# Current status and future directions of mobile GIS

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## 1.0 INTRODUCTION

Mobile GIS as a term describes the deployment and usage of Geographical Information Systems (GIS) on mobile devices, i.e. small, hand-held computing devices that typically have a touch screen or miniature keyboard. Like mobile device technology in general, mobile GIS is a fast-moving field. Mobile GIS is related to the fields of location-based services, Web-GIS and mobile computing. In the following paper we give an overview of the current status of mobile GIS, with a focus on the most important technologies in regard to current market shares. We will also discuss several use-cases and technology demonstrators that are currently being developed within Landcare Research, as well as possibilities for future development. The overall aim of the article is to present a description of the current status of the field as well as providing a starting point for those interested in mobile GIS from a software development or research perspective.

## 2.0 CURRENT STATUS OF MOBILE GIS TECHNOLOGY

### 2.1 Mobile devices and operating systems

Mobile devices are one of the high-tech areas that are very dynamic, innovation driven and predicted to have considerable growth potential especially in those areas of the world termed emerging markets. The market is currently dominated by smartphones and tablet computers. The term “smartphone” was coined around 1997. Smartphone development took a major step forward after Apple Inc. introduced the original iPhone in 2007, which used a touchscreen as its main means of interaction. Apple Inc. has also had a significant role in the establishment of the modern tablet devices market, i.e. those using touchpads, with the release of the iPad in 2010. The current market for mobile devices consists mainly of phones and tablets of different sizes that use touchpad technology. The most dominant platforms are Android, iOS and Windows Phone, each having separate and different software development kits (SDK) (Koetsier 2013). In the following only these three platforms will be considered.

Touchpads have some specific features that are important for the geospatial field offering new ways of interaction with dynamic maps. In particular touchscreen-devices are a game changer in dealing with the challenge of designing user interfaces of GIS for non-specialists.

## 2.2 Products and projects

Considering the huge number of mobile GIS software products and projects, we will focus on the most important ones in regard to market share (Google Maps, Bing Maps, iOS maps and ArcGIS) and in the area of Open Source (OpenLayers).

Different types of mobile GIS apps can be distinguished based on the provided functionality and use cases. One major group of apps consists of the widely known map apps Google Maps, Bing Maps and iOS maps. The overall functionality of these three apps is similar, the major use cases being search e.g. POI, navigation and location based services. They three packages also bundle in their own spatial data including street maps, satellite pictures and 3D-views. There are possibilities to add customized data to some degree (for example using Google My Maps), including lines and polygons. There is no support for adding or interacting with thematic maps. All of these Map apps include SDKs that allow customization.

ArcGIS mobile can be considered representative of fully-fledged, proprietary Mobile GIS apps. These applications are general-purpose tools that allow users to add thematic data (ArcGIS App) or even edit and update geometries and attributes. Also included is an SDK that allows the development of specific applications.

A number of Open Source projects support mobile devices, mainly in the form of web applications but only a few of them in the form of native applications. The OpenLayers project is probably the project with the highest number of users and instances. Both the current (v2) as well as the upcoming version 3 include mobile examples.

# 3.0 A CONTINUUM OF DEVELOPMENT APPROACHES

## 3.1 Platforms and programming languages

The number of mobile SDKs and corresponding map SDKs is very high and not all of them can be considered here. Generally there is a continuum of approaches between a web app and a native app (Figure 1).

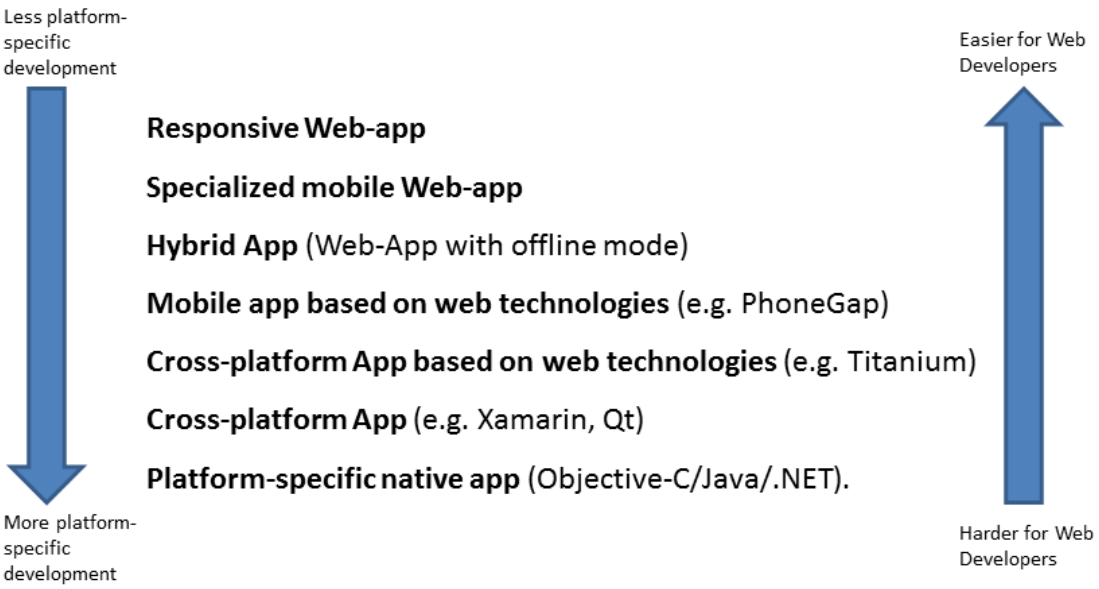


*Figure 1: Development approaches for mobile apps*

The continuum begins with web applications that are responsive i.e. adapt their layout to smaller devices. At the other extreme are native apps that are programmed using one specific SDK and will only run on one of the platforms. In between these two extremes are approaches that are based to varying degrees on web technology and therefore also differ in regard to them being specific to a platform and the level of web development skills (HTML, CSS, JavaScript) required to develop apps upon them.

## 3.2 Some technology experiments

Landcare Research is currently in the process of developing and evaluating demonstrators built using different kinds of mobile technologies. The major use cases are:

- Provision of land resource or biodiversity information to users such as farmers, land managers or conservationists
- Access to and collection of data in the field by specialists e.g. soil data, vegetation plots, pest monitoring
- Display of maps in the context of responsive websites. Maps and other content can be linked to each other.
- Citizen science – collection of data by non-specialists e.g. the creation and validation of a citizen driven national land use map, crowd sourced identification of photographed and described insects, etc.

Besides leveraging existing web development skills, our intention is to use Free/Open Source software to stay independent from specific vendors, to save on license costs and to give us the possibility of making our developments available to the wider public by contributing to the respective Open Source projects.

Our first set of demonstrators have been based on web-technologies to leverage existing web browser based development. They are OpenLayers applications that are either made responsive or are converted to cross-platform apps using PhoneGap. In the following we will show examples of these two approaches.


*Figure 2: Layer menu of the mobile soils app displayed in an iOS sumulater*

The first example is the mobile soils app which is a mobile GIS app for Android, developed using traditional web technologies, and converted to native app via PhoneGap. Figure 2 shows its layer menu that allows the user to choose from a variety of available soil information, while Figure 3 shows how maps are displayed; in the example the New Zealand Soil Classification.


*Figure 3: Map display of the mobile soils app on an Android phone*

The second example is the Antarctic Environments Portal, a cooperation project between Antarctica New Zealand and Landcare Research, which includes an OpenLayers-based mobile/web GIS app (Figure 4). The aim of the portal is improvement of communication between scientists and policy makers in regard to the environmental management of the Antarctic. It is developed as a responsive website using the Twitter Bootstrap framework.

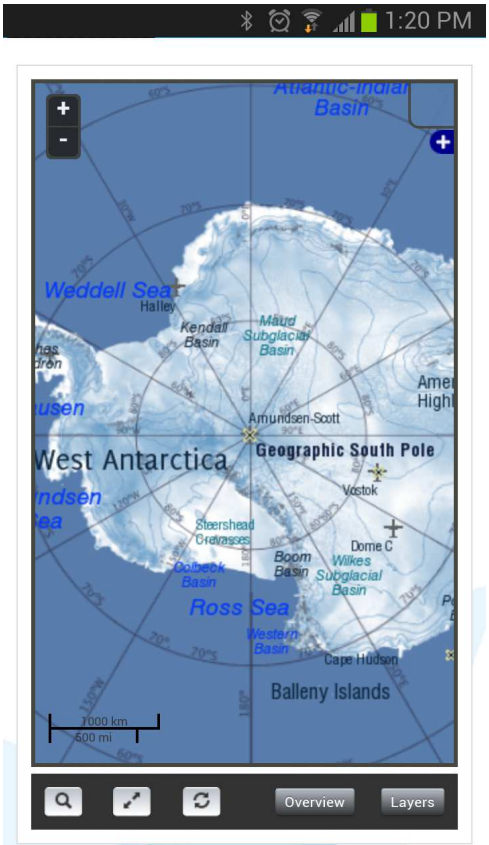


*Figure 4: Map display in the Antarctic Environments Portal on an Android phone*

Where more complex GIS functionality is required in a mobile app, other Open Source GIS projects are more appropriate, e.g. QGIS. The user interface of QGIS is based on Qt, a cross-platform application framework. As Qt is already ported to Android and iOS, this technology stack might be an alternative to the aforementioned OpenLayers/PhoneGap combination supplying richer GIS functionality although not based on web technologies.

## 4.0 NEXT STEPS

Comparing analyses of the direction of mobile GIS even just a few years ago with now (Brovell & Magni 2007, Solyman 2005) certain trends have become clearer. There is a fragmented development environment and a growth in the importance of touch-screen technology. Web-based development or at least development based on web technologies is helping leverage cross-platform development costs but at the expense of the ability to use platform-specific or very new functionalities. At the same time the distribution of native apps via app stores is driving native development against pure web development approaches. Approaches like PhoneGap, which allow the re-use of web technology but resulting in native apps might be a feasible approach but this needs more research using technology experiments.

We will discuss a number of additional topics that pose interesting research questions:

- Offline use
- Transfer of data from mobile to server
- User interaction with complex data models
- Mobile collaboration
- Mobile augmented reality
- Mobiles as sensor

- Mobile and cloud computing

## 5.0 SUMMARY

Mobile GIS is a highly dynamic field that is providing new research opportunities for GIScience particularly as these devices are bringing geospatial capabilities to large numbers of relatively naive geospatial users and allowing new ways of interacting with spatial data. Landcare Research is currently in the process of undertaking a number of technology experiments and intends to develop best practice guidelines for those developing mobile applications and ideas for further research and development.

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