Nokia Siemens Networks

SGEM WP5

Deliverable 5.2.1: Use Case Descriptions

Task 5.2.1 Operation and service architecture for distributed charging station infrastructure

Table of Contents

1. Introduction

Electric Mobility – transportation based on Plug-in Electric vehicles – is expected to have a transformational effect on several aspects of modern economy: automobile manufacturing, electricity generation & distribution, primary energy consumption and transportation infrastructure. It also has the potential to disrupt existing value chains & introduce innovative services and business models.

While the promises & excitement around Electric Mobility is quite evident from various announcements across countries, large scale deployment and successful market development depend on overcoming many challenges (Ex. managing impacts on electricity grid, adequate vehicle charging infrastructure, convenient end user experience, favourable regulation and most importantly investment).

As part of SGEMWP5 Task5.2.1 following research questions enumerated in application were investigated:

1. What are the overall concepts and architectural principles necessary to create user friendly EV charging infrastructure and associated services so that
   – Users can charge their vehicles at any charging station and pay conveniently
   – Vehicle charging process can balance user preferences and grid situation intelligently
   – Users are provided simple and actionable information

   Results from SGEM first funding period:
   – Overall Electric Vehicle market characteristics were studied
   – Requirements for service control & billing for first generation of charging stations were studied
   – *The key learning has been to keep the user perspective in mind while creating a comprehensive approach that covers all aspects of Electric Vehicle interaction*

2. How service control, billing, operation and management architecture for distributed charging station infrastructure and associated services can be accomplished by using principles common in the telecommunication sector to ensure easy and secure operations
   Results from SGEM first funding period:
   – Concepts for service control & billing for first generation of charging stations were created
   – *The key learning has been to create a comprehensive approach to seamlessly integrate the various components {(a) charging stations of various characteristics (b) car devices (c) user devices (d) network ICT components}*

Result:

This document covers the proposed Architecture and Use cases of Task5.2.1 that address the above questions and incorporate stated learning.

2. Architecture

A high level architecture proposed as part of Task 5.2.1 is shown below.
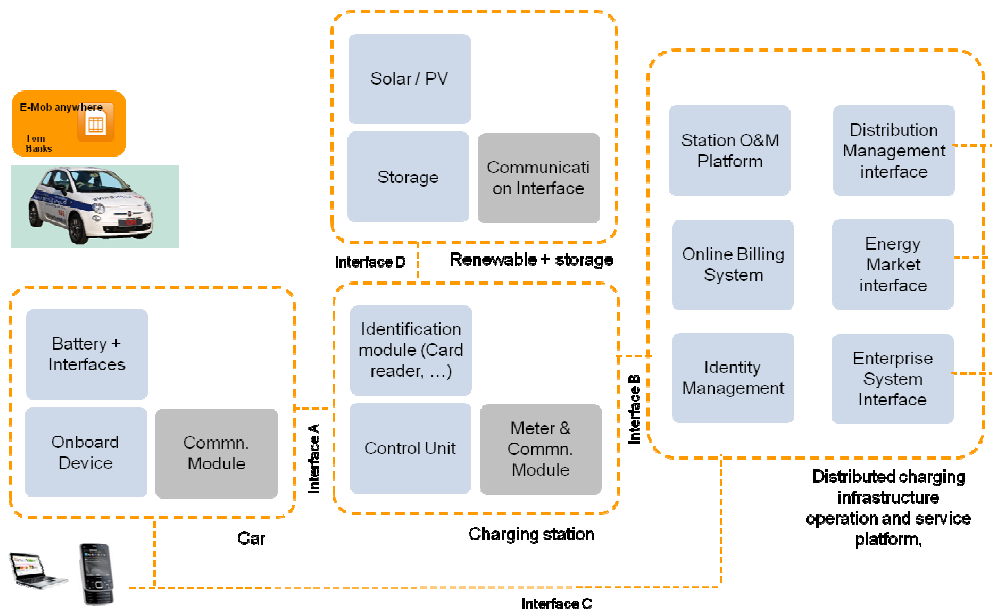
Learning #1: Architecture to address User perspective in a comprehensive manner

- User engages with three main entities related to Electric Vehicle charging: Vehicle / Onboard system, Charging Station and Information device (Mobile phone, Laptop, Tablet, etc)
- To support a cohesive experience, a network service platform must hold all user centric information and provide suitable interfaces that different devices use as part of service delivery.
- This is accomplished through "Distributed charging infrastructure operation and service platform". This platform contains user authentication information, user service information and an online billing system and exposes user centric services (Interface C, B above)

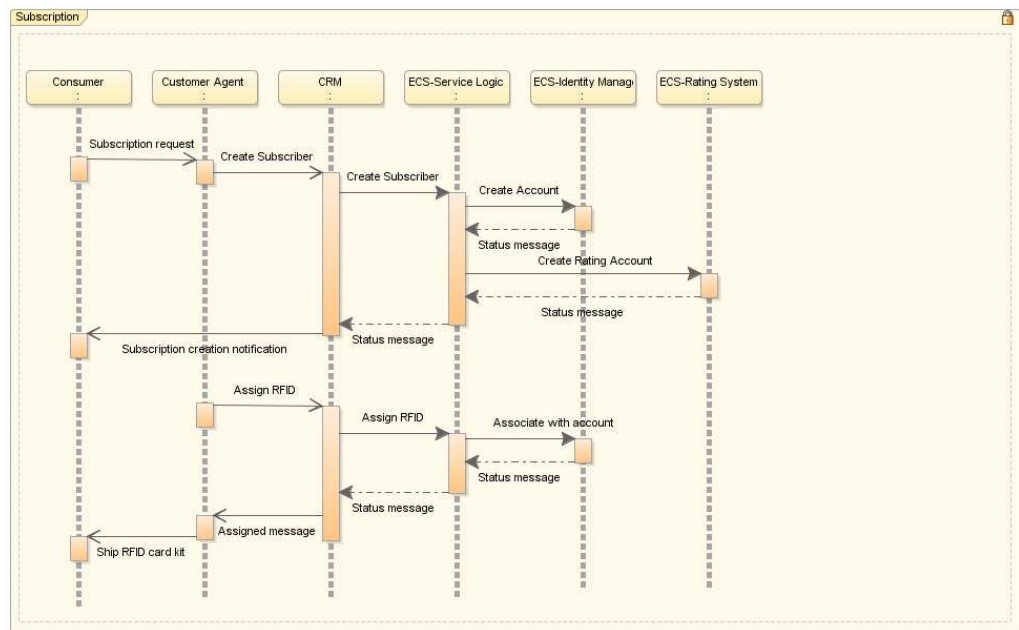Learning #2: Architecture to integrate multitude of devices

- Electric Vehicle charging ecosystem will comprise of a variety of devices (e.g. charging stations from multiple vendors and vehicle on-board systems from multiple vendors) and variety of systems (e.g. distribution management systems, energy market information systems, enterprise systems).
- To support growth of the charging ecosystem, a network operation platform must provide a flexible way to integrate the field devices. This is accomplished through "Distributed charging infrastructure and service platform". The platform contains a common information model and charging service delivery system into which field devices of various characteristics are integrated through a "mediation" approach (i.e. platform implements a variety of protocols but uses a common application logic that controls charging service).
- To integrate with other systems (distribution management, energy market, etc), the platform uses a Service Oriented Architecture / Web services approach.

3. Use cases

Proposed use cases are grouped logically and described in subsequent chapters
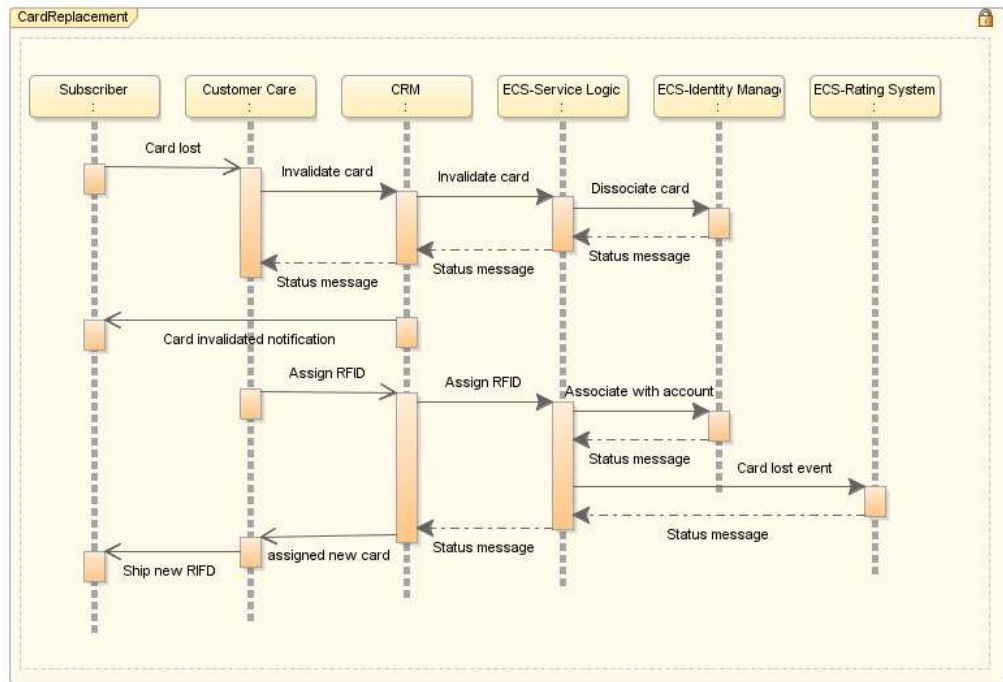
3.1 Subscriber lifecycle

<u>Case: New subscription</u>

Actors	• Consumer – Driver of Electric Vehicle • Customer Agent – Representative of Electric Vehicle Charging Service Provider • CRM – Enterprise system that contains service and profile information of users • ECS – Emobility Central System that contains authentication, billing and service delivery logic
Flow	• Consumer makes a subscription request with relevant information (in some cases this can be made through a Web site) • Customer Agent uses relevant user interface of CRM system to initiate subscriber creation • CRM system instructs creation of user account in ECS system by passing relevant information (user details, selected service, selected tariff, etc) • ECS system creates the account and maps the account to selected tariff • Suitable status message is shown to Customer Agent / Consumer • Customer Agent selects a subscription card from a pool and instructs CRM and ECS to assign the card to the previously created user account • On successful assignment, Customer Agent provides the

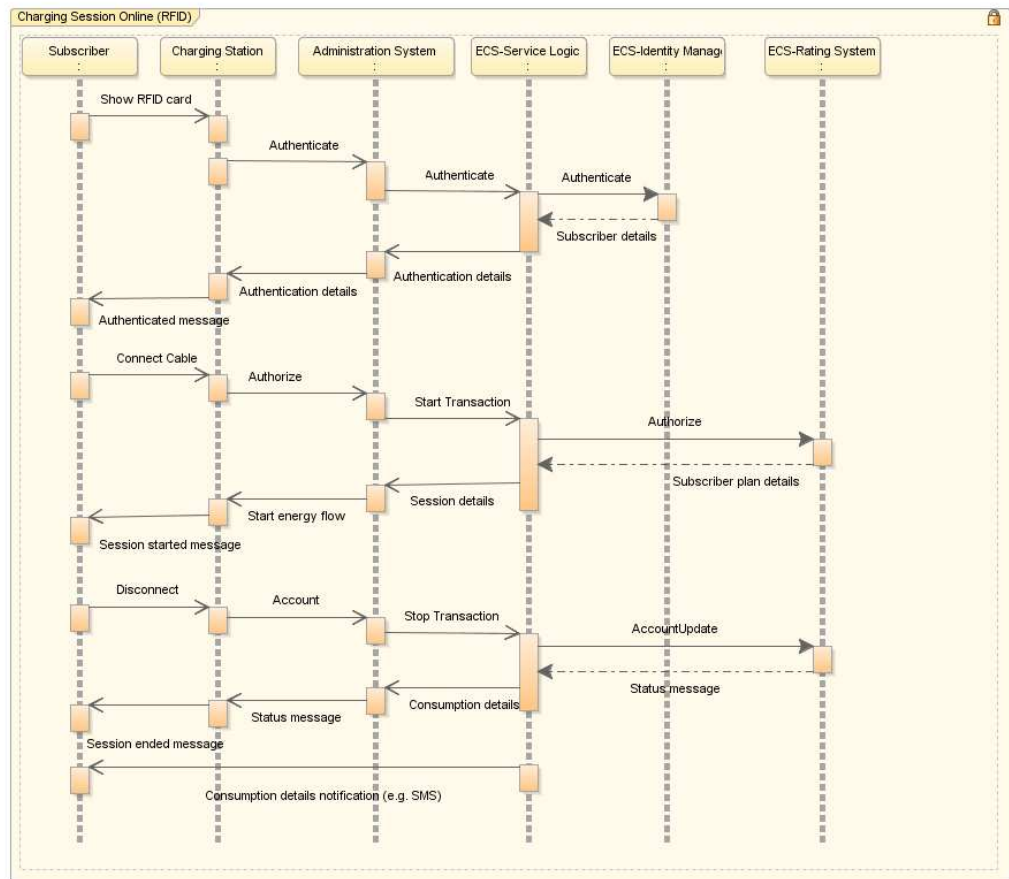|	card and an information kit to the Consumer

Case: Subscription card replacement

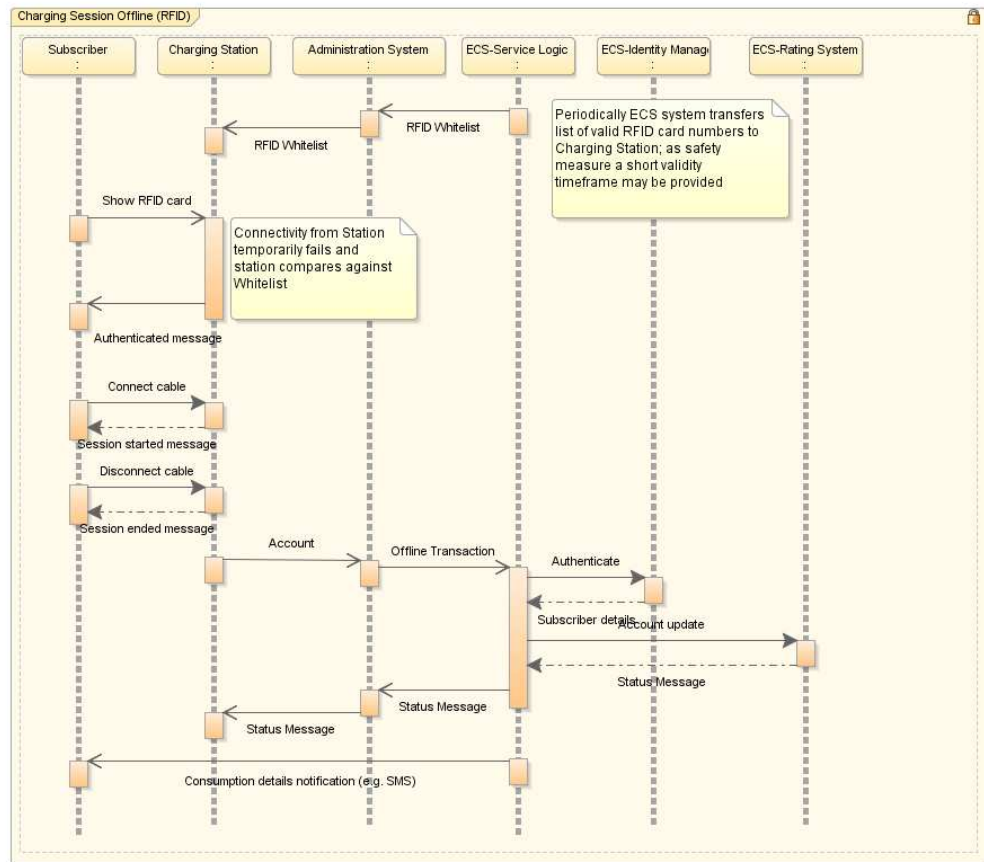| Actors	• Subscriber – User who has subscribed to Electric Vehicle Charging Service • Customer Care – Representative of Electric Vehicle Charging Service Provider • CRM – Enterprise system that contains service and profile information of users • ECS – Emobility Central System that contains authentication, billing and service delivery logic
Flow	• Subscriber contacts Customer care to invalidate current subscription card and to issue a new card • Customer Care agent uses relevant user interface of CRM system to invalidate current subscription card • CRM system instructs ECS to disassociate the subscription card from user account; ECS system removes the association (new service requests from that card will start to fail) • Suitable status message is shown to Customer Agent / Consumer • Customer Care agent selects a new subscription card from a pool and instructs CRM and ECS to assign the card to the user account • On successful assignment, Customer Agent provides the new card to the Subscriber

3.2   Service Delivery

<u>Case: Online session with subscription card</u>
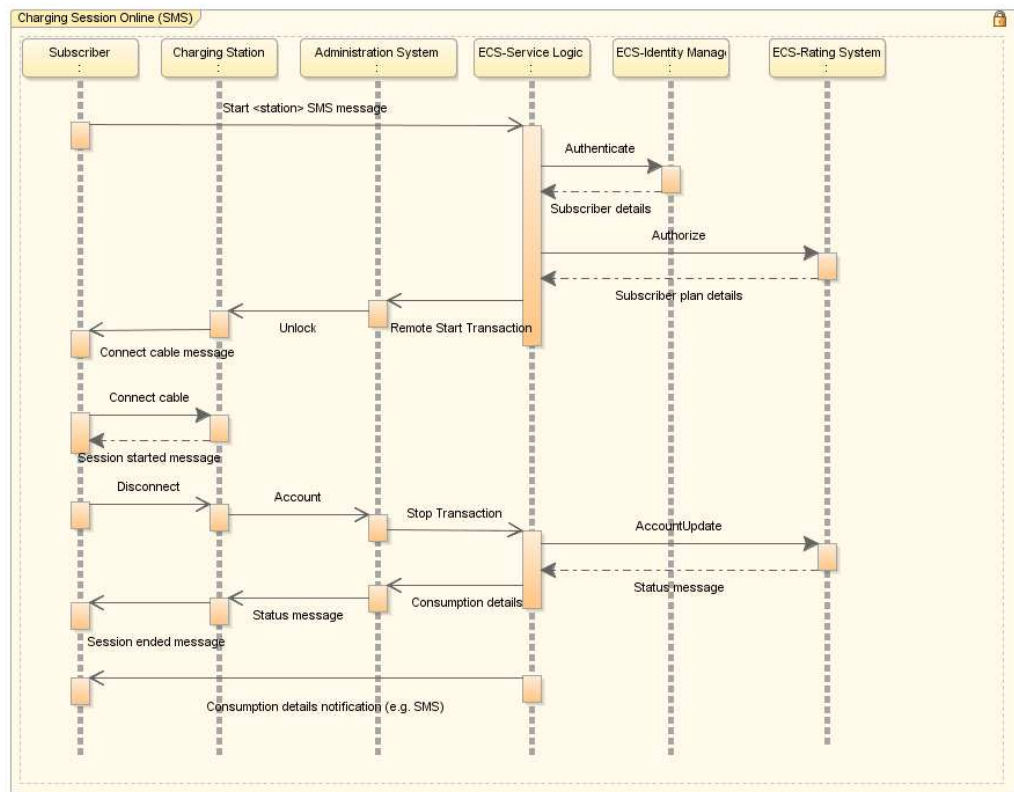
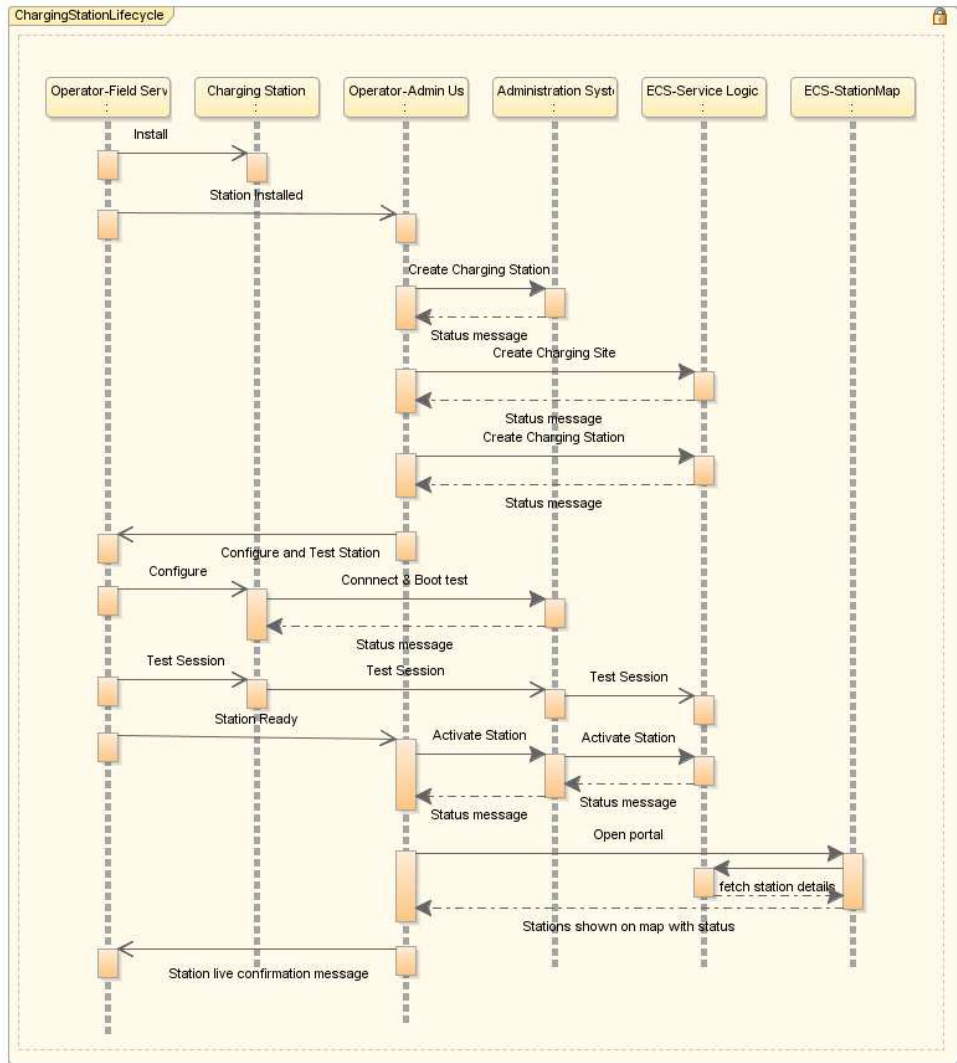|	
Actors	• Subscriber – User who has subscribed to Electric Vehicle Charging Service • Charging Station – Infrastructure device that delivers electricity • Administration System – Mediation System that implements protocol towards the Charging station • ECS – Emobility Central System that contains authentication, billing and service delivery logic
Flow	• Subscriber shows his subscription card at the Charging Station; station reads the card and initiates Authentication • Authentication request is received at the ECS system which maps the card to the relevant Subscriber and if the subscriber is valid, a success message is returned. Charging station displays suitable message on display • Subscriber connects the cable to the station; station initiates Authorization request • Authorization request is received at the ECS system which examines if the user is allowed to perform the system (e.g. remaining balance, credit, etc); on success a transaction is started and details are sent to the station. Station starts energy flow and displays suitable message. • After a time interval, Subscriber disconnects the cable; station computes the energy usage information and initiates Account request • Account request is received at the ECS system which records the usage information in the rating system; rating system selects the tariff and records the correct monetary value. On success, the transaction is stopped and status message sent to station. Station displays suitable message • ECS system also sends asynchronous notification (e.g. SMS, email) to the Subscriber with details about the service usage (e.g. date, time, station details, energy consumed, monetary value)

Case: Offline session with subscription card

Actors	• Subscriber – User who has subscribed to Electric Vehicle Charging Service • Charging Station – Infrastructure device that delivers electricity • Administration System – Mediation System that implements protocol towards the Charging station • ECS – Emobility Central System that contains authentication, billing and service delivery logic
Flow	• Periodically valid subscription card numbers are pushed from the ECS system to various charging stations (this step can use some intelligence e.g. only premium customers, only users within nearby distance of station) • Subscriber shows his subscription card at the Charging Station; station reads the card and initiates Authentication which fails due to communication failure • Station now checks if subscription card is part of the valid list that it has received from ECS; if the subscriber is valid, Charging station displays suitable message on display • Subscriber connects the cable to the station; station initiates Authorization request • Station starts energy flow and displays suitable message. • After a time interval, Subscriber disconnects the cable; station computes the energy usage information and initiates Account request providing subscription card details. • Account request is received at the ECS system which first validates the subscription card and then records the usage information in the rating system; rating system selects the tariff and records the correct monetary value. On success, status message sent to station • ECS system also sends asynchronous notification (e.g. SMS, email) to the Subscriber with details about the service usage (e.g. date, time, station details, energy consumed, monetary value)

Case: Online session using SMS

Actors	• Subscriber – User who has subscribed to Electric Vehicle Charging Service • Charging Station – Infrastructure device that delivers electricity • Administration System – Mediation System that implements protocol towards the Charging station • ECS – Emobility Central System that contains authentication, billing and service delivery logic
Flow	• Subscriber sends an SMS message to ECS system providing station details • ECS system maps the SMS sender to the relevant Subscriber and if the subscriber is valid and allowed to perform the system (e.g. remaining balance, credit, etc); on success an unlock message with transaction details is sent to charging station • Charging station displays suitable message on display • Subscriber connects the cable to the station; station starts energy flow • After a time interval, Subscriber disconnects the cable; station computes the energy usage information and initiates Account request • Account request is received at the ECS system which records the usage information in the rating system; rating system selects the tariff and records the correct monetary value. On success, the transaction is stopped and status message sent to station. Station displays suitable message • ECS system also sends asynchronous notification (e.g.

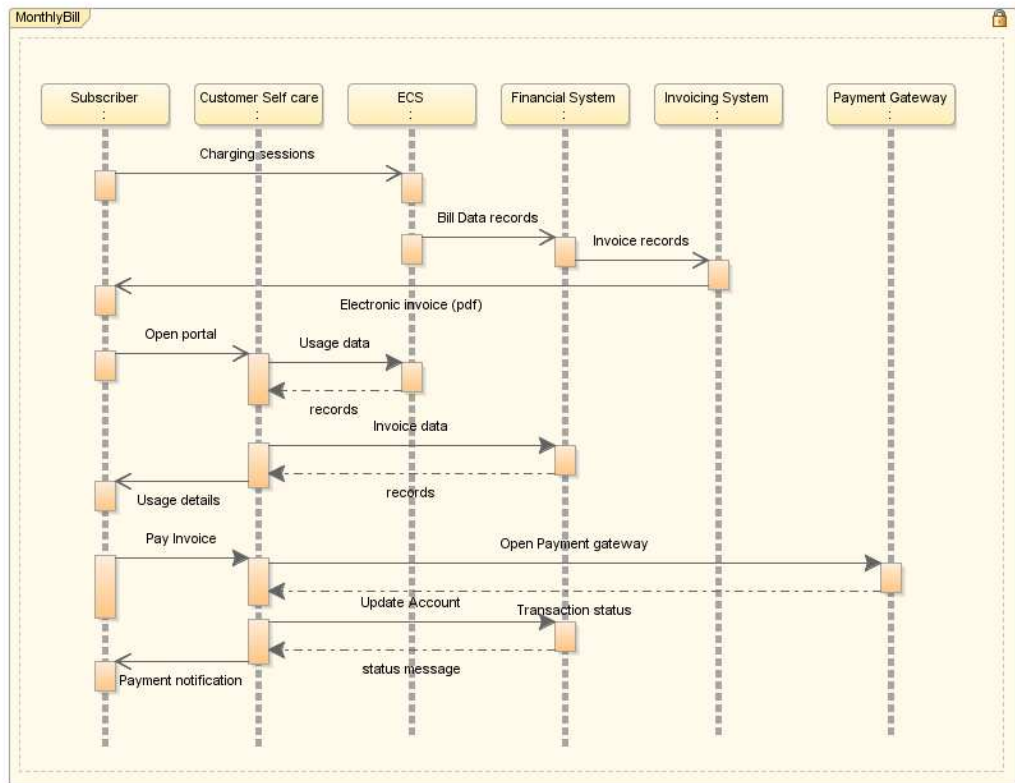|	SMS, email) to the Subscriber with details about the service usage (e.g. date, time, station details, energy consumed, monetary value)

3.3   Station lifecycle

Actors	• Charging Station – Infrastructure device that delivers electricity • Operator Field Service – Field Engineer that installs charging station • Administration System – Mediation System that implements protocol towards the Charging station • Operator Administration – Operation Engineer that configures charging station in ECS • ECS – Emobility Central System that contains authentication, billing and service delivery logic

Flow	• Operator Field Service completes physical installation of the charging station and informs Operator Administration
	• Operator Administrates creates a Charging station entry with relevant details in Administration system; this triggers a creation of charging station within the ECS system. On success a suitable message is displayed.
	• Operator Administration informs Operator Field Services to power up the station and provide configuration parameters (e.g. station details, central system details)
	• On successful configuration, Charging Station connects and performs a boot test with the Administration system
	• Operator Field Service initiates a test session with a test subscription card. This triggers an Authentication, Authorization flow upto the ECS system. On success, Operator Administration is informed that station can be activated for normal use
	• Operator Administration activates the charging station in ECS system; on success, the charging station is visible in ECS user interface in active state; Operator Field Service is informed that the station is live (so that activities can be concluded)

3.4 Billing lifecycle

<u>Case: Monthly invoice</u>

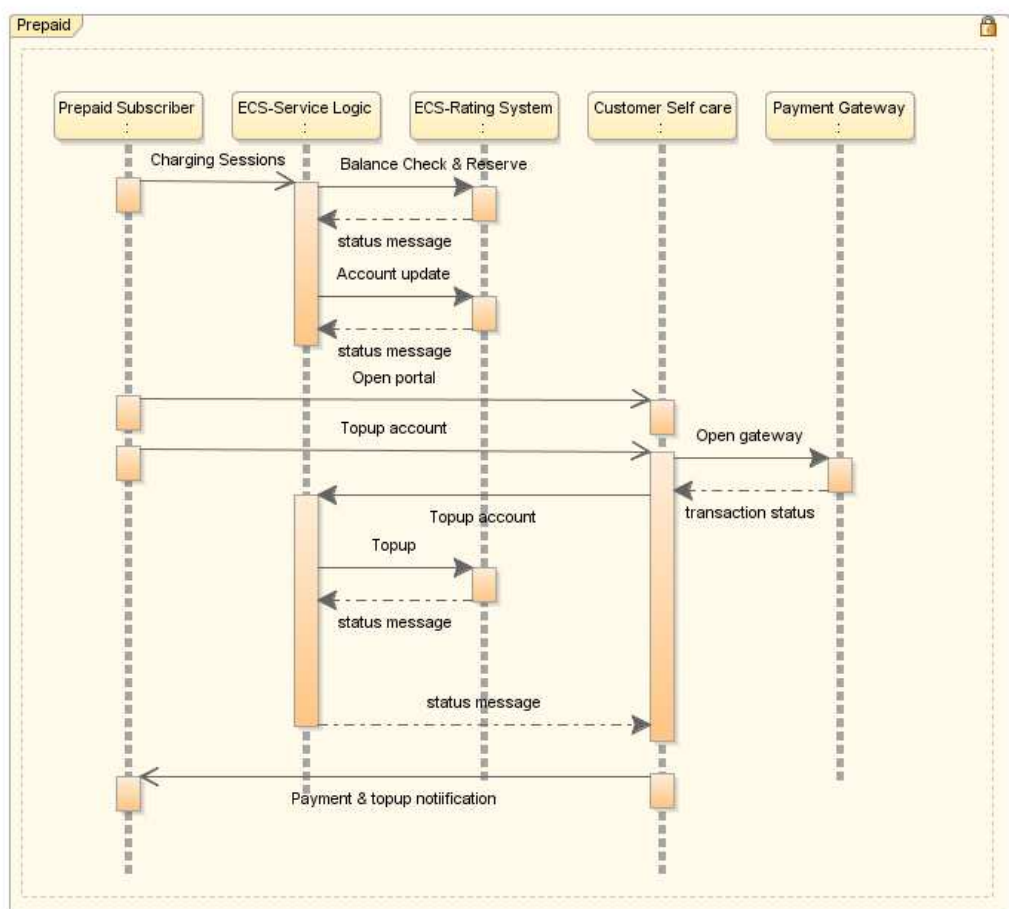|	
Actors	• Subscriber – User who has subscribed to Electric Vehicle Charging Service • Customer Self care – Web portal for Subscriber to see service usage details • ECS – Emobility Central System that contains authentication, billing and service delivery logic • Financial System – Maintains subscriber account monetary information (credit, monthly usage, payments, etc) • Invoicing System – Generates an invoice • Payment Gateway – Electronic payment system
Flow	• Subscriber performs vehicle charging sessions during the course of the month; for each session ECS system has recorded the usage, applied the tariff and generated bill data record • At the end of the month, ECS transfers bill data records of user to Financial system • Financial system records the monetary value for the month and generates Invoice records; Invoicing system generates an invoice and informs the Subscriber (e.g. email with pdf, SMS notification) • Subscriber opens Customer Self Care portal which shows various usage statistics (supplied by ECS system). Portal also shows invoice data (supplied by financial system).

	• Customer Self Care portal provides an option for electronic payment; this forwards the request to the Payment Gateway (by providing the required amount). User provides his electronic payment authentication and confirms payment. • On successful payment, Customer Self care system updates the Financial system and payment notification is displayed to the Subscriber

Case: Prepaid

Actors	• Subscriber – Prepaid User who has subscribed to Electric Vehicle Charging Service • Customer Self care – Web portal for Subscriber to see service usage details • ECS – Emobility Central System that contains authentication, billing and service delivery logic • Financial System – Maintains subscriber account monetary information (credit, monthly usage, payments, etc) • Invoicing System – Generates an invoice • Payment Gateway – Electronic payment system

Flow	- Subscriber performs vehicle charging sessions during the course of the month; as the Subscriber is a prepaid user, for each session ECS system checks the balance & makes reservation before session and at end of session reduces the account balance as per usage. This ensures that a user with insufficient balance will not be able to charge his vehicle. - Customer Self Care portal provides option for electronic payment to add credit to Subscriber account. This forwards the request to the Payment Gateway (by providing the user entered amount). User provides his electronic payment authentication and confirms payment. - On successful payment, Customer Self care system updates the ECS system which increases the available balance for the Subscriber. This allows the Subscriber to initiate new charging sessions. - Suitable notification (SMS, email) is sent to the Subscriber with details of the increased balance.

4. Abbreviations

CRM	Customer Relationship Management
ECS	Emobility Central System
ICT	Information and Communication Technology
SGEM	Smart Grids and Energy Markets

5. References

1. ISO15118-1: Vehicles to grid communication interface: General information and use cases
http://www.iso.org/iso/iso_catalogue/catalogue_ics/catalogue_detail_ics.htm?ics1=43&ics2=120&ics3=&csnumber=55365

6. Document History:

Version	Changes	Modified by	Date
1.0	**First publication**	**T. Kabilan**	**3-Feb-2012**