Signal Tower Location Map
For communication provider
Ran Shi (student id: 1505173)
EE master student of UCSC
CA, Santa Cruz
shaniranq@gmail.com

Abstract—The aim of this project is to provide the communication provider visualized map that can help them to build a new tower or adjust their signal cell. The main research target is show the several information on a map with clear layering and concise visualization. Information include Population, Traffic volume, Signal tower location and Signal Coverage. The visualization should provide communication a clear sight of map, which should help them pinpoint a new location to build a new tower to increase user coverage or help them adjust their signal cellular to improve the efficiency of user coverage. So, the research on this project is focus on how to showing different kinds of data on map and deal the relationship between visualization.

I. MOTIVATION
This project in stimulated by the open signal website\(^1\). It provide user with signal coverage map with the data collected from the user. It helps user to find nearby cell phone signal. So, in my primary thought I want to build a map to show the simple signal tower coverage instead of using the the collected data from the user. So, this will reduced the time in collect data from user. After the inspiring conversation with professor, he provided me with an idea. The idea is that rather than provide user with a signal coverage map, I can build a signal coverage map to help signal provider to manage their signal. The truth is that the signal provider need such visualization to have a big picture on their signal. By using such visualization they can easily locate their signal source and coverage area. It can help them to manage their signal network such build new signal tower and adjust their signal frequency cell.

This project is also related to the course. The project is a good practice for me to put the the knowledge on actual use. The project required several visualization such like the population and traffic volume. And I also need to handle the relation between them.

II. PROPOSED RESEARCH DIRECTIONS
The goal of this project is produce a map visualize the information including Population, Traffic volume, Signal tower location and Signal Coverage.

To achieve the project goal, there is several questions:
1. Use what kinds of GIS software to run the project?
2. Where can I find the data set of the project.
3. In what kind of method to show population and traffic volume on map?
4. How to show signal tower coverage in GIS?
5. How to show multiple information on a map without conflict and efficient?

Base on what I learn form this project. There is ways to solve the problem. First, The Google map\earth is a useful tool to show a map with information on it. It has a highly developed API and contain the information like elevation which is very useful in implementation of signal coverage. Second, I find several data set from inter net. And I have chooses some data set which I will include in source section. Third, The traffic volume and population can be a heat map or an Isolines’ map with the re-sampling data from data set. And I need to research more papers to decide the method to visualize the population and traffic volume. Forth, for signal coverage I decide to use the light-model. The reason that I made this decision is that I can't get information of signal tower. So, I decide to use the light-model first and make further implementation if I have enough time. Fifth, for reducing the visualization conflict and providing a clear visualization, i need to make research on paper on color and shape on visualization.

Then I summarize the question into few task.

1. HTTP://opensignal.com/
Task:
1. Get familiar with Google map API.
2. Implement the population and traffic volumes to map.
3. Use the light model to show the signal tower cover area on map.
4. Improve the visibility between different data.

Optional Task:
1. Improve the algorithm of signal coverage.

And following is the outline of the task.
First, Google provide enough information about Google map/earth API at Google developer. I need to study it to visualize map on Google map. Second, by study paper of how other people visualize the population and traffic form IEEE and other source, I can get idea for choosing the model to visualize those data. Third, to use light model I need to study similar application on Google map. And i need build code to show the polygon of signal coverage in this process. Forth, I need find other example and paper about showing many information on single map. And I need to adjust my map base on it.

III. RELATED WORK
There is several paper that shows the visualization on population and traffic for example:
Genetic algorithms solution to automated zone design based on urban population map:
http://ieeexplore.ieee.org/xpls/icp.jsp?arnumber=6729706
LiTMaS: Live road traffic maps for smartphones
http://ieeexplore.ieee.org/xpls/icp.jsp?arnumber=7158217

And there is a software that shows how signal source project its signal on a map.
http://www.cplus.org/rmw/english1.html

IV. SOURCE
The data set that will used in Implementation:
Population data set:

Traffic Volumes data set (CA):
http://traffic-counts.dot.ca.gov/

Signal tower location:
http://www.cellreception.com/towers/
http://antennasearch.com/

Google developer for Google map API
https://developers.google.com/maps/documentation/javascript/examples/