Distributed Management Platform based Charging Stations for Plug-In Electric Vehicles in Distribution Networks

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Introduction

The majority of automobiles on the market now runs on internal combustion engine (ICE), which are known to cause major issues such as environmental pollution. The alternative Plug-In Electric Vehicles (PEVs) can not only eliminate carbon emissions (reduce the greenhouse effect), but also run at a lower cost, compared to traditional ICE vehicles.

To maintain the security of energy supply under the pressure of large penetration of PEVs, the injection of PEVs in the distribution network (DN) should be controlled, which will also be beneficial when managing the DN.

Features

Raspberry Pi 3 (Model B)
3 Raspberry Pi (a credit card-sized single-board computer) are used in this project. 1 for the MS (Master Station), 2 for the RTSs (Remote Terminal Stations)

Python
Python 2 (Tkinter model) is used in this project to build a simple UI to display charging time, voltage, charging power on the LCD screen.

Socket
A network socket is an endpoint of a connection across a computer network. As we know, most communication between devices(computers) is based on the Internet Protocol. A socket is a "handle" that a local program can pass to the networking application programming interface(API).
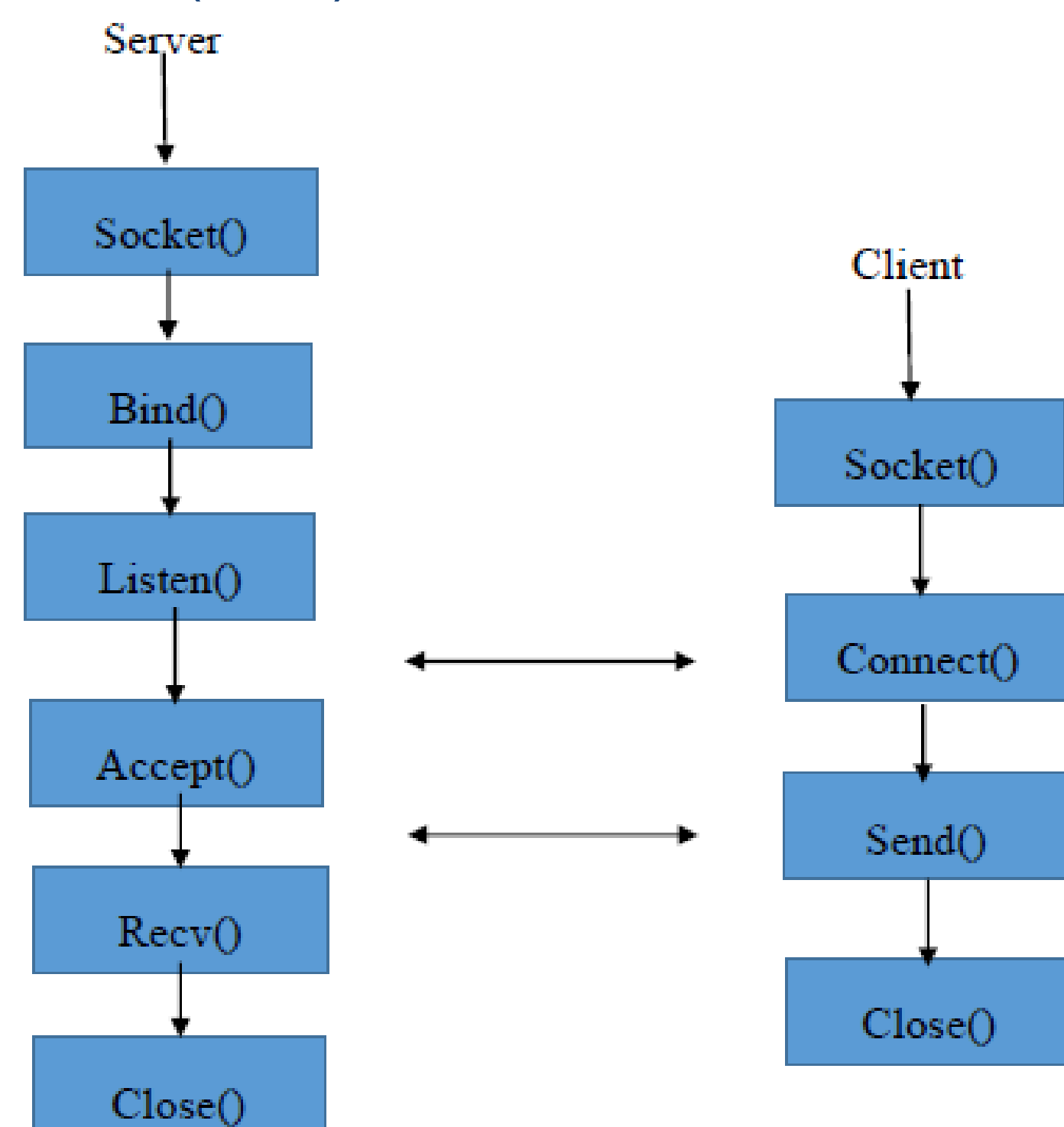

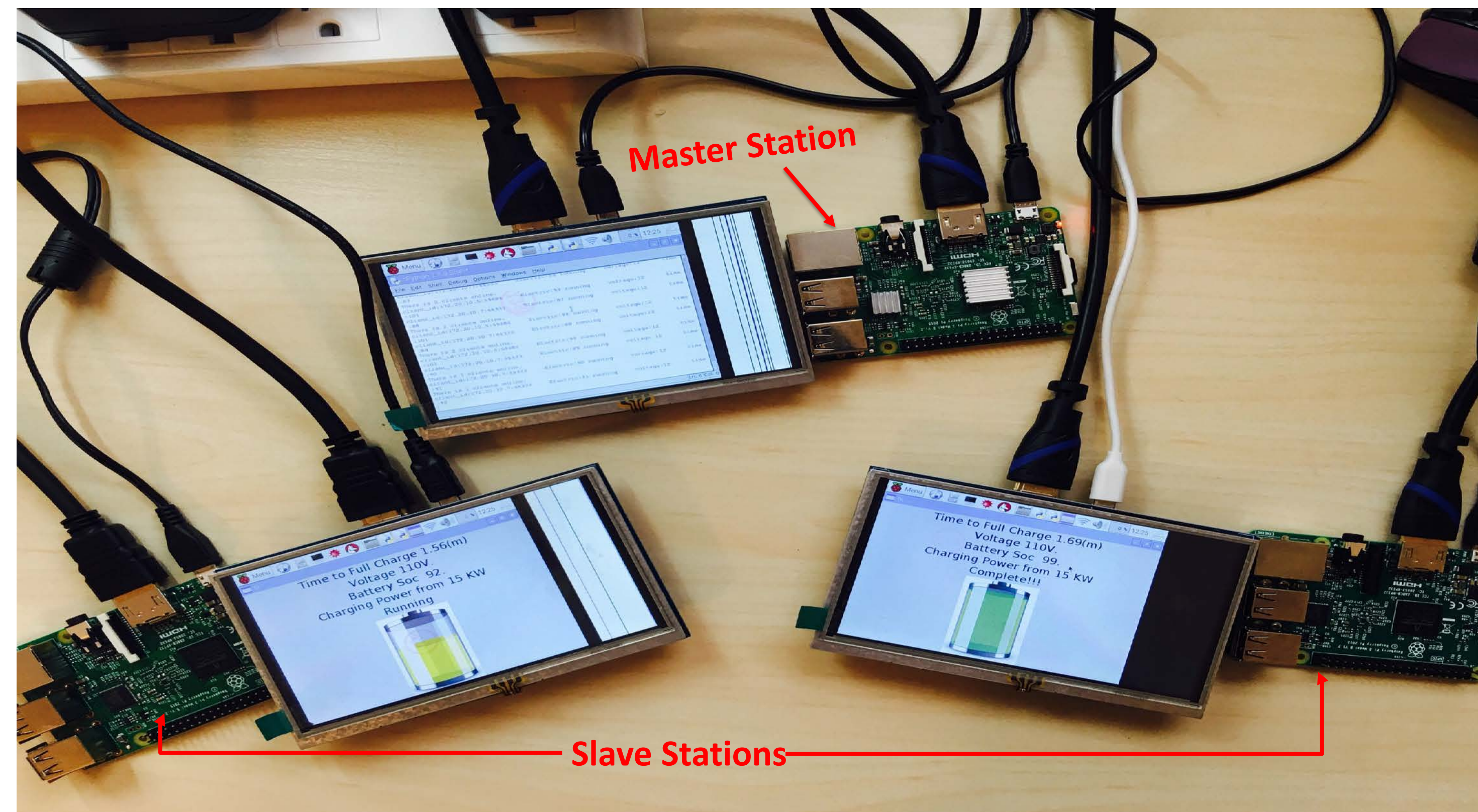Fig 1. Communication flow by using Socket

Methodology and Results
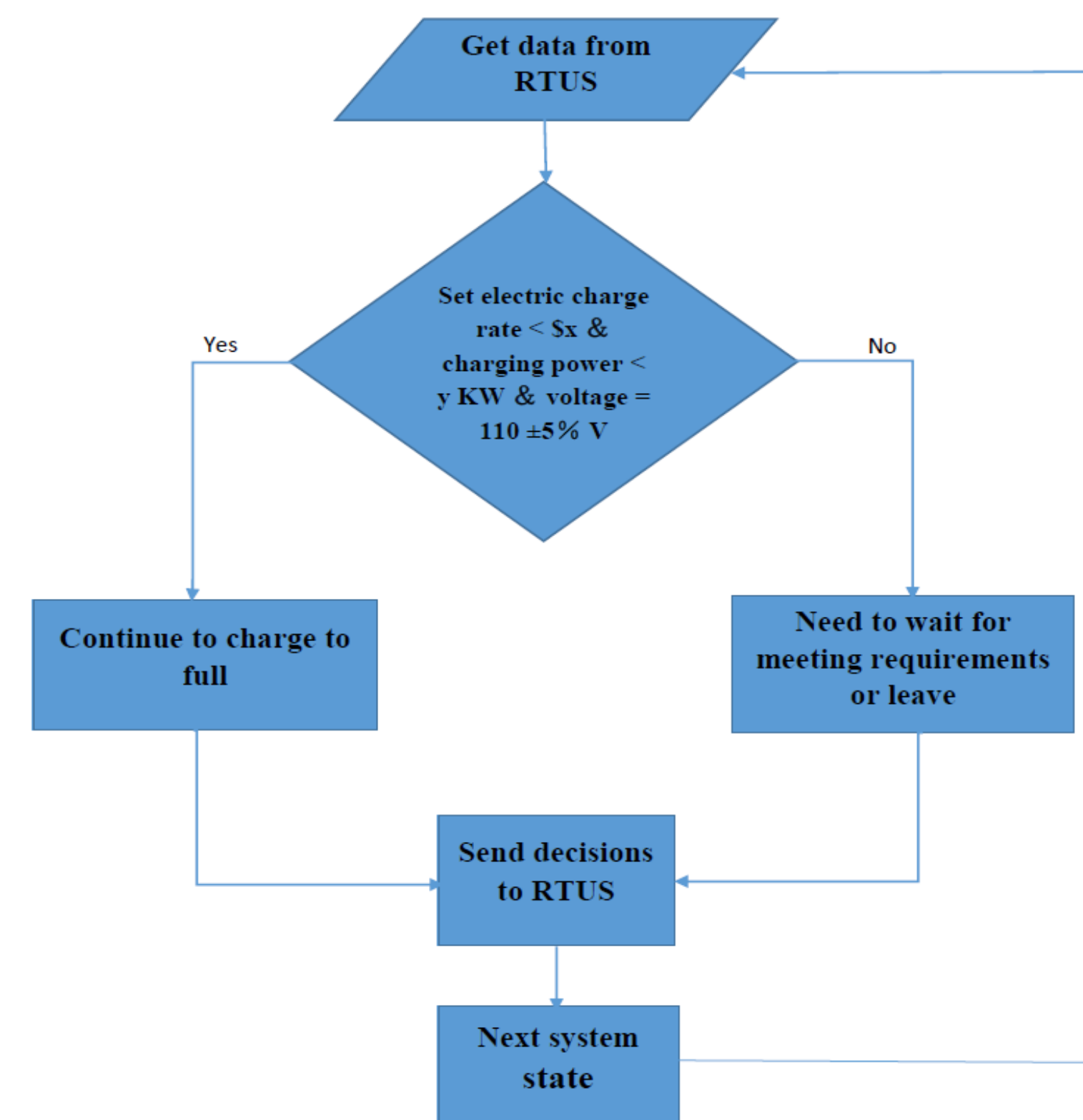

Fig 2. MS and RTUSs are Simulated by 3 Raspberry Pi
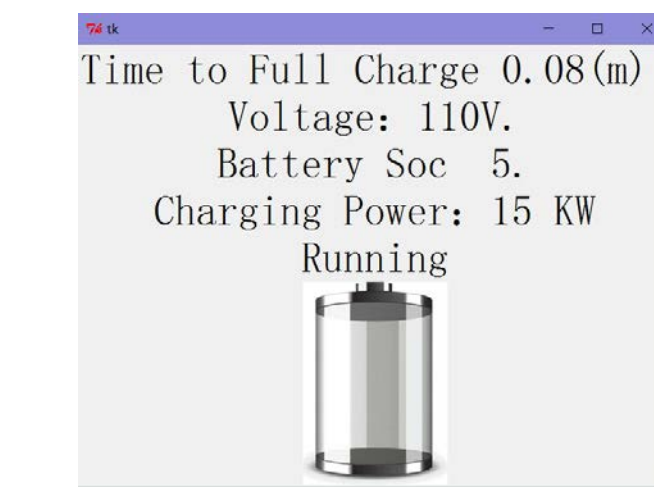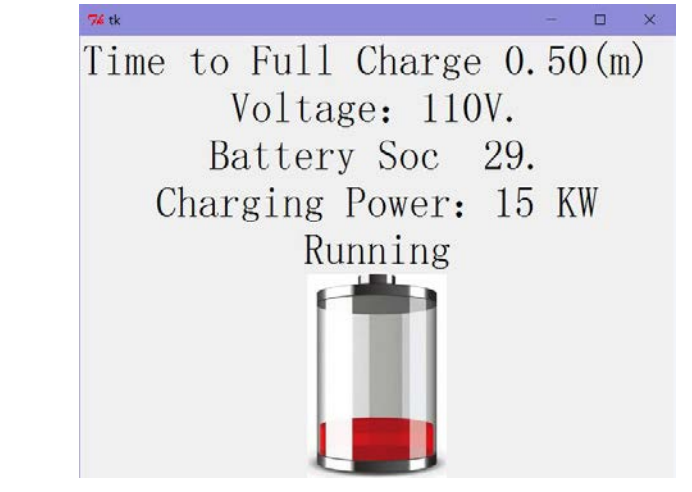

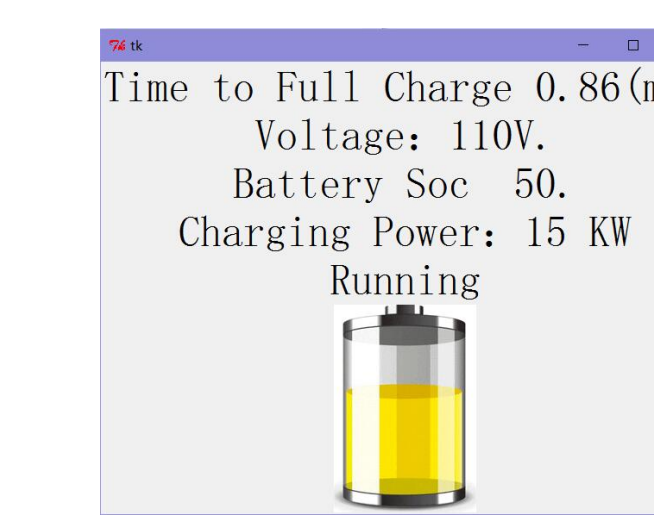Fig 4. 1 Charging at 5%

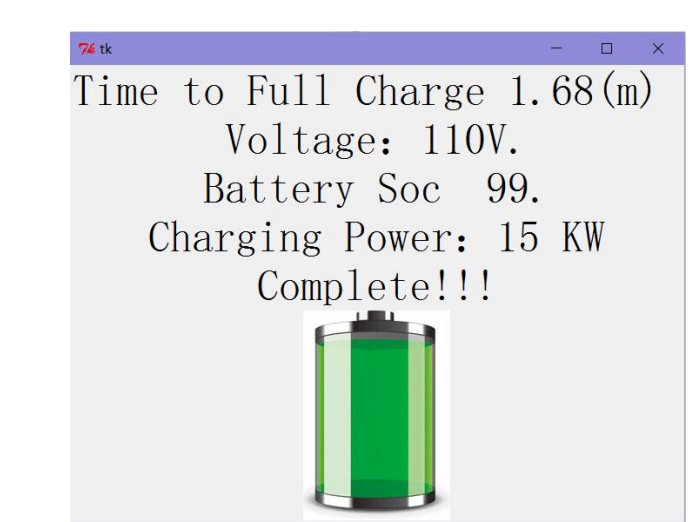Fig 4. 2 Charging at 29%

Fig 4. 3 Charging at 50%

Fig 4. 4 Fully Charged

The objective of this project is to design a power management platform to manage the charging demand from PEVs without violations to the power and voltage limit of the DN. The slave controller, also called Remote Terminal Units (RTUs) directly control the charging stations which would send and receive signals from the control stations. The platform would create connections between center controller and the RTUs, as well as connection among those RTUs.

The center controller collects data from the RTUs and would make decisions on the basis of real time information and predefined management algorithm. When the electric charge is larger than x/ kWh & total charging power is larger than y KW & voltage is within $[0.95*110, 1.05*110]$, the MS will limit the slave stations to charge PEVs. When the requirements are met, the MS will allow the slave stations to charge. Users also can stop it whenever they want. When the battery is fully charged, the connection will be disconnected automatically. The management platform can also show the state of charge of the battery and the time to full charge.

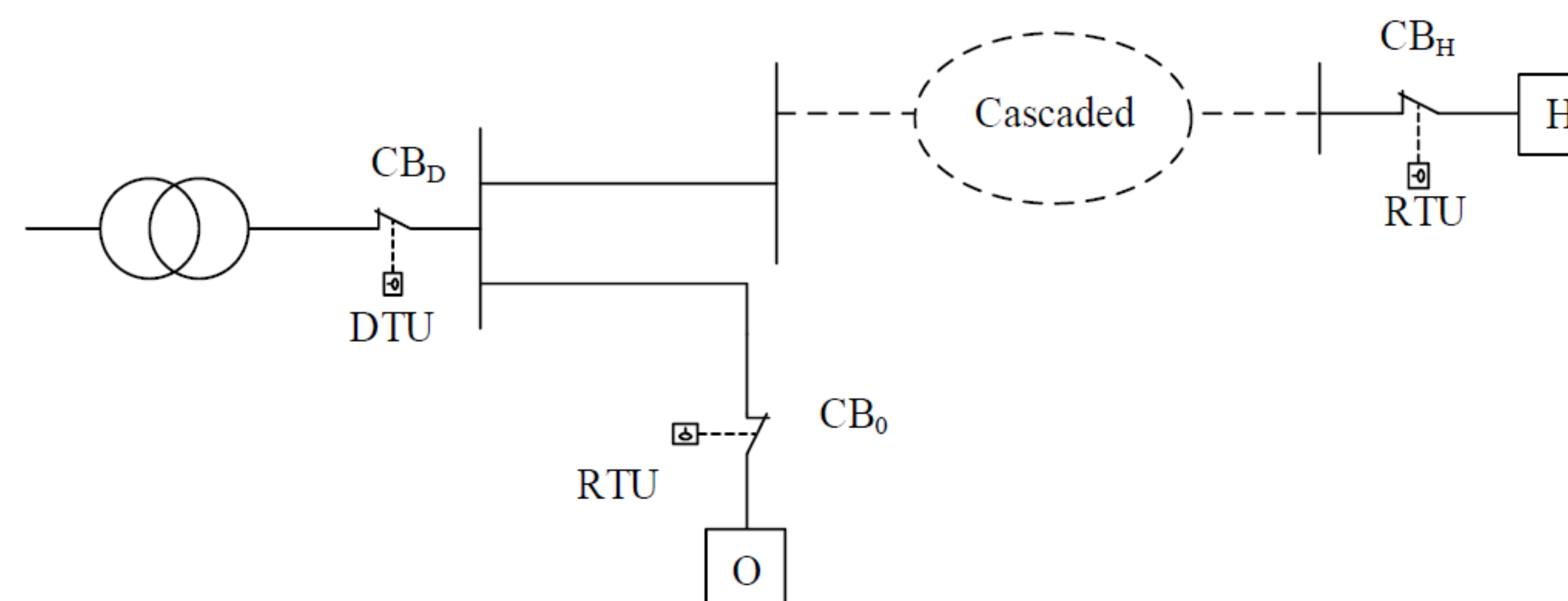Fig 3. 1 Management algorithm in the Master Station

Fig 3. 2 Management algorithm in the Slave Station

Fig 5. Management of PEVs in active DNs