Plug-in Electric Vehicle Diagnostics

1 Descriptions of Use Case

The utility and the vehicle are actors in this use case related to diagnostics. The diagnostics cover the end-to-end communication system between the utility to the PEV, as it relates to the functions described in other use cases pertaining to utility to vehicle communications. This document does not cover what would traditionally qualify as automotive diagnostics or OBD II type requirements, as they are specific (and sometimes proprietary) to vehicle manufacturers. The PEV communicates the status of it connection and communications through diagnostics information to the utility, including any indications as to why it is or is not charging. The diagnostics information can be transferred to the utility if a physical path is available for the data to be transferred from PEV to the utility. If no physical path is available, then the diagnostics will be available at an hardware port on the PEV / Utility interface or an equivalent device connected to the PEV.

1.1 Use Case Name

Plug-in Electric Vehicle (PEV) Diagnostics

1.2 Function ID

To be assigned.

1.3 Brief Description

Diagnostics is an essential part of the system that allows energy providers to provide continuous and high quality services to the consumer for charging the PEV with a minimum number of interruptions and in the most convenient manner. In the case where some problems are observed, the diagnostics should inform the utility to be back on track within a short time whenever possible. The system for the diagnostics use case is an end-to-end system from utility to the PEV. However, it is envisioned that if there are additional nodes between the vehicle and the utility, additional diagnostics related to their state of health may be required.

1.4 Narrative

The diagnostics for the system will be divided into four layers of categories: Physical, Network, Security and Application

I. Physical Layer Diagnostics

In the physical layer of the system, the diagnostics should contain information if anything is wrong with the system connectivity. Primitives for the physical layer diagnostics should indicate if the physical layer is available for connectivity. Diagnostics in this system should provide

- HARDWARE_DISCONNECTED (Indicating that there is no physical connection is available)
- HARDWARE _CONNECTED (Indicating that the physical connection succeeded)
- HARDWARE _ERROR (Physical layer available but not there is an error on the physical layer/bus, for example improper voltages, or improper HW protocol pulses.)

II. Network Layer Diagnostics

In the network layer of the system, the diagnostics should provide information about the errors in the physical layer protocol connecting the systems together. The primitives for the protocol should cover the network higher 6 protocol layers of the OSI networking model. Some example primitives are:

- NETWORK_SUCCESS (Successfully connected to network)
- NETWORK_INVALID_PACKET (Packets have errors, invalid packet data received)
- NETWORK_INVALID_FORMAT (Failed to decode packets, invalid format or invalid frame)
- NETWORK_ERROR (Error occurred in the network layers, more primitives can be added to cover cases of interest to the utility or the user)

III. Security Layer Diagnostics

Security is very important factor in the communication between the utility and the PEV. This enables the user to use the services provided by the utility and enables the utility to charge the appropriate customer (individual user, guest, business). In this set of diagnostics, the user should be authenticated to ensure that the customer is a valid user for the utility, and prevent fradulent use of utility services.

- SECURITY_AUTHENTICATED (user has been authenticated, and charging of PEV occurs)
- SECURITY_INVALID_KEY (user has invalid key, and hence cannot charge PEV)
- SECURITY_INVALID_USER (user id, or the utility provided id is invalid, thus preventing fraudulent use of utility services)
- SECURITY_INVALID_PARAMETER (Some expected parameters in the security layer are invalid, for example, the predefined network key for the security system is incorrect).
- SECURITY_INVALID_SESSION (This system is not allowed to talk to the utility for charging)

IV. Application Layer Diagnostics

The application layer is the system that allows the utility services to be consumed by the PEV. This layer will be able to function once all the other layers have been successful. The diagnostics messages could give indications of problems occurring in the application layer. Some application primitives' diagnostics are:

- APPLICATION_RUNNING (The application code is executing normally)
- APPLICATION_WAITING_FOR_NETWORK (The application is waiting for joining the network)
- APPLICATION_INVALID_RESPONSE (The response received in the application layer is invalid)
- APPLICATION_USER_CANCELLED (User cancelled the current process or session)
- APPLICATION_REJOIN_NETWORK (The application is requesting to rejoin the system due to an error)

- APPLICATION_INTERNAL_ERROR (An error occurred while executing the application)

1.5 Actor (Stakeholder) Roles

Grouping (Community)		*Group Description*
Electric Vehicles		*Diagnostics*
Actor Name	***Actor Type (person, device, system etc.)***	***Actor Description***
Utility	Device(s)	The device can either be a utility device connected to the PEV through an interface (for example ESI or any other interface)
Customer	Person	Customer is the operator of a PEV and an electric customer of the home utility. Customer is responsible for connecting PEV to an Energy Portal for charging.

Replicate this table for each logic group.

1.6 Information exchanged

1.6.1 Scenario: Customer connects to Utility services

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Customer connects to the utility to enable charging the PEV	*Customer*	*Customer has a PEV, and has a connection to the utility services, and is enrolled with*	*The Utility has successfully enrolled a Customer PEV.*

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
		the utility to use the services.	

Information Object Name	*Information Object Description*
Customer charging request	Customer initiates request to charge PEV with a valid Customer Account information, PEV ID, and related information. Diagnostics information will provide the customer with any issues that occurred with getting services from the utility.
Utility provides energy services	Utility authenticates the session, and allows user to use charge the PEV.