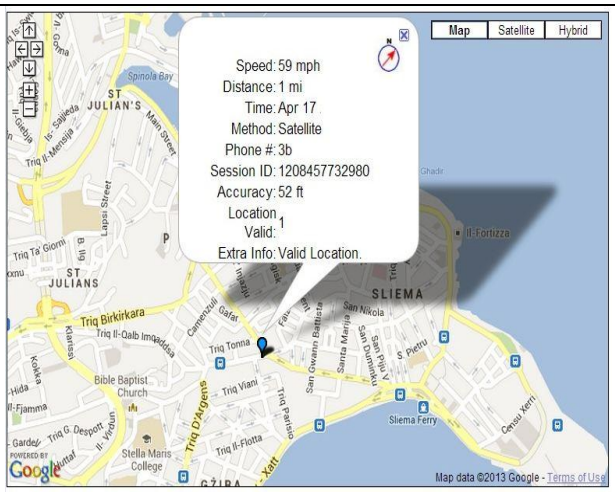


Figure 12: The map with the real time Geolocation information Source: Authors

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7. Conclusion

Geolocation application needs to be aware of the users that are targeting and understand their general behavior and geographic movement patterns that answer questions such as:

How often do they access the map from a different location: once a day, several times a day, once a month? How far do they travel per each trip: getting groceries (1 – 3 km?), going to work (10 – 20 km), visiting client sites (20 – 100 km?), etc.? Are their trips always within a dense city limits? City center users may encounter many more stop lights and traffic jams in town but drive shorter distances. Urban users who are out in the suburbs might travel longer distances. Do they travel or live near many canyons, mountains, tunnels or large buildings that might affect an accurate signal? What country do they live in? Not all countries offer network provider services. At the end, are the use cases so varied that simply can't predict the behavior patterns? If this is the case then it is good to build one application in ways to gather statistics to analyse the behavior.

Geographic behavior of a period of time can significantly affect the model, which means that it must be the flexibility in a model itself to cached location data in new and different ways.

The advantages of the new framework:

- Modularity: Easy to replace any piece or parts in the framework
- Flexibility: The framework could be applied in the different scenarios and projects.
- High Interoperability: SOA communication happens through Web Services which is a standard protocol. Replace any components with any implementation on any platform.
- Business Process Communication: Web service provide a platform to machine to machine communication.
- Security: With a WS-Security implementation it get message level security in any application.

The framework which is presented in this model should be the base to work in the line of integrating the different technologies related with Geolocation services.

The new research and recommendations will be to create the other prototypes of the software solutions based on the above-mentioned integrated framework..

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