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GENG-5511

Dissertation

REView-Online Monitoring of Charging Stations for Electric vehicles.

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Date: 26th October, 2015

Masters of Professional Engineering-Software Engineering

Abstract

The escalating fuel prices ensuing from dwindling fossil fuel reserves and menacing climate change issues have led to the development of projects destined to the exploration and development of systems to help combat these problems. One such promising project is the Renewable Energy Vehicle Project (REV) initiated by the University of Western Australia (UWA) with the vision of creating zero-emission vehicles driven by electricity produced from renewable energy resources. Unlike other cars powered electrically, these vehicles would not only be simpler and cheap but would also be commercially viable. Several alternating current (AC) charging stations have been established so far which are under operation. In 2014, REV established the first ever commercial Direct Current (DC) Fast-charging station in the UWA campus. It is said that this station can charge an electric vehicle (EV) to 80 % in 20 minutes which is equivalent to being seven times faster than AC charging stations and twenty five times faster than charging at home. This thesis aims at monitoring and analysing the effectiveness of DC charging by designing a robust online web-based user interface. Thereafter, a comparison will be made between the effectiveness of AC and DC charging stations. To serve the purpose, a web-based software package called REView portal will be used that has a collection of statistical data obtained from electric vehicle trackers, charging stations and renewable energy resources. This portal helps present results in a meaningful way in order to motivate people for shifting to zero-emission transportation. The portal automatically evaluates the data statistically allowing the drivers, charging stations owners and station users to monitor their vehicle's efficiency and used energy, effectiveness of their charge stations and energy usage and expenses respectively. To help ease data availability, users can access the afore-mentioned information by means of mobile phone web applications, desktop web applications and can also export and print it. The REView portal is already monitoring the AC charging data of EV so the focus will be given on collecting the data of DC charging station by means of our designed web-user interface. The results for number of charges consumed per day, number of charges consumed per week, time taken per charge, energy consumed per time of day and number of charges as per connector ID (Chademo and CSS) will be graphically represented in the form of bar and pie charts. For the sake of comparison of AC and DC charging, parameters like charge frequency and energy frequency per time of day and per time of week will be used. Lastly, Veefil station data (DC charging station) will be integrated into the REView system.

Keywords: Renewable Energy Vehicle, charging stations, DC charging, Electric Vehicles

Acknowledgements

Contents

1. Introduction

The escalating fuel prices ensuing from dwindling fossil fuel reserves and menacing climate change issues have led to the development of projects destined to the exploration and development of systems to help combat these problems. Other than investing in power-producing projects that are powered by solar, wind and hydel projects, numerous attempts have also been made to produce zero-emission vehicles. Some of these including solar powered aircraft, electric and hybrid cars have been successfully launched. However, these vehicles are quite expensive and complex and hence have never been able to make to the commercial market.

The University of Western Australia (UWA) with the vision of creating zero-emission vehicles initiated Renewable Energy Vehicle Project (REV) which aims at building plug-in electric vehicles (EV) driven by electricity produced from renewable energy resources. Unlike other cars powered electrically, these vehicles would not only be simpler and cheap but would also be commercially viable (REV, 2010). Automobile companies like Nissan, Mitsubishi, BMW, Renault, Ford and Tesla have so far release their EVs into the market (Speidel & Bräunl, 2014). However, a shift to such cars cannot be instantaneous as it requires significant changes in one's driving habit (Cunningham, 2009). An additional charging infrastructure would be required to be installed, maintained and managed for the convenience of the EV owners (Speidel et. al, 2012). But the growth of EV in the market is dependent on the electrical grid infrastructure's capability to keep up with the increasing demand of recharging the EVs (Mullan, 2011). Thus, a need arises for a robust user-friendly portal that does not only help the local electrical grid station track an increase in demand caused by the charging stations but also helps the drivers to check their vehicle's performance. This would as a result promote the use of EVs in the commercial market that can help revolutionize the auto industry in the long run. To serve this purpose, an online web portal by the name of REView was launched by Stuart Speidel (REV, 2010). Section 1.1 highlights the details of the portal.

1.1. Overview of REView online portal

The REView portal is web-based online portal easily accessible by various use groups to motivate the use of zero emission transportation (REV, 2010). The package works by collecting the data from different AC charging stations, the EV trackers and sources of renewable energy (primarily solar installed in Western Australia) and then automatically evaluates the data statistically after every half an hour allowing the drivers, charging stations owners and station users to monitor their vehicle's efficiency and used energy, effectiveness of their charge stations and energy usage and expenses respectively (REV, 2010). To help ease data availability, users can access the afore-mentioned

information by means of mobile phone web applications, desktop web applications and can also export and print it (REV, 2010).

REView is a combination of two projects, the first one being the West Australian EV trial which comprised of locally converted electric vehicles owned by business tycoons, the second being the establishment of 23 public charging stations in the Perth metro area, Western Australia (REV, 2010). The portal receives data automatically from the EVs and the charging stations via a GSM network. While for the EV the data transmitted gives the GPS location of the vehicle, its remaining charge etcetera, the data transmitted from charging stations gives information regarding the consumed energy and the time at which the EV was plugged-in and out (REV, 2010).

1.2. Overview of DC charging station

The charging stations installed in Western Australia were all based on Alternating Current (AC). It was not until November 2014, that a charging station based on Direct Current (DC) was installed by REV within the campus of UWA (UWA, 2014). The director of the project, Professor Thomas Braunl, claims that the DC charging station can charge an EV vehicle from scratch up to 80 percent in half an hour which is equivalent to being seven times faster than AC charging stations and twenty five times faster than charging at home (UWA, 2014). The drivers soon after having charged their EVs will have to leave. This can help separate the parking space from the charging area since the latter had been mostly under use for parking instead of charging (UWA, 2014). In addition to this, more customers have been attracted owing to the charging speed, making it quite profitable.

Figure 1: First DC charging station installed in University of Western Australia by REV project (UWA, 2014).

2. Problem Identification

The online REView portal is already monitoring the data coming from the AC charging stations. Since DC charging station (Veefil station) is a new technology, our focus will be driven to collecting the data of DC charging station. The received data will be monitored and analysed by designing an online web-user interface. Thereafter, the data from the Veefil station will be integrated into the REView system for the purpose of comparison between the effectiveness of AC and DC charging stations.

3. Literature Review

With the efforts of Stuart Speidel, a Software Engineering PhD student under Professor Dr. Thomas Braunl an online web-portal REView was launched (REV, 2010). The portal is freely available for users to help them analyse the data for research purposes (REV, 2010). The portal, however, covers the AC EV charging stations only. The present work aims at supervising all the DC EV charging stations in a sophisticated manner. For this purpose, papers were reviewed to understand how to get the raw data from the charging stations via OCPP and SOAP protocols and store it in the database. Following sub-sections provides the details of these papers.

3.1. Overview of OCPP

In 2009, the Dutch foundation E-laad developed a protocol by the name of Open Charge Point Protocol (OCPP) with an aim of making possible the communication between the charging stations from different vendors and the central supervising system (OCA, 2012). A standard that is followed is uniform and makes the coordination a whole lot easier. OCPP uses Simple Object Access Protocol (SOAP) over Hypertext Transfer Protocol (HTTP) as a transport since the former already has an infrastructure for sending messages making the implementation of the protocol quite easy (OCA, 2012). As per the OCPP version 1.5. OCPP comprises of 25 operations, out of which 10 are initiated by the charging stations (Authorize, Boot Notification, Data Transfer, Diagnostics Status Notification, Firmware Status Notification, Heartbeat, Meter Values, Start Transaction, Status Notification and Stop Transaction) and the rest by the central supervising system (Cancel Reservation, Change Availability, Change Configuration, Clear Cache, Data Transfer, Get Configuration, Get Diagnostics, Get Local List Version, Remote Start Transaction, Remote Stop Transaction, Reserve Now, Reset, Send Local List, Unlock Connector and Update Firmware) (OCA, n.d.).

3.2. Overview of SOAP

SOAP operates on a structure that helps sending messages over the internet among different components. SOAP enjoys an advantage of the Extensible Mark-up Language (XML) standard facilitating the transmission of the messages which are in the form of readable text, images and executable code. This helps hasten its implementation (OCA, n.d.).

4. Methodology

4.1. OCPP structure

Whenever a communication takes place between the charge point and the central system, a request is first made. This request is made by the sender via sending a signal in the form of "operation.req()." The recipient will then reply with a confirmation signal "operation.conf()" (OCA, 2012). The communication flow between the two is illustrated in Figure 2.
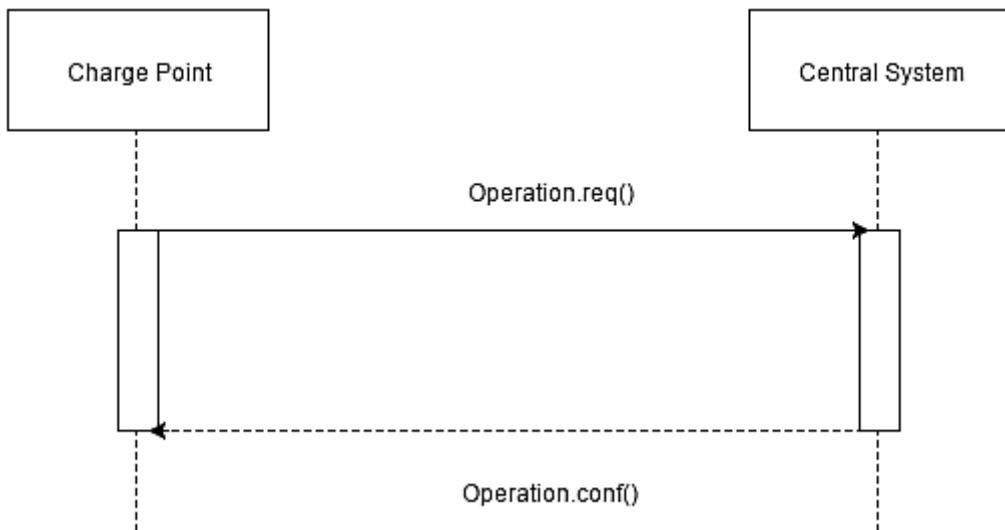
Figure 2: Communication flow between the charging point and the central system (OCA, 2012).

The central system shown in Figure 2 is the supervising station which contains all the information about authorized users which is used at charge points. Charge point, on the other hand, is a physical system where an electric vehicle plugs-in to get itself charged. Every charge point has one or more connectors which are independently operated electrical outlets. The charge point is controlled by its control unit, commonly known as the charge box (Elaad, n.d.).

4.1.1. Functional description of the OCPP operations

The functions that are exchanged between a charge point and the central system are described as follows:

1. **Initializing the charge point:** On turning on a charge point, contact between it and the central system is established. The charge points send signals to the central system indicating the configuration, brand and type. The central system responds by checking if the charge point is in its system. In case the charge point is found in the system, the central system replies affirming that it has been accepted along with details like time, date of the central system and the configured heartbeat interval. In the case it is not accepted, charge point continues sending signals to the central system (Elaad, n.d.).

2. **Heartbeat:** Upon establishing the contact with the central system, the charge point sends a heartbeat to the central system at the designated time interval set by the central system. This

signal is sent to let the central system know that the charge point is alive. The central system replies with the current time and date(Elaad, n.d.).

3. **Starting a transaction:** Once an EV has plugged-in, the owner of the vehicle is required to authorize the transaction. A message is sent to the central system containing the ID of the charge pass. The central system replies with the details about the charge pass including its validity. Upon approval, the charging process starts. The charge point can even keep a local white list which contains the records of the ID cards the central system accepts. This will be helpful in the situations of no connection with the central system. The central system can request changes in the list with regards to replacing, synchronization, adding or removing IDs from the local white list (Elaad, n.d.).

4. **Terminating a transaction:** to terminate the charge action, the owner of the EV has to identify himself by the charge pass. The charge points requests the central system to stop the transaction along with meter reading, the number of the transaction, the ID and the time.

5. **Firmware updates:** with every firmware update, central system messages the charge point detailing about the location from where the update is to be downloaded, exactly when it is to be collected, attempts that can be made and the time interval between them. Charge point replies a confirmation message and would update the firmware at the configured time. Thereafter, it sends the signal to the central system informing whether the installation went successful or not.

6. **Dealing with errors:** In case of an error in the charge point, it informs the central system. The errors might arise in the plug lock, extremely high temperatures, communication with the central system, kWh meter and the magnetic switch.

7. **Reserving:** As per OCPP version 1.5, a charge point can be reserved. This would require the central station sending the message to the charge point with the details about the reservation; the time, the ID card and the reservation ID. The charge point depending on its current status would accept or refuse the reservation. If the charge station is in use, it will reject the reservation. If the charge point has certain faults, it will be informed to the central system. The central system has an authority of cancelling any reservations already made by sending the charge point a cancellation message with the reservation Id. If the charge point recognizes the ID, it will reply indicating that it has accepted the request, otherwise it will indicate that it has refused the request (Elaad, n.d.).

4.1.2. Operations Initiated by the charging point

Out of 10 operations initiated by the charging point only a few are implemented which have been enlisted as follows:

1. **Authorize:** As soon as the EV plugs in at the charging point, a request for authorization is sent to the central system which upon recognition of the user responds by sending an

authorization confirmation signal. Having received the confirmation, the charge box unlocks the connector (OCA, 2012).

If the charge box has the record of the previously authorized users, it may authorize the owner of the EV itself (OCA, 2012).
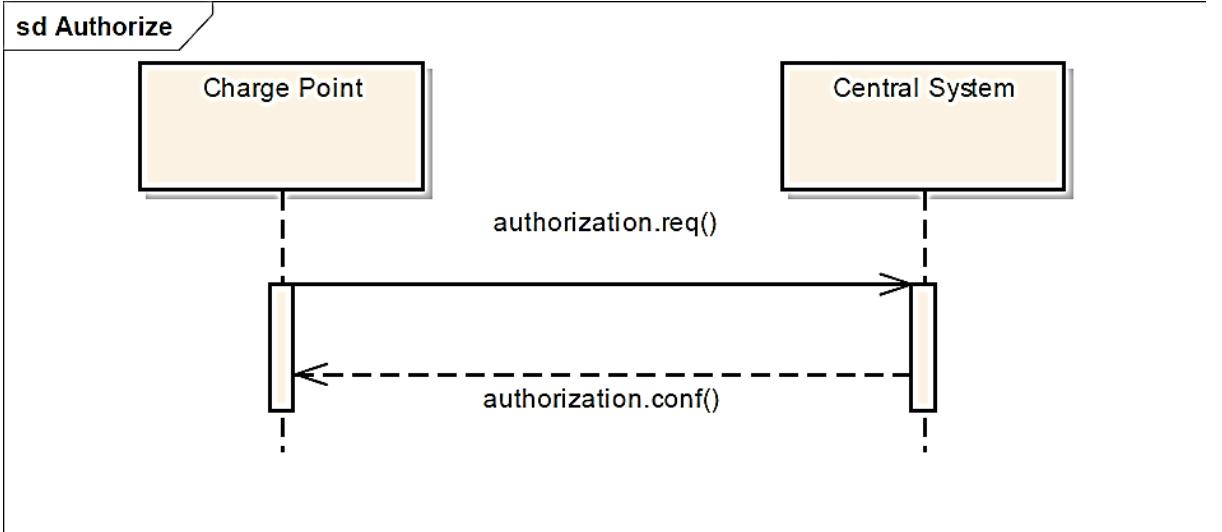
Figure 3: Communication flow between the charge point and the central system at the time of authorization (OCA, 2012).

Figure 3 shows the information exchange between the charge point and the central system at the time of authorization. The authorization.req() contains the information about the identifier to be authorized by the central system. The authorization.conf() contains the information about the validity of the charge pass (OCA, 2012).

2. **Boot Notification:** Having unlocked the connector, the charge box sends a signal with the information about its configuration that is the version and vendor, for boot notification to the central system which responds by either accepting the charge box registered with it or rejecting the ones that have not been registered with the central system (OCA, 2012). The central system along with the acceptance signal, also sends the current time and the heartbeat interval to let the charge station synchronize with it (OCA, 2012). The charge box sends the request every time it reboots (OCA, 2012). Until the central system does not respond its request, the charge point should not send any other request (OCA, 2012).
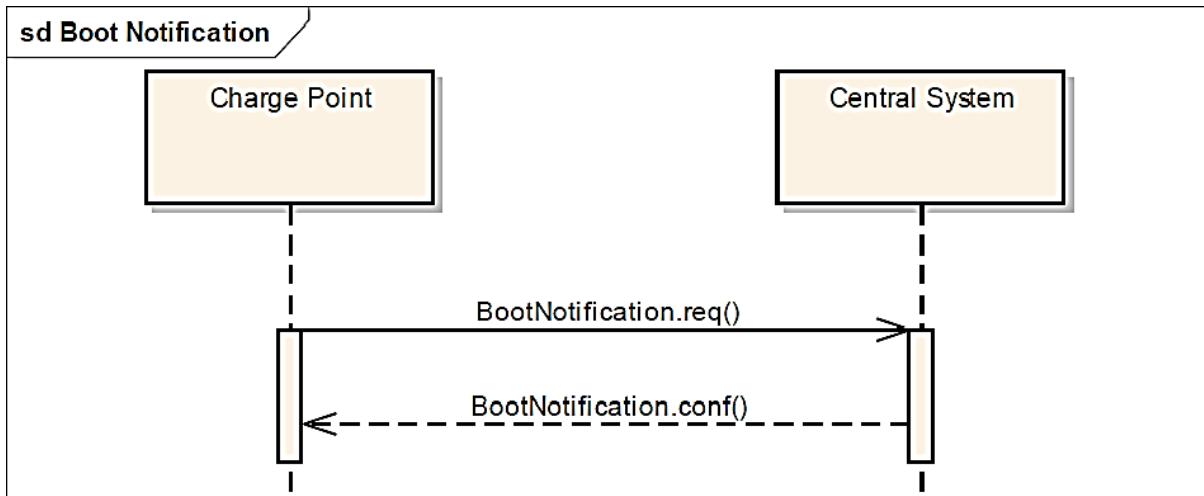
Figure 4: Communication flow between the charge point and the central system at the time of booting up of the charge station (OCA, 2012).

Figure 4 shows the information exchange between the charge point and the central system at the time of bootup process of charge point. The BootNotification.req() contains the information about the charge box contained in the charge point, the vendor and the model of the charge point. The BootNotification.conf() contains the date/time, the heartbeat interval and the registration status (OCA, 2012).

3. **Heartbeat:** To let the central system know that it is still connected and alive, the charging system sends a heartbeat signal after the set time interval as configured by the central system. The central system then sends the confirmation signal often with the current time so as to make sure the charging point synchronises its internal clock (OCA, 2012). In case any other message has been sent at the designated time for sending the heartbeat, the charge point may not send the heartbeat PDU. In this case, the former PDU would let the central system know that it is alive (OCA, 2012).
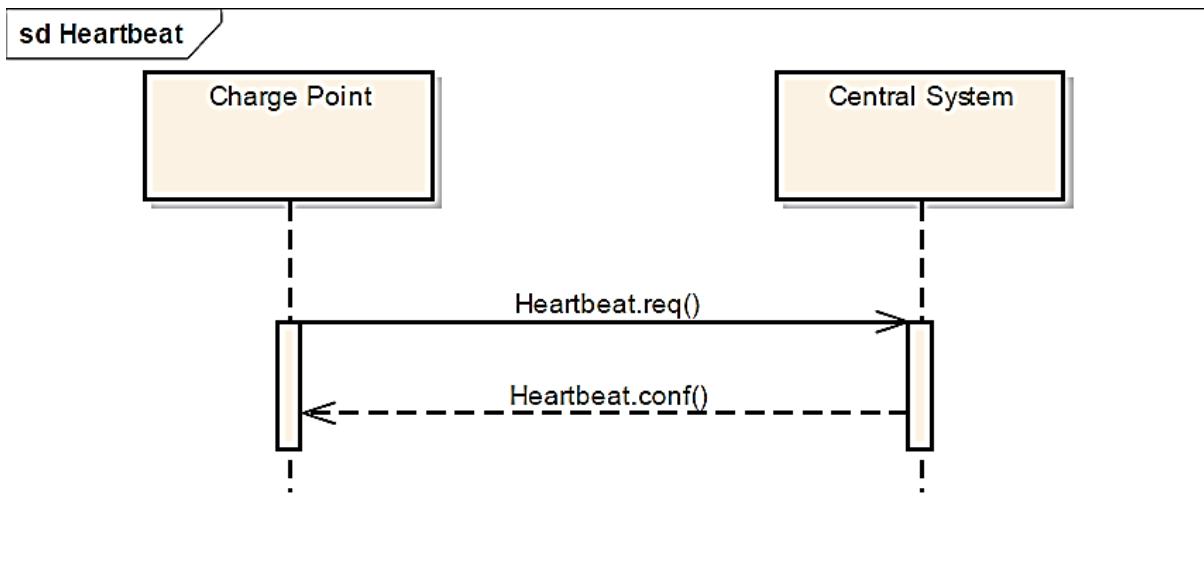
Figure 5: Communication flow between the charging point and the central system at the time of sending a heartbeat PDU (OCA, 2012).

Figure 5 shows the information exchange between the charge point and the central system at the time of scheduled heartbeat. The HeartBeat.conf() contains the current date/time set at the central system (OCA, 2012).

4. **Start Transaction:** If an EV is allowed to get itself charged, the central system is notified by the charging point. If the transaction is valid, the charging point replies by a confirmation signal along with the transaction ID and the status of authorization value (OCA, 2012). If the charge box has maintained its own local white list, then upon receiving the reply from the central station, it must update its list (OCA, 2012).
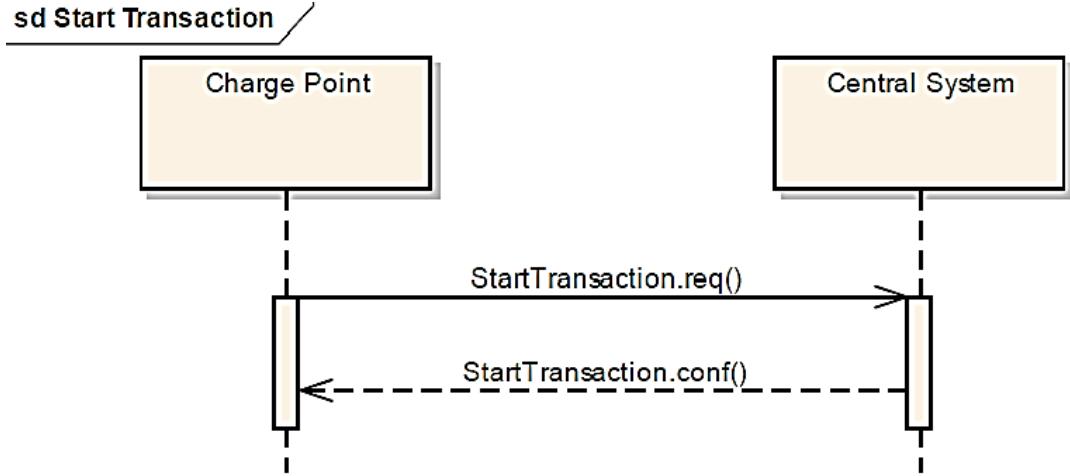
Figure 6: Communication flow between the charging point and the central system at the time of starting the charging process (OCA, 2012).

Figure 6 shows the information exchange between the charge point and the central system at the time of starting the charging process. The StartTransaction.req() contains the information about the connector ID, the authorized EV owner's ID, the meter value in Wh and the date/time at which the charging process started. The StartTransactio.conf() contains the status of the authorization and the transaction ID (OCA, 2012).

5. **Status Notification:** To update about its error condition, the charging point sends signal to the central system which responds by sending back a confirmation signal (OCA, 2012). It is important for the central system to know about the unavailability of the charge point in case of an error (OCA, 2012).

Figure 7 shows the information exchange between the charge point and the central system at the time of informing the central system about the availability of the charge point. The StatusNotification.req() contains the information about the connector ID, error code in case an error is developed in the charge point and the current availability status of the charge point (OCA, 2012).
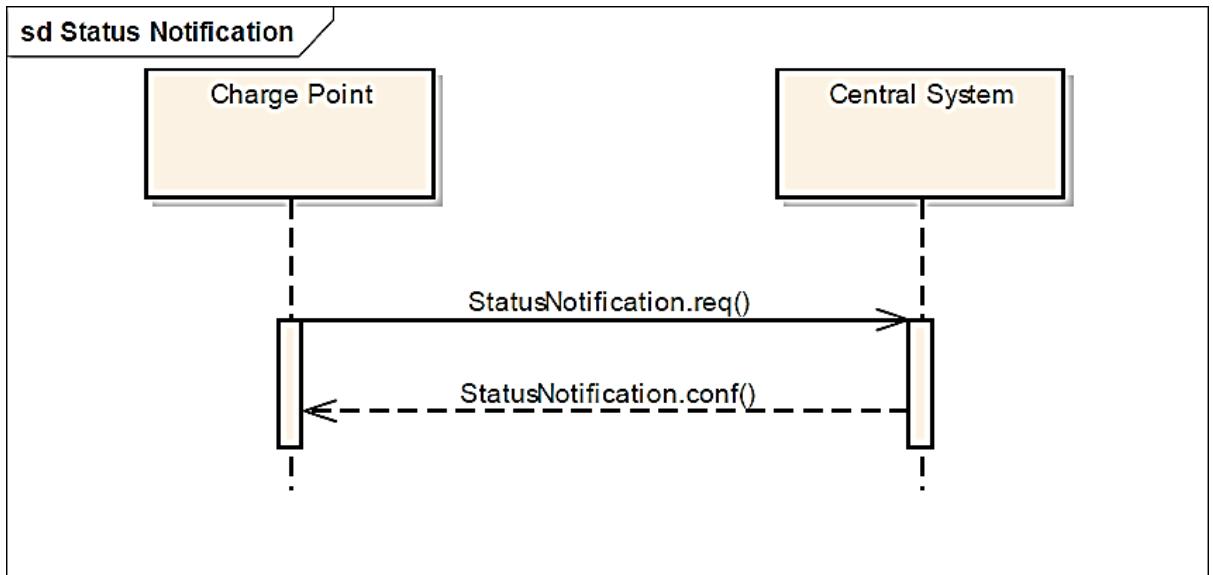
Figure 7: Communication flow between the charging point and the central system at the time of informing the central system about the current availability of the charge point (OCA, 2012).

6. **Stop Transaction:** To stop charging an EV, the charging system signals the central system which stops the transaction (OCA, 2012).
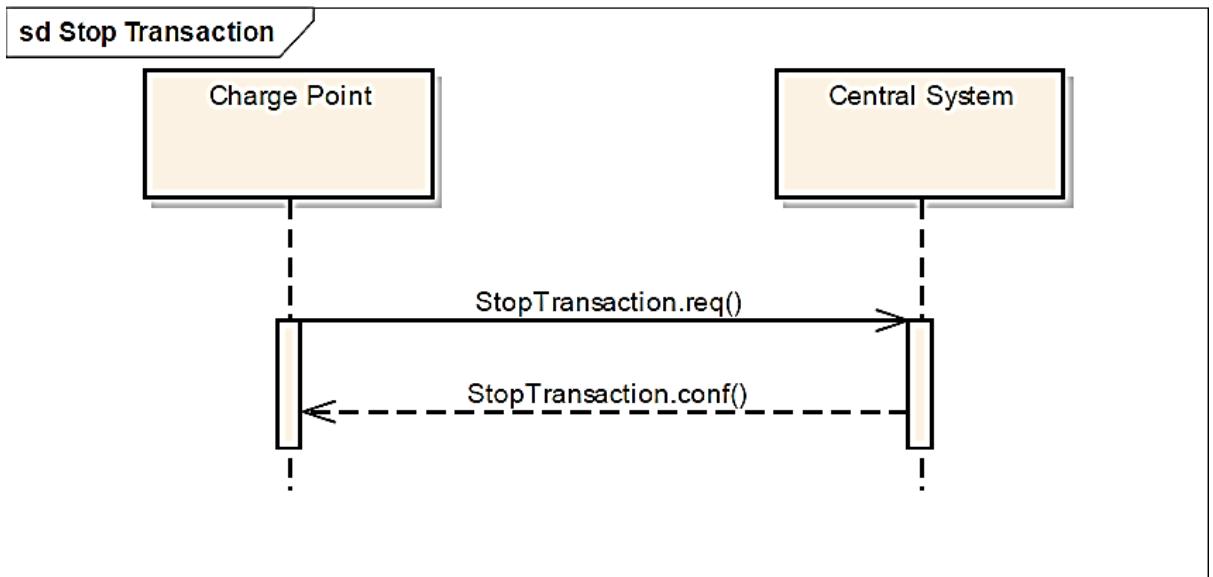
Figure 8: Communication flow between the charging point and the central system at the time of stopping the charging process (OCA, 2012).

Figure 8 shows the information exchange between the charge point and the central system at the time of stopping the charging process. The StopTransaction.req() contains the information about the meter value in Wh, date/time when the charging stopped and the transaction ID received at the start of the charging process. The StopTransaction.conf() contains the status of the authorization (OCA, 2012).

4.1.3. Operations initiated by the central system

The operations that are initiated by the central system are under the supervision of Bosch eMobility solutions.

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4.2. Binding to the Transport protocol SOAP

OCPP delivers its messages in the form of Protocol Data Unit (PDU) via the transport protocol "SOAP." The version of SOAP to be used is 1.2. The PDU's delivered by any charge station must be attached with an identification of the station to let the central system identify the station distinctively. To serve the purpose, the charge box sends the identifier of the station in the SOAP header with every PDU. Care is taken when sending the charge box identity since they are case sensitive.

In the case when the central system is to send any request to the charge box, it must indicate the charge box identity the request is intended for. If the request lands at the wrong charge box, the charge box responds by sending back a fault response message (Elaad, n.d.).

To ensure the security of a sensitive data sent via SOAP, the messages are well protected with SSL/TLS. The sending party should also make sure it uses the client certificate so as to gain the receiver's trust (Elaad, n.d.).

It is in Web Service Description Language (WSDL) file that the operations initiated by the charge point are written in (OCA, 2012). These files are essential with regards to testing the services offered by SOAP. SOAP versions 1.1 and 1.2 support the 1.1 version of WSDL which is used to make tests, messages, validations and mock services (Smart bear, n.d.).

4.3. System Design
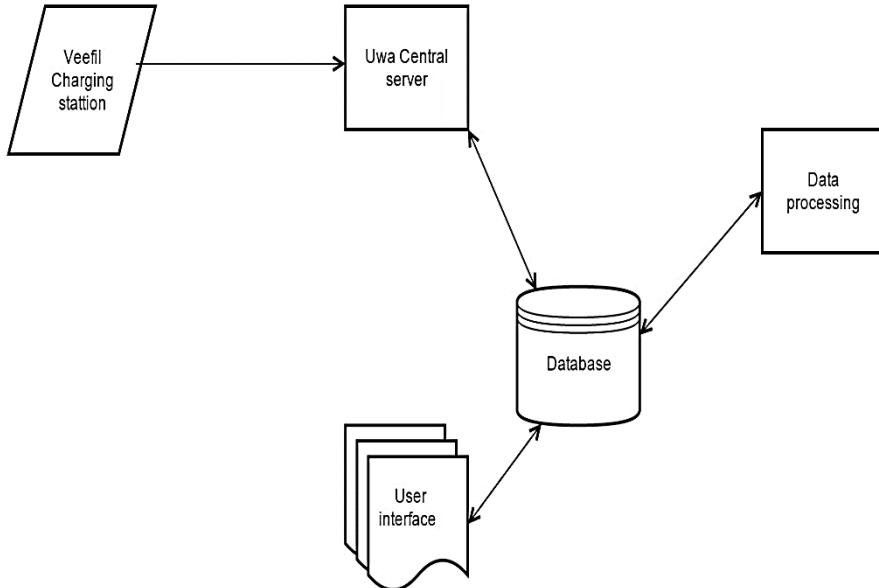
Figure 9: The system architecture

Figure 9 illustrates the whole architecture of the design. The process begins when an EV plugs itself at the Veefil DC charging station for charging. Upon plugging, an update is sent to the UWA central server which is the Rev blue host server running parallel with the Bosch Central server. The information is then sent to the Database from the central server. The database used for REV software is PostgreSQL database 8.4.20. The database receives the information in raw form. To present it in a

meaningful way, it is then sent to the data processing unit which processes data by php scripting which helps in generating graphs. This has a few benefits, when performing statistical evaluations the parsed data is used to greatly speed up the processing. Lastly, the processed data in the graphs together with statistical data such as Number of charges per day, Number of charges per week, Time taken per charge, charges per day of week, kWh energy consumption are displayed in the web-user interface.

Veefil's Charge point implementation will communicate with both UWA Rev Central server (Blue host) and Bosch's Central system endpoints, ignoring any response given back by UWA Rev central server. Effectively only giving monitoring information to UWA Rev Central server and at the same time using Bosch's central server for regular operations.

UWA Rev Server will be an implementation of the Bosch Central Server. For communication of data, Veefil charge point would be using OCPP 1.5 version. In order to implement the UWA Rev central server as the replica of Bosch central server we need to first implement the web service at our end point which is the SOAP over http for accepting the request coming in from the veefil charge point. The steps that have been undertaken for the entire design of the system have been enlisted below:

1. In order to capture the request made by the Veefil charge point, the SOAP server has been created at our end point.

2. In order to define the operations initiated by the charge point referred in the ocpp specification document, the wsdl file has been exposed which contains the operations defined for the charge point with specific input and output parameters.

3. For the sake of having a backup of the data, log file (.txt) has been created.

4. To test the soap server created on Rev blue host server, simulator tools like SoapUI and ocpp charge box by Eurisco have been made used of.

5. The new data for DC charging stations has been imported to the Postgre SQL database.

6. As for the previous data for the DC charging station usage, it has been downloaded from the Bosch eMobility site and also imported to the Postgre SQL database.

7. A User interface has been created which displays the graphs with statistic data such as Number of charges per day, Number of charges per week, Time taken per charge, charges per day of week, kWh energy consumption per time of day, number of charges based on the connector type (Chademo or CSS).

4.4. System Integration

Figure 10 is the schematic diagram explaining how the data is fetched from a different server i.e. blue host server which has the DC charge data and displays it dynamically in the REVproject web portal. Whenever the DCstation.php page on the REVproject is refreshed, getDCdata.req calls the

Application Programming Interface (API) that is located in the blue host server to fetch the data locally and later sends it to Robotics server in Json format which is then used to display the graphs generated (Number of charges per day, Number of charges per week, Time taken per charge, charges per day of week, kWh energy consumption per time of day, number of charges based on connector type: Chademo, CSS.) in the REV portal. Comparison between the AC and DC charging stations are also displaying in the form of graphs of Charge Frequency per time of day, Charge Frequency per week, Energy per time of day, Energy per week.
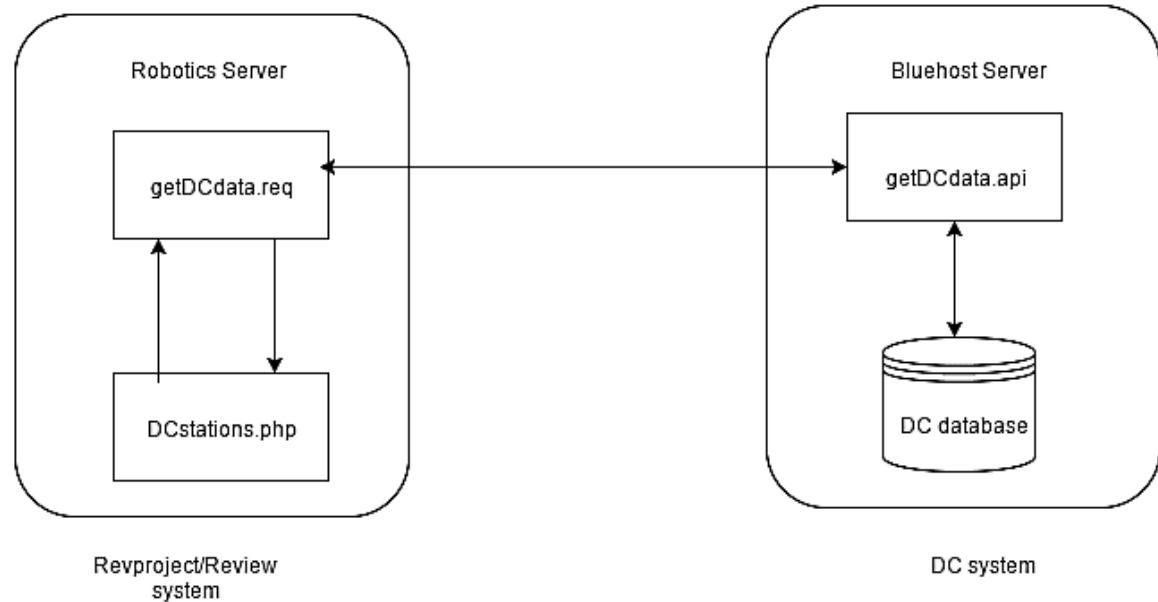
Figure 10: Schematic diagram showing the data fetched from a different server i.e. blue host server containing the DC charge data is dynamically displayed in the REVproject web portal.
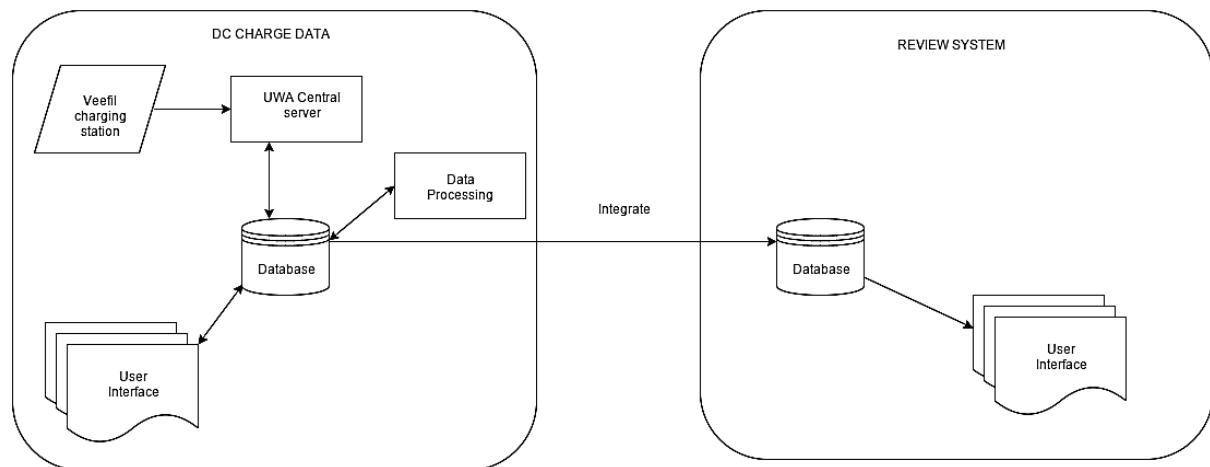
Figure 11: Schematic diagram showing integration of the web portal designed at UWA Central server (blue host server) with the REView system.

Figure 11 shows schematically how the web portal designed at UWA Central server (blue host server) is integrated with the REView system (REV project) displaying the DC station usage (veefil station). The REV project web portal also displays whether the charging station is in use or not in use by fetching the data from the station status for the convenience of the user who would like to know

whether the station is free for use or not. Figure 12 shows the icons displayed depending on the status of the DC station. The REView DC station portal also displays the exact location of the station via Google maps as shown in Figure 13.

a) **Station in use**   b) **Station not in use**   c) **Station not functioning**

Figure 12: Icons displayed on the web portal indicating the status of the charging station (REV, 2010).
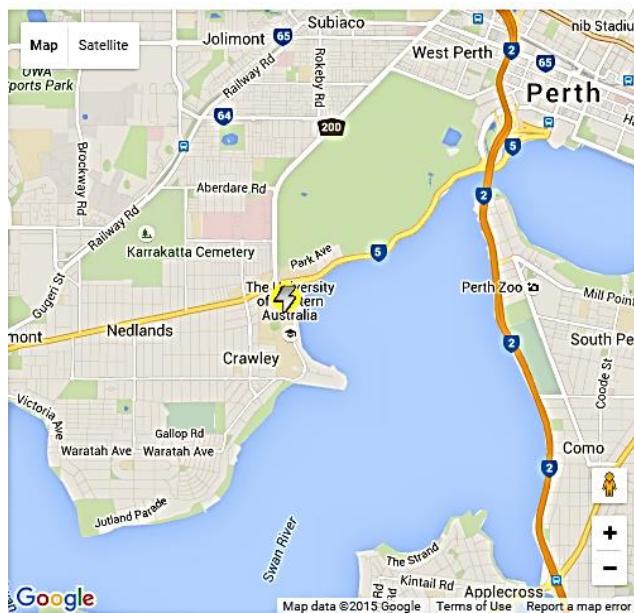
Figure 13: Google map indicating the location of the charging station (REV, 2010)

5.   Verification and Validation

Verification and validation are the most critical part of any research (Macal, 2005). Unless the model is well verified and validated, it is highly likely that it is rejected (Macal, 2005). While verification is important to ensure the model is free of errors and have been programmed correctly, it does not necessarily mean that it depicts the real-world scenario. However, no model can ever be 100% free of errors. Validation, on the other hand, is important to make sure that the model solves a particular problem (Macal, 2005).

To verify the operations initiated by the charged point, simulator tools like SoapUI and ocpp charge box by Eurisco have been made used of to send and receive data.

In order to validate if the data received from the DC station is accurate and depicts real values, it is compared with charge entries data recorded at the Veefil tritium vendor station (Veefil, n.d.).

6. Results and Analysis

6.1. DC Station Usage

The graphs generated on the usage of DC station are presented in this section.

Figure 14 displays the number of charges per day based on the number of charge transactions been made which is grouped by date. The figure also gives the average number of charges per day (the red line) which falls in between 3-5 charges approximately.

Figure 15 displays the number of charges per week based on the total number of charge transactions made on a particular week. The figure also gives the average number of charges per week (the red line) which falls in between 20-22 charges approximately

Figure 16 displays the time taken for each charge transaction to complete. The figure also gives us the average time taken per charge in minutes (the red line) which falls in between 19-22 minutes approx.

Figure 17 shows a pie chart that shows that the time to charge the EV also varies from less than 20 to above 40 mins but more than 50% the charging time is less than 20 minutes.

Figure 18 displays number of charges being consumed on a particular day of the week. It shows Saturday to be the day when most of the charges are consumed.

Figure 19 displays the energy consumed in kWh on a particular time of day.

Figure 20 shows a pie chart displaying total number of charges based on connector id (Combo-CCS-1 and Chademo). It shows more than 50% of the charges are consumed using the Chademo connector.
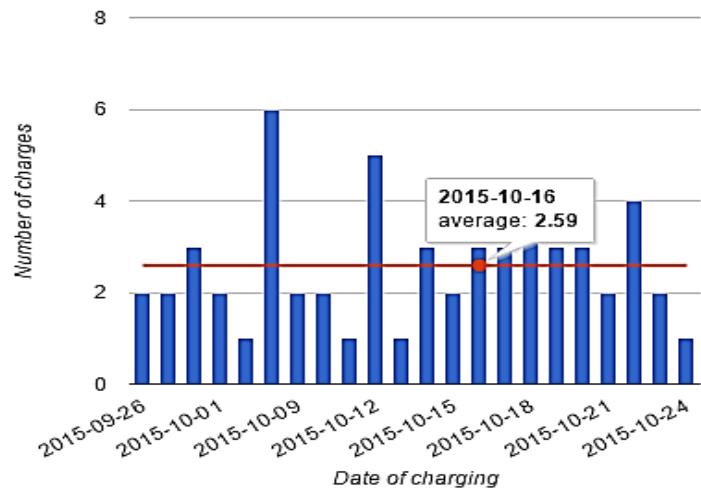
Figure 14: Number of charger per day from 2015/09/24 (at 17:22:04) to 2015/10/24 (at 03:33:52)
(X-axis: Date of charging, Y-axis: Number of charges)
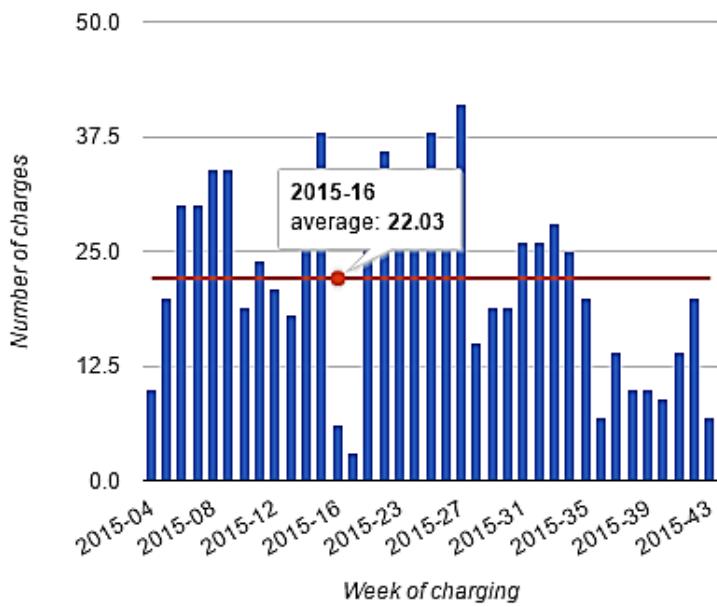
Figure 15: Number of charger per week from 2015/01/24 (at 17:22:04) to 2015/10/24 (at 03:35:27)
(X-axis: Week of charging, Y-axis: Number of charges)
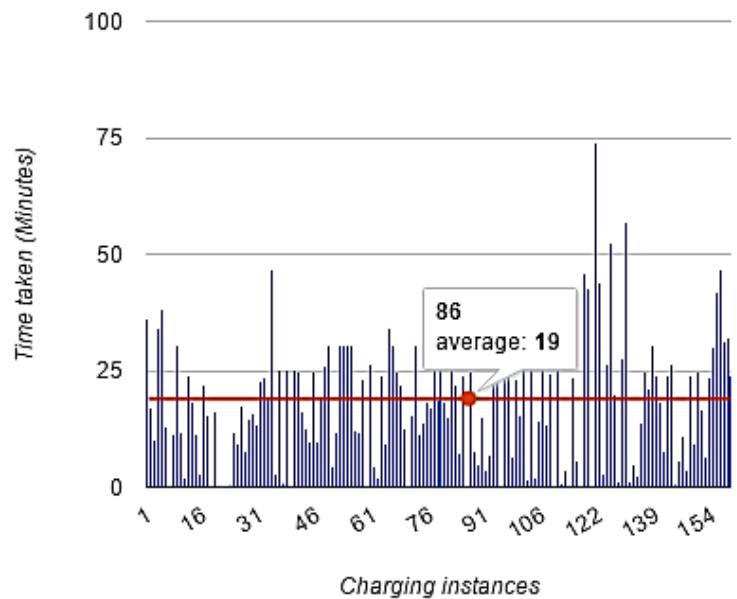
Figure 16: Time taken per charge
(X-axis: charging instances, Y-axis: Time taken in minutes)
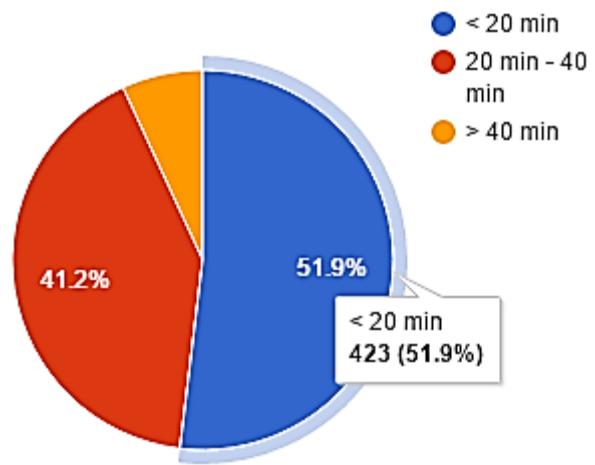
Figure 17: Pie chart showing the percentage of EVs taking different time intervals for charging.
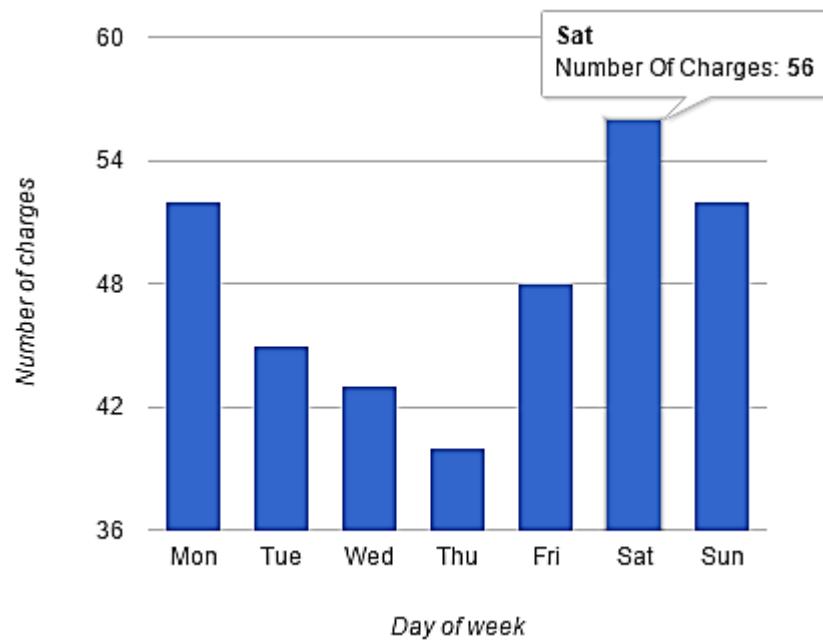
Figure 18: Number of charges per day of week
(X-axis: Day of week, Y-axis: Number of charges)
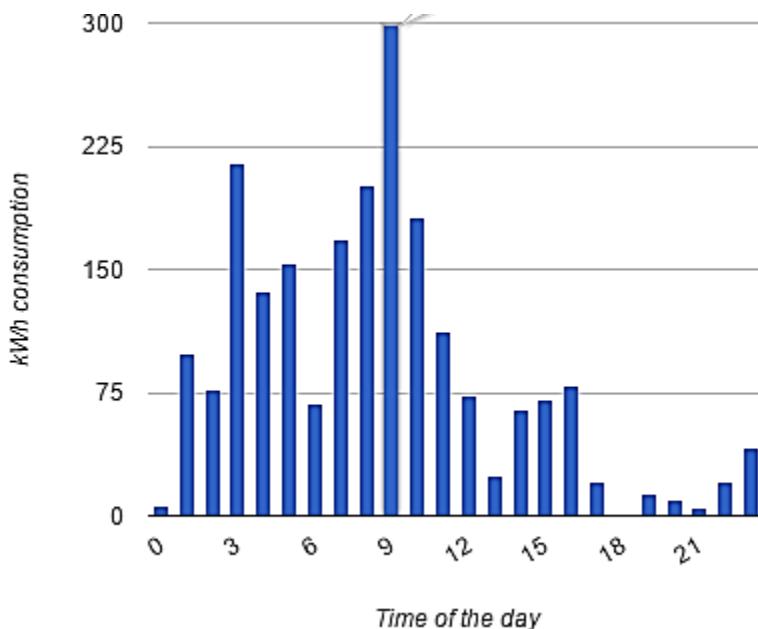
Figure 19: Energy consumption in kWh per time of day
(X-axis: time of day, Y-axis: Energy Consumption in kWh)
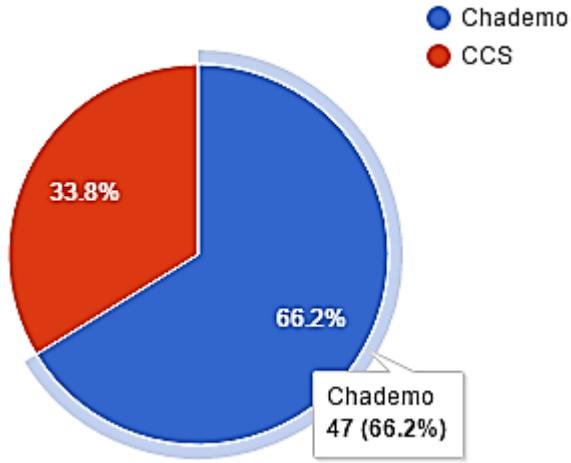
Figure 20: Pie chart showing the percentage of number of charges per connector id.

6.2. AC vs DC comparison

It is to be noted that since there are 23 AC charging stations, so for the sake of comparison between AC and DC charging stations, average is calculated as follows:

$$\text{Average AC charges} = \frac{\text{Total no of AC charges}}{\text{Total no of active stations}}$$

where the total number of stations are dynamically calculated based on AC stations being active. The graphs generated are presented below.
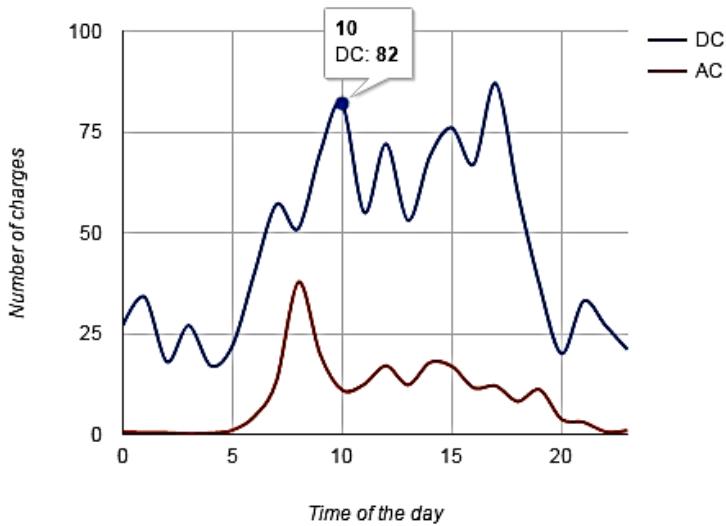
Figure 21: Charge frequency per time of day from 2014/01/01 (at 18:39:30) to 2015/10/25 (at 04:40:12) (X-axis: Time of the day, Y-axis: Number of charges

Figure 21 shows that DC charging has frequent peaks occurring from time to time. One peak appears at 10:00 in the morning and the other around 17:00 in the evening. Other peaks can also be found at noon and at 15:00 in the afternoon. On the contrary, for AC charging the peak occurs only once at 8:00 in the morning. This difference in the occurrence of the peak is due to the fast charging

capability of the DC stations which takes only 20 minutes to charge up an EV from zero to 80%. This would mean the other vehicles would not have to wait much like they do at AC charging stations.
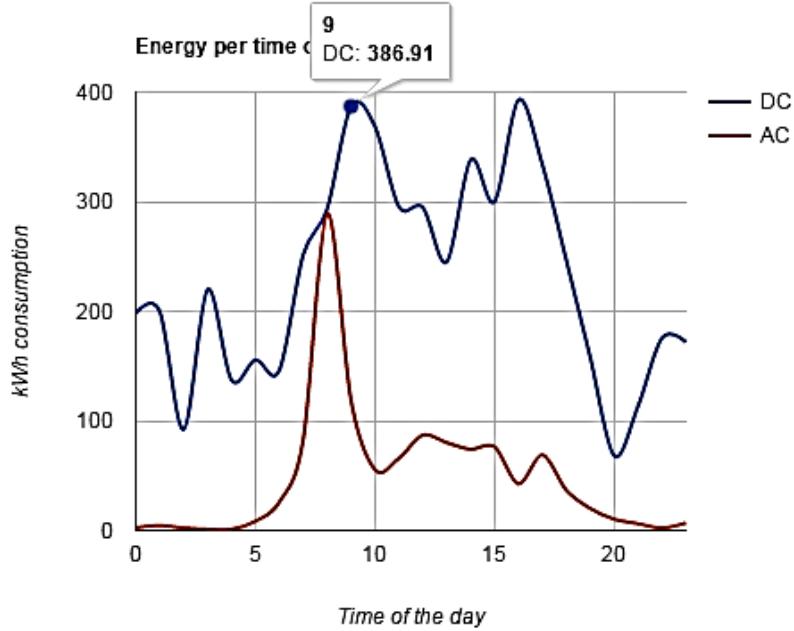
Figure 22: Energy consumption in kWh per time of day from 2014/01/01 (at 18:39:30) to 2015/10/25 (at 04:40:12)
(X-axis: Time of the day, Y-axis: energy consumption in kWh)

Like Figure 21, Figure 22 shows that while for AC energy consumption peaks only once at 8:00, highest energy consumption for DC charging stations peaks multitude times. One at 10:00 in the morning and the other around 17:00 in the evening. Other peaks can also be found at noon and at 15:00 in the afternoon. This is again because of the fast charging speed of the DC charging station.
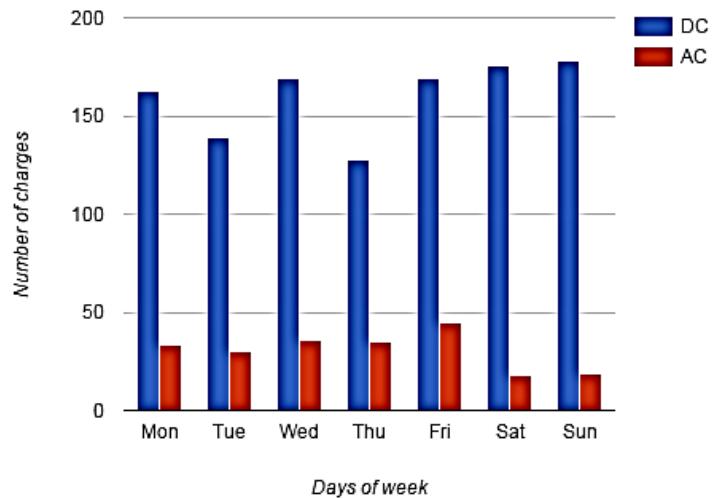
Figure 23: Charge Frequency per week for DC and AC charging stations
(X-axis: Day of week, Y-axis: Number of charges)
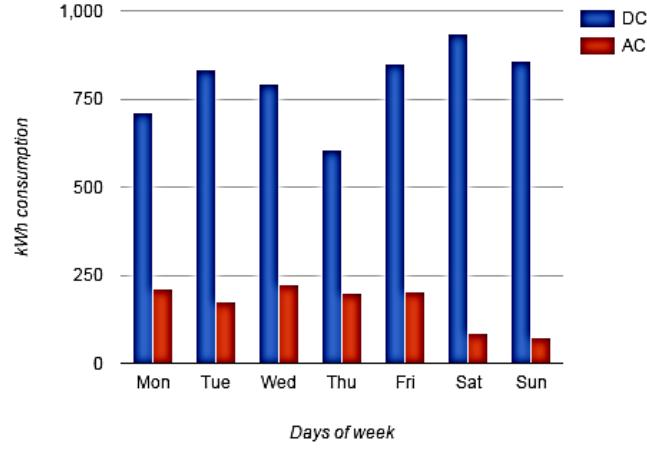
Figure 24: Energy Frequency per week for DC and AC charging stations
(X-axis: Day of week, Y-axis: Energy consumption in kWh)

Figures 23 and 24 show that for AC charging stations the busiest day of the week is Friday and for DC charging stations it appears to be Saturdays and Sundays.

7. Conclusion

After the establishment of the first DC charging station, it was imperative to trace its capability. This thesis aimed at designing one such platform like the REView portal already available for AC charging stations that could help the researches in analysing the comparison between the two. The thesis has successfully achieved its objective by designing a web user interface for DC charging station. This portal is useful in monitoring the DC station usage which provides us with the following statistics; charges consumed on a particular day and week, energy consumption in kWh, peak hours of charging by checking charging instances per time of day statistics. It also gives the status of the charging stations whether the station is currently in use or not. It also provides the exact location of the charging station via Google maps for the convenience of the user.

8. Future work

Bosch eMobility solutions have control over authorising the user to charge the car when the user tags his charge card at the charging station. Depending on whether the user is registered in the system the access is granted. Also all central system operations are initiated by Bosch eMobility solutions which keeps a track of successful charges, unsuccessful charges and errors. In future we could implement such an authorising operation along with other operations initiated by the central system so that we do not have to depend on external third party vendors anymore. As of now the DC station is free of use, we could start charging the users depending on the id tag by implementing a billing system.

9. Resources

Data sent from the veefil station is monitored by Bosch eMobility solutions. The eMobility Solution is a software platform provided for use to its clients to run and manage their networks of charge stations. Bosch is responsible for maintaining the operating software and access to it. In our case the data from the charging stations to the UWA Rev server (blue host) is managed by Bosch eMobility solutions which provide OCPP access to our server in parallel to the Bosch system.

The resources used in this project are primarily: the REView web portal access, Bosch eMobility services to monitor and send data to UWA Rev server (blue host), Access to postgre SQL database to store the data and access to Veefil station data.

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