



**sgem**

Smart Grids and Energy Markets

- 1 -

## Project Title

# REPRESENTATION OF ELECTRICAL NETWORK USING GOOGLE MAP API

### Submitted by:

SEMANTA RAJ NEUPANE,

Research Assistant,

Department of Electrical Energy Engineering,

Tampere University of Technology

### Submitted to:

SAMI REPO,

Professor,

Department of Electrical Energy Engineering,

Tampere University of Technology



## 1. Introduction:

This project is about representation of electrical network using Google map. An electrical network is an interconnection of electrical elements such as resistors, inductors, capacitors, voltage sources, current sources, switches, breakers, bus bars etc. An electrical circuit is a network consisting of a closed loop, giving a return path for the current.

Electricity has become vital in almost all aspects of society today. Home Heating, lighting, television, radio, computer, telephones all rely on electricity. Transport Trains, buses, trams and cars all use electricity. In short we can say that we cannot imagine life without electricity. This brings the need for uninterrupted supply of electricity. In addition to regular supply, we are also concerned about the quality factors like voltage levels, pricing of electricity etc.

Use of Information and Technology techniques can greatly help in supply, regulation and monitoring of electrical systems. The electrical system consists of huge amount of data. We can use data formats such that they can be processed efficiently. There are different information model like CIM which simplifies the data transmission and modeling. Different simulation software can be used to investigate the electrical grids under different conditions. We can study the response of the grid in the abnormal conditions and work accordingly. So, there are various application areas of software tools in electrical system. It varies from small scale application to large scale application.

The Google map representation of electrical network helps in efficient monitoring of electrical system. It displays electrical equipment according to the location information. Each equipment is represented using an individual marker which holds the electrical information of the particular equipment. We can update, delete and change the equipment in the network at ease. Since this is a web based application, end users sitting in remote place can access the information from another distant place machine. The potential users of this application can be power station administrators, electricity using customers.

To implement this project different software tools are used. JavaScript, html, Ajax, XML, Google map api, PHP and MySQL are mainly used. Since this is web based application it has frontend and backend. The frontend is the webpage which displays map. Html and JavaScript are used in the frontend. The backend stores the data in fixed format. The backend consists of database which contains tables and corresponding xml files. The webpage gets information from the xml files. The communication between webpage and the xml files is handled by Ajax technique.



## 2. Environment:

Hardware environment: We can run this program in normal modern day computers. It has no specific extra hardware requirements.

Software environment:

Programming languages and software tools:

**2.1 XAMPP server:** It is a free and open source cross-platform web server solution stack package which consists of apache HTTP server, MySQL, PHP and Perl. It allows website designers and programmers to test their work on their own computers without any access to the Internet. After the installation of XAMPP we do not have to separately download PHP and MySQL.

Downloads and Installation:

The latest version of XAMPP for Windows was downloaded from [apachefriends.org](http://apachefriends.org). XAMPP for Windows exists in three different flavors: Installer, zip and 7zip. Installer package is used to download XAMPP since it is half the size of zip and it is easy to install. Using the directions given in the installation procedure, XAMPP is installed in C directory. We can select any destination folder to install the package.

After the installation we can see XAMPP Control Panel to start/stop all servers and also install/uninstall services. The universal control center is the "XAMPP Control Panel". It is started with: `\xampp\xampp-control.exe`.

**2.2 NetBeans:** NetBeans is an integrated development environment (IDE) for developing with Java, PHP, C/C++, and HTML5. We have used NetBeans for writing and running PHP codes. The NetBeans Platform allows applications to be developed from a set of modular software components called modules.

Downloads and Installation:

We can download the latest version of NetBeans from [netbeans.org](http://netbeans.org). The NetBeans IDE Download Bundle consists of various options. Since we are primarily concerned about



running PHP code, NetBeans IDE with supporting technology as PHP is downloaded. The installation can be done following the procedures given.

After the installation of XAMPP server and NetBeans IDE, we can write and run PHP code in NetBeans.

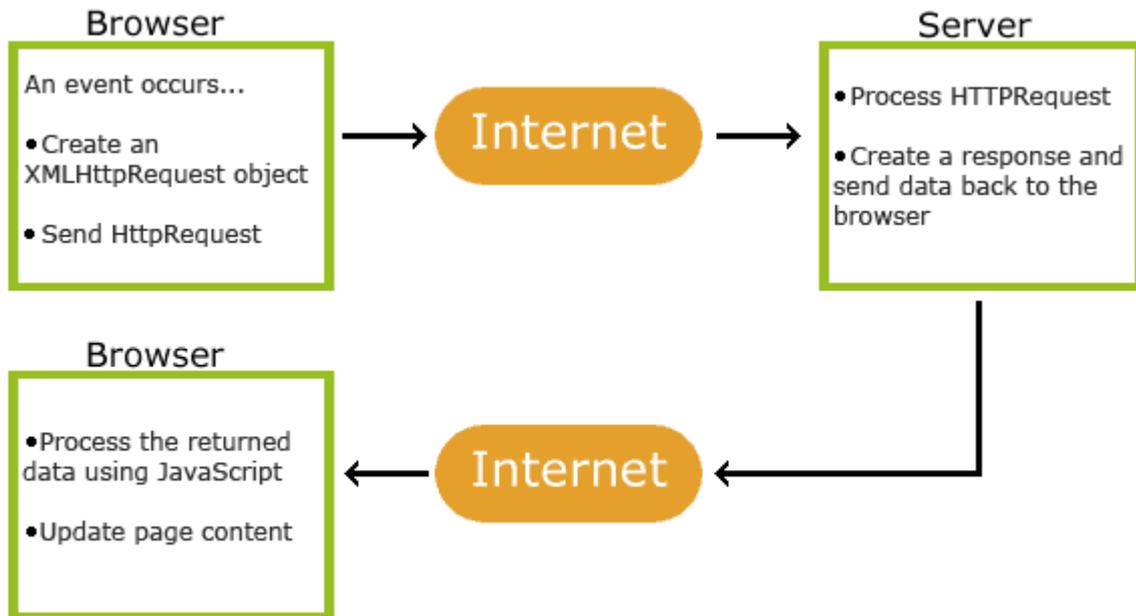
**2.3 HTML:** HTML is a language for describing web pages which stands for Hyper Text Markup Language. A markup language is a set of markup tags and these tags describes the document content. HTML documents contain HTML tags and plain text. HTML documents are also called web pages. HTML can be edited by using different HTML editors. Notepad++ is used since it is simple and easy to use.

**2.4 JavaScript:** JavaScript is the scripting language of the Web. JavaScript is used in most of Web pages to add functionality, validate forms, communicate with the server, and much more. JavaScript is programming code that can be inserted into HTML pages. JavaScript inserted into HTML pages, can be executed by all modern web browsers. To insert a JavaScript into an HTML page we have to use the <script> tag.

**2.5 Ajax:** It stands for Asynchronous JavaScript and XML. AJAX is the art of exchanging data with a server, and updating parts of a web page without reloading the whole page. AJAX allows web pages to be updated asynchronously by exchanging small amounts of data with the server behind the scenes. This means that it is possible to update parts of a web page, without reloading the whole page.

Working of Ajax:

How AJAX Works



In this project Ajax is used for the communication between webpage and XML files.

**2.6 XML:** XML stands for extensible Markup Language. XML is designed to transport and store data. XML was designed to carry data, not to display data like HTML. XML documents form a tree structure that starts at "the root" and branches to "the leaves". In this project, XML is used to store the electrical data which are kept in individual tables in database. So, for each table there will be one separate xml file.

**2.7 Google map API:** An API is a specification used by software components to communicate with each other. An API may describe the ways in which a particular task is performed. **Google Maps JavaScript API v3** is used in this project.

How to use Google map API:

First of all we need a specific API key from Google which is free of cost. The procedures for obtaining the key are:

- a. Visit the APIs Console at <https://code.google.com/apis/console> and log in with your Google Account.
- b. Click the Services link from the left-hand menu.
- c. Activate the Google Maps API v3 service.
- d. Click the API Access link from the left-hand menu. The API key is available from the API Access page, in the Simple API Access section.



Now we can use this api key in our project.

**2.8 PHP:** PHP is a server scripting language, and is a powerful tool for making dynamic and interactive Web pages. PHP code is executed on the server. A PHP script can be placed anywhere in the document. A PHP script starts with `<? php` and ends with `?>`. PHP can generate dynamic page content and can create, open, read, write, and close files on the server. PHP can add, delete, and modify data in the database. PHP is used in this project to manipulate the database.

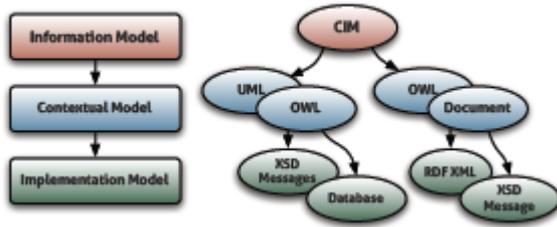
**2.9 MySQL:** MySQL is a database system used on the web which runs on the server. SQL stands for structured query language which is a standard language for accessing and manipulating databases. SQL can execute queries against a database. It can retrieve data from a database, insert records in a database, update records in a database, and delete records from a database. We have used a utility called phpMyAdmin which is used to administrate MySQL databases. Since XAMPP server is used, both PHP and MySQL are integrated in XAMPP server in our case.

## 3. Overview of implementation

### 3.1. Implementation at backend:

#### 3.1.1 CIM (Common Information Model):

Need for exchanging power system data between various sections is increasing day by day. This results in need of a common model of representing data. CIM is an open standard for representing power system components. CIM defines information used by electrical utilities as UML model. The UML model represents components using classes along with the relationship between these classes like inheritance, association and aggregation. CIM is the information model which contains generalized relationships. This model needs to be restricted for each context into profile, a subset of the full model. Each profile is collection of classes, attributes and references along with additional restrictions. This is the contextual model.



Now, this contextual model is used to derive the implementation model which defines the serialization structure for data. The implementation model can be database schema, XML schema or RDF schema.

The RDF schema provides means of mapping object oriented design to XML. There are tools available which generates RDF schema from CIM UML model. Hence we can generate XML format from CIM UML.

The XML is RDF XML which is different from normal XML file. The RDF XML format allows relationships to be defined between XML nodes. In basic XML there is no way to denote a link between two elements that are not parent or child. In RDF, this is achieved by using unique ID attribute under the RDF namespace. This allows references to be made by having its value refer to another element's ID.

### 3.1.2 XML parser:

An XML parser is the piece of software that reads XML files and makes the information from those files available to applications and programming languages.

In the project, XML parser is written in PHP. This parser takes the CIM XML file as input. Then the information of XML file is written in database. Each node in the CIM file corresponds to one table in the database. Each table contains information of child element of particular node of CIM file. There are total of twenty eight tables in our case.

### 3.1.3 Converting database table into XML file:

Each individual table is converted to individual XML file. SQL to XML converter program is written in PHP to accommodate this task. This results in smaller XML file. Loading smaller XML file takes less time and only the needed information can be loaded using small XML file.

These XML files are stored in the location C:\xampp\htdocs that is inside the htdocs folder of XAMPP server.



### 3.2 Implementation at frontend:

The frontend displays the actual webpage. HTML is used for generating webpage. The scripting language is JavaScript. Google Maps JavaScript API v3 is used to display the Google map. When we run the program using web browser, the web page is displayed. The web page in our case is the Google map. The map provides marker with unique location.

Each marker represents one electrical entity in our case. The latitude and longitude information for the marker is obtained from the CIM XML file. Each marker has its own information window. The information window contains different type of information about the equipment like name, id, power, voltage and current which are obtained from CIM XML file.

When we click on the marker the information window pops up. The listener functions are used for this. When the marker is clicked the listener function is executed which contains the information to be displayed in information window.

Different color and different shapes can be used for marker. Electrical symbols are used for the shape of the marker.

## 4. Communication between frontend and backend:

The communication between frontend and backend is done by using Ajax technique. It is the latest technique for creating dynamic webpage.

The XMLHttpRequest object is created which handles the actual communication. After the request is made by an event in webpage, the server processes this request and sends the data from XML file as response. Now this data is used in the webpage.

## 5. Using the Google map application:

To use this application, Web Browser is needed. When the program is launched using Web browser like Firefox, the Google map is obtained.



**sgem**

Smart Grids and Energy Markets

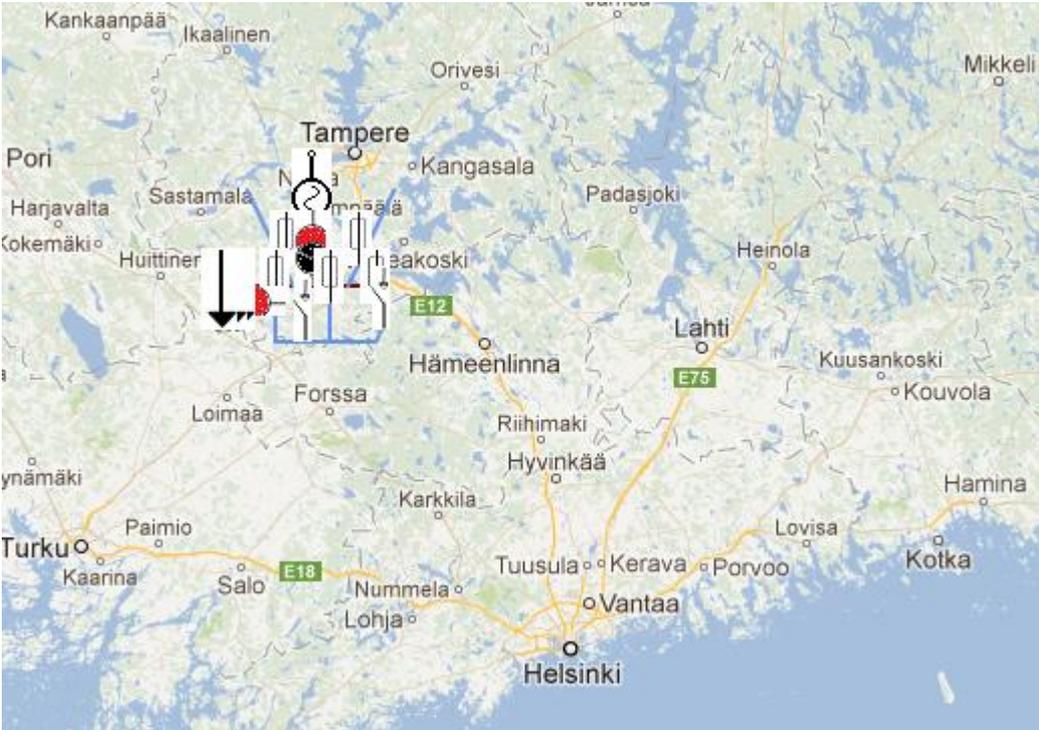


Fig1: map obtained when we run the program with default zoom level which shows electrical network.



fig2: Using this scrollbar zoom level can be changed.

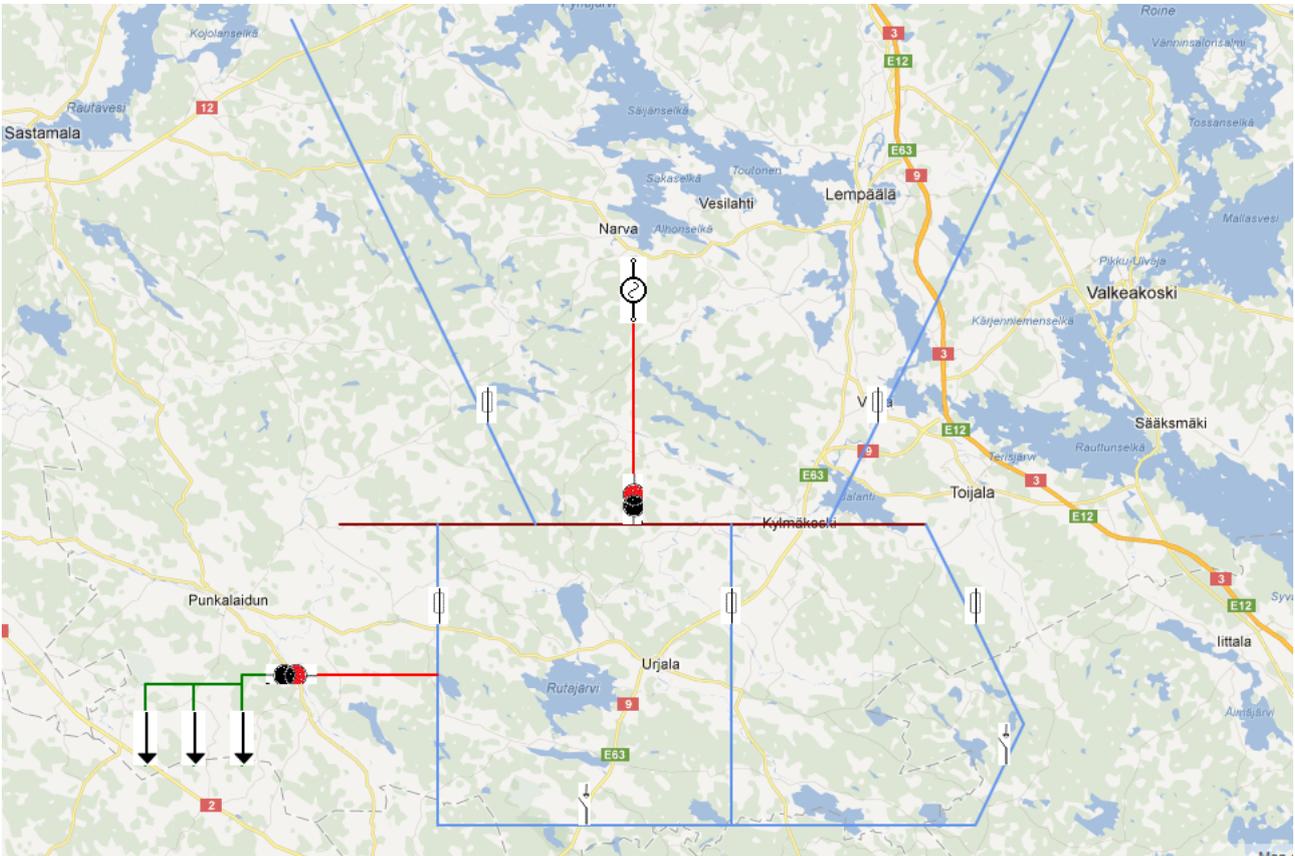


Fig3: map when zoom level is increased which shows the electrical network.

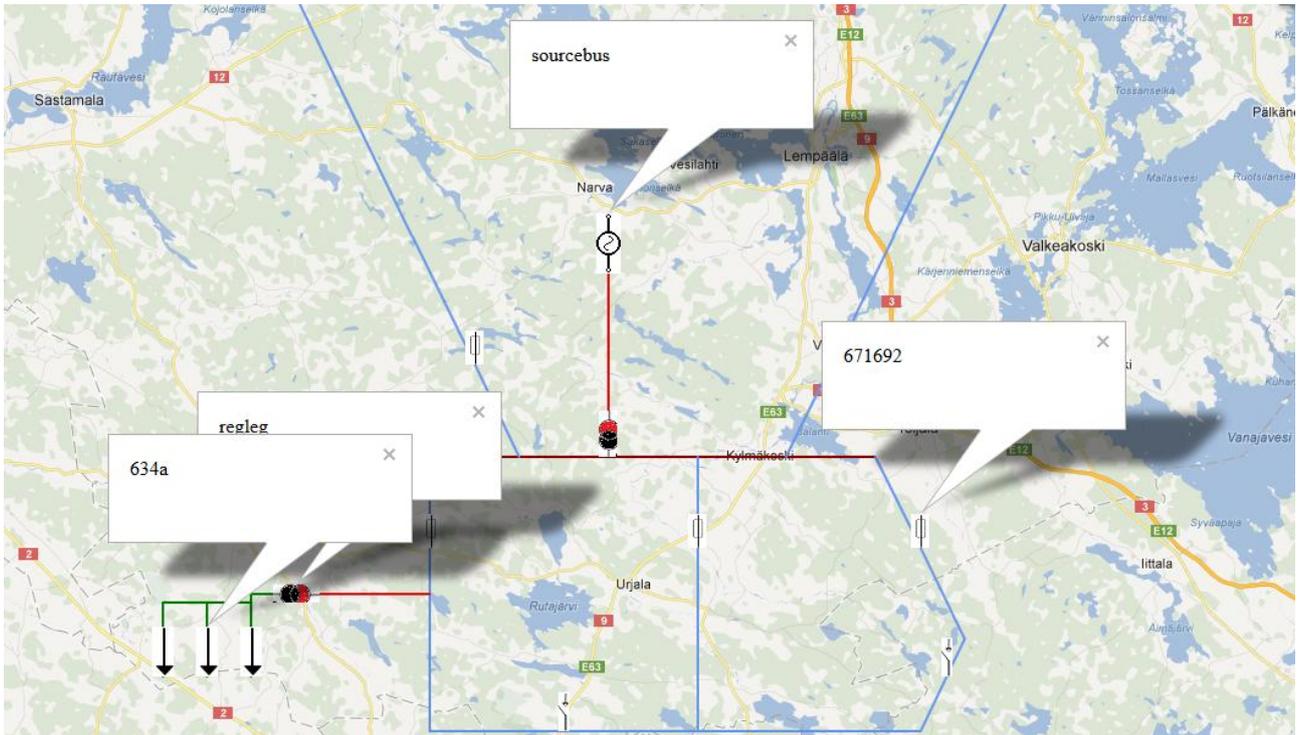


Fig4: map with marker and its info window showing different value.



## 6. Application areas:

Using the Google map representation of electrical network, we can visualize the whole grid. The connection of marker shows the structure of the network. The info window of each marker shows the electrical information of each equipment. This information can be used in various decision making processes.

The power station administrators can use the map to monitor the network. The power flowing through different sections of network can be known using the info window of the marker. End users can know the amount of voltage and current flowing in their house.

## 7. Future Enhancement:

The map takes data from XML file. We can make this real time application. We can update the XML file according to the changing condition of the network. The change in the XML file will eventually cause change in structure and values associated with equipment in the network. This change will be reflected in the map. This will greatly help in detecting fault in the network, identification of high voltage areas, low voltage areas, different power sources available in particular section etc. This helps in decision making process for every sector associated with control and monitoring of the electrical grid.