Developing a GIS Based Mapping App for Android Devices

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Introduction

With the rapid development of technology, mobile GIS has become an important component of the GIS industry, and its integration is expected to expand in the future. Mobile GIS is a software and hardware framework that allows users to access geospatial data and services on their mobile devices. This project was designed to explore different aspects of mobile GIS to develop a mobile application or "app".

California State University, Long Beach, the third largest CSU campus, was established in 1949 and is home to nearly 40,000 students and 2,300 faculty members. The existing CSULB campus mobile apps support Android and iOS devices, but although their app design has proven to be suitable for a number of uses, their mobile map lacks functionalities and poorly displays spatial data. The purpose of this project was to develop a mobile map displaying spatial data for the CSULB campus that allows nontechnical users to engage in GIS.

The final deliverable of this project is a mobile app developed in Android Studio, suitable for Android devices, integrating spatial and non-spatial components to allow users to connect themselves to the CSULB campus.

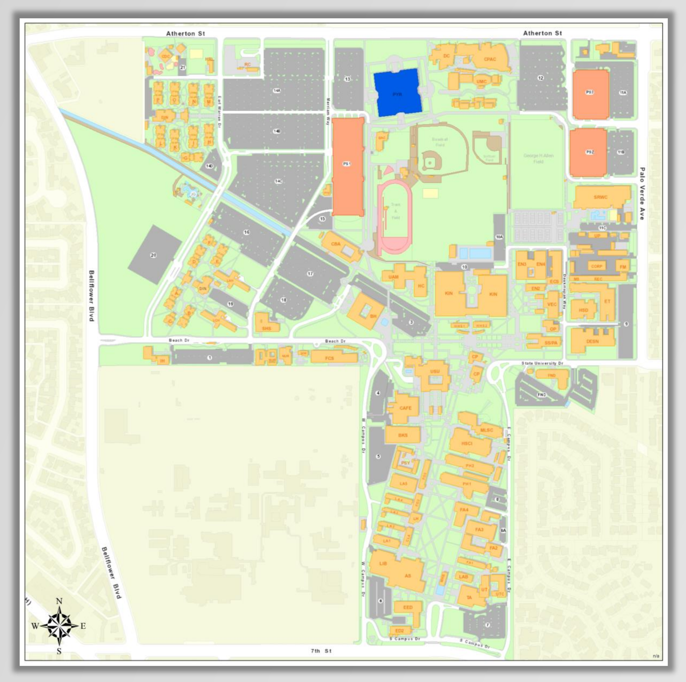


Figure 1. *California State University, Long Beach*

Data and Data Sources

The data used to complete this project (Table 1) belong to the CSULB Geography Department. The data layers, hosted as ArcGIS Services, relate to a number of features on the CSULB campus. The Department's current configuration runs on a single GIS server machine, not dependent on any other component (Figure 2). A great number of data layers used are dynamic layers, thus lacking attribute data. The food services data layer is a feature service layer containing attributes and categorized symbology.

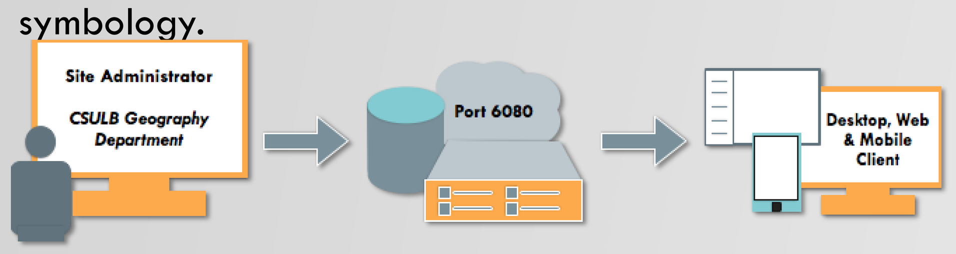


Figure 2. *CSULB ArcGIS Server Single Machine Deployment*

Table 1. *List of data and data sources used in the project*

DATA TYPE	DATASET	SCALE	SOURCE
Feature Service Layer	Food Services	Min scale: 4515 Mac scale: 2258	CSULB Geography Department
Dynamic Service Layer	CSULB Campus Basemap	No set scale	CSULB Geography Department
	Bus Stops	No set scale	CSULB Geography Department
	Parking Meters	No set scale	CSULB Geography Department
	Bike Stands	No set scale	CSULB Geography Department

Methodology

The methodologies adopted to complete this project may be divided into four categories, (1) setting up the development environment, (2) app development, (3) debugging and testing the app, and (4) publishing the final app (Tables 2 and 3).

During the setup phase the Android Studio software, Android SDKs, and Android development tools were downloaded to setup the development environment. The Android Virtual Device was setup and hardware devices were connected for testing.

An Android project containing source code, resource files and an Android manifest file was created. The ArcGIS Runtime SDK for Android was integrated to embed ArcGIS services and functionalities, and the map was licenced through the Esri developer website. Supporting activity files were created, and the activities were linked together to create a multi activity application.

Next the app was debugged and using Android debugging and tested using logging tools and the Android testing and instrumental framework.

The final phase of the mobile app development workflow, consisted of configuring, building and testing the application in release mode.

Table 2. *Mobile app development workflow*

SETUP	Setup development environment
	Set up AVDS & devices for testing
⇩	⇩
DEVELOP	Create application
	Add map using ArcGIS Runtime SDK for Android
	License application (ArcGIS)
	Add other activity pages
⇩	⇩
DEBUG & TEST	Build & run application
	Debug application
	Test application
⇩	⇩
PUBLISH	Prepare application for release
	Release application

Timeline

Table 3. *Project timeline*

Phase 1: Research	Research concepts & methodologies	April 1st - May 31st
Phase 2: App Development	Trial app development	June 1st - June 30th
	Begin app development & build mobile map dependent on the ArcGIS Runtime SDK for Android	July 1st - July 10th
	Design supporting app activities	July 11th - July 15th
Phase 3: Troubleshoot & Debug	Build, run, debug & test app	July 16th - July 20th
Phase 4: Complete Supporting Documentation	Write applied thesis project paper, create poster & prepare presentation	July 21st - July 31st

Results

After endless hours of learning how to develop an app, debugging, and resolving errors, the main purpose of this project was met and an Android mobile app containing an interactive mobile map was created. The app contains a total of five activities. Figure 3 displays the relationship between these activities.

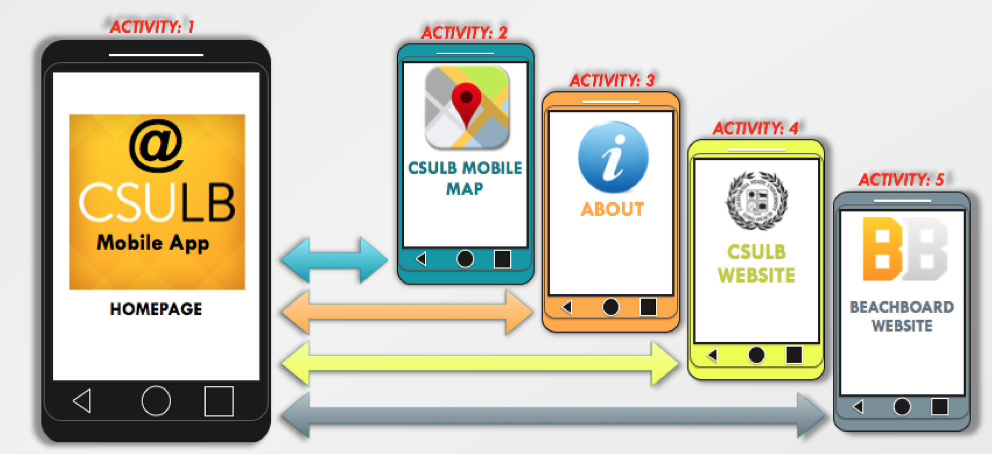
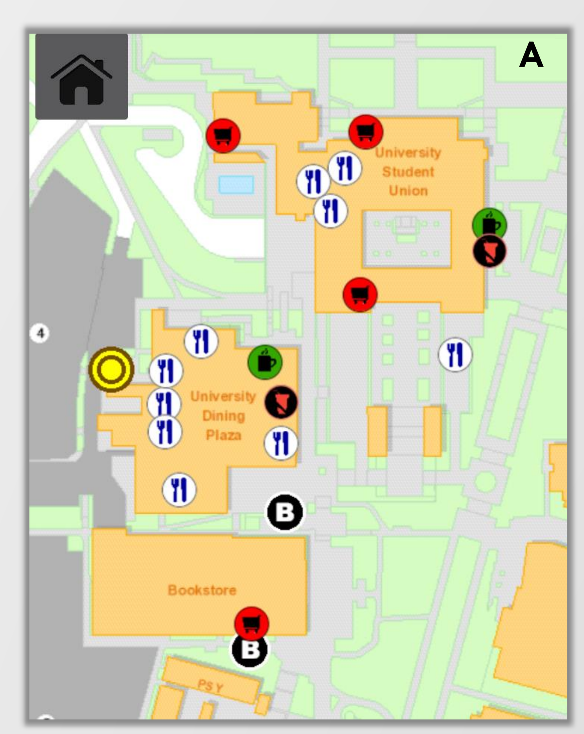


Figure 3. *App activity layout*

The app icon, assigned in the code displaying the name of the app, is visible on the homepage of the mobile device. Clicking on the icon leads to the homepage of the app. The homepage, simple in design, contains the app title and buttons leading to other activity pages.

Clicking on the map icon, a new activity page opens containing a map dependent on the ArcGIS Runtime SDK for Android. The map is displayed in full screen centered around the central quad at CSULB. The four dynamic layers are loaded at the set extent and displayed in the map. Android gestures are used to zoom in, out and pan through the map. Clicking on the features belonging to the food service feature service layer enables a callout classifying the name of the location and the type.



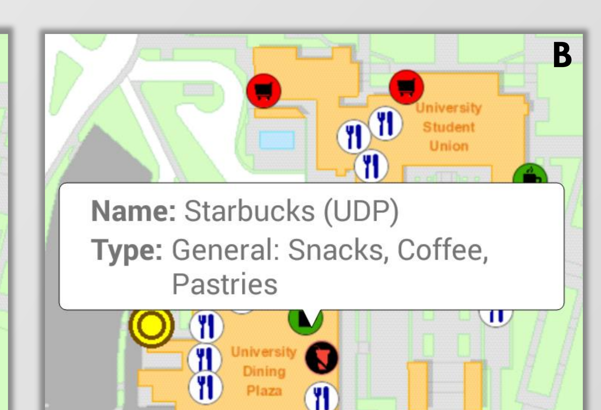


Figure 4A and 4B. *CSULB mobile map dependent on the ArcGIS Runtime SDK for Android*
4B. Callout displaying attributes relating to feature

The CSULB and BeachBoard activities work as browsers, set to display the specified websites. In order for both these activities to properly display, the mobile device must be connected to the internet. Figure 5 displays the different activities as they are displayed within the app.

Figure 5: *App activities*

Discussion

An Android mobile app, containing a number of activities and an interactive mobile map was built using the ArcGIS Runtime SDK for Android dependencies displaying dynamic and feature service layers. Prior to completing this project, I had no experience in Android app development, or using the ArcGIS developer tools. I learned how mobile maps are created within an Android project while researching Android app development and the applications of the ArcGIS Runtime SDK for Android. Learning about the different components and features of a mobile map prior to piecing them together within my mobile app helped me understand the need for the different components. Upon the creation of the main feature of the app, the mobile map, the supporting activities were developed.

Limitations relating to the dynamic and feature service layers limited their functionalities within the map. For example, each feature service layer contains a set zoom scale, only visible within a minimal scale frame and dynamic service layers lack attribute data. Due to the limitations related to the ArcGIS Runtime SDK for Android, Android Studio, and time constraints, I was unable to add the following features to my mobile map.

- A layer toggle option to allow users to turn layers on and off.
- A legend displaying information relating to the layers being displayed.
- Zoom option buttons that allow the users to zoom in and out of the map.

Utilizing Android Studio, and the ArcGIS Runtime SDK for Android, the expectations of this applied research project were met. The methodologies presented in this project to create a mobile map are not universal to different mobile platforms, thus a developer replicating this project will be limited to creating a mobile map for Android platform devices. Utilizing the ArcGIS API for JavaScript, app developers may develop and integrate a map similar to the one created through this project into the existing Android and iOS mobile apps.

Conclusion

The purpose of this applied research project was to develop an Android mobile GIS app for the CSULB campus. The future of this project may be categorized into three main categories.

- Development of apps supporting different platforms
- Integrating a greater number of map features
- Improving overall app design.

Through this project a GIS Android mobile app, utilizing the ArcGIS Runtime SDK for Android a mobile application was successfully created. Though the app designed is still in its preliminary stages, it is the first of its kind presenting spatial data relating to CSULB Campus. The Android app framework designed through this project may be utilized in the future to develop a complete mobile map app for the CSULB campus.

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