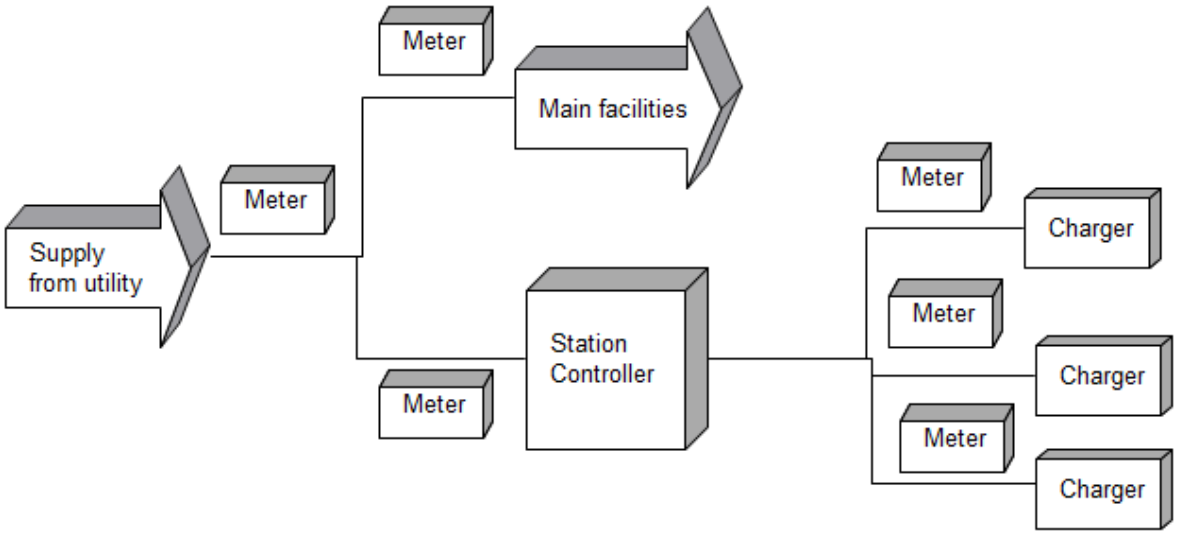
EV Car Charging System

Introduction∫

The first version of EV Car Charging Station was developed in 2014 for China Light & Power. It was using NEC Quick Charger and deployed in Science Park. It was composed of two components, server installed in CLP for charging station monitoring, meter data usage and payment verification. Each charging station was connected with Elster meter and NEC charger while providing two kinds of payment channel, Octopus and CLP RFID card. Real time data was sent to the server to reflect charger status.

The second generation was developed in collaboration with HKPC in 2017. It was deployed in headquarter of CLP and Heya Crystal Carpark site. The charger was made by Hong Kong based company, Adtronics Technology Co. Unlike previous generation, the charging station was managing up to 32 chargers while it controlled how much power delivered to each charger by providing different kinds of data to a small library provided by HKPC which returned power dedicated to each charger. It then communicated with charger through OCPP (Open Charge Point Protocol) standard protocol to limit the power consumption. The reason of performing this kind of power management is the limited power supply to building or shopping mall as car park and shopping mall shared the supply. The advantage of using this mechanism is to save additional cost on electricity supply.

As HKPC got funding from the government and CLP, the payment channel was not used in first generation. More charger management features were provided from server such as unlocking the charger from the car. Each station communicated with the server over 4G mobile network in real time while all transactional data including meter reading was rebuilt each day in case of mobile network interruption. The meter data for individual charger, other kinds of power consumption and overall power consumption was logged in database. It was being studied by HKPC for further data analysis on charger and EV car.



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Features of the system

Here is the summary of the features.

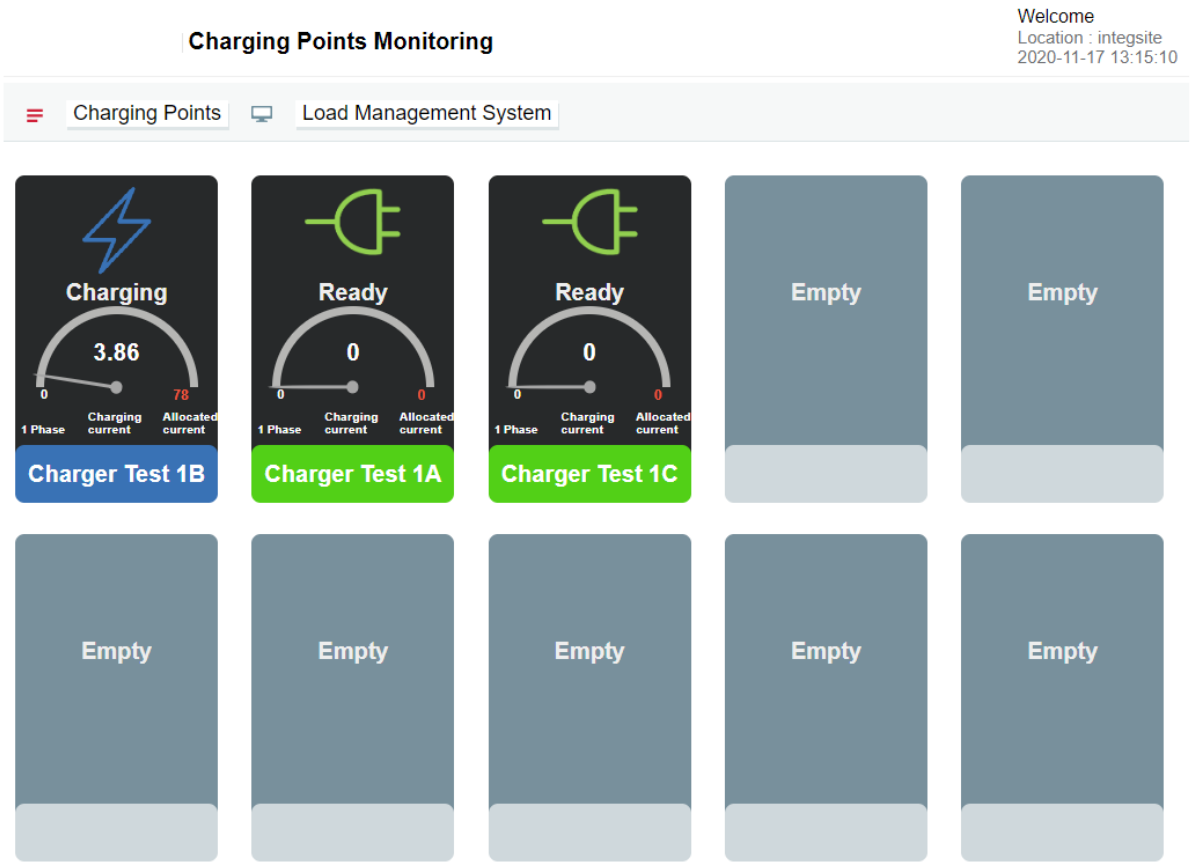
Server

- User management (user role mapping and user data permission setup)
- Site management (site and device setup, site parameter enquiry)
- Data monitoring (station status and control management)
- Historical data (transaction, meter data, charger status)
- Transactional and audit report

Station

- Control flow of charging (using Octopus or RFID over amount of required power consumption in kWh or charging duration) in first generation
- Displaying of charging status, individual power usage and overall power usage in second generation

In second generation, the screen is for information and the customer could not specify the requirement as in the first generation. On the other hand, a small screen on charging would instruct the customer to start, stop and unlock the charger. It is possible to perform the operation in station screen especially when payment channel is introduced.



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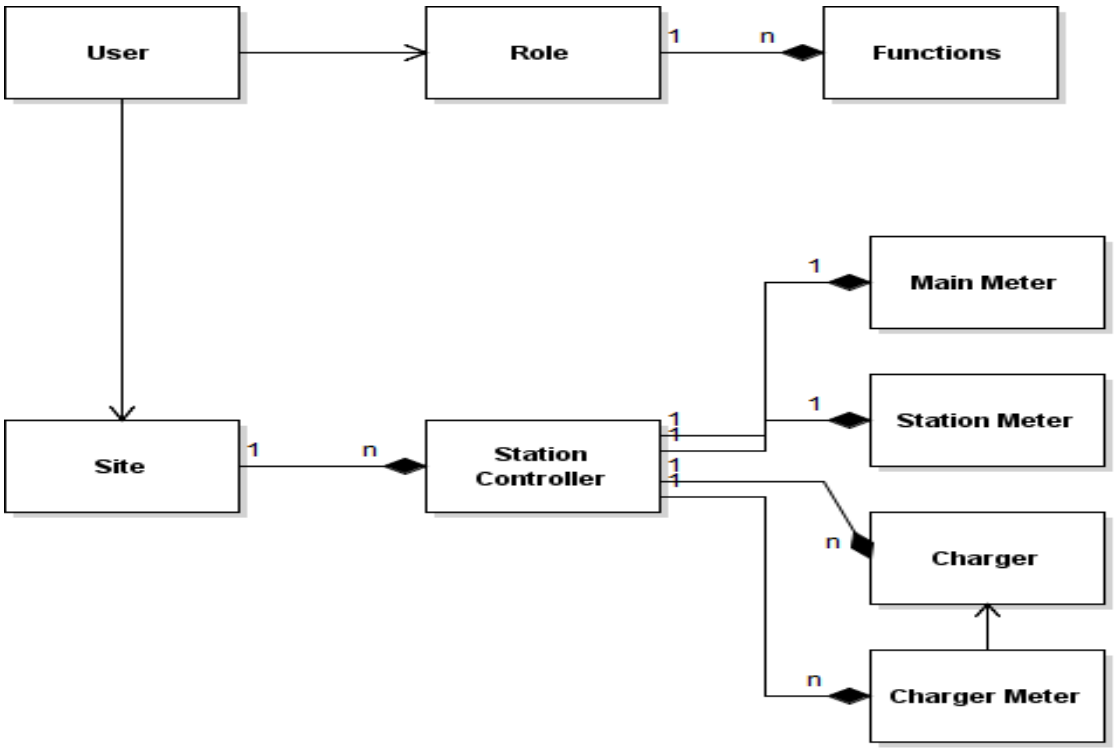
Description of the system

The system was designed with easy management, scalability and security in mind. After getting user feedback from the first generation, some major improvements were on central management in order that the administration could manage individual charger through the controller. The parameter of load management in individual sites can only be managed through the GUI of the server. Incidentally both the hardware and software were upgraded significantly to manage up to 32 EV chargers. In case of deploying smaller number of EV chargers, the hardware specification can be lowered to save overall initial cost.

Architecture of the system



With reference to the above diagram, the user is assigned with role that a set of functions are allowed. The permission is governed in server side so that even though the user finds out the tricks on accessing non-permitted functions, the server denies the access. Data permission is controlled by the sites allowed for individual user.

In general, OCPP supports meter data transmission where some brands of charger are equipped with built-in meter circuit. In our implementation, industrial standard meter is installed with each charger to fulfill higher data accuracy and standard required by utility. This is especially important when payment is involved such as in the first generation.

Although station meter seems to be redundancy in which its reading can be derived from individual meter reading of the charger, the advantage is to better managing power consumption so as not to overload the overall circuit. In addition, it can overcome any fault arising from the chargers.

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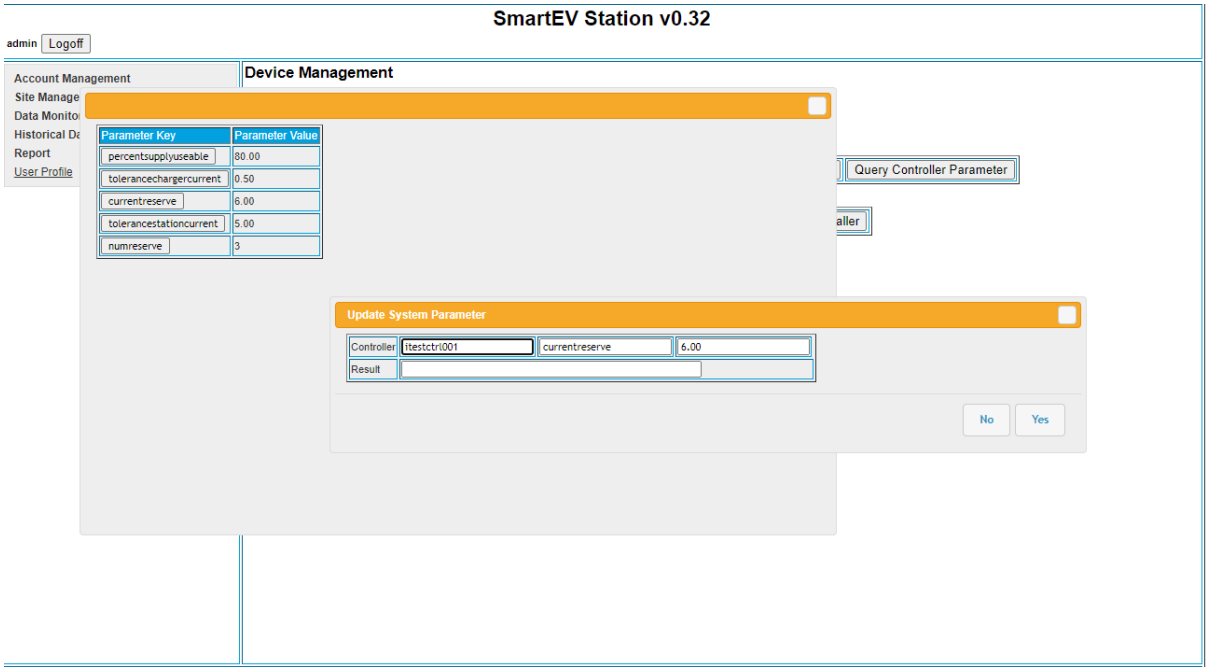
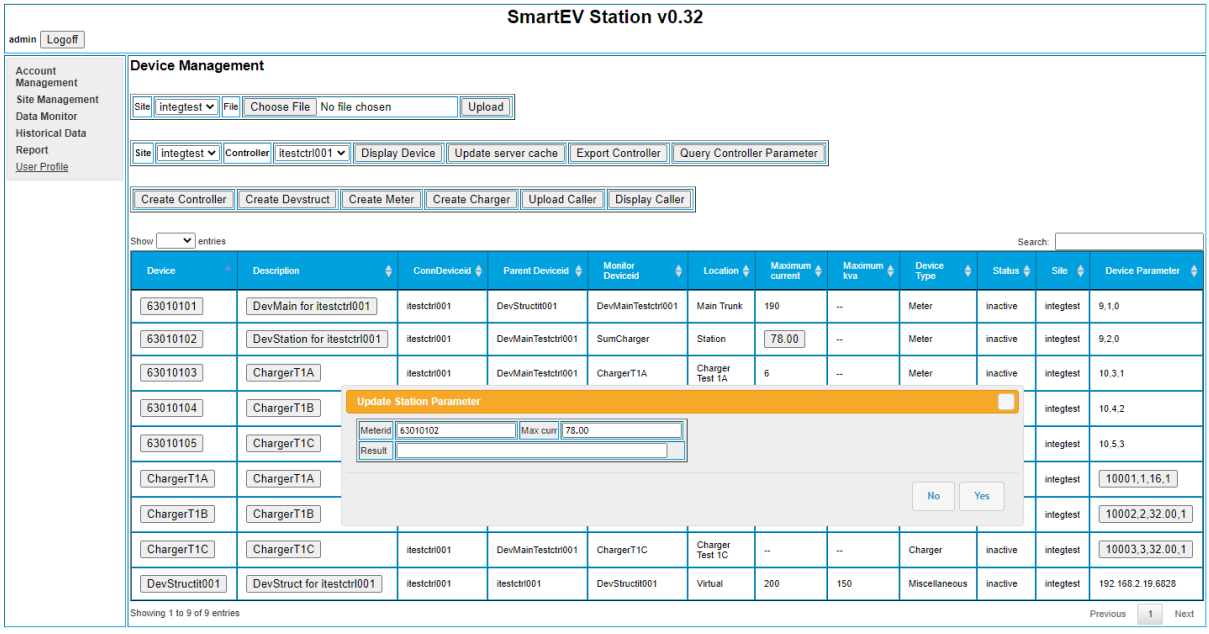
Central Management

The central management is composed of 2 parts, site-based parameter configuration, real time monitoring and control. The first one deals with the tolerance of the consumption in each station of the site.



The parameters are queried from the server on individual station and can be updated in real time. Furthermore, individual charger and maximum current allowed through each charger and station meter can also be adjusted from the server. This instruction would be effective immediately to the power management library which then calculates the adjusted value to the station controller to deliver information to charger through OCPP.



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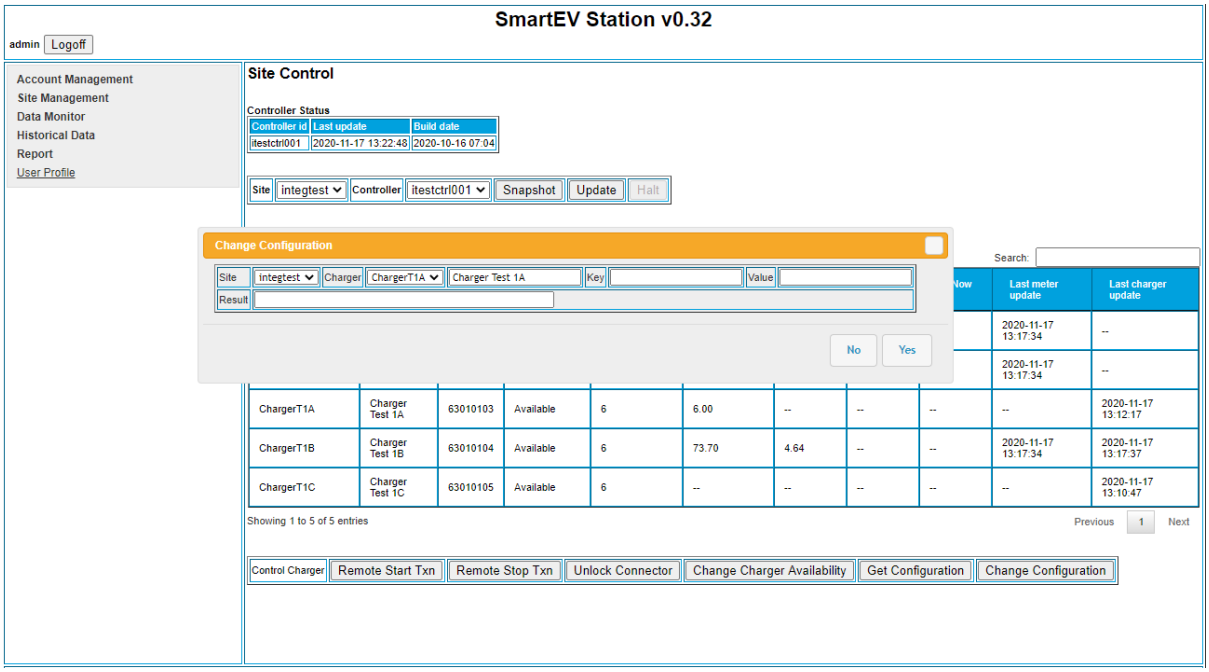
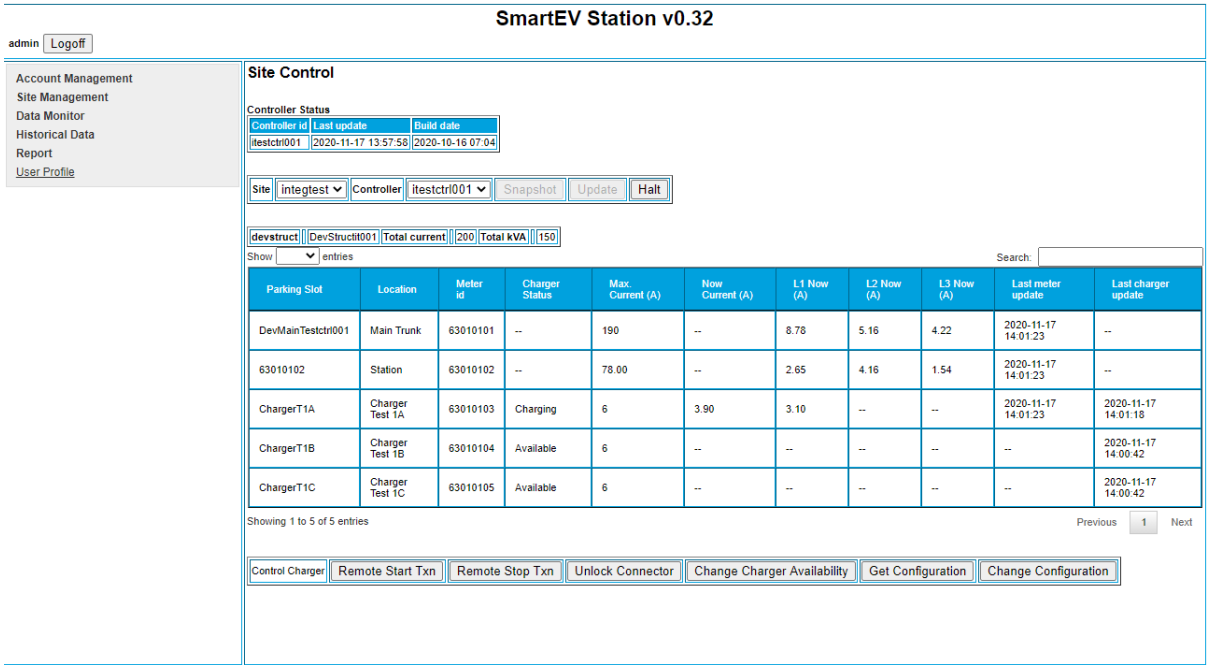
To cater for different types of charger, the server provides the facility to deliver specific parameter in form of key-value pair to individual charger.



For real time monitoring and control, the system facilitates data and control command over secure streaming protocol over 4G mobile or LAN network. Electric current and charging status can be viewed per station controller.



A set of remote control on individual charger is provided, remote start transaction, remote stop transaction, unlock connector in case of operational issue in the site.

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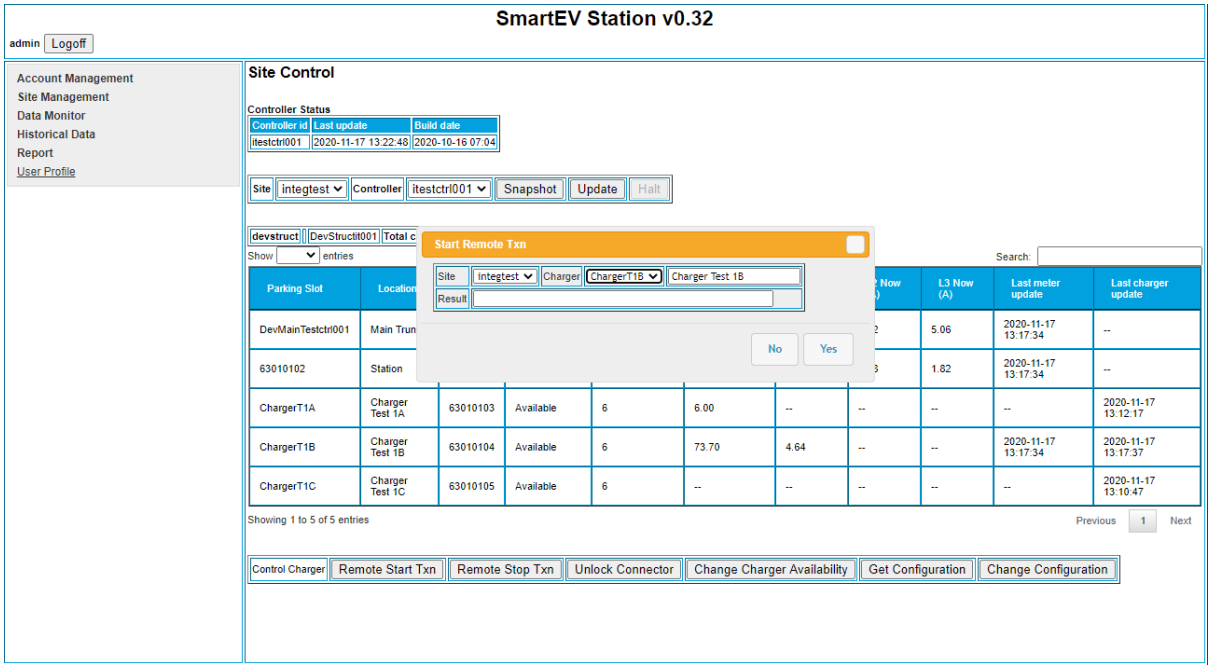
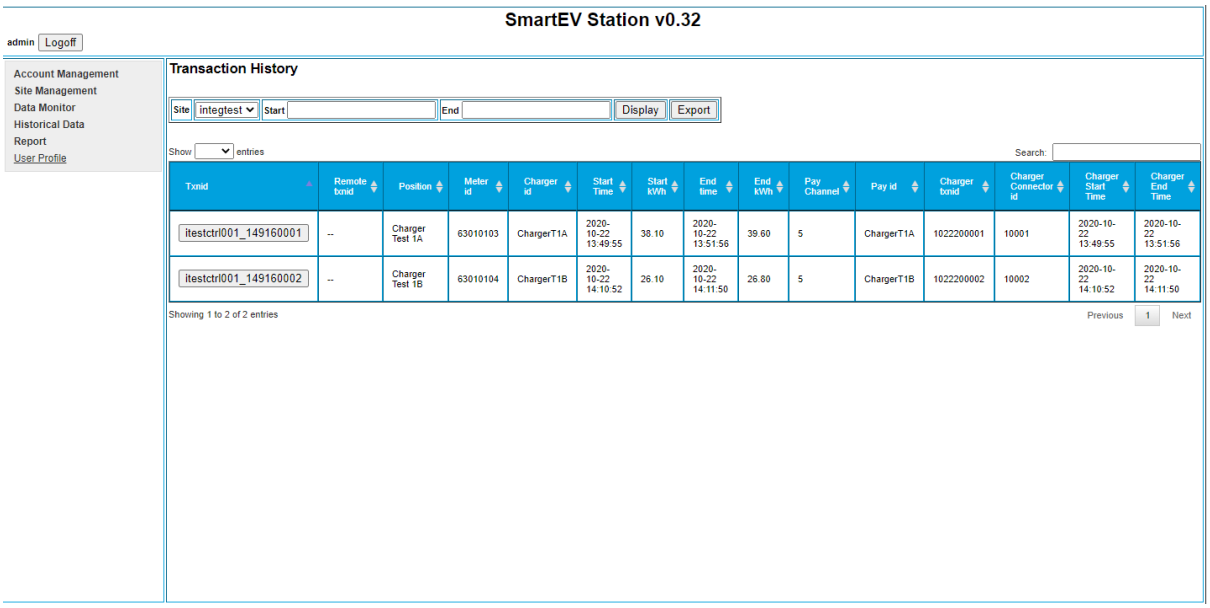


This kind of command can also be integrated with external booking system such as using RFID or Octopus as in the first phase of EV station.

Data Report

Different kinds of data (consumption, charging status or transaction) are stored in the system. As the system employs industrial grade meter which is generally used by utility for bill calculation, two kinds of metering data are historical data stored in meter and snapshot meter data requested by station controller during charging. The system supports two ways of data collection, real time delivery and day-end data upload. This technique has been used since the first generation to include third party data such as Octopus files. In fact, the system in the first generation got information such as blacklist from Octopus headquarter and downloaded to the station controller.



To perform preliminary study on the behavior of charger for each transaction, the system provided sufficient information on charger status and consumption.

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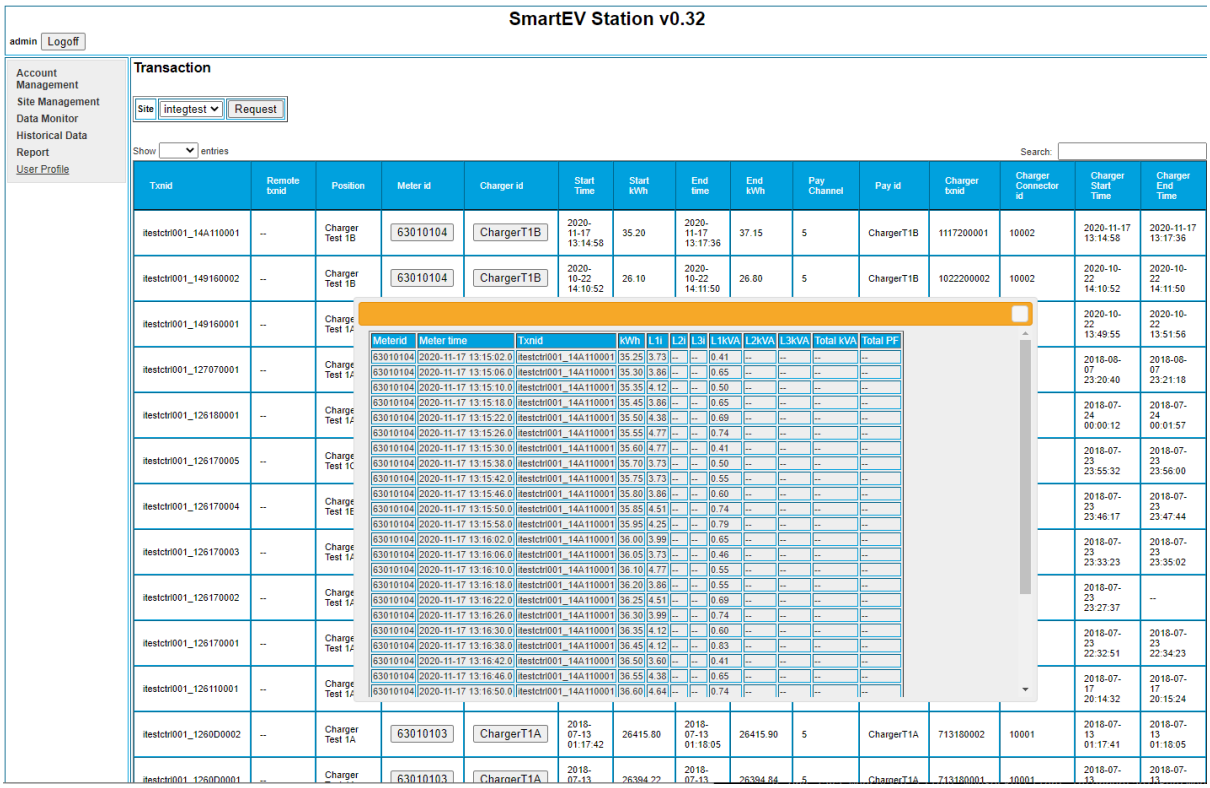

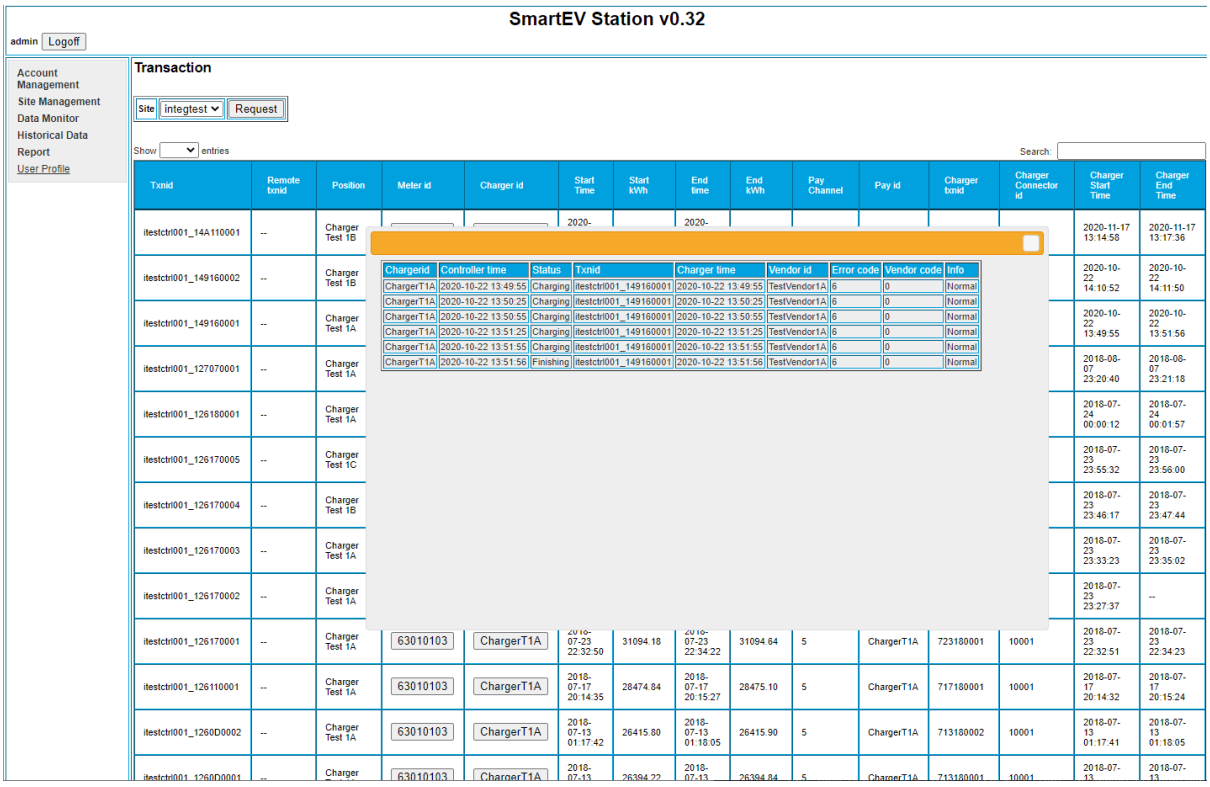

Although only one meter consumption can be displayed, data export provides all metering consumption during transaction. These kinds of information provide background study on how effective the power management module and also as the criteria of upgrading electricity supply.

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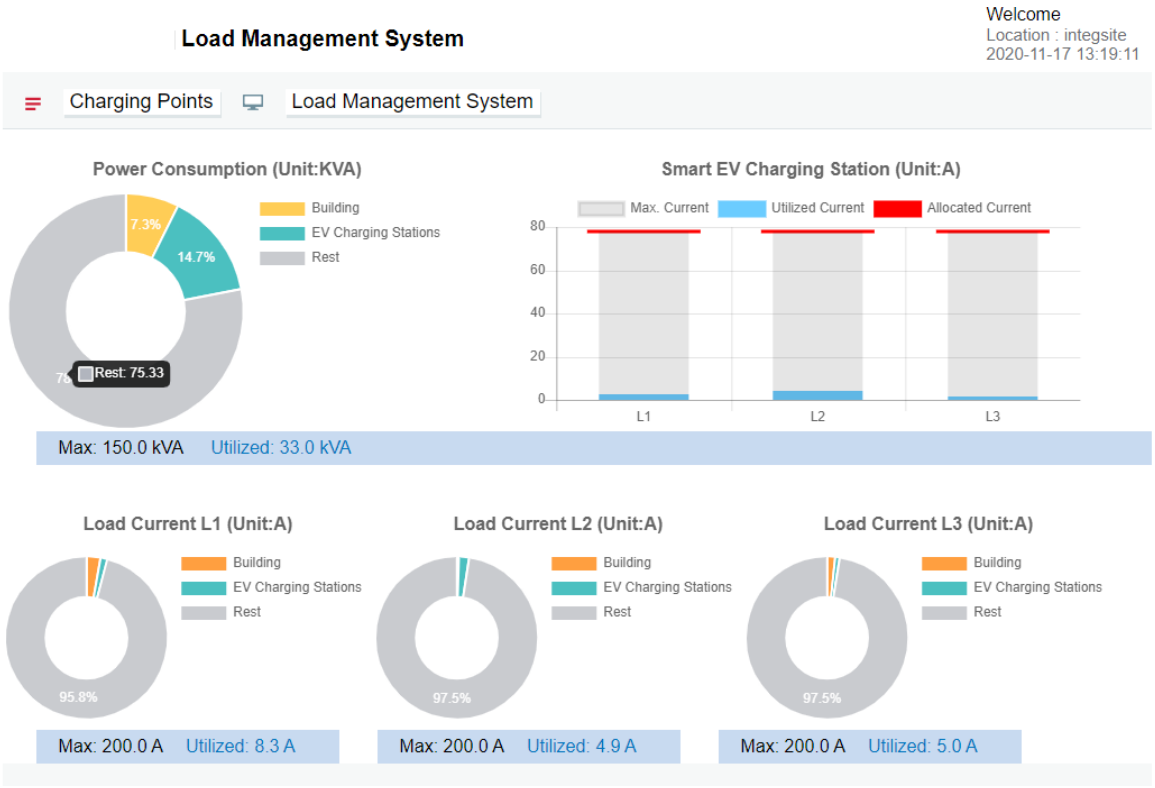
Station Controller

Additional screen is also provided about the power usage in real time. This screen is also available in separate server page.



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Technical Information

Both server and station controller are running on Intel based platform, either Windows or Linux. Its backend database is MSSQL that can either be running on Windows or Linux. The hardware requirement for station controller is Pentium based CPU on Ubuntu subject to number of chargers supported. For those chargers that cannot support OCPP, standalone application which acts as OCPP client with Modbus command can be used.

All the software is written in pure Java with sets of open source software such as Spring Framework, Mybatis, OCPP library, Apache Tiles, JQuery and Web socket.