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## Apple iPhone Technology in Mobile GIT

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**Abstract.** In 2007, Apple company released the first generation of iPhone cell phones. The device has gained worldwide popularity thanks to its revolutionary features. New iPhone 3GS is equipped with a GPS module and a compass. Combination of a fast data communication and a revolutionary way of controlling makes it a great tool for using in a mobile GIT (geographic information technology). Many different applications have been developed in a short time, since the device was made available on the market. There were not only map or navigation applications created but many original and usable applications as well.

Thanks to the data communication and access to the Internet, it is possible to use many web services. Examples of such services are OGC standards as Web Map Services (WMS) or Web Feature Services (WFS). This solution enables to skip preparation of maps that we need. Users may use the data from the Internet in an instant.

WhateverMap application was developed with the help of a grant provided by Internal Grant Agency of the Faculty of Forestry and Wood Technology MUAF in Brno. The application uses WMS services as map sources. It is possible to move over the map by gestures and controls seem to be very intuitive. In addition it is possible to use current position and show a map of an area, where the user is standing. The database of available WMS servers was integrated to the application to make adding of map sources user-friendlier. Whole application was designed in a way of User Experience design. So the application should be easily controllable for everybody.

**Keywords:** iPhone, WMS, User Experience, mobile technology, WhateverMap

### Introduction

Apple company has released the first generation of iPhone telephones in 2007. This device has gained worldwide popularity thanks to its revolutionary features. Nowadays iPhone OS market share has increased to 40 percent and it became the most widely used mobile operating system as presented in a study of Ad Mob Metrics[1]. The iPhone and iPhoneOS have caused a revolution in a mobile phone industry thanks to their original features. For example, the iPhone doesn't need a stylus. It is possible to control it using your fingers only. It is considered to be more comfortable and often much faster because you don't need to draw the stylus out of a slot. But the iPhone is not unique just because of the finger touch control. The whole operating system must be adapted for a finger controlled touchscreen. A ball of the thumb is much more bigger than a tip of a stylus so the user interface must be ready for this way of controlling. That means all of control elements should be redesigned. For example buttons are bigger and some of control elements were completely modified.

The Apple company has redesigned user interface by the User Experience design pattern[1]. It means that the user interface should be designed especially for users (philosophy of user-centered design). It was this approach, that made the iPhone so popular and also inspired the idea of utilizing the Apple iPhone Technology in mobile GIT. We can take well-known services and present them in a new attractive design.

Now the third version of iPhone is available. It is called "iPhone 3GS" and it is equipped with large multi-touch LCD screen with high resolution. This device combines fast processor, graphic accelerator and big storage capacity up to 32 gigabytes. It also supports fast mobile data communication as GPRS, EDGE or 3G. The iPhone device provides several sensors including a proximity sensor to detect proximity of a head to the device and an ambient light sensor to regulate brightness of a display. Another sensor is an accelerometer. This sensor provides information about a tilt of the device. This feature enables not just to rotate the display view according to the rotation of the device, but it is great for control in User Experience style too. We can use it to move a map according to the actual tilt of the device for example. In addition, iPhone 3GS has built-in GPS module and a

compass. Those features make an ideal candidate for GIS (geographic information system) purposes in new User Experience style.

## Services

Many organizations just store geoinformation data, but these data should also be shared some way. According to recent trends of Service-oriented architecture it should be done by services. It is much easier to develop third part application to consume data in this way. In addition it is suitable for mobile devices because a part of data processing can be performed by a server. There are organizations that deal with standards as Open Geospatial Consortium, Inc. or Open Source Geospatial Foundation. Those organizations have released many standards for data storing and sharing.

Two of the main standards in GIS are WMS (Web Map services)[5] and WFS (Web Feature services)[4]. WMS is the most common standard of geoinformation data sharing. It allows an access to raster data stored on a specialized server offering this service. Clients prepare query with requirements as a specific layer and area definition to a server. The server processes the query and sends single image of desired area back to the client. WFS works in a similar way but it processes data in a vector format. There are many applications for WMS and WFS services. Most of professional software has built-in support of WMS and it is possible to find many free versions of such applications too.

Besides WMS and WFS services there are another services for geoinformation data distribution based on the tile system. The tile system is not so commonly used for special geoinformation but it is much faster. Servers don't have to to prepare data for clients. Clients just download specified images from the server. This service type is used for frequently visited servers as Google Maps, Bing Maps, Mapy.cz or Open Street Map.

## WhateverMap

WhateverMap is a prototype of a geoinformation application for the iPhoneOS. This application was designed in the "iPhone style". During the development each control element of WhateverMap was discussed to fit the nature of iPhone. Almost every feature designed in this way has met with positive response. The whole concept of application is similar to the concept of Mail application in iPhoneOS. This means that iPhone user launching the WhateverMap for the first time is already familiar with controls and may focus on work instead of studying the application environment.

## Catalog

When the user launches the application, the first displayed view shows a list of favorite items. Each item represents a WMS server and its settings. To show WMS server contents we need to specify layers we want to see. This list of items is editable by users. It is possible to add, remove, order and edit items. Everybody works in a different field and everybody needs different data. It would not be practical to show each WMS server accessible in the Internet. Everybody may add his favorite WMS servers and than use them.

To add an item to the favorite list we need to know URL address of WMS server. It is possible to search servers on the Internet and then type whole address to the special input box. But addresses are usually very long and not so easy to remember. Even typing on the iPhone is not very comfortable for long and difficult addresses.

There is an another issue. When we want to add servers we have to know that the servers exist. People working in a branch and working with those servers are familiar with some of them. But nobody knows every server on the Internet. And there is another group of users - users out of branch who want just to get the data and they do not want to worry about searching. That is an issue of the most WMS viewers. User gets an application to view WMS server contents but what would be the sense of such application if the user didn't know any server addresses? Because of this reason, there is a built-in catalog in WhateverMap as shown in Fig.1.



**Fig.1.** Catalog of WMS servers in WhateverMap

The catalog is based on XML files. It includes only basic information as a title and URL address of WMS server in an XML file as shown in Example 1. In the example the first item represents WMS server. There is a title of server and URL address of GetCapabilities represents a WMS server. The second item represents link to another XML file and it may contain another items. It makes possible to organize items as files in directories. Besides of GetCapabilities address there is an XML file. Catalog system is entirely based on a tree structure. In this case title and address is sufficient to select appropriate server for users. There is a title which provides short information about server. From titles user gets basic information about data type or area of WMS servers. User then may perform basic decision whether or not to employ the server. More information can then be obtained directly from the server. In this example GetCapabilities address of WMS service will be used. In WhateverMap during the adding process users see information about the server and it usually contains detailed information from GetCapabilities. When the user wants to add this server, he chooses some of the offered layers and saves it. Then a new item representing chosen server and layers setting is added.

#### Example 1.

```
<?xml version="1.0" encoding="UTF-8"?>
<rss xmlns:georss="http://www.georss.org/georss" version="2.0">
  <channel>
    <title>WMS Catalog</title>
    <link>http://mapserver.mendelu.cz/whatevermap</link>
    <description>Catalog example</description>
    <language>en</language>
    <category>root node</category>
    <item>
      <title>World</title>
      <link>WMSWorld.xml</link>
    </item>
    <item>
      <title>ŠLP Křtiny</title>
      <link>
        http://mapserver-slp.mendelu.cz/cgi-bin/mapserv?map=/var/local
        /slp/krtinyWMS.map&service=wms&request=GetCapabilities
      </link>
    </item>
  </channel>
</rss>
```

The XML files in the catalog are based on GeoRSS[2]. It is great as exchange format in the Internet environment. This format makes possible to separate the catalog to an independent service in the future. The catalog should be represented by a web site accumulating information about WMS or any other servers with spatial data. The web site should provide data in a format compatible with WhateverMap. In addition it is possible to implement another services as searching by any parameters stored in XML files.

It is possible to extend this XML in the future. It is needed for another services working with catalog information. For example we may use information from built-in GPS module to use it and show only servers mapping the area we are located in. We have information about actual position everytime and everywhere. But in this case additional information are required. We have to add area information

for each stored server as a bounding box of an area (GeoRSS define box property). Then it is possible to perform searching of data based on an area of interest. Similarly it is possible to add more information as a short text description, speed or quality of server and any other information.

### Map Controller

The core functionality of WhateverMap is to show data from WMS servers. Map data are displayed in Map View provided by Map Controller. Map View is displayed immediately after item selection (item represents a WMS server and layers settings). Map view displays map as a raster image. Map Controller allows to browse over the chosen map. It is very simple to manage browsing in this application as in Google Maps on the iPhoneOS based devices. To pan a single touch of finger and a movement is required. Map movements trace movements of finger as shown on Fig.2.



**Fig.2.** Map Pan(Finger start position – Finger end position)

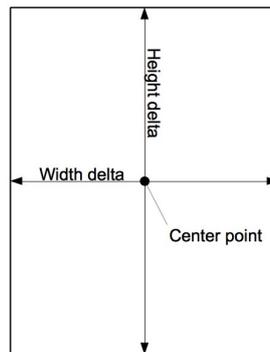
Another important task while browsing the map is zooming (scale changing). There are more possibilities to perform this job. One way is to double tap for zoom in or triple tap to zoom out. This solution changes map scale by multiplying or dividing by 2. Second way is to perform zoom by pinch. Pinch is one of the gestures possible to use with iPhone. When there are two fingers on a touch screen it is possible to change their distance. While the distance is changing the map scale is changing smoothly too. When the zooming is done a new image is loaded. An example of using pinch for scaling is shown on Fig.3.



**Fig.3.** Map Zoom (Fingers start position – Fingers end position – New image loaded)

## Navigation principle of Map Controller

The main information in request is bounding box of an area. Bounding box is represented by maximum x, y and minimum x, y coordinates (top right and left bottom points). To generate a bounding box we need a center point of a bounding box in world coordinates which determine position of an area and a difference (delta) of world coordinates in x and y axes which determine zoom level (Fig.4).



**Fig.4.** Bounding box

Whenever we start to browse a map we start from an initial bounding box (bounding box of a server or last one). When we want to pan or zoom a map we calculate new bounding box from the previous one. We know width and height of an image in pixels. Also we know starting and ending state of user gestures movement and previous bounding box. This is enough to calculate a new bounding box.

Zoom is performed by dividing width and height difference (delta) of bounding box:

```
newDeltaWidth = oldDeltaWidth / scale
newDeltaHeight = oldDeltaHeight / scale
```

Where `scale` represents distance change ratio between two fingers on the screen:

```
scale = finalDistance / initialDistance
```

Then two cases may occur:

`scale > 1` – zoom in  
`scale < 1` – zoom out

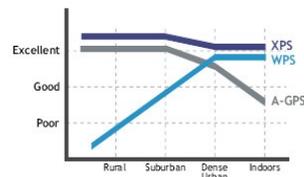
To pan we need to change center point of a bounding box. When we are moving a finger on the screen we know positions where the movement starts and ends. It is simple to calculate a new center point in pixel coordinates. But for generating of a bounding box world coordinates are needed. The calculation is performed in this way:

```
newCenterPointX = oldCenterPointX - deltaX / pictureWidth * (centerPixelPointX - newPixelPointX)
newCenterPointY = oldCenterPointY - deltaY / pictureHeight * (centerPixelPointY - newPixelPointY)
```

## Location support

The elementary control has been introduced. But it is only basic functionality. Map Controller supports built-in localization module. It is possible to turn on and off detection of local position by left bottom button. But localization support provided by the iPhone does not mean only GPS module. There is a possibility to find out actual position by WiFi or GSM networks too. This locating system is called XPS by Skyhook Wireless[9] and it combines the best of GSM triangulation, WPS(Wi-Fi Positioning System) and GPS as show in Fig.5. Table 1. compares performance of XPS, GPS and A-GPS location systems. Real GSM cell towers can be used for simple locating by GSM triangulation. It is based on a distance from the nearest cell tower. WiFi AP (access points) can be used in similar way (WPS service). Each AP has unique identifier and that can be used to determine a location. It is done with

the help of database of WiFi AP identifiers and their locations. GSM and Wireless are not as accurate as GPS signal based positioning but they are much faster and consume less power. Sometimes when we want to locate larger regions it is accurate enough. Even when we want accurate GPS position it could provide fast location before we get final GPS results and orientate ourselves on a map. An independent study[7] of XPS in iPhone show results in accuracy of this solution.

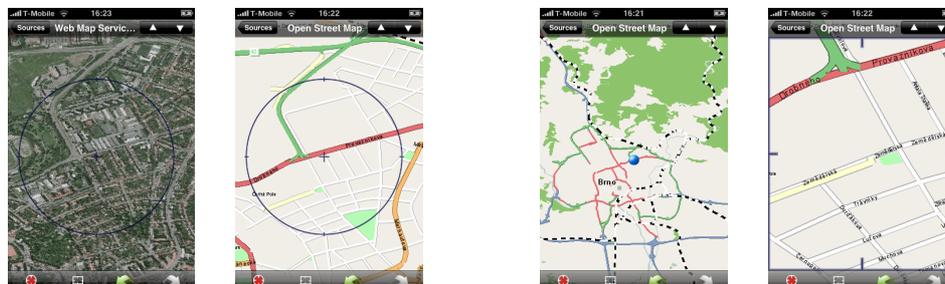


**Fig.5.** Comparative Performance of Location Technology[11]

**Table 1.** Performance table[10]

	XPS	GPS	A-GPS
Accuracy	10 meters	10 meters	30meters
Availability	99,80%	80,00%	95,00%
Time-To-First-Fix	1 sec	65 sec	30 sec

Provided location is obtained with a great variance. The variance could be in range from kilometers to meters and user must be aware of position accuracy. For this purposes there is a special feature to show an accuracy on a map using a circle, enlarging and decreasing according to changes in the accuracy of the GPS measurement. If there is accurate information in respect of displayed area, the circle changes to single point. Simply this feature says your current location is inside of this circle or you are in this point (Fig.6).



**Fig.6.** Location by Cell Network (Ortophoto – Open Street Map – Zoom Out – Zoom In)

### Movement history

The last feature implemented in WhateverMap is a movement history support. Sometimes it is a great tool when your GPS signal gets lost and displays wrong area. Then few presses of history button restore a previous view that was displayed before.

Movement history have a secondary usage. Movement history records only bounding boxes of areas visited by a user. But there are many map layers to show in WhateverMap. It is possible to watch data in one layer than switch layers and watch the same areas in a different map data as shown in Fig. 7.

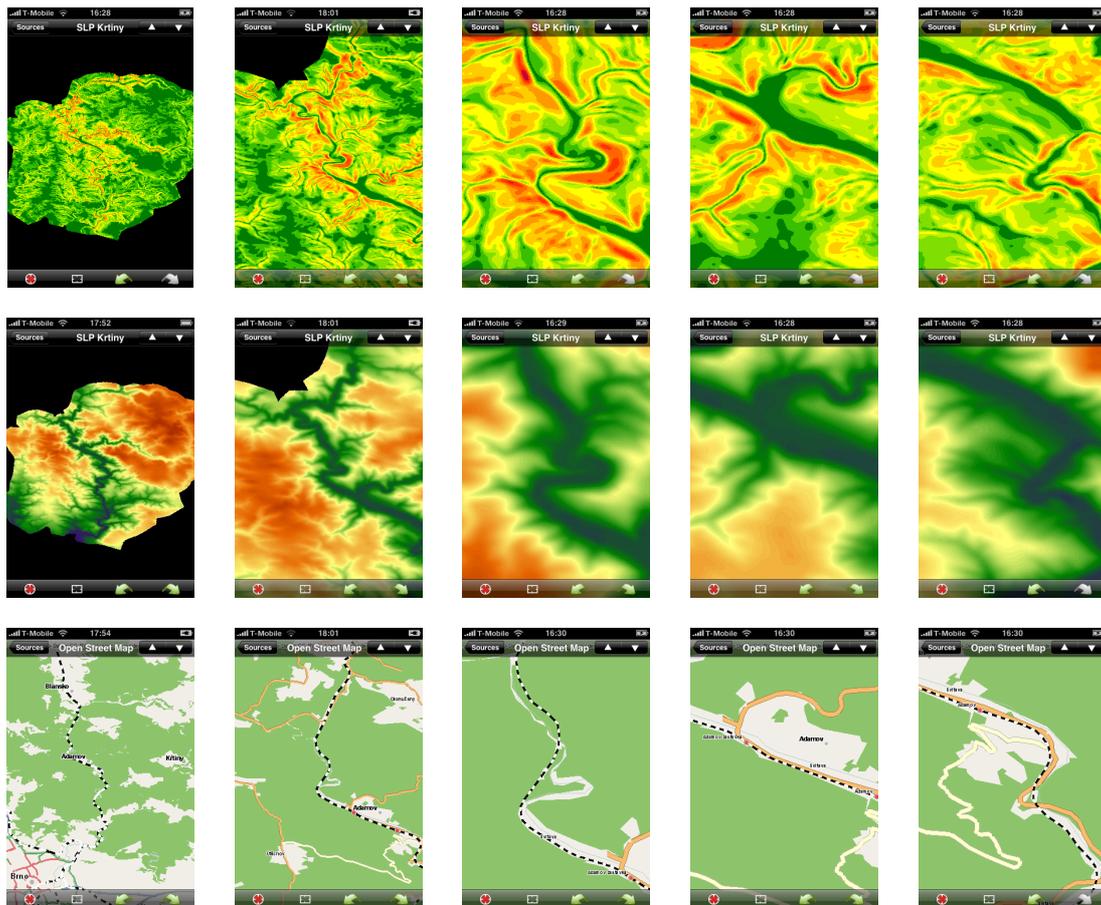


Fig.7. Movement history and its usage

## Conclusion

WhateverMap was developed as an open-source project. It is available in the AppStore as a free application. It is one of many mobile GIS projects but it is rare project for iPhoneOS platform. Of course there are many specialized solutions, for example armored devices of Trimble Juno SC and Terrasync that make the same work possible in a field. But Trimble solution is designed for experts. Although it is possible to find accessories for iPhone as armored cases[6] (Fig.8), we can not however replace forementioned specialized devices by the iPhone. But the iPhone is a great choice as a combination of mobile phone with a possibility of free GIS extension with easy using which is the feature preferred by common users.

The data model of WhateverMap is based on mobile data communication only. But in some cases it should be better to store data directly in iPhone[3]. This solution makes possible to access map data offline without spending money for a data communication and solve problems with slow data transfer in areas with GPRS signal only. Even many WMS servers are slow and this feature could solve the problem too. In the future development we want to add offline data support and use more data sources as WFS or tile based map sources.

The main purpose of the WhateverMap is to extend the community map portal MapShake.cz. It can enhance it's functionality with a mobility solution to provide the same data which can be found on the portal. User is then able to preview map sources on the portal, compose a map and share the compositions using a mobile device in a field. There are ideas of implementing some basic functionality for points, lines or polygons capturing or place marking somewhere in the future, but it is not the primary goal for now.



Fig. 8. Armored Briefcases (2600 Series PDA Case – iPhone 3G/3GS Impact Case)

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