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Programme Area: Light Duty Vehicles

Project: Electricity Distribution and Intelligent Infrastructure

Title: Completion Report - Systems Integration and Architecture Development - Appendix A1

Abstract:

This project was undertaken and delivered prior to 2012, the results of this project were correct at the time of publication and may contain, or be based on, information or assumptions which have subsequently changed. The purpose of this deliverable was to develop an open architecture (i.e. system design requirements) for recharging infrastructure to enable the system to be operated and managed effectively while also enabling compatibility between different business models. This is Appendix A1, covering the outline solution requirements, high level system context and high level initial use case model.

Context:

This project looked at the potential impact of electric vehicles on the UK electricity distribution grid.

ETI EV Work Package 2.4

SP2/IBM/14 Intelligent Infrastructure Requirements Report

Version: 2.1

CONFIDENTIAL	not to be disclosed other than in-line with the terms of the ETI Technology Contract

Deliverable Title	ETI EV Work Package 2.4 Requirements Report
Deliverable Reference	SP2/IBM/14_v.2.1

Interim or Final	Final Report

Original Due Date	14/05/10
Initial Submission Date	14/05/10

Author	Simon Parker - IBM UK
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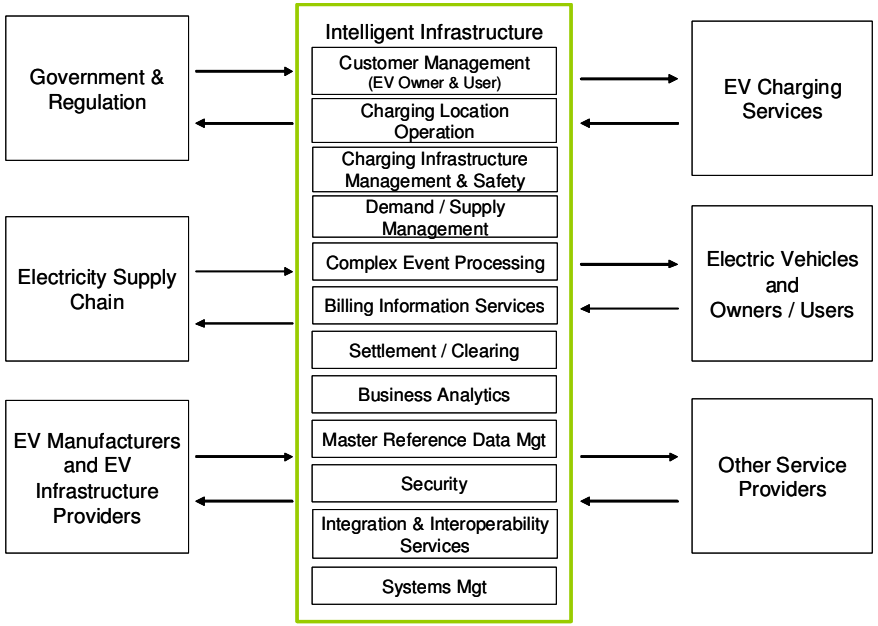
Approver	Nigel Baker-Brian - IBM UK
Version	History
v.1.0	Initial Submission 14/5/10
v.2.0	Resubmission following ETI Review 9/6/10
v.2.1	Updated following IAG discussions
IP Ownership	As defined in the ETI Technology Contract

Executive Summary - Intelligent Infrastructure – 'Provide Information Technology, Data and Services which support the roll out and operational aspects of Electric Vehicle usage'

- **Intelligent Infrastructure 'Actors' (Stakeholders)** :-
  - Government and Regulatory Bodies
  - Electricity Supply Chain Organizations
  - Electric Vehicle Manufacturers and Electric Vehicle Infrastructure Providers
  - Electric Vehicle Charging Services Providers
  - Electric Vehicles and Electric Vehicle Owners and Users
  - 'Other' Service Providers, including Emergency Services and Operators of the Intelligent Infrastructure and others
- **Intelligent Infrastructure Functionalities and Requirements**:-
  - **Customer Management (EV Owner & User)** - account and contact management
  - **Charging Location Operation** – managing availability, bookings, charging activity and location reference data
  - **Charging Infrastructure Management & Safety** – managing charging assets, monitoring condition status, performing EV telemetry and control
  - **Demand / Supply Management** - supporting the management of electricity network load – e.g. impact of charging activities
  - **Complex Event Processing** - aggregating and correlating events and applying rules to support operation
  - **Billing Information Services** -supporting the production of bills and statements
  - **Settlement / Clearing** – managing the settlement and clearing of billing and payments with operators and suppliers of services
  - **Business Analytics** - providing dynamic and static analytics – data warehousing, dashboards, report generation, queries
  - **Master Reference Data Management**
  - **Security** - users, hardware, data, applications, comms network
  - **Integration & Interoperability Services** – supporting communication and integration across components, stakeholders and externally
  - **Systems Management Services** – the management of the Intelligent Infrastructure itself



…about the Requirements and Functionalities…

- The physical location of functionality of the II is not defined in this report, e.g. some will reside in the EV itself. - this will be considered in the Conceptual Technical Architecture Report
- The possible range of business models through which the II may be provided is not defined in this report - this will be considered in the Conceptual Business Architecture Report
- The actors identified are conceptual - there may not be a one-to-one relationship between real world organisation and actor e.g. one organisation could be both an EV charging equipment manufacturer and an EV charging services operator – this will be explored in the Conceptual Business Architecture Report
- A key objective has been to identify the full gamut of requirements and functionalities – from 'must have' to 'nice to have', from the immediate to the future long term, whilst recognizing that the scope of services to support EVs is huge and expanding and that not every possible future requirement can be accommodated in this deliverable. It is part of the scope of the Conceptual Business Architecture to categorize and prioritize the requirements and functionalities defined here.

Contents

Note : on certain of the pages, additional narrative and explanation may have been provided in the notes section. This is indicated by the inclusion of see notes on the slide. You are advised to view / print the slides in notes view

ETI EV Work Package 2.4

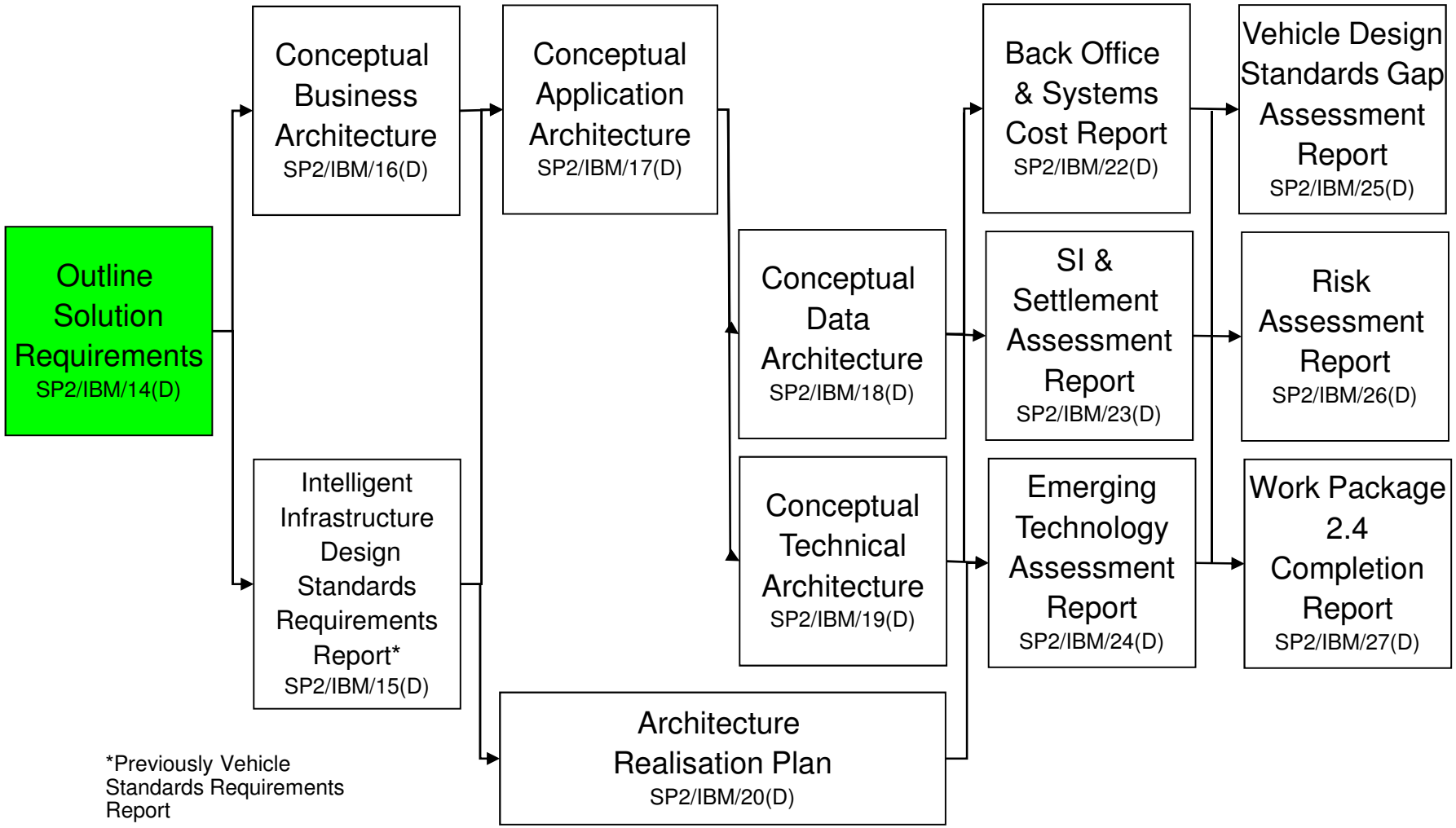
SP2/IBM/14 Intelligent Infrastructure Requirements Report

Introduction

Purpose, Objective and Limitations of the Intelligent Infrastructure Requirements Report

- Purpose
  - This document is a deliverable of the ETI Technology Contract for the Electrification of Light Vehicles - Project: Electricity Distribution & Intelligent Infrastructure. The deliverable is the Intelligent Architecture Requirements Report from Work Package 2.4 – Intelligent Infrastructure.
- Objective
  - Outline Solution Requirements (2-4.7 to develop the supporting function requirements to the extent required for use in the demonstration):
    - Capture decisions about which business processes will be supported in the Intelligent Infrastructure Architecture
    - Identify the scope of the Intelligent Infrastructure Architecture as a System Context diagram, identifying the key information exchanges within scope
    - Outline requirements for the Intelligent Infrastructure Architecture in an initial Use Case Model. The main actors will be identified and each use case will include the name, description and actor for that use case
    - Identify the users of the Intelligent Infrastructure Architecture and their characteristics
    - Develop a commentary on critical non-functional requirements, such as security
    - Produce Intelligent Infrastructure Requirements Report
- Limitations
  - The requirements report provides an initial high level view to assist in scoping a pragmatic boundary for the remaining work package activities and deliverables. The expectation is that this information will be refined, matured, developed during the remainder of this and future phases

Relationship of this deliverable to other Work Package 2.4 deliverables



*Previously Vehicle Standards Requirements Report

Overview of key Work Package 2.4 deliverables

- **Intelligent Infrastructure Requirements Report**
  - Outline solution requirements; High Level System Context; High Level Initial Use Case Model
- **Intelligent Infrastructure Design Standards Requirements & Gap Assessment Reports**
  - Develop inventory of current intelligent infrastructure design standards and later a report that identifies gaps against the requirements of the intelligent Infrastructure
- **Conceptual Business / Application / Data / Technical Architectures**
  - Decide on the overall shape and style of the architectures and evaluate alternative high-level architectures and choose between them
  - Includes artefacts such as CBM, component model, entity relationship diagram, operational model
- **Plan for Architecture Realisation**
  - High-level plan defining scope, activities and deliverables required in Stage 2;
- **Back Office and Supporting Systems Cost Report**
  - Estimate high level costs for the design and build of the back office and systems
- **Systems Integration and Settlement Assessment Report**
  - Settlement landscapes and alternatives and scope of systems requiring integration
- **Emerging Technology Assessment Report**
  - Provide a snapshot evaluation of emerging vehicles technologies and scenarios, such as demand side management, network constraints, vehicle-to-grid and future charging options
- **Risk Assessment Report**
  - Develop recommendations as to the areas and levels of risk mitigations / avoidance and safety / security to be pursued for further analysis and design

Acceptance Criteria for this deliverable from the contract – System Context

Criteria	How the report represents the criteria
System Context	
System Context Diagrams with key information flows	A series of system context diagrams and functional models are provided showing different levels of detail (slides 15 – 36)
Highlights important characteristics of the "intelligent architecture": users, external systems, inputs and outputs, and external devices such as charging points and smart meters.	The system context diagrams and functional models illustrate the users, systems and flows (slides 15 – 38)
Events – external and generated	An initial list of key events external to the system and generated by the system are noted (slide 37)
Data received and produced	An initial high level view of key data items is provided (slide 38 & 39)
Initial Use Case Model	
Actors	An initial list of key actors is provided (slide 40 – 83)
Use Cases	An initial set of use case models is provided. It includes a specification and a diagram per use case area (slides 40 – 83)

See Appendix 1 for a fuller illustration of the criteria

Intelligent Architecture Standards Group (IASG) – key messages for the Intelligent Infrastructure Requirements Report

- ETI Plug-in Vehicle Economics and Infrastructure Project will develop an open standard architecture
- The Project will work with the ETI / IASG to enable compatibility with different business models
- Architecture will enable consumers to easily use different providers' charging points in different locations around the UK
- Joined Cities will be able to exploit the open standard architecture developed in consultation with the IASG
- Complimentary to existing international groups already working on issues like electrical wiring standards and plug design
- Architecture will be shared with international standards bodies

Adapted from

ETI Plugging in Ultra Low Carbon Vehicles – Accelerating Market Growth for Plug-in Vehicles by Enabling Effective Collaboration – September 2009

Existing thinking on Intelligence Levels and relationship to the Intelligent Infrastructure Requirements Report

- The systems comprising the Intelligent Infrastructure will evolve over time, moving through various levels of functionality – termed “intelligence” in the contract
- The ETI have already provided a view of how intelligence level might develop – 1st generation (lowest level) to 4th generation (highest level), and a workshop has already been held to discuss this subject. The findings are summarized in the Intelligence Levels Workshop Report (SP2/E.ON/01) – the summary table from the workshop is provided in the appendices
- The output from the workshop has been used as an input into the preparation of this deliverable
- During future design stages, further consideration will be given to these intelligence levels – focusing on the suitability and practicality of achievable levels for different actors, and for different aspects of functionality

ETI EV Work Package 2.4
Intelligent Infrastructure Requirements Report

High Level System Context Views

A high level introduction to the System Context Diagram

- The System Context Diagram is a way of illustrating the boundary and scope of a system. Developing the system context view is important, because this view is used as a mechanism to bridge the business context, and the functional and operational architecture.

- A System Context Diagram helps to:
  - Clarify the environment in which the system has to operate
  - Illustrate a pragmatic boundary for the system
  - Identify and depict interaction with external interfaces and actors
  - Represent the system-to-be-built as a black box

- The main elements of a system context are the system to be built, the entities it links to and the nature of the information flowing between them. In this report it has also been used to illustrate the high level functional components of the system

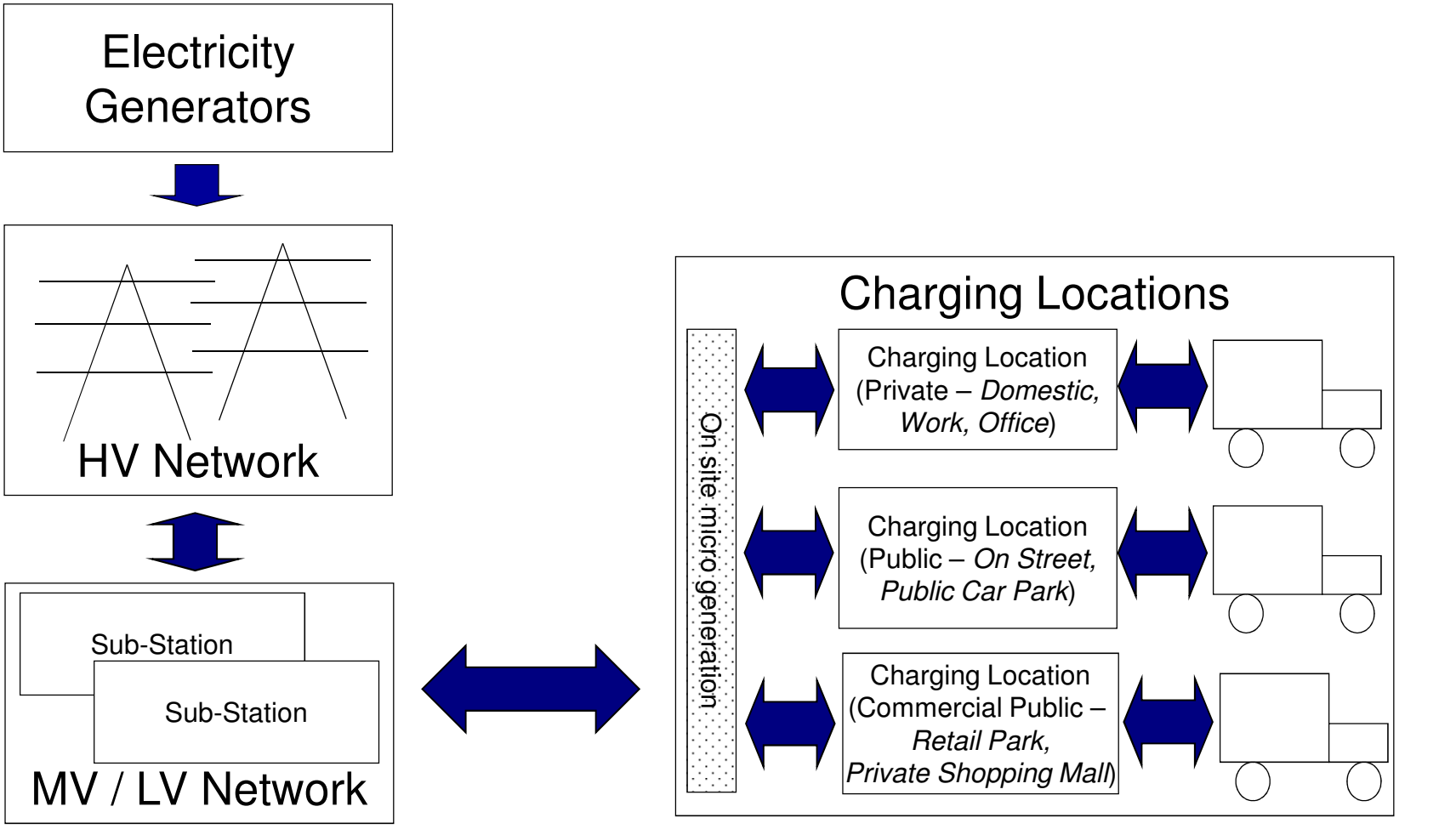
System Context Diagram – the need for iteration

The system context will be revisited at various points of the Project to allow for:

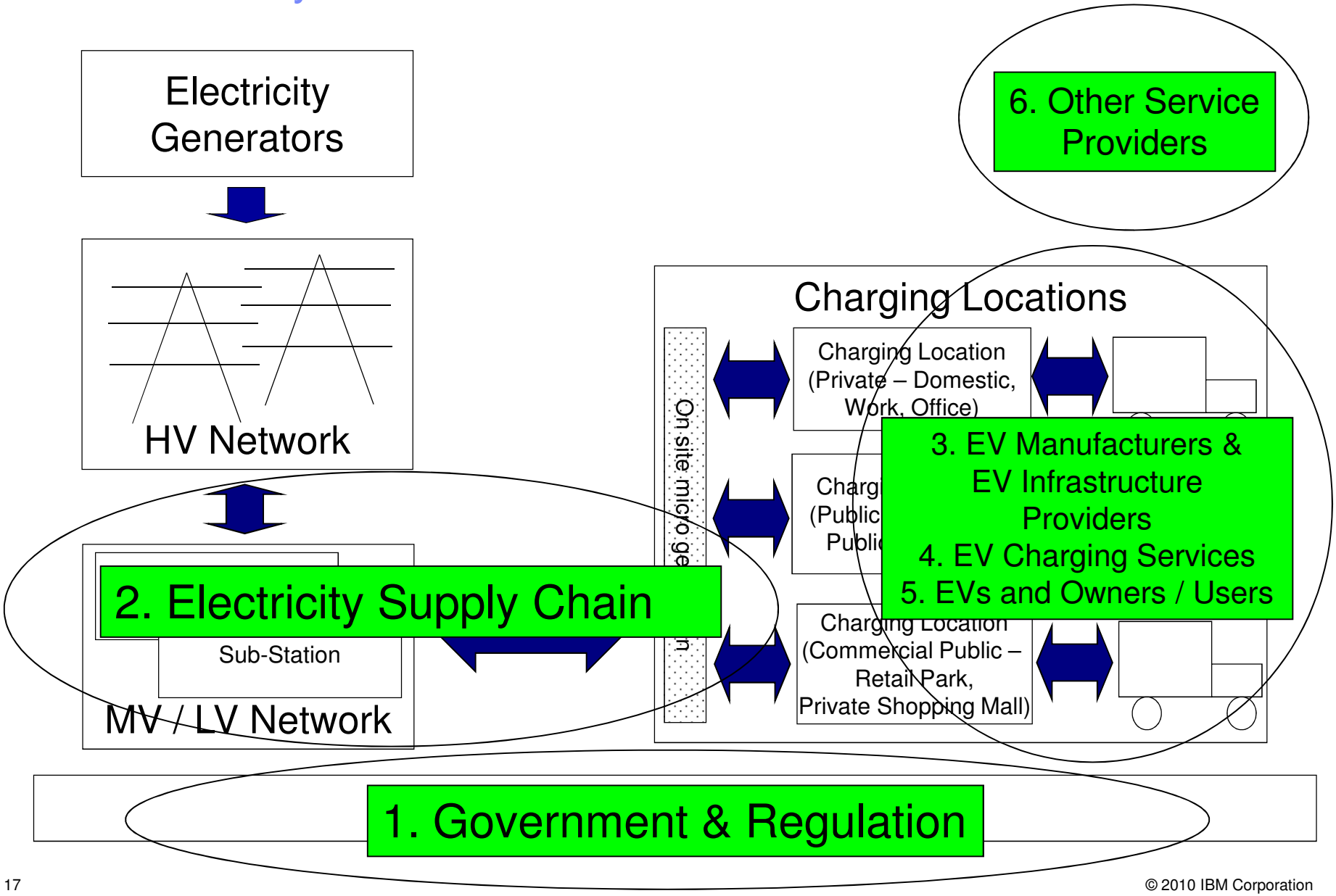
- the more detailed analysis of business, application, technical and data architecture development to iterate, evolve and adjust the system;
- consideration of the outputs of work taking place in other work packages which may be taking place in parallel to the requirements activity;
- direction the IASG may provide when they next convene, which is after this deliverable is due to be submitted;
- consideration of relevant information from the large number of other trials, studies and research activities taking place;
- changes to the actors (users and systems) which the system will be linking to

see notes

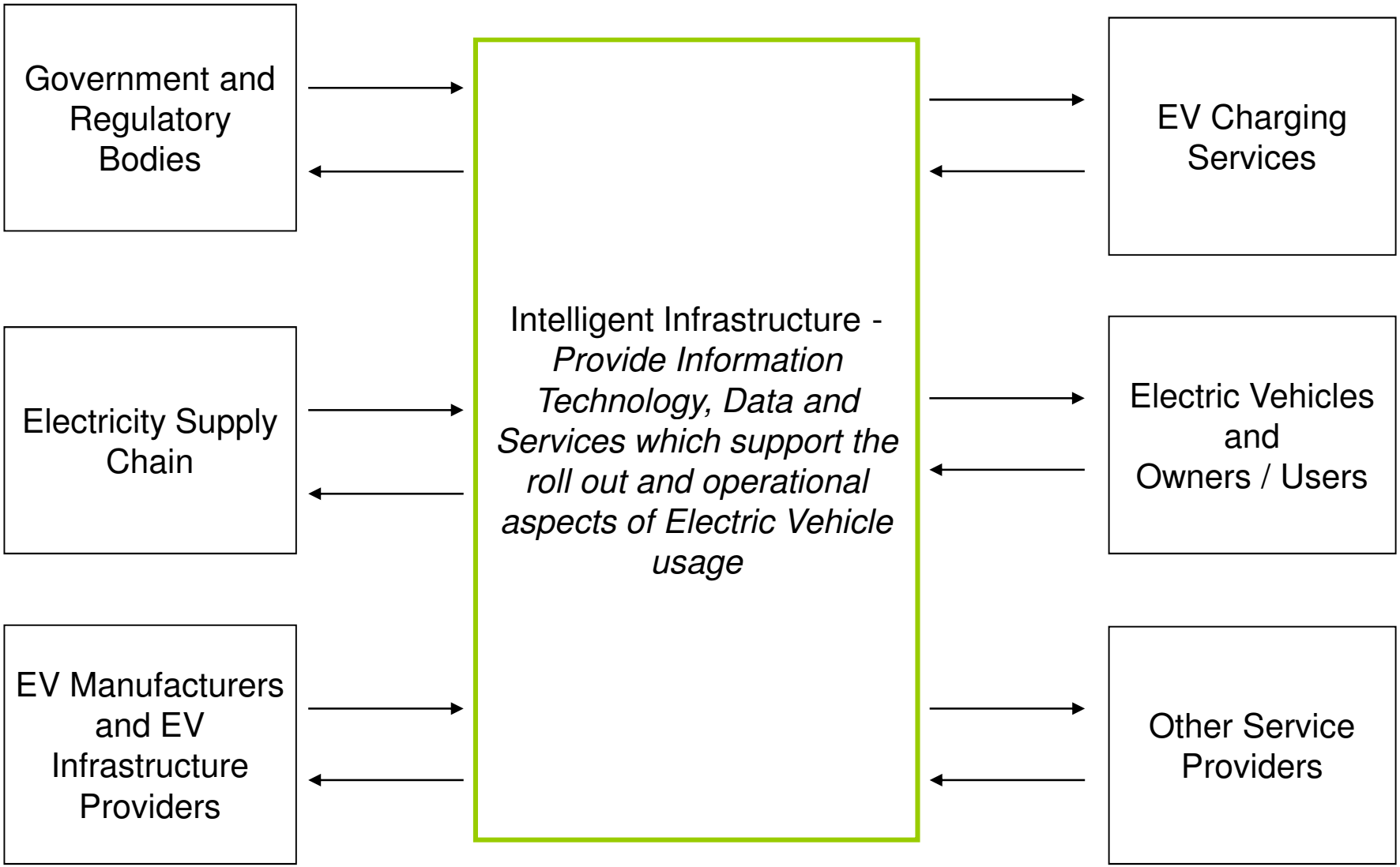
EV Intelligent Infrastructure
Simplified Physical Electricity Infrastructure Overview



EV Intelligent Infrastructure
Derivation of 'System Context Actors'



EV Intelligent Infrastructure – Level 0 Context Diagram



EV Intelligent Infrastructure – Context Diagram Actors – Characteristics and Definitions

see notes

‘Government & Regulation’ comprises:- ▪ European Union Commission ▪ Core Government Departments – e.g. Department for Transport, DECC etc ▪ Executive Agencies – e.g. DVLA ▪ Non Departmental Public Bodies (Executive, Advisory) – e.g. Commission for Integrated Transport ▪ Public Corporations ▪ Regulators – e.g. Ofgem, IEC, ISO ▪ Local Government & Local/Regional Transport Authorities including local borough councils who are key stakeholders in rolling out public charging infrastructure	**‘Electric Vehicle Charging Services’ comprises:-** ▪ Organisations which operate and manage the charging location - providing services which allow the EV user to complete the charging (or V2G) operation, with the capability to provide/receive data and information to/from other Service Providers ▪ EV Charging Assets such as posts ▪ EV Electricity Retailer – the actor providing electricity to the charging location which may or may not be the same as the more traditional electricity retailer
‘Electricity Supply Chain’ comprises:- ▪ Electricity Retailers ▪ Distribution Network Operators *(see notes re Electricity Generators and National Transmission Grid operators)*	**‘Electric Vehicles & Owners / Users’ comprises:-** ▪ The vehicle itself – EV, PHEV or other variation *(see notes regarding the EV being an actor)* ▪ EV, PHEV owners and users ▪ Fleet owners and operators – private (retail and commercial), public
‘Electric Vehicle Manufacturers and Electric Vehicle Infrastructure Providers’ comprises:- ▪ Electric Vehicle (EV) and Plug In Hybrid Electric Vehicle (PHEV) manufacturers including those unique-to-EV-component manufacturers ▪ Charging equipment and infrastructure manufacturers – including charging posts, meters and connectors ▪ EV Maintenance Providers, including Breakdown Services	**‘Other Service Providers’ comprises:-** ▪ Emergency Services ▪ Operators of the Intelligent Infrastructures including billing, back office and settlement providers ▪ EV Information Service Providers ▪ Navigation Services Providers ▪ Payment Services Providers ▪ Other businesses – e.g. Battery Leasing

EV Intelligent Infrastructure – Context Diagram Actors – examples of ***Strategic*** Initiatives and ***Key*** Motivations concerning Electric Vehicles

Government & Regulation

- Promote health & environmental improvements in urban areas
- Support the electrification of light vehicles as a significant contributor to meeting the commitment to reduce the amount of CO_2 emitted by the UK
- Grow the UK's competence in EVs (a green technology), with the consequential creation of jobs
- Ensure safety, interoperability, quality of services and competition
- Ensure the operation of appropriate tax mechanisms to manage road usage

Electric Vehicle Charging Services

- Opportunity to develop and provide new revenue generating services that can be offered to EV users and EV related businesses
- Forge relationships with critical partners – landlords, electricity retailers, DNOs, charging equipment suppliers, Local Government (esp. Borough Councils) - to establish 'core' business
- Opportunity to grow the business by vertical expansion into related businesses, products and services to other service providers

Electricity Supply Chain

- Maintain security of supply and customer service levels (for distribution networks these are maintained by Ofgem and may require updating for EVs)
- Forecast & control demand for power, including techniques like load-shifting to limit stress on localised distribution assets
- Provides an opportunity to further demonstrate green credentials
- Enhance the stability of the network by using techniques such as local storage, V2G storage, voltage and frequency regulation
- Efficiently manage any requirements to renew or update the network as a result of increasing EV usage (DNO)
- Exploit business opportunities through sales of new energy (retailers)

Electric Vehicles and Owners / Users

- Attractive Total Cost of Ownership of EVs when compared to ICE vehicles and other green technologies
- Contribution to environmental cause
- Products are safe, desirable and provide sufficient practicality and ease of use, for example:
  - removal of range anxiety;
  - able to charge at home / work so EV ready to use;
  - familiar in operation & 'look and feel'
  - able to use across different geographies

Electric Vehicle & EV Infrastructure Providers

- Exploit the market opportunity for EVs and EV Infrastructure and Services and the opportunity to enhance green credentials
- Develop affordable electric vehicles for the global mass market
- Use the provision of EVs to the market as a strategy to meet product portfolio CO_2 emissions.
- Exploit the opportunity to grow vertically from being an equipment manufacturer and supplier to a service provider

Other Service Providers

- Opportunity to develop and provide new revenue generating services that can be offered to EV users and EV related businesses
- Target green market segments
- Integrate across different intelligent infrastructures

Designing for the Future – ***Key*** Political, Economic, Social, & Technological Trends affecting the Electric Vehicle Market

Political

- Climate change abatement measures increasingly part of the mainstream political agenda – CO_2 aspirations and targets
- Increasing desire for large scale public funding for green technology, but tempered by political uncertainty and economic conditions
- Increasingly coordinated international action on climate change – harmonization with mainland EU
- Increasing investment in intelligent transport and smarter cities
- Pursuit of energy security
- Increasing investment in large scale public infrastructure projects – e.g. high speed rail
- Political investment motivated by developing UK based industries, creating and sustaining levels of employment, attracting inward investment and enhancing export & trade

Social

- Increasing population
- Increasing age profile of population skewed to older age groups
- Continued rise in urban and suburban living
- Increasing personal wealth
- Extended working age – deferral of retirement
- Increasing demand for flexible, high speed mobility
- Continuing demand for personal mobility solutions
- A wide range of awareness of climate change and motivation to action – swinging between low and high, differing from group to group
- Increasing concerns of information security
- Increasing pressure to recycle and renew – affecting EVs and EV batteries in particular

Economic

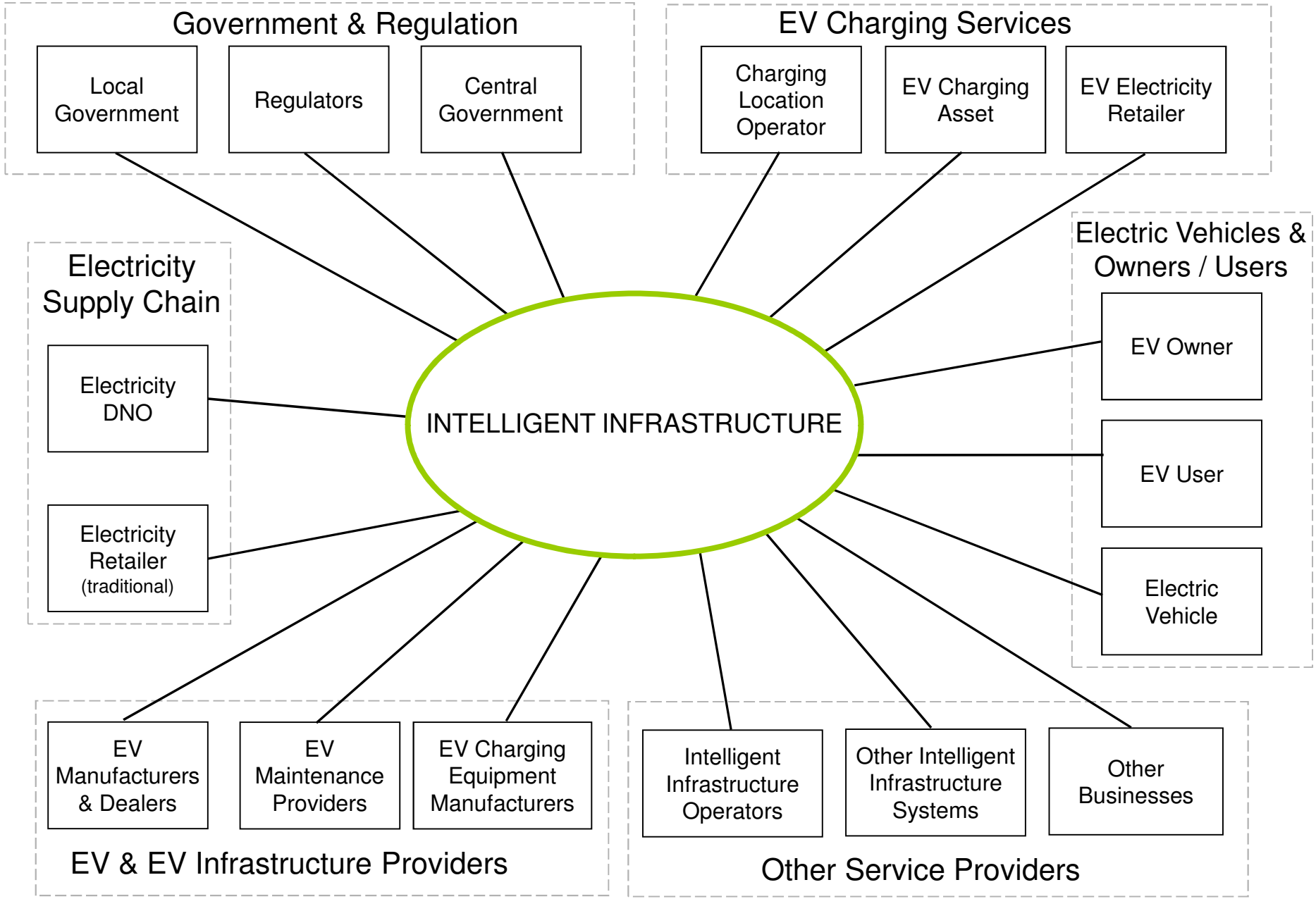
- Rising costs of fossil based fuels (scarcity, increased cost of more remote exploration and production, local ownership)
- Increasing demand for electricity
- Reducing production of indigenous sources of oil and gas
- Replacing of ageing power generation technologies
- Global demand increasing for non-fossil fuel power generation products (wind, marine, hydroelectric, nuclear)
- Increasing rise of developing countries (population, wealth, political power), increased economic activity, demand for consumer products including vehicles
- Increasing demand for raw materials – will impact on EVs and batteries

Technology

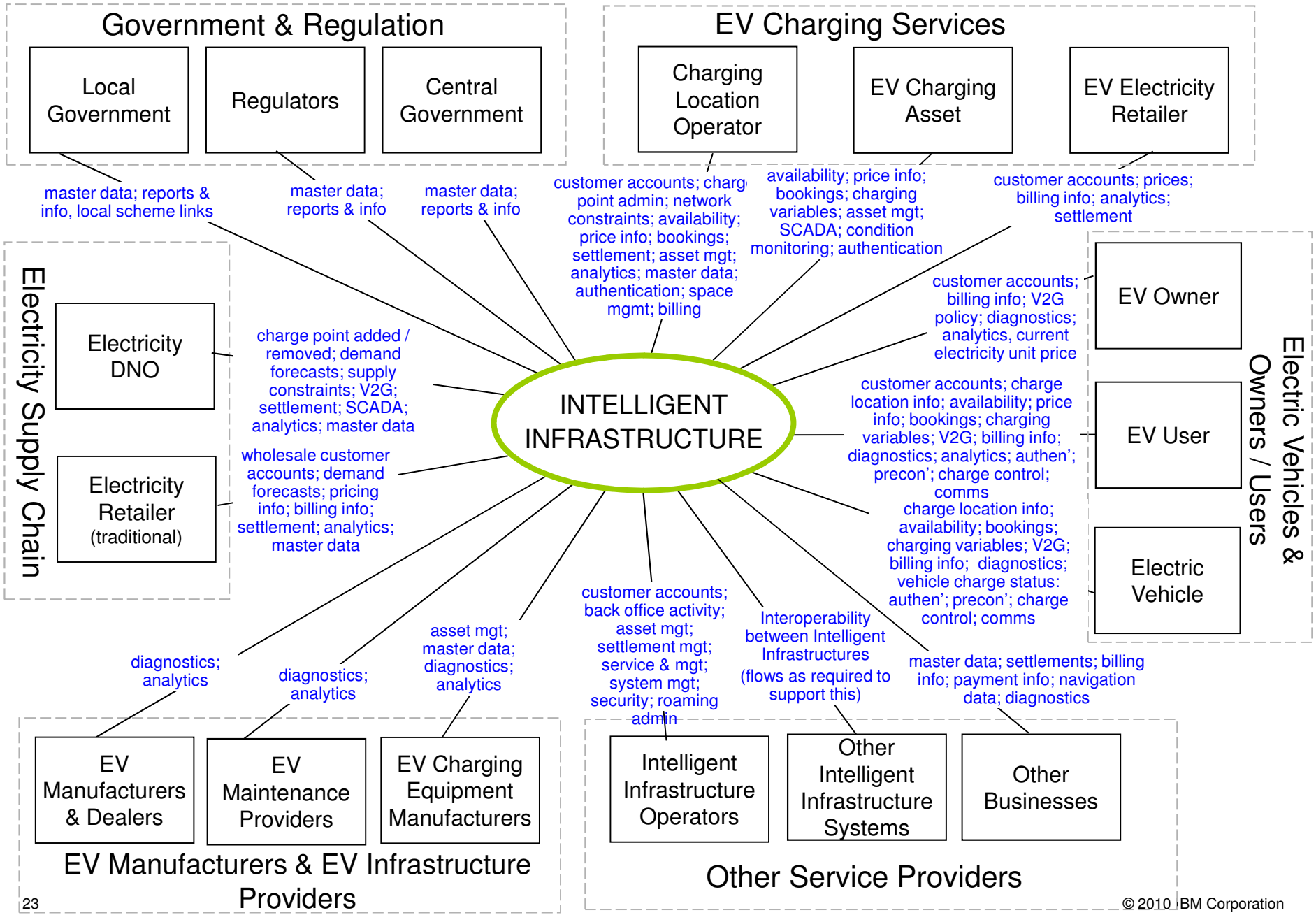
- Increasingly smarter planet and cities – the integrated world – instrument, interconnect and intelligence
- Increasing integration of components of overall transportation system (e.g. multi mode)
- Increasingly energy will be derived from a broad mix of sources – traditional fossil and renewables
- Increasing integration of existing and future components of the energy system
- Increasing capability to generate power via renewable sources and micro-generation
- Increasing improvements in battery technology
- Increasing sophistication of non ICV vehicles, and competition between vehicle options – advanced ICE, Biofuels and EVs

EV Intelligent Infrastructure – Level 1 Context Diagram

see notes

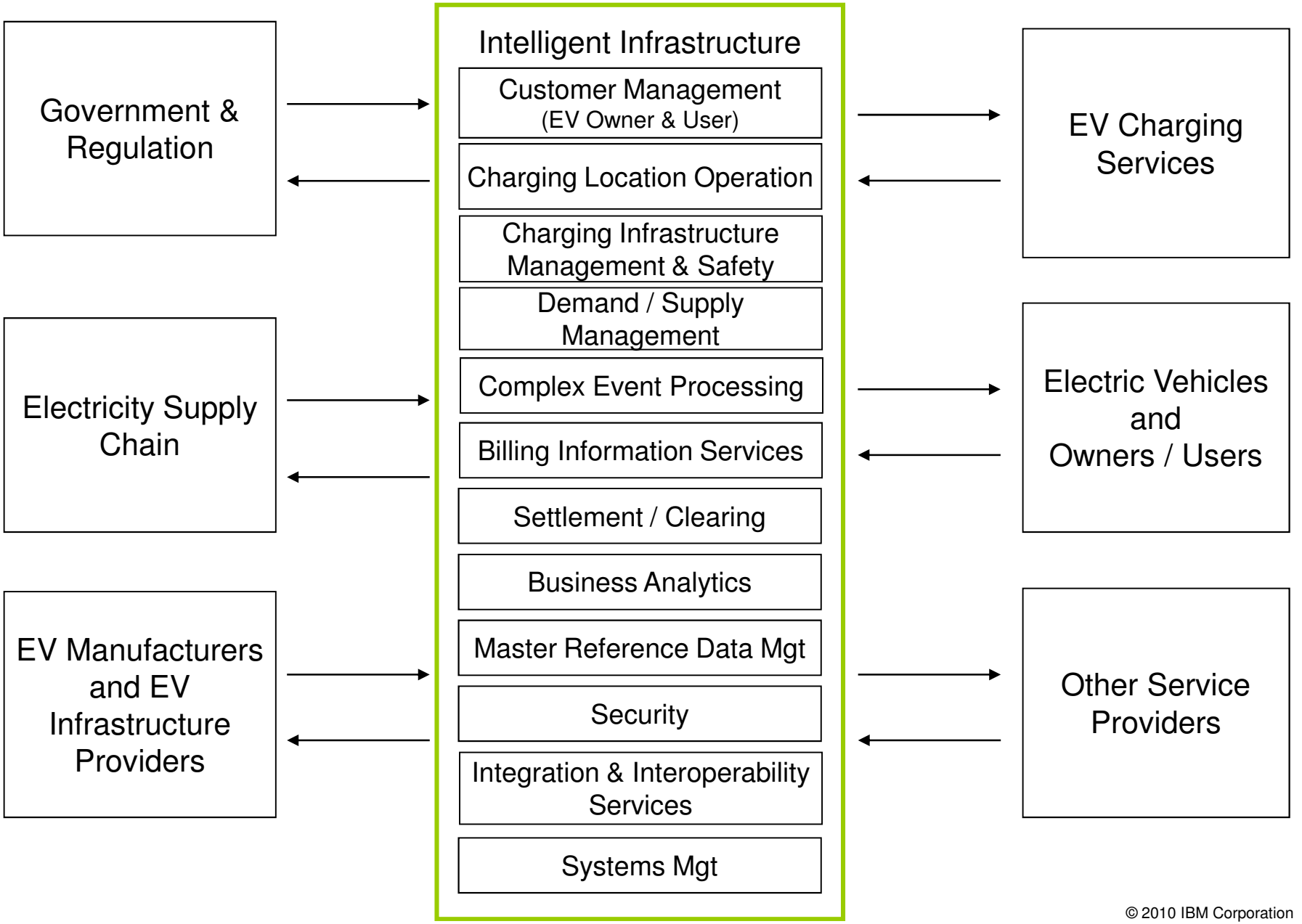


EV Intelligent Infrastructure – Level 1 Context Diagram (labelled) *see notes*

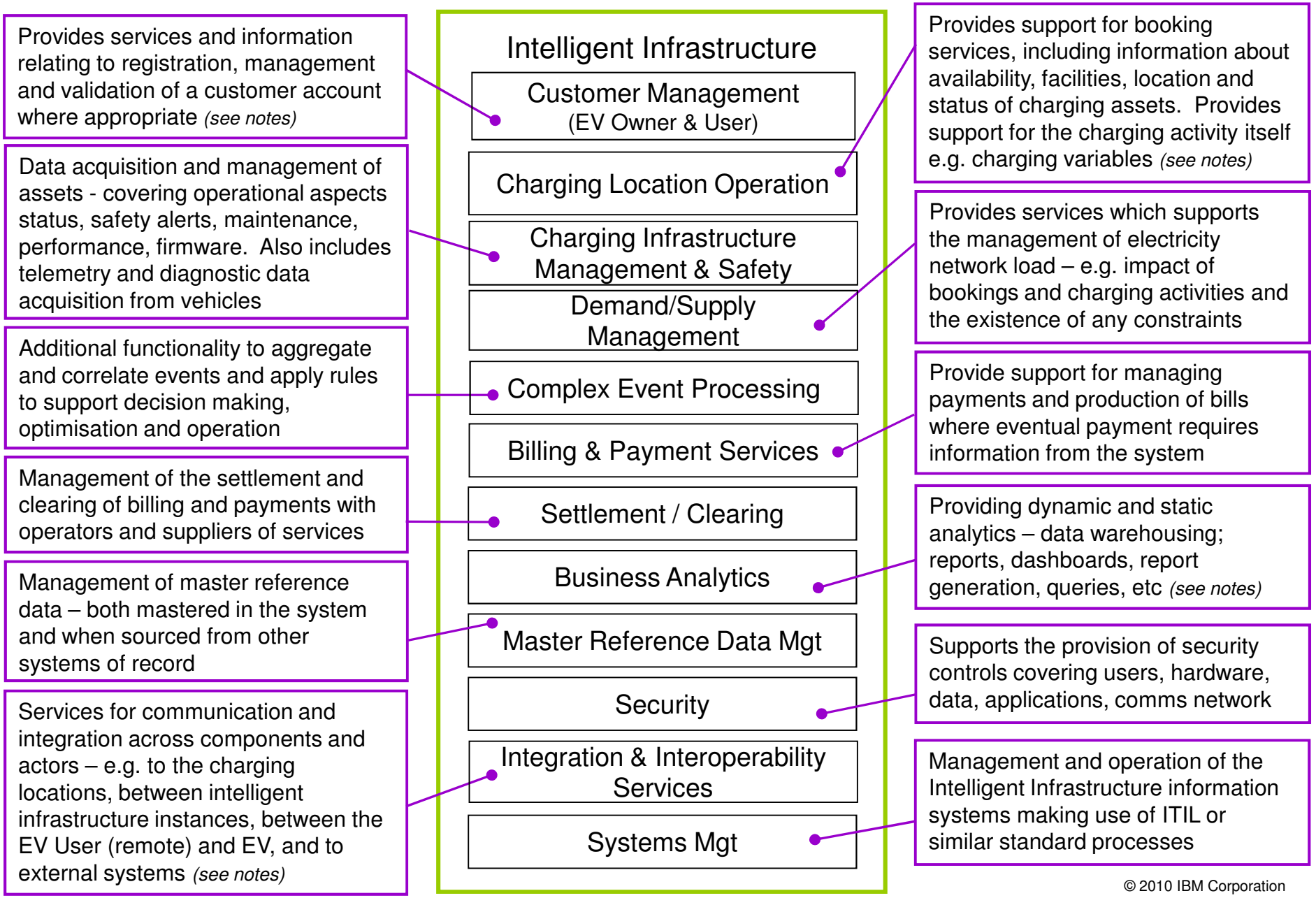


EV Intelligent Infrastructure – Conceptual Functional View

see notes



EV Intelligent Infrastructure – Conceptual Functional Description



EV Intelligent Infrastructure – System Context Views and the scope of the II Requirements Report

- The physical location of functionality of the II is not defined in this deliverable, e.g. some will reside in the EV itself. - this will be considered in the Conceptual Technical Architecture Report
- The possible range of business models through which the II may be provided is not defined in this deliverable - this will be considered in the Conceptual Business Architecture Report
- The actors identified are conceptual - there may not be a one-to-one relationship between real world organisation and actor e.g. one organisation could be both an EV charging equipment manufacturer and an EV charging services operator – this will be explored in the Conceptual Business Architecture Report
- A key objective has been to identify the full gamut of requirements and functionalities – from 'must have' to 'nice to have', from the immediate to the future long term, whilst recognizing that the scope of services to support EVs is huge and expanding and that not every possible future requirement can be accommodated in this deliverable. It is part of the scope of the Conceptual Business Architecture to categorize and prioritize the requirements and functionalities defined here.
- The II will be impacted by a maturing and evolving market for electric vehicle usage and so the Requirements Report will need to be revisited through the project and through different phases, (not currently allowed for in the ETI contract).
- The swapping of batteries is currently viewed as not in scope for the project

EV Intelligent Infrastructure – System Context Views – Assumptions concerning Actors

- The commercial relationship between a Charging Location Operator and the owner of the land on which the locations resides will exist outside of the II and hence is out of scope of the analysis. Information may be requested from the II in order to support this relationship and is covered by the analysis. Where the owner is also the Charging Operator then this is also covered by the analysis.
- Electricity Generators and Transmission Grid Operators will interact with other stakeholders notably Electricity Retailers and DNOs for the purposes of meeting demand and supply requirements. It is assumed that this will be accommodated through existing electricity market mechanisms and smart metering & smart grid developments outside the scope of the II
- The II defines an EV Electricity Retailer as an actor. This refers to an actor who provides electricity to another actor (user, owner or charging location operator) as part of the charging activity. The EV Electricity Retailer role could be undertaken by a wide range of businesses. It could, for example include a new business set up for that purpose, a traditional electricity retailer, a charge location operator or an EV manufacturer / dealer.
  - for example, the charging location operator could enter into a wholesale contract with a commercial energy provider / retailer for the provision of electricity at its parking locations and offer that to an EV user
- Currently, the understanding is that the EV Electricity Retailer would need to be a licensed domestic retailer and it is likely that the regulations in this area may need to be revised to move away from that position.
- In the possible business model where the battery is owned or leased separately from the EV, then the relationship between the battery owner and the battery user is assumed to be not managed via the II.
- Customer information will be held in the system but only as is required for the operation of system functionality. It is likely that other actor system would retain master ownership of the customers of those organisations – e.g. Electricity retailer CRM systems

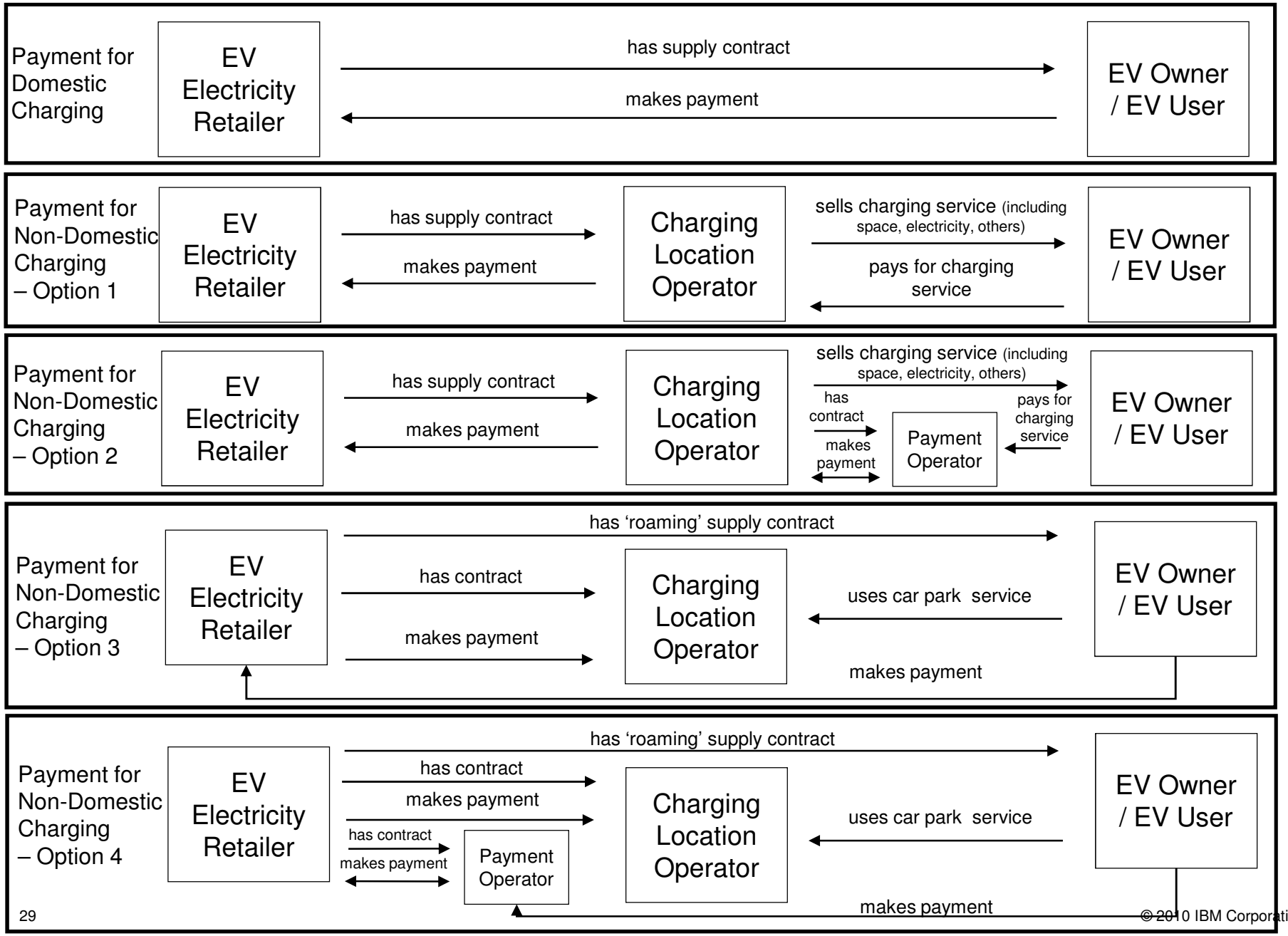
EV Intelligent Infrastructure – System Context Views - Payments for Charging

- Payments for charging will be made directly to the organizations holding a customer relationship, such as charge location operator and electricity retailer. This is functionality which is provided by the relevant organizations' core systems, although external (outsourced) businesses may provide payment services on their behalf.
- Therefore, the Intelligent Infrastructure itself will not provide payment functionalities - requests for payment / collection / authorization - but will provide a mechanism to interface with these actors and external organizations to provide information.
- The II will provide services and information to support billing, clearing and settlement activity.
- It is assumed that a range of payment types and payment channels will be made available by the organizations holding the customer relationship:-

Payment Type	At Location	Telephone	Web Site	SMS	Utility
Credit / Debit Card	Y	Y	Y		
Pre Pay Card	Y				
Cash	Y				
Direct Debit					Y
Electricity Bill					Y
Voucher	Y	Y	Y		
Season Ticket	Y	Y	Y	Y	
Mobile Phone Bill	Y			Y	

- The II's services and information will support these payment types and channels.
- The following slide illustrates the possible options for payment for charging in terms of the relationship between the different actors and external organizations.

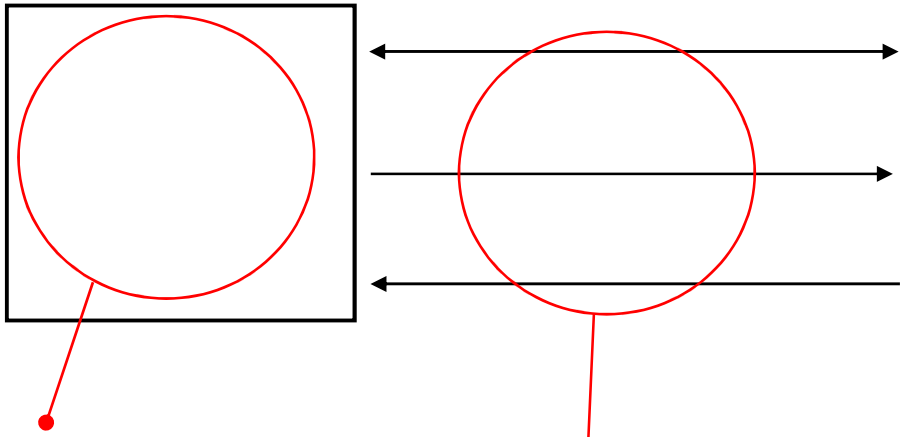
EV Intelligent Infrastructure – System Context Views - Payments for Charging



ETI EV Work Package 2.4
Intelligent Infrastructure Requirements Report

System Context Diagram – Inputs and Outputs

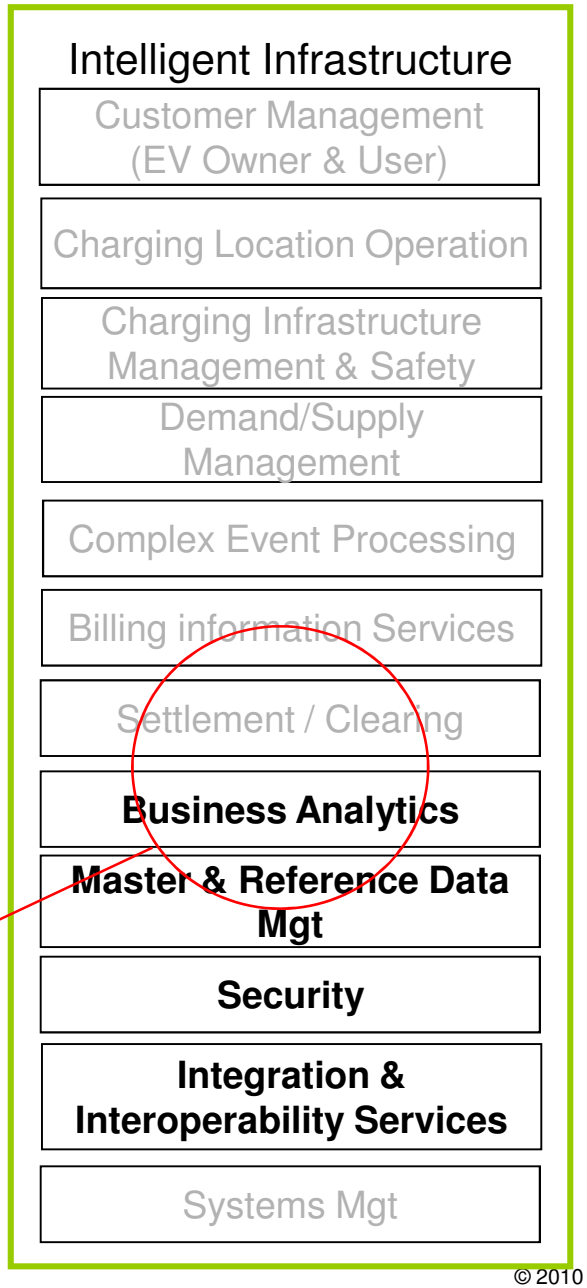
EV Intelligent Infrastructure - Context Diagram Inputs and Outputs – Introduction



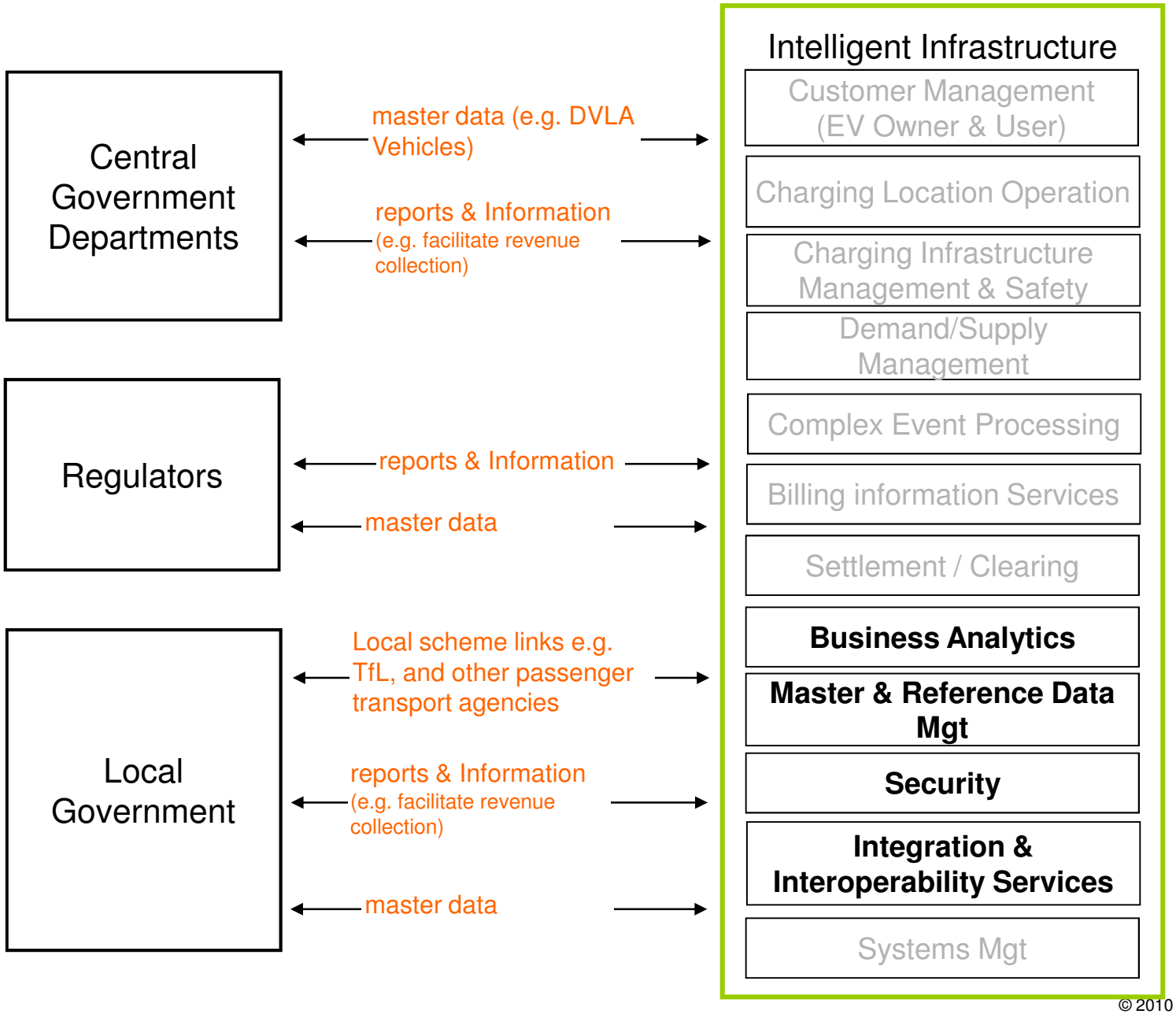
actor
- users and systems interacting with the intelligent infrastructure
- does not at this stage preclude or specify the deployment of system functionality

data flow
- indication of type of data & directionality
- not a detailed / physical interface level

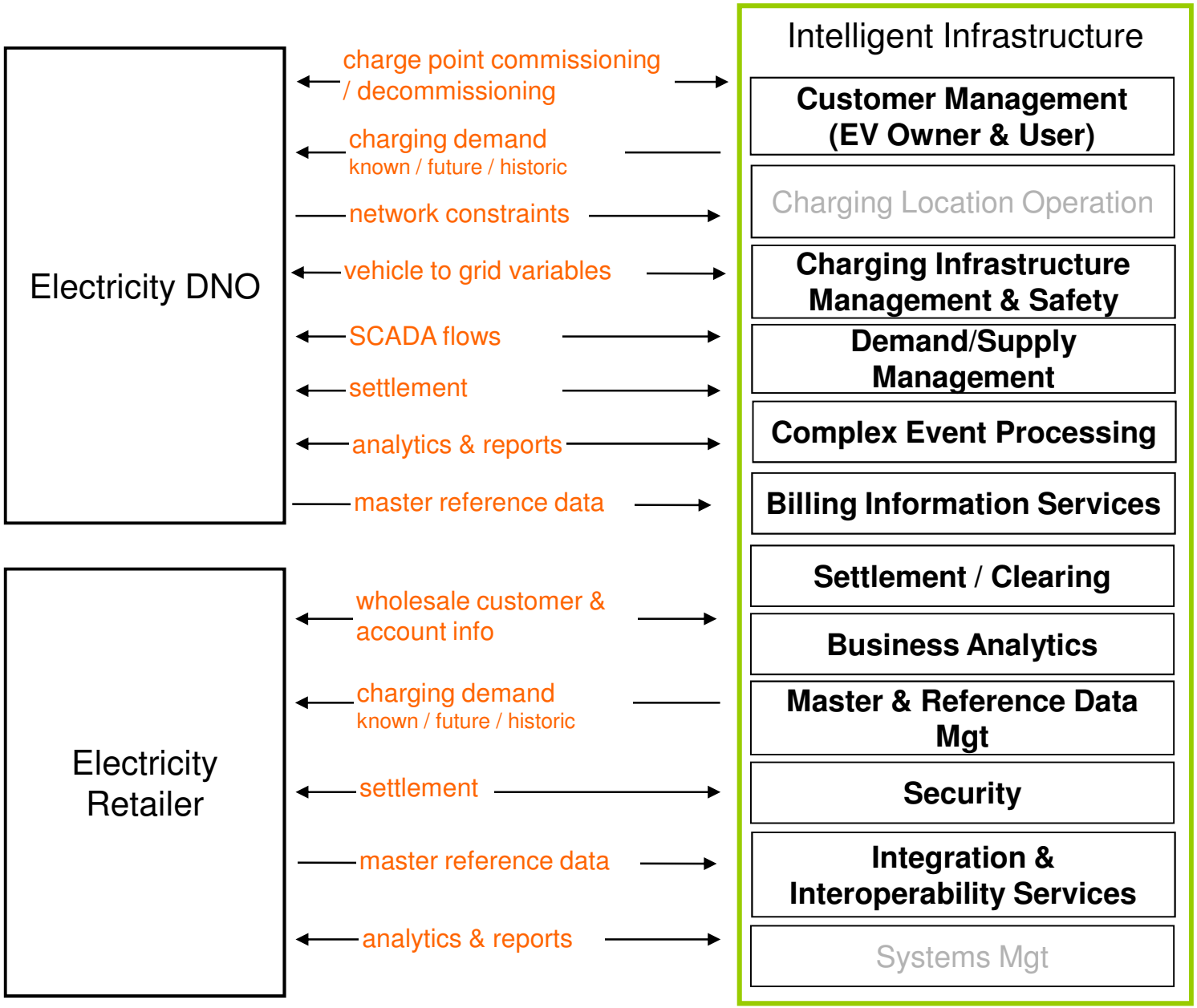
High level system functionality
- indication of functionality in the II
- indication of applicability to the actor and data flow - greyed out = not applicable



Context Diagram Inputs and Outputs – Government and Regulation

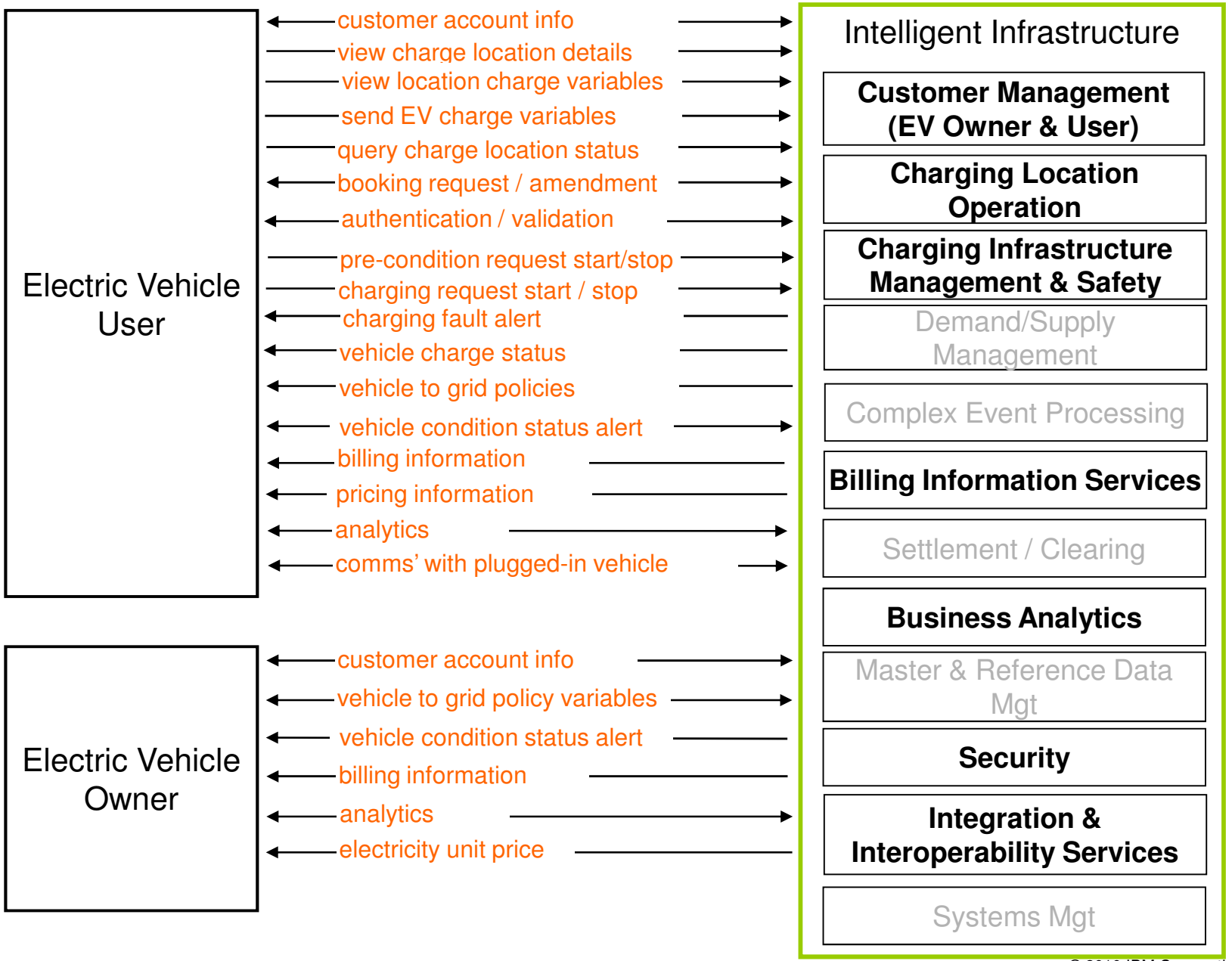


Context Diagram Inputs and Outputs – Electricity Supply Chain



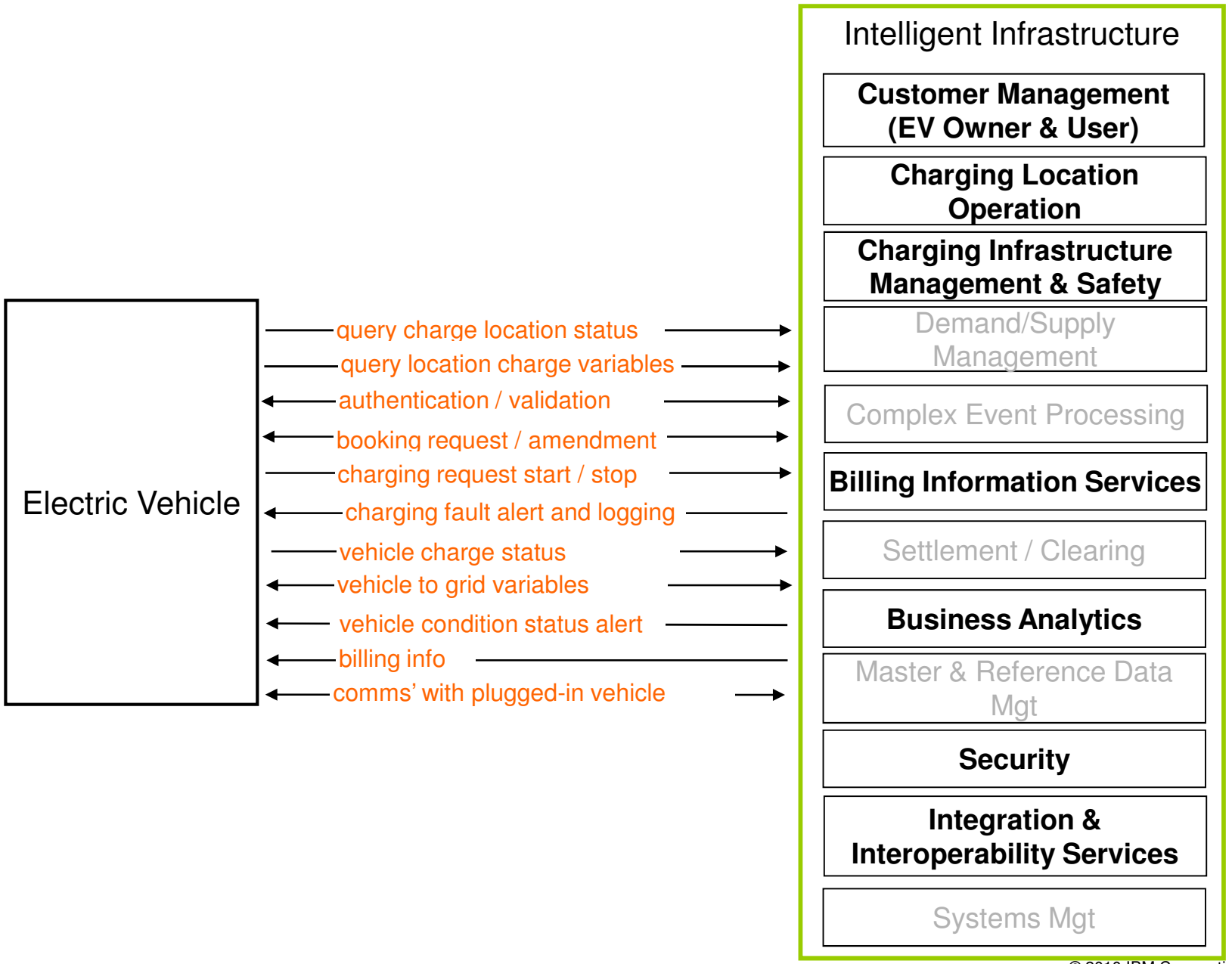
Context Diagram Inputs and Outputs - EV Owners and Users

see notes



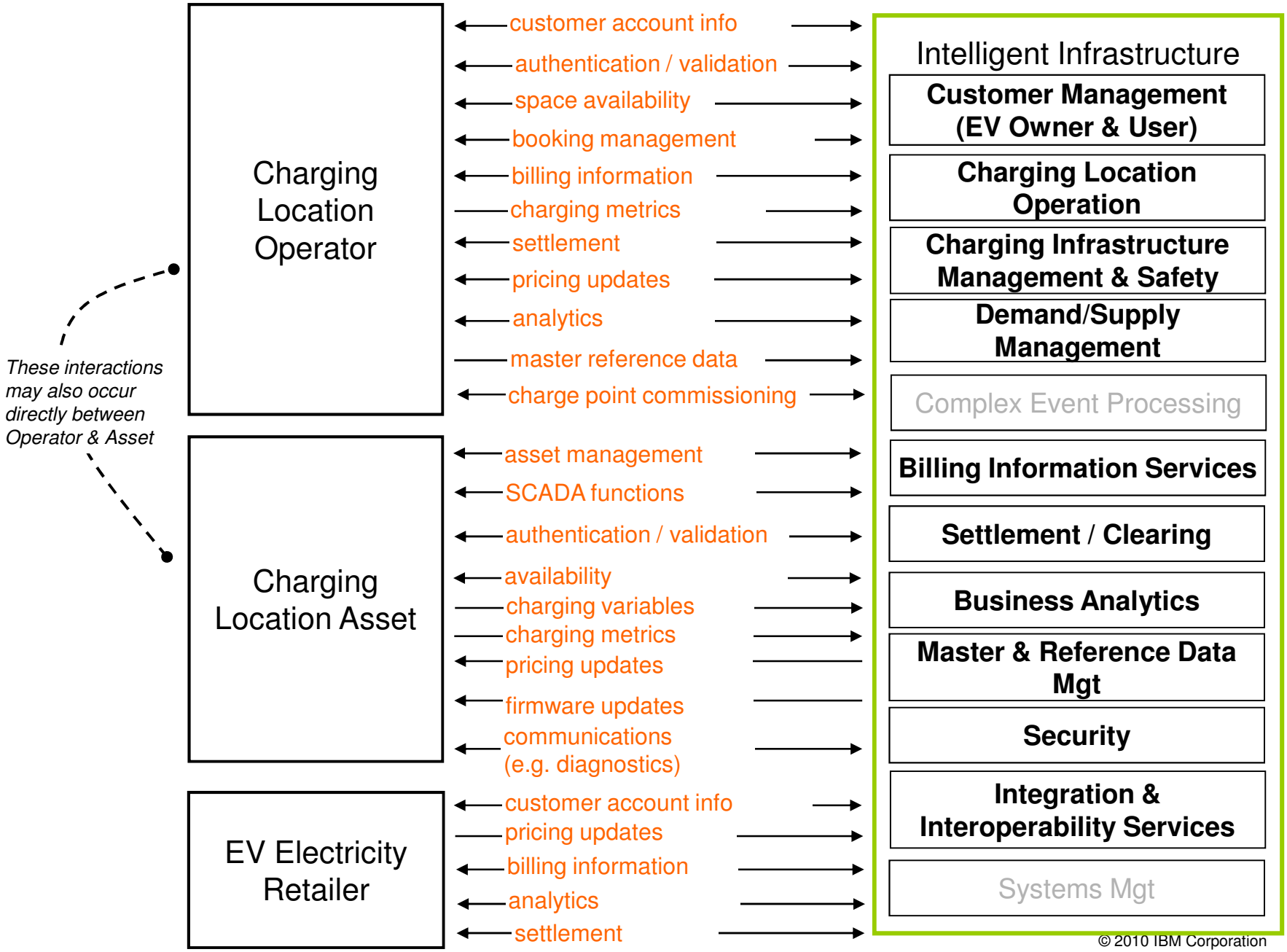
Context Diagram Inputs and Outputs - EV

see notes



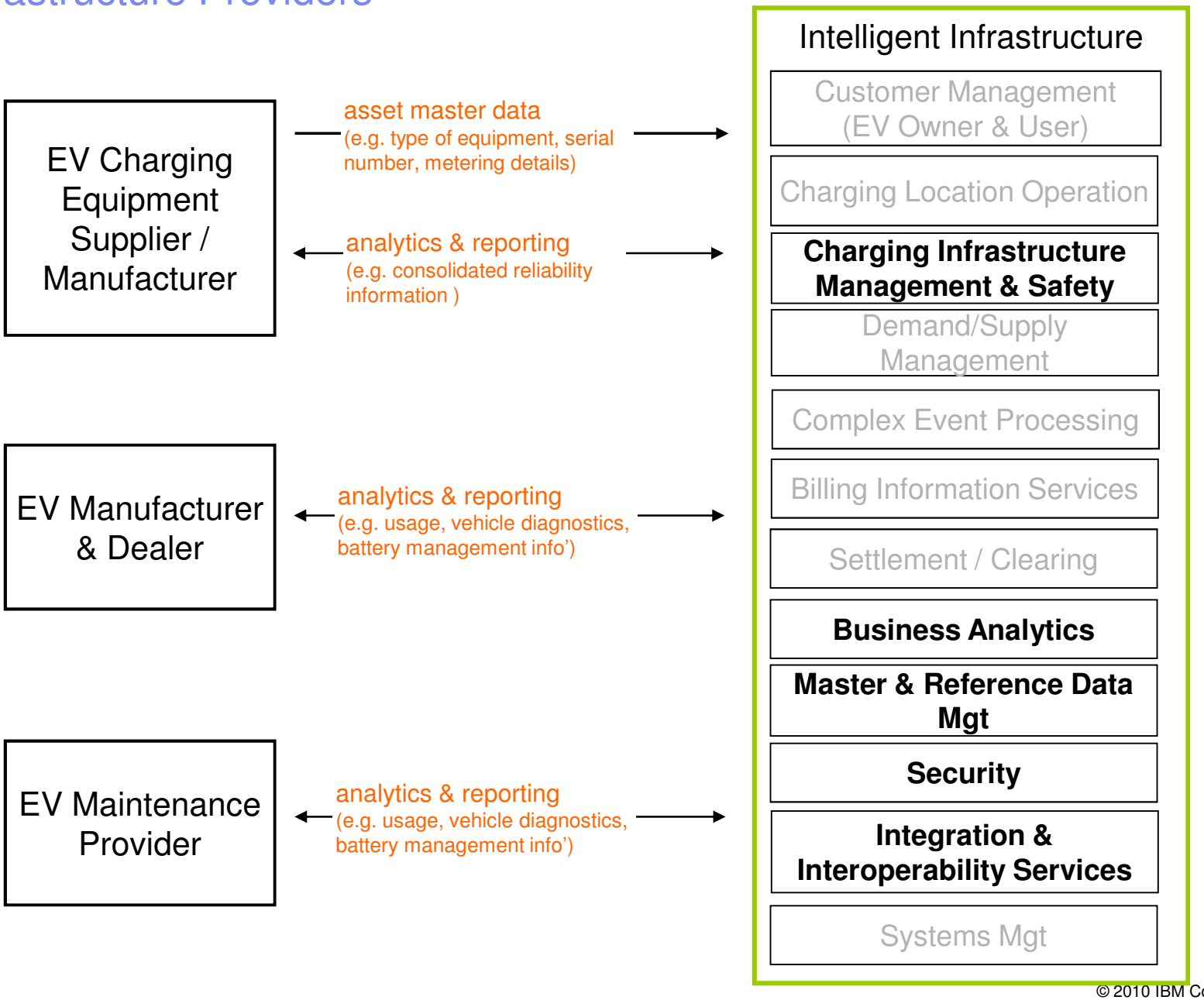
Context Diagram Inputs and Outputs – Charging Service

see notes



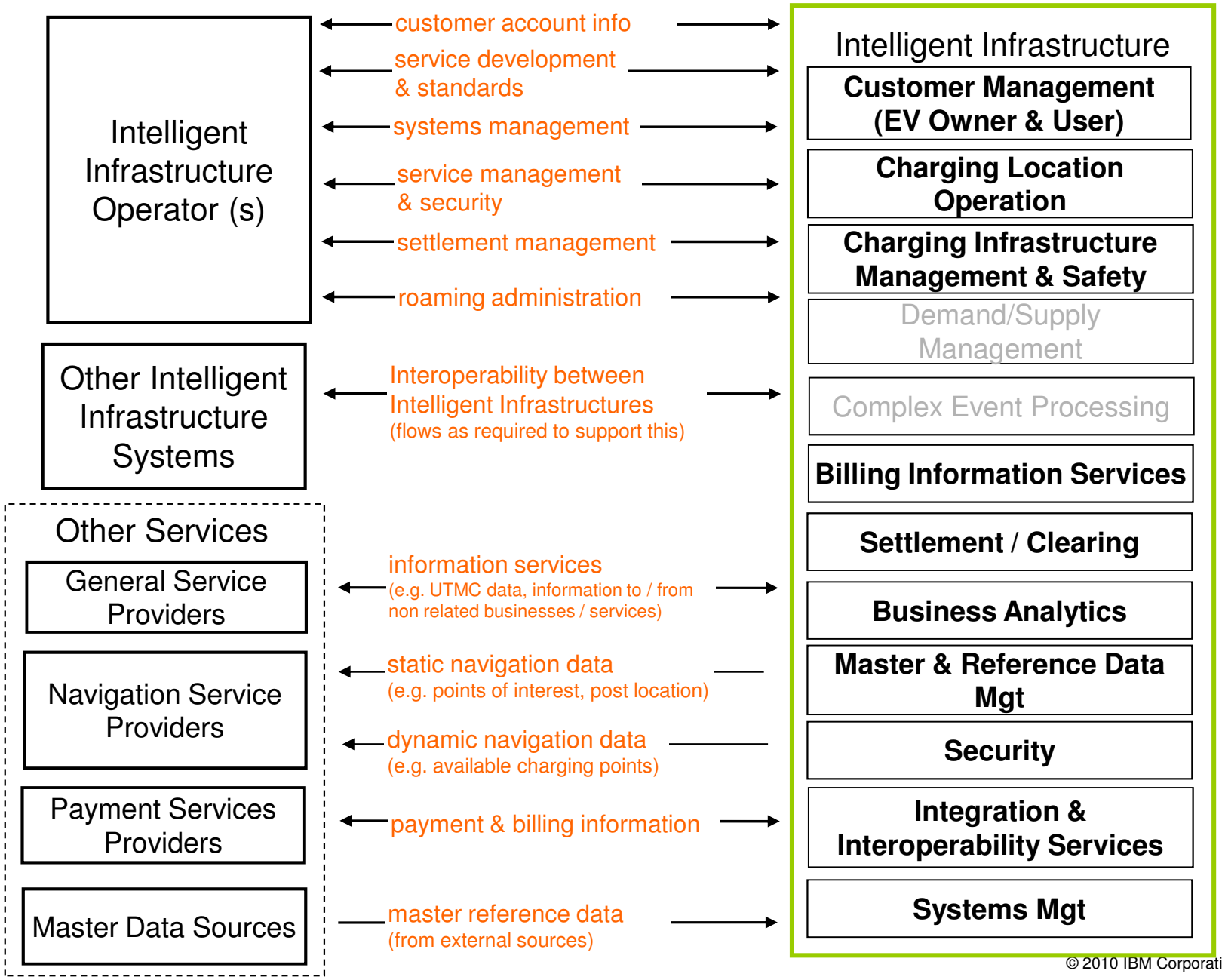
Context Diagram Inputs and Outputs – EV Manufacturers & EV Infrastructure Providers

see notes



Context Diagram Inputs and Outputs – Other Service Providers

see notes



ETI EV Work Package 2.4
Intelligent Infrastructure Requirements Report

Key Events and Data Entity Definitions

EV Intelligent Infrastructure – Key Events

Externally Generated Events (to which the Intelligent Infrastructure must respond)

- Charging location / asset status change
- Charging location / asset out of action (planned / unplanned)
- Charging point fault
- Charging point commissioned
- Charging point decommissioned
- Existing charging location / asset altered
- Electricity network power outages (reduced capacity and increased constraints)
- Load balancing action
- Meter reading provided / Meter reading requested
- Request to book charging space, amend booking, cancel booking, booking not honoured – cancel booking
- Price changes, tariff changes
- Request for EV preconditioning (heating, cooling) whilst charging
- Request for charging (also battery swap)
- Request for a new account
- Request to make payment
- Request for information / reports
- Detection of EV fault
- Requests from external II systems / actors
- Interest in discharge via vehicle to grid

Internally Generated Events (which the Intelligent Infrastructure generates that affect external entities)

- Notify EV user of proactive cancelled / amended booking
- Notify EV/EV User of charging location fault when recharging
- Notify EV/EV User of allowable consumption – how long/how much is the ev going to be allowed to charge given flexible charging methods
- Confirm to EV user a booking, amendment or cancellation they requested
- Provide a meter reading / Request a meter reading
- Broadcast pricing
- Generate errors / warnings
- Report generation – scheduled and ad-hoc
- Request payment / request payment authorisation
- Create demand forecast

EV Intelligent Infrastructure – Top Level Master Data Entities

see notes

Master Data is information that is non-transactional and is key to the operation of an organization or business. Master data supports transactional processes and operations.

- Context Diagram Actor Identification Data (e.g. Postcode, Email address), for:-
  - Government and Regulators
  - Electricity Retailers and Customer
  - EV Owner
  - EV User
  - Location Operator
  - DNO
  - Other Service Providers
- User Account (e.g. account number, vehicles registered, payment arrangement, etc)
- Location
- Vehicle Data (e.g. make, model, battery capacity, efficiency, etc)
- Charging Asset Information (location, type, etc)
- Security Credentials
- Roaming Identifiers (e.g. codes, services, etc)

The full Conceptual Data Architecture itself will be addressed in the Conceptual Data Architecture Report - SP2/IBM/18(D).

EV Intelligent Infrastructure – Top Level Transaction Data Entities

see notes

Transaction Data is data that results from the processing a particular transaction

- Charging Variables – data controlling the charging activity – e.g. rate of electricity transfer, time of start of charging, charging calendar (forward plan to charge at a particular location, with x% charge needed by this time…), pre-condition the EV (heating, cooling) prior to completion of charging, maximum CO_2 content of the charge
- Charging Metrics - data recording the actual transmission of electricity between charging location and EV, e.g. time & length of charge, amount of electricity received (meter reading), CO_2 content of the charge
- Location Status / Charging Asset Status
- SCADA data
- Availability data
- Booking data
- Billing Information
- Settlement data
- Reports & Queries
- Correspondence
  - email, letter, SMS, phone recording, etc
- Service Mgt data
- System Mgt data
- Maintenance schedule
- Roaming requests
- Network Constraint
- Travel data (data derived from the movement of an EV from one location to another)

The full Conceptual Data Architecture itself will be addressed in the Conceptual Data Architecture Report - SP2/IBM/18(D).

ETI EV Work Package 2.4
Intelligent Infrastructure Requirements Report

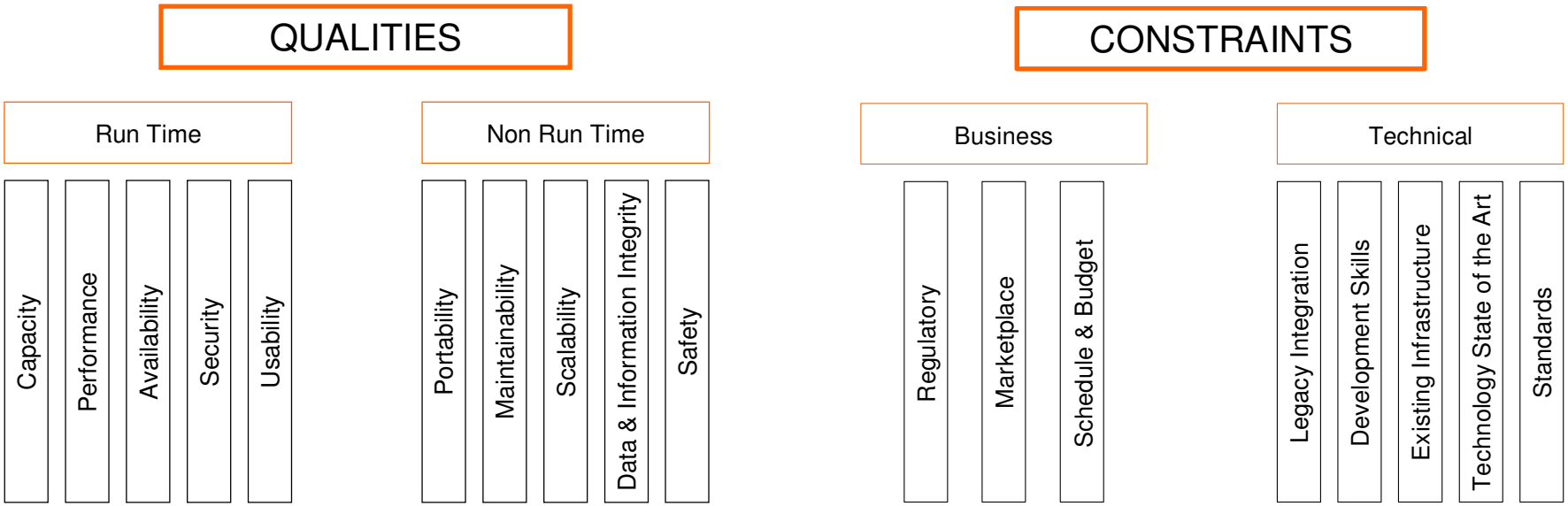
Non Functional Requirements

EV Intelligent Infrastructure – Non Functional Requirements

Non-functional requirements (NFRs) specify 'how' the system should operate, rather than 'what' the system should do. Non Functional Requirements define the qualities and constraints to which a system must be built:

>> Qualities define the expectations and characteristics the system should support;

>> Constraints are limitations or specifications imposed upon a solution.



As specified for the Requirements Report, a document has been produced which provides a **high level framework and commentary** on the areas shown above. Non Functional Requirements (NFRs) of the Intelligent Infrastructure will need to be developed in more detail once the requirements have reached a higher level of maturity. NFRs are very dependent on the work being undertaken in other work packages and sub-projects.

EV Intelligent Infrastructure – Requirements and Factors to be addressed when developing the Non Functional Requirements

- The II should be built using ‘open’ standards and well defined interfaces so that new users and operators can join the infrastructure and new technologies can be incorporated.
- The design, build, deployment and operation of the II should not constrain the take-up of EVs.
- The II should enable business and operating model innovation as the EV market develops.
- The II should be expandable in terms of volumes and functionality.
- The II must meet the current legislation requirements, e.g. data protection, freedom of information etc.
- Standards and interoperability are key requirements of the Electric Vehicle Market in general and of the Intelligent Infrastructure in particular.
- A common classification system for Intelligent Infrastructure data exchanges will be adopted. This includes categorising services that a user has access to such that they can receive similar service access when roaming.
- The II should support a mechanism for enabling future trials in terms of being able to provide diagnostic and analytical information on usage, trends, etc.

ETI EV Work Package 2.4
Intelligent Infrastructure Requirements Report

High Level Initial Use Case Model

Overview

- The initial Use Case Model describes the high level functional requirements of the “intelligent Infrastructure”. The model uses graphical symbols and text to specify how users in specific roles will use the system (i.e. use cases)

- It provides a list of the main actors and a high level initial set of use case packages for the system

- Each use case package has a simple specification and a diagram showing which actors undertake which activities

Main Actors (derived from system context)

- Electric Vehicle, Owners & Users
  - Vehicle User
  - Vehicle Owner (e.g. individual, fleet)
  - Electric Vehicle
- EV Charging Service Providers
  - Charging Location Operator
  - Charging Field Asset (e.g. charging post)
  - EV Electricity Retailer
- Electricity Supply Chain
  - Electricity DNO
  - Electricity Retailer
- EV Manufacturers & EV Infrastructure Providers
  - Vehicle Manufacturer
  - Vehicle Servicer / Dealer
  - Breakdown Services
  - Charging Equipment Manufacturers
- Government / Regulatory Body
- Intelligent Infrastructure Operators
- Other Intelligent Infrastructures
- Other Service Providers
  - Emergency Services

Main Actor Groups related to System Context functions

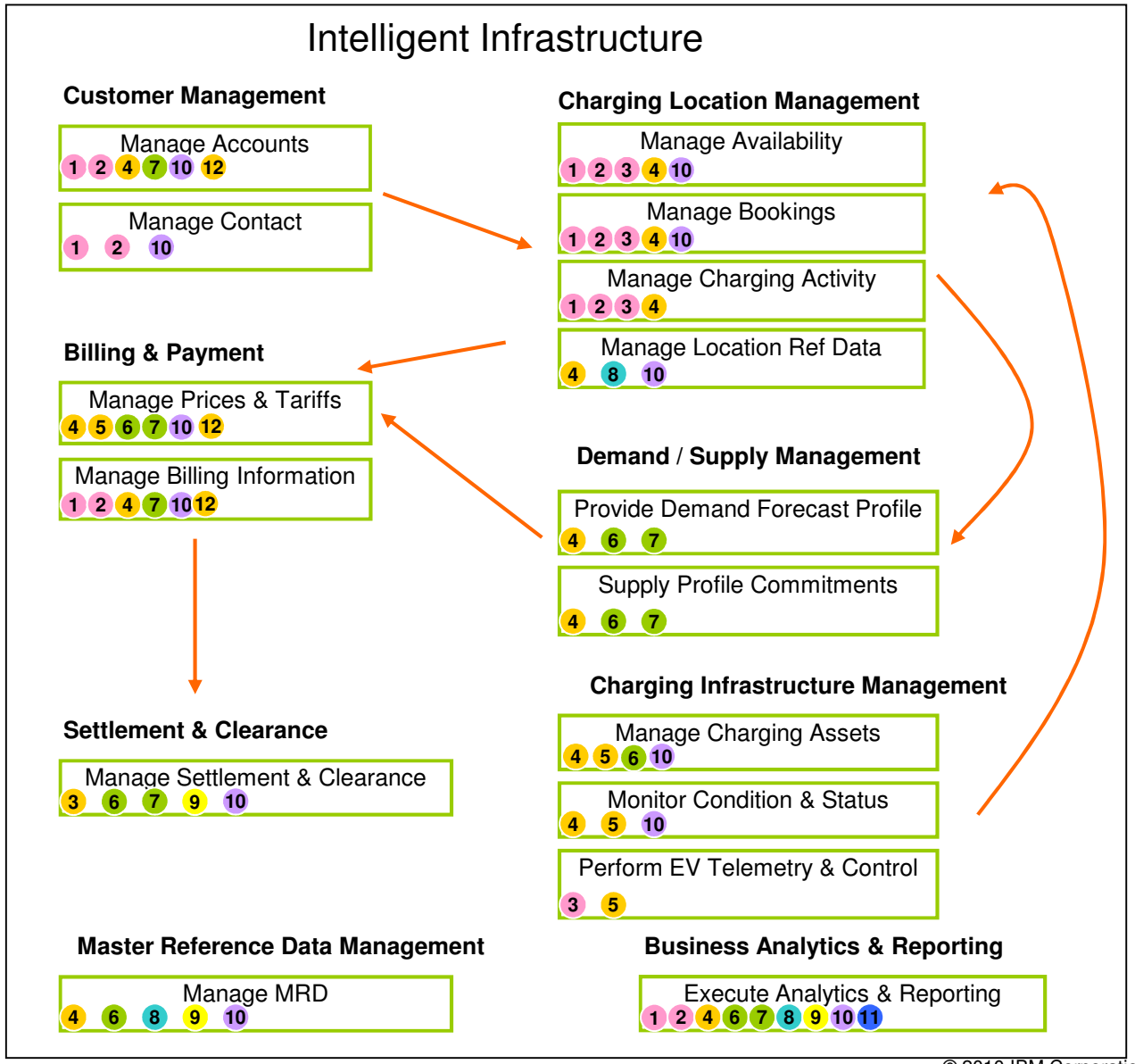
	Customer (EV Owner & User) Mgt	Charging Location Operation	Charging Infrastructure Mgt	Demand/Supply Management	Complex Event Processing	Billing & Payment Management	Settlement & Clearing	Business Analytics	Master Reference Data Management	Security	Integration & Interoperability Services	Systems Mgt
Electric Vehicle & Owners / Users	■	■	■			■		■		■	■	
EV Charging Service Provider	■	■	■	■		■	■	■	■	■	■	
Electricity Supply Chain	■		■	■	■	■	■	■	■	■	■	
EV Manufacturers & EV Infrastructure Providers			■					■	■	■	■	
Government & Regulation							■	■	■	■	■	
Other Service Providers		■	■			■		■		■	■	
Intelligent Infrastructure Operators (split out from above)	■	■	■	■	■	■	■	■	■	■	■	■

Initial High Level Use Cases Models (Functional)

- Customer Management – Account Management
- Customer Management – Contact Management
- Charging Location Management – Availability Management
- Charging Location Management – Bookings Management
- Charging Location Management – Charging Activity Management (Domestic Charging)
- Charging Location Management – Charging Activity Management (Non-Domestic Charging)
- Charging Location Management – Charging Activity Management V2G(rid)
- Charging Location Management – Charging Activity Management V2H(ome)
- Charging Location Management – Location Details Reference Data Mgt
- Pricing & Billing Management – Pricing & Tariff Management
- Pricing & Billing Management – Billing Information Management
- Settlement & Clearance Services
- Demand / Supply Management – Demand Profile Forecasts
- Demand / Supply Management – Supply Profile Commitments
- Charging Infrastructure Management & Safety – Charging Assets Management
- Charging Infrastructure Management & Safety – Condition & Status Monitoring
- Charging Infrastructure Management & Safety – Telemetry & Control
- Information Provision
- Master Reference Data Management
- Business Analytics & Reporting
- Manage Payments

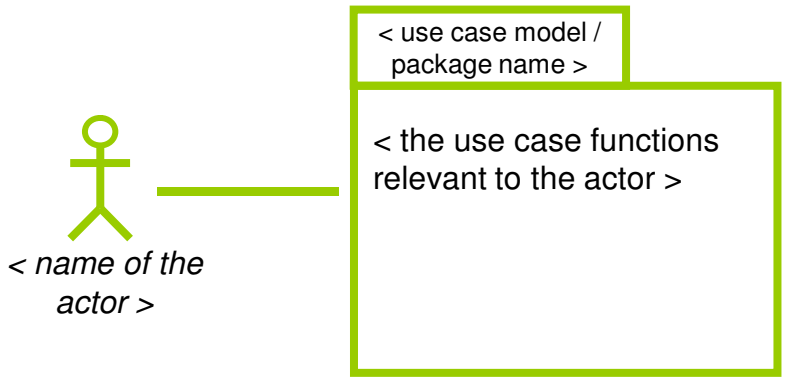
Initial High Level Use Cases – graphical view

1. Vehicle Users
2. Vehicle Owners
3. Vehicle
4. Charging Location Service Providers
5. Charging Asset
6. Electricity DNO
7. Electricity Retailer
8. EV & EV Infrastructure Providers
9. Government / Regulatory
10. Intelligent Infrastructure Operators
11. Other Business Services
12. EV Electricity Retailer



Use Case Model Specification & Diagram Format

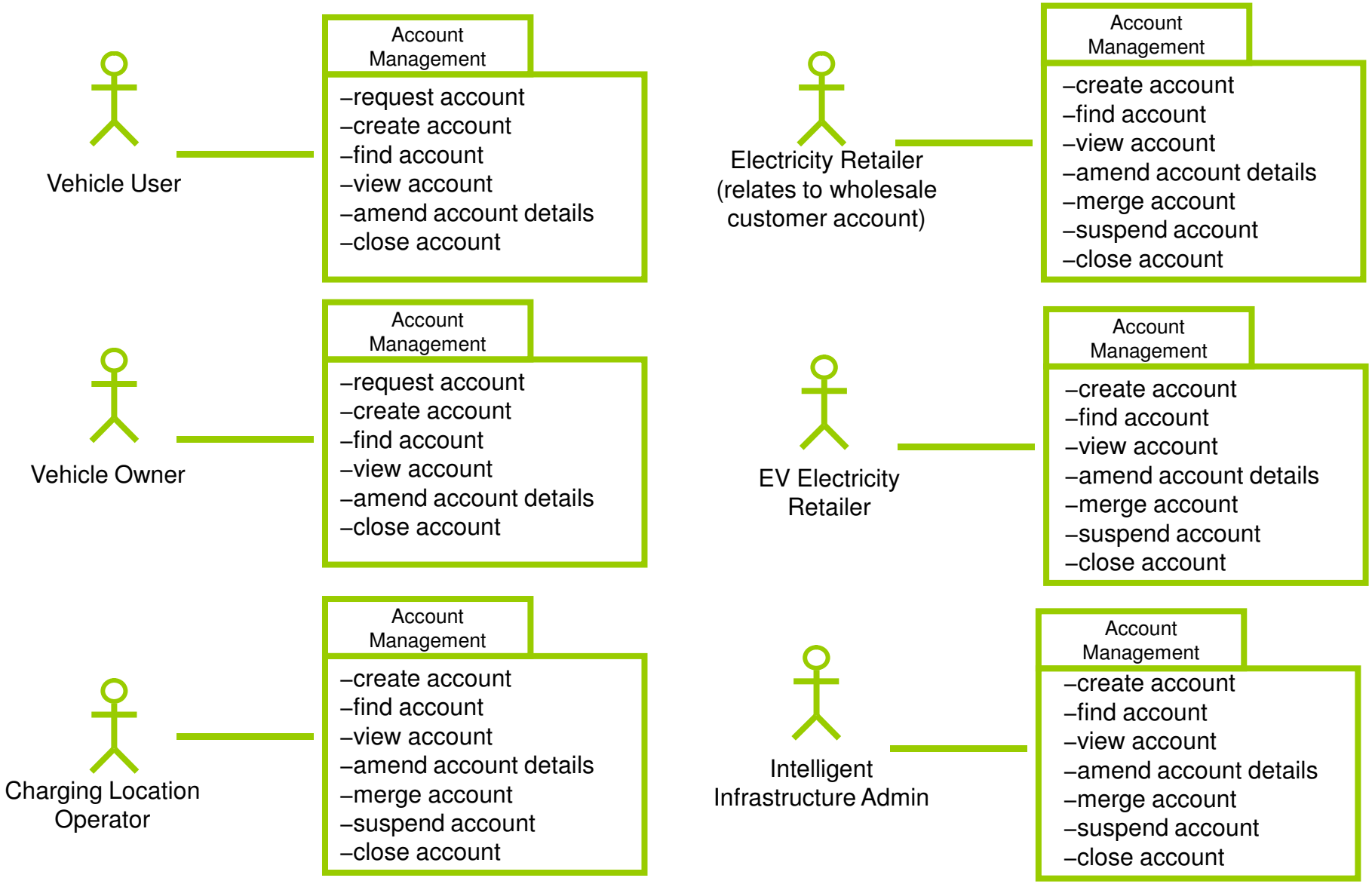
ID Number	*< to identify the use case model >*
Name	*< the functional area – use case model name >*
Description	*< a brief outline of the intent of the use case model >*
Use Case Functions	*< what the use case model includes – effectively these would be viewed in most cases as the lower level use cases in the package >*
Actors	*< the main participants >*
Pre conditions	*< what has already occurred or be in place beforehand >*
Post conditions	*< documents what would be true once complete >*
Notes	*< observations or feature of relevance or interest >*



Customer Management – Account Management
Use Case Model Specification

ID Number	
Name	Customer Management – Account Management
Description	Allows the relevant actors to create and manage customer accounts
Use Case Functions	request account; create account; find account; view account; amend account details; merge account; suspend account; close account
Actors	Vehicle User; Vehicle Owner (e.g. individual, fleet); Charging Location Operator; Electricity Retailer; EV Electricity Retailer; Intelligent Infrastructure Operator
Pre conditions	New user; Change in user details; Change in user status
Post conditions	Account created; Account amended; Account status amended; Account closed
Notes	The account details may be managed by various actors depending on the ownership of the relationship. The customer may have multiple relationships, for example: ▪ at an intelligent infrastructure level (if that is the approach adopted) ▪ with charging scheme & location operators; ▪ with energy retailers; ▪ with a vehicle owner (e.g. leasing or hire car fleet)

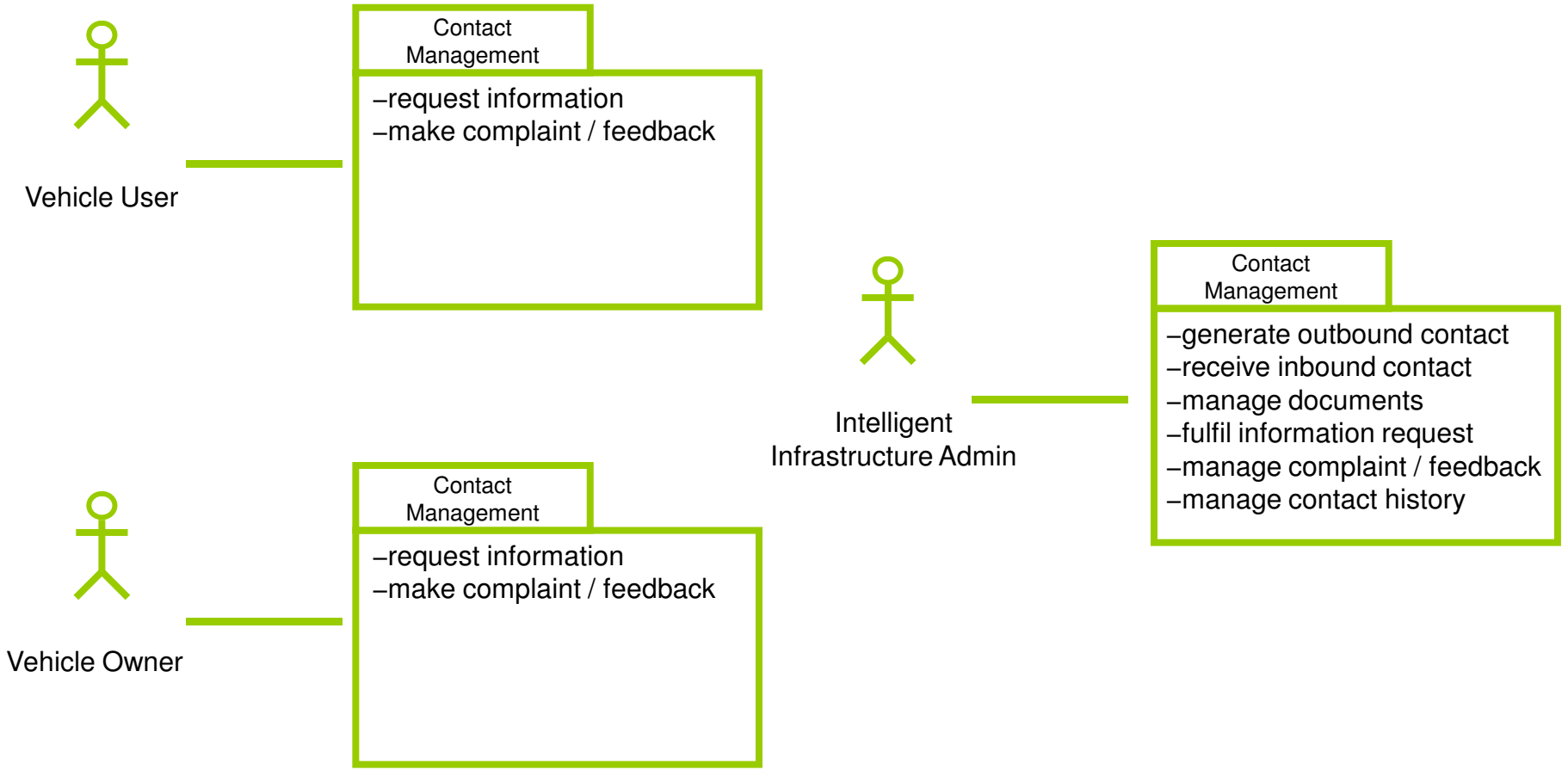
Customer Management – Account Management Use Case Model Diagram



Customer Management – Contact Management
Use Case Model Specification

ID Number	
Name	Customer Management – Contact Management
Description	Allows the relevant actors to generate, send, receive and process customer contact across all channels.
Use Case Functions	generate outbound contact; receive inbound contact; manage documents; request information; fulfil information request; make complaint / provide feedback; manage complaint / feedback; manage contact history
Actors	Vehicle User; Vehicle Owner (e.g. individual, fleet); Intelligent Infrastructure Operator
Pre conditions	Customer contact occurs; Customer account exists (for all but information request and provide feedback)
Post conditions	Customer request serviced; Customer history updated (where customer has an account)
Notes	Includes handling errors, issues, complaints, feedback, disputes, etc In practice, there will be significant system generated customer contact in response to events and conditions which do not involve a human actor. For example, auto acknowledgment of a customer complaint. Actors such as electricity companies, charge location operators, EV manufacturers are assumed to manage relationships with their customers in their own CRM systems.

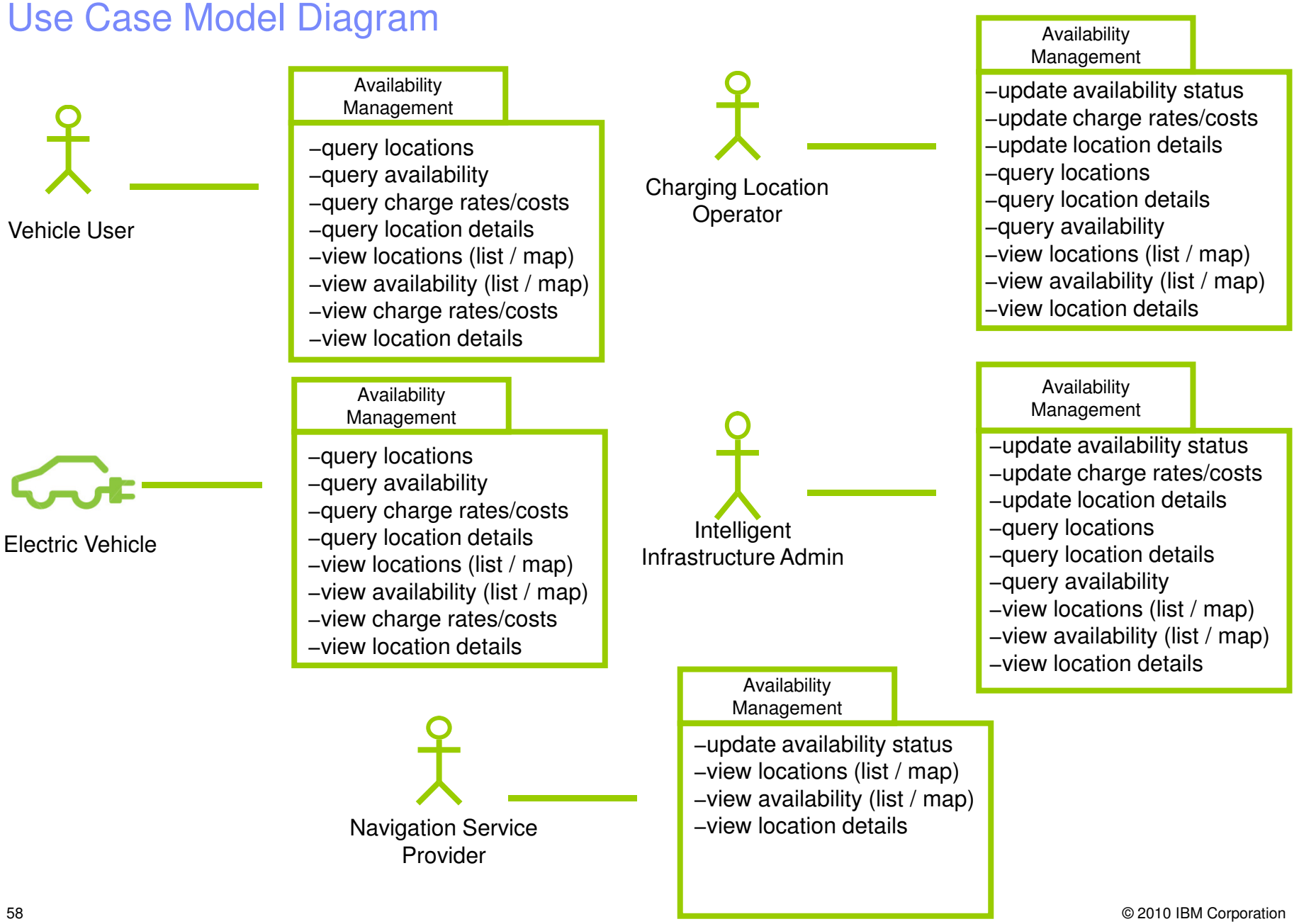
Customer Management – Contact Management
Use Case Model Diagram



Charging Location Management – Availability Management
Use Case Model Specification

ID Number	
Name	Charging Location Management – Availability Management
Description	Allows the relevant actors to find information about the charging locations they wish to use and check specific availability, charge rates/cost and status of charge point locations and details and nature of services provided at locations (e.g. indoor/outdoor, security/assistance provided)
Use Case Functions	query locations; query availability; query charge rates/costs; view locations; view availability; view charge rates/costs; view location details; update availability status; update charge rates/costs
Actors	Vehicle User; Electric Vehicle; Charging Location Operator; Intelligent Infrastructure Operator
Pre conditions	Location search is specified; Location exists; Location status has changed
Post conditions	Location status updated; Location displayed / listed; Availability removed; Availability released
Notes	Status updated automatically in response to a booking, a network constraint, etc as well as by the charging location operator

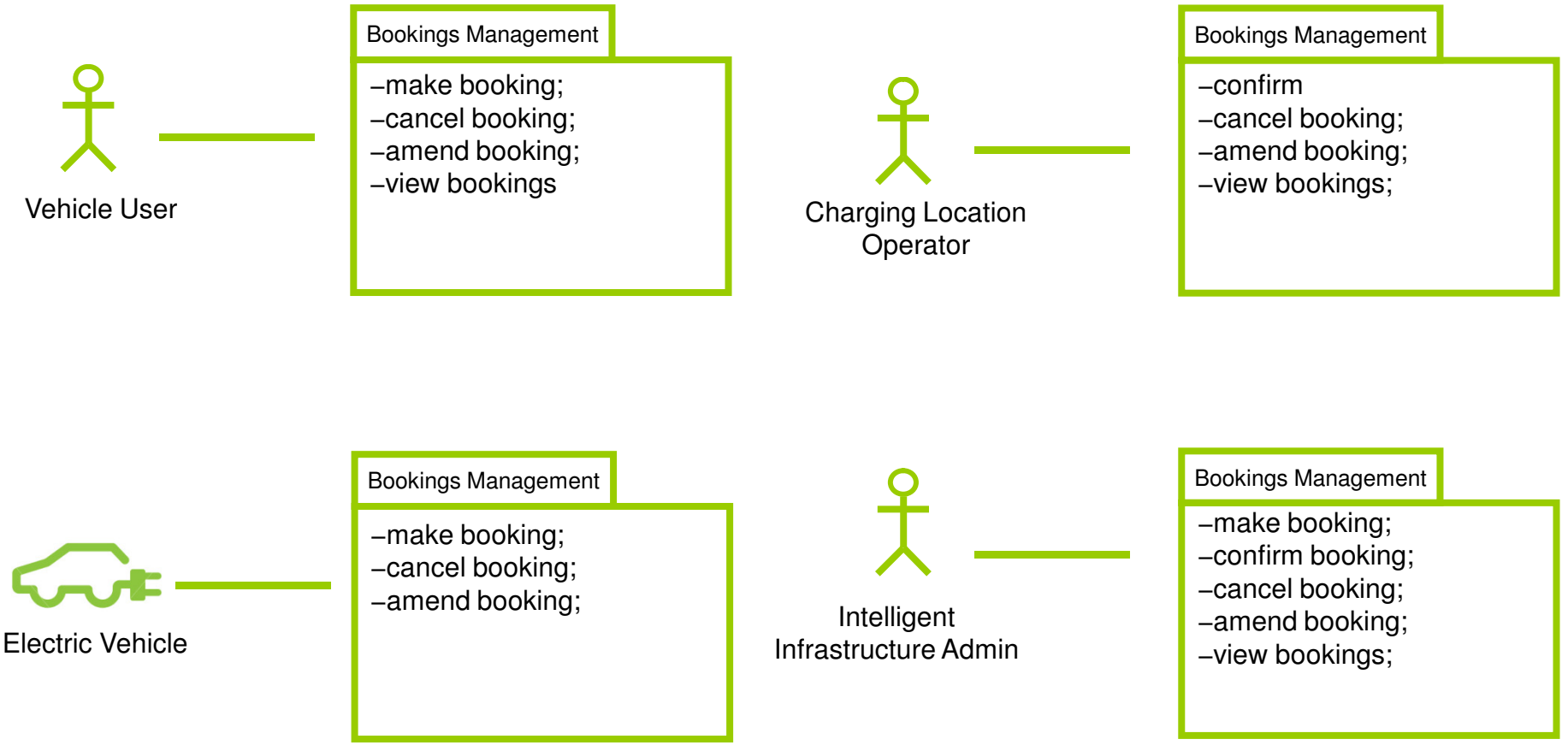
Charging Location Management – Availability Management Use Case Model Diagram



Charging Location Management – Bookings Management
Use Case Model Specification

ID Number	
Name	Charging Location Management – Bookings Management
Description	Allows relevant actors to make a charging location booking, change / cancel an existing booking or view bookings
Use Case Functions	request booking; cancel booking; amend booking; confirm booking details; view bookings
Actors	Vehicle User; Charging Location Operator; Intelligent Infrastructure Operator
Pre conditions	Charging location has suitable availability; Customer account is valid; Booking exists
Post conditions	Booking is made; Booking is updated; Booking is cancelled
Notes	Bookings could be made by a customer via any valid channel. Bookings could be cancelled in the event of a network constraint or a change in the charging location status.

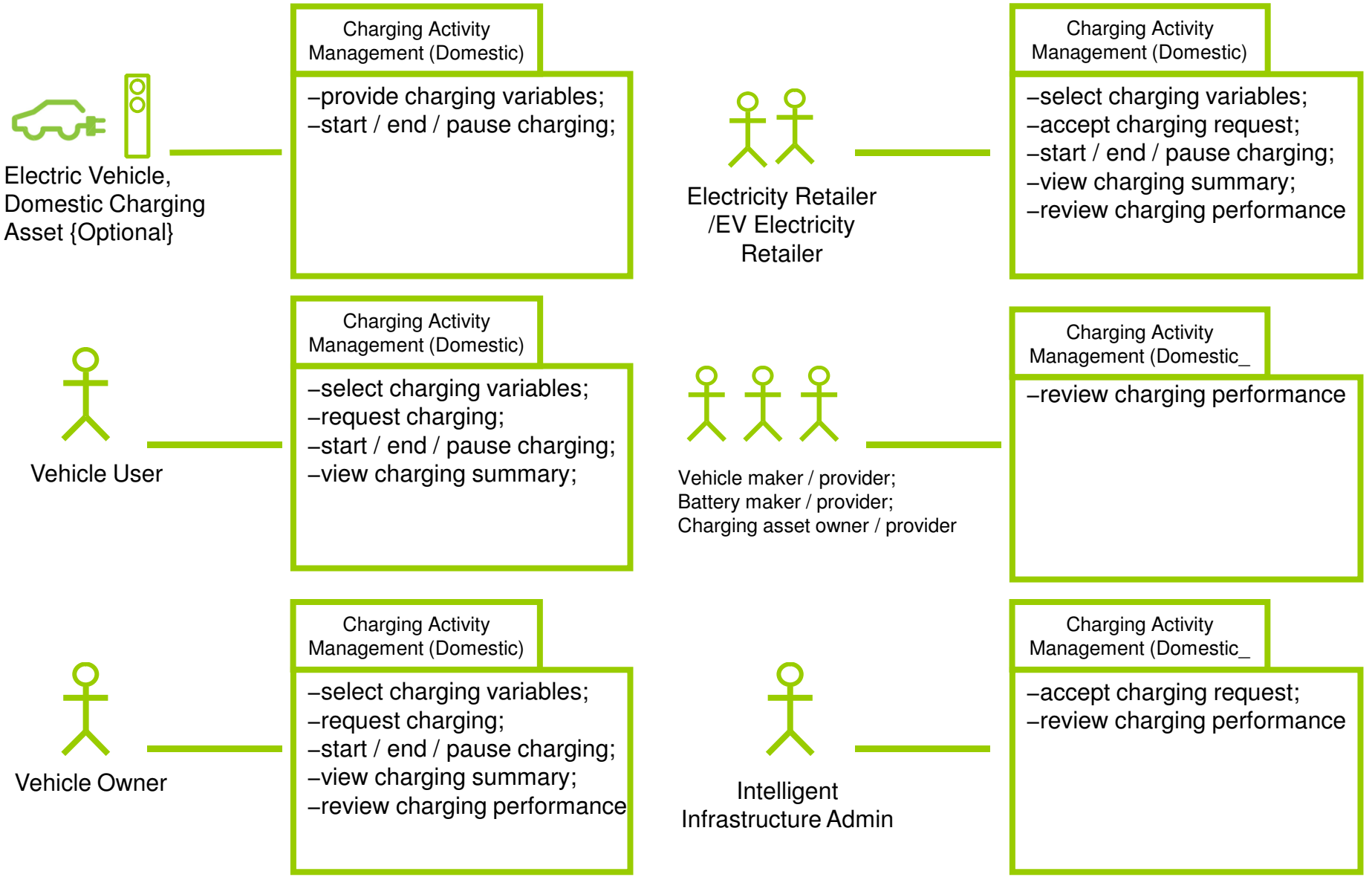
Charging Location Management – Bookings Management Use Case Model Diagram



Charging Location Management – Charging Activity Management (Domestic Charging) - Use Case Model Specification

ID Number	
Name	Charging Location Management (Domestic Charging) – Charging Activity Management
Description	Allows relevant actors to participate in and review charging activities at a domestic charging location.
Use Case Functions	provide charging variables; select charging variables; request charging; accept charging request; start charging; end charging; pause charging; view charging summary; review charging performance;
Actors	Domestic Charging Asset – (optional); Vehicle User; Vehicle Owner; Electric Vehicle; Intelligent Infrastructure Operator; Charging Equipment Provider (optional); Electricity Retailer; EV Electricity Retailer
Pre conditions	Electric vehicle is at a domestic charging location; Customer has domestic electricity supply contract – optional additional contract to cover EV charging; Charging is possible
Post conditions	Charging has taken place; Billing information generated;
Notes	Preconditioning of the EV (heating, cooling) whilst being charged may extend range significantly – preconditioning may be signalled either via mobile to the EV directly or via the Intelligent Infrastructure - set as a charging variable or initiated separately. Charging asset performance information made available to manufacturers / providers

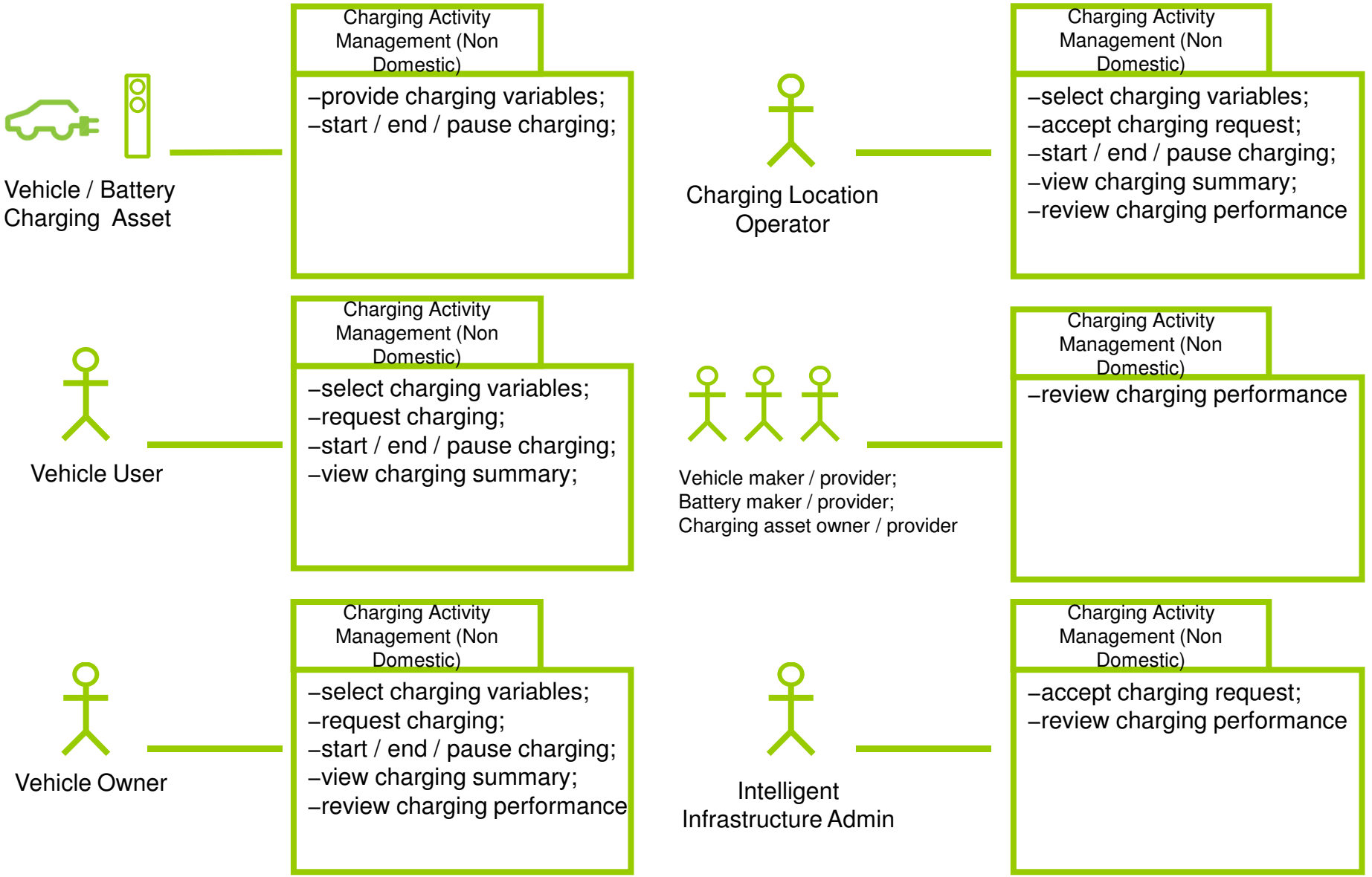
Charging Location Management – Charging Activity Management (Domestic Charging) Use Case Model Diagram



Charging Location Management – Charging Activity Management (Non Domestic Charging) Use Case Model Specification

ID Number	
Name	Charging Location Management – Charging Activity Management
Description	Allows relevant actors to participate in and review charging activities at a charging location.
Use Case Functions	provide charging variables; select charging variables; request charging; accept charging request; start charging; end charging; pause charging; view charging summary; review charging performance;
Actors	Charging Field Asset; Vehicle User; Vehicle Owner (e.g. individual, fleet); Electric Vehicle; Charging Location Operator; Intelligent Infrastructure Operator; Charging Equipment Provider
Pre conditions	Vehicle / Battery is at a valid charging location; Customer payment has been taken or method of payment validated; Charging is possible;
Post conditions	Charging has taken place; Billing information generated;
Notes	Preconditioning of the EV (heating, cooling) whilst being charged may extend range significantly – preconditioning may be signalled either via mobile to the EV directly or via the Intelligent Infrastructure - set as a charging variable or initiated separately. Charging asset performance information made available to manufacturers / providers

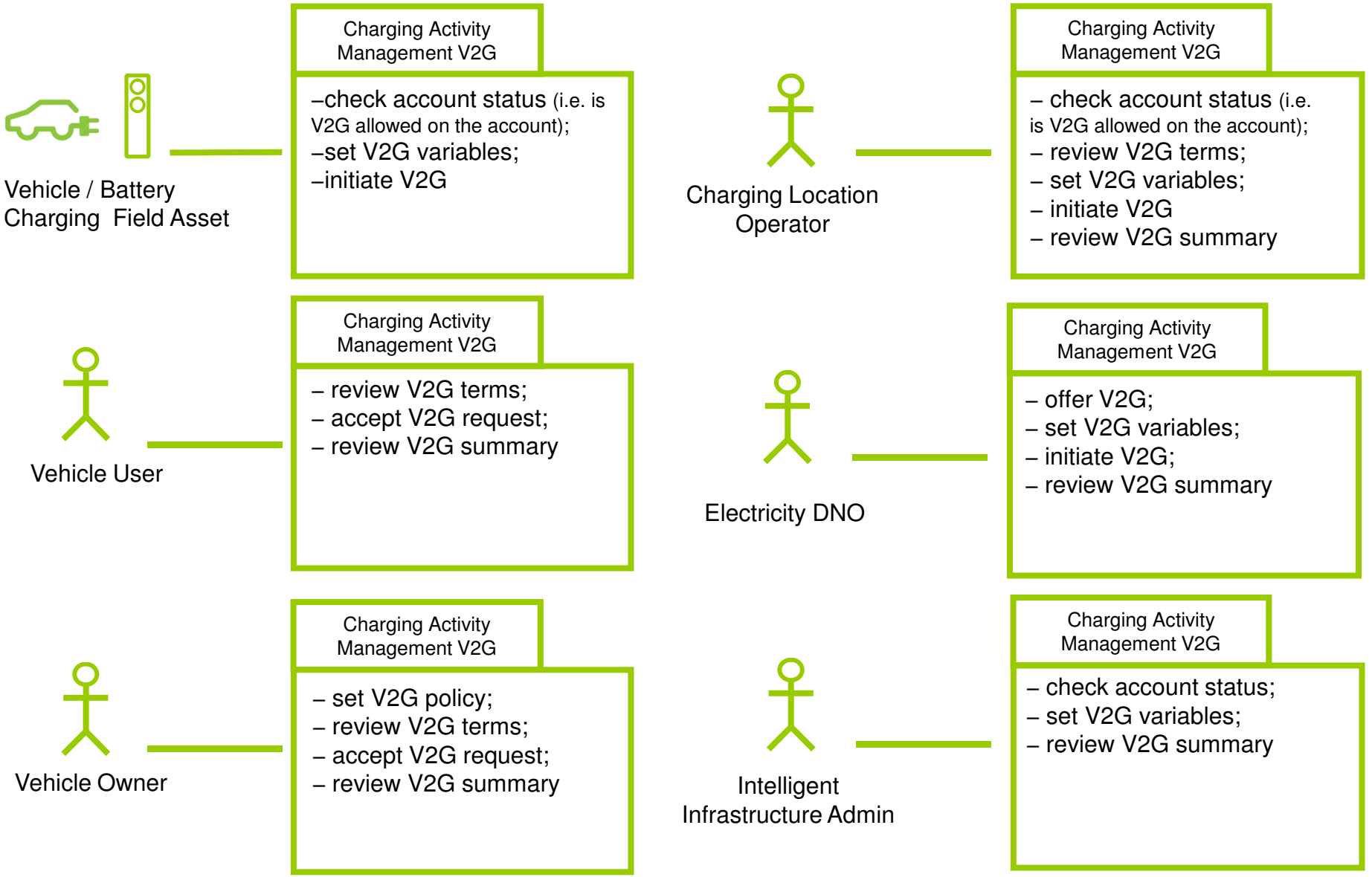
Charging Location Management – Charging Activity Management (Non Domestic Charging) Use Case Model Diagram



Charging Location Management – Charging Activity Management V2G Use Case Model Specification

ID Number	
Name	Charging Location Management – Charging Activity Management V2G
Description	Allows relevant actors to participate in and review charging activities at a charging location where there is a an opportunity for a vehicle to grid flow via a discharge of the battery
Use Case Functions	set V2G policy; offer V2G; review V2G terms; accept V2G; set V2G variables; initiate V2G; review V2G
Actors	Charging Field Asset; Vehicle User; Vehicle Owner (e.g. individual, fleet); Electric Vehicle; Charging Location Operator; DNO; Intelligent Infrastructure Operator;
Pre conditions	Vehicle / Battery is at a valid charging location; Customer / smart meter / vehicle allows V2G; There is a need for V2G flow.
Post conditions	V2G activity taken place; Possible charge of the vehicle / battery scheduled. Bill calculated.
Notes	This use case may only be possible in a controlled environment – such as a large fleet operator/owner.

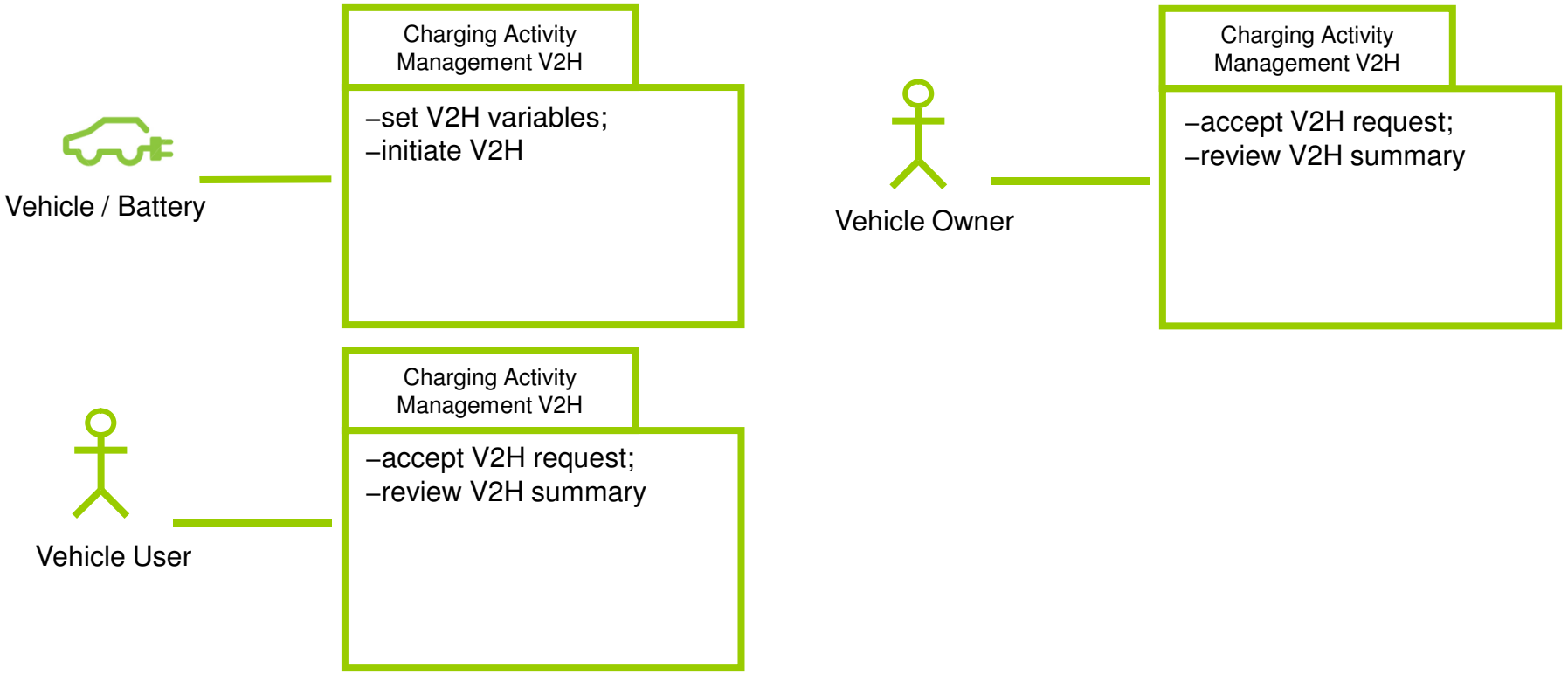
Charging Location Management – Charging Activity Management V2G Use Case Model Diagram



Charging Location Management – Charging Activity Management V2H Use Case Model Specification

ID Number	
Name	Charging Location Management – Charging Activity Management V2H
Description	Allows relevant actors to participate in and review charging activities at a charging location where there is a an opportunity for a vehicle to home flow via a discharge of the battery
Use Case Functions	initiate V2G
Actors	Vehicle User; Vehicle Owner; Electric Vehicle;
Pre conditions	Vehicle / Battery is at a valid domestic location; Customer / smart meter / vehicle allows V2H; There is a need for V2H flow.
Post conditions	V2H activity taken place
Notes	

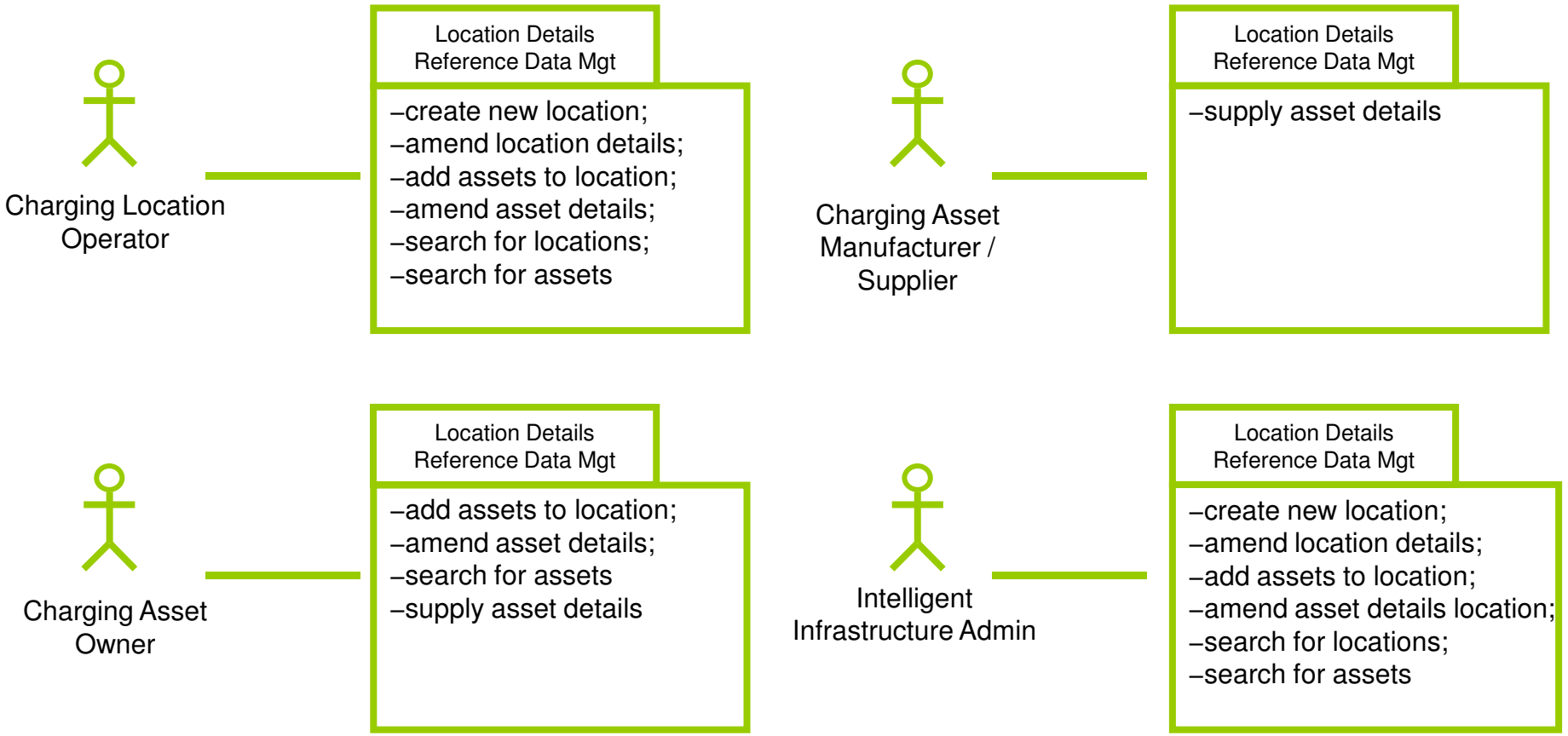
Charging Location Management – Charging Activity Management V2H Use Case Model Diagram



Charging Location Management – Location Details Reference Data Mgt Use Case Model Specification

ID Number	
Name	Charging Location Management – Location Details Reference Data Management
Description	To allow relevant actors to configure and manage reference data connected with the charging locations and the assets in use at those locations
Use Case Functions	create new location; amend location details; add assets to location; amend asset details at a location; search for locations; search for assets; supply asset details
Actors	Charging Location Operator; Charging Asset Owner; Charging Equipment Manufacturers; Intelligent Infrastructure Operator
Pre conditions	New charging location; New assets released; New assets at charging location; Change to charging location
Post conditions	Charging location details created / updated; Charging asset details created / updated
Notes	Would expect there to be screens for individual updates, bulk data uploads and possibly industry flows involved here. Could also be some links to metering flows.

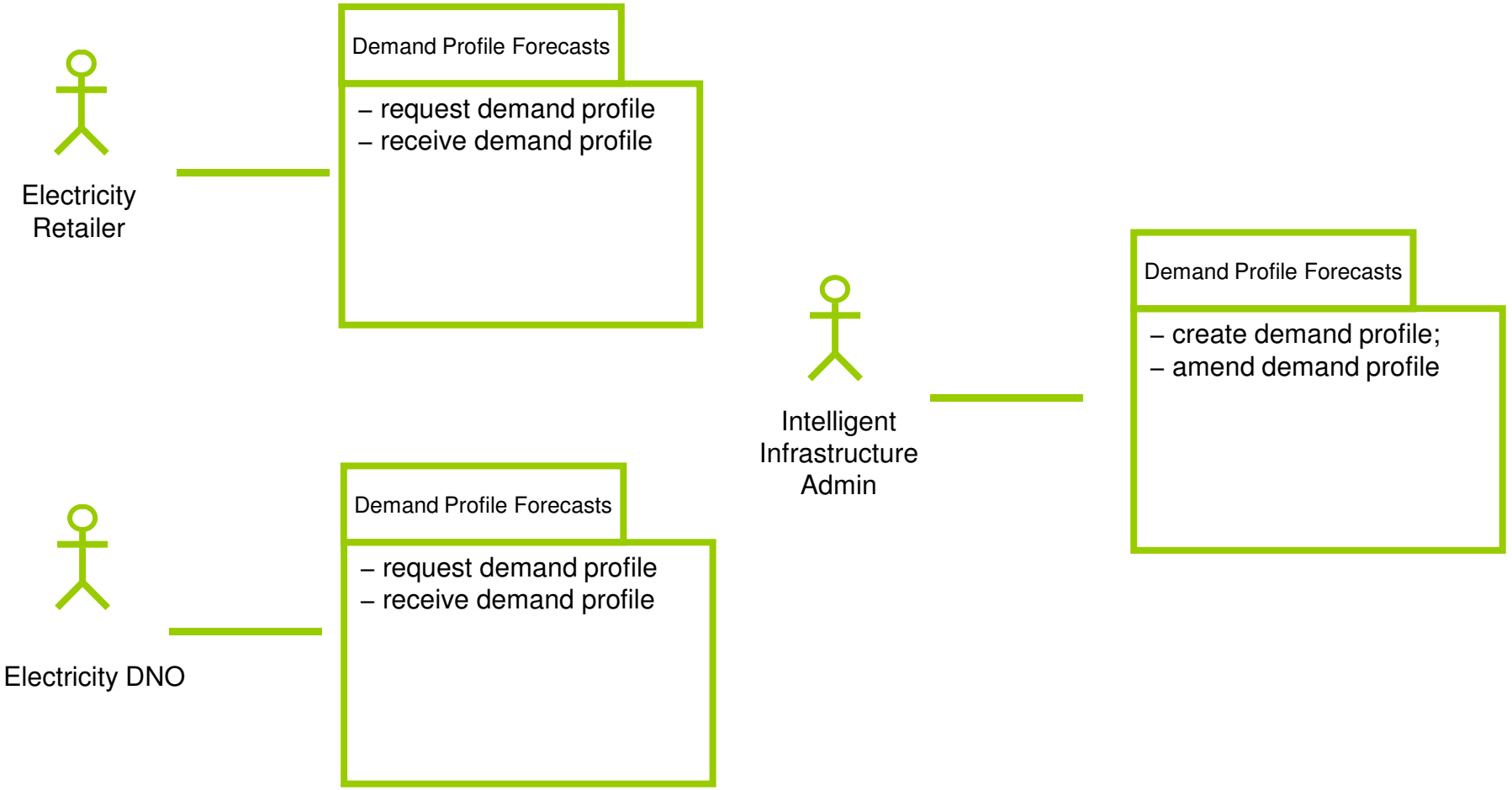
Charging Location Management – Location Details Reference Data Mgt Use Case Model Diagram



Demand / Supply Management – Demand Profile Forecasts
Use Case Model Specification

ID Number	
Name	Demand / Load Management – Demand Profile Management
Description	To support the provision of information to the electricity supply chain concerning the actual and potential demand for power related to vehicle charging requests / activity
Use Case Functions	request demand profiles; create demand profiles; amend demand profiles; receive demand profiles
Actors	Electricity Retailer; Electricity DNO; Intelligent Infrastructure Operator
Pre conditions	Request made for a demand profile; Scheduled production of a demand profile; Unexpected change in demand
Post conditions	Demand profiles created / amended
Notes	Assumed that the electricity supply chain actors will be taking the profile into their own business as usual demand, optimisation and trading systems as one of a number of inputs. Demand profile likely to be generated by the system with allowance for manual trigger as well. Demand profiles may relate to locations or groups of locations, times of the day, parts of a year, etc.

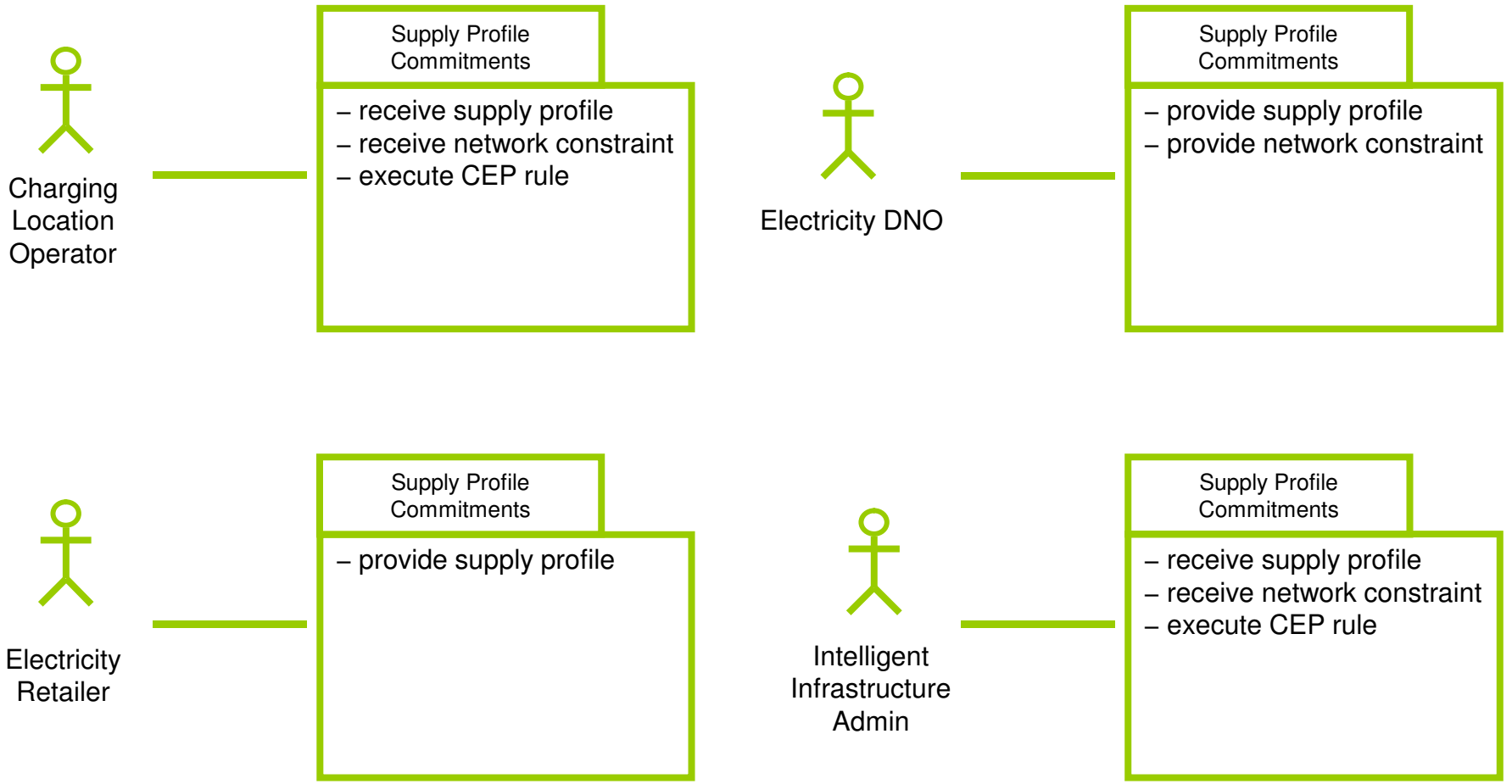
Demand / Supply Management – Demand Profile Forecasts Use Case Model Diagram



Demand / Supply Management – Supply Profile Commitments
Use Case Model Specification

ID Number	
Name	Demand / Supply Management – Supply Profile Commitments
Description	To enable the provision of supply profiles and network constraints which will impact on the operation and availability of charging services
Use Case Functions	provide supply profile; update supply profile; execute Complex Event Processing rule - (**Complex Event Processing** (CEP) refers to processing many events happening across all the layers of an infrastructure, identifying the most meaningful events, analyzing their impact, and taking subsequent action in real time)
Actors	Charging Location Operator; Electricity Retailer; Electricity DNO; Intelligent Infrastructure Operator; Charging Location
Pre conditions	Demand profile forecast produced; Network event;
Post conditions	Supply profile updated; Network constraints processed; Asset status amended
Notes	Includes both automated rules (perhaps executed via CEP) and manual status updates. Supply profile would be more predictable for a period of time – e.g. next hour, next half day, peak time, next week. Network constraints could be more dynamic and affect the supply profile – e.g. network outage, frequency issue, optimisation event on the network, etc Impact can be positive (more capacity, less constraints, cheaper price) or negative (less capacity, more constraints, higher price).

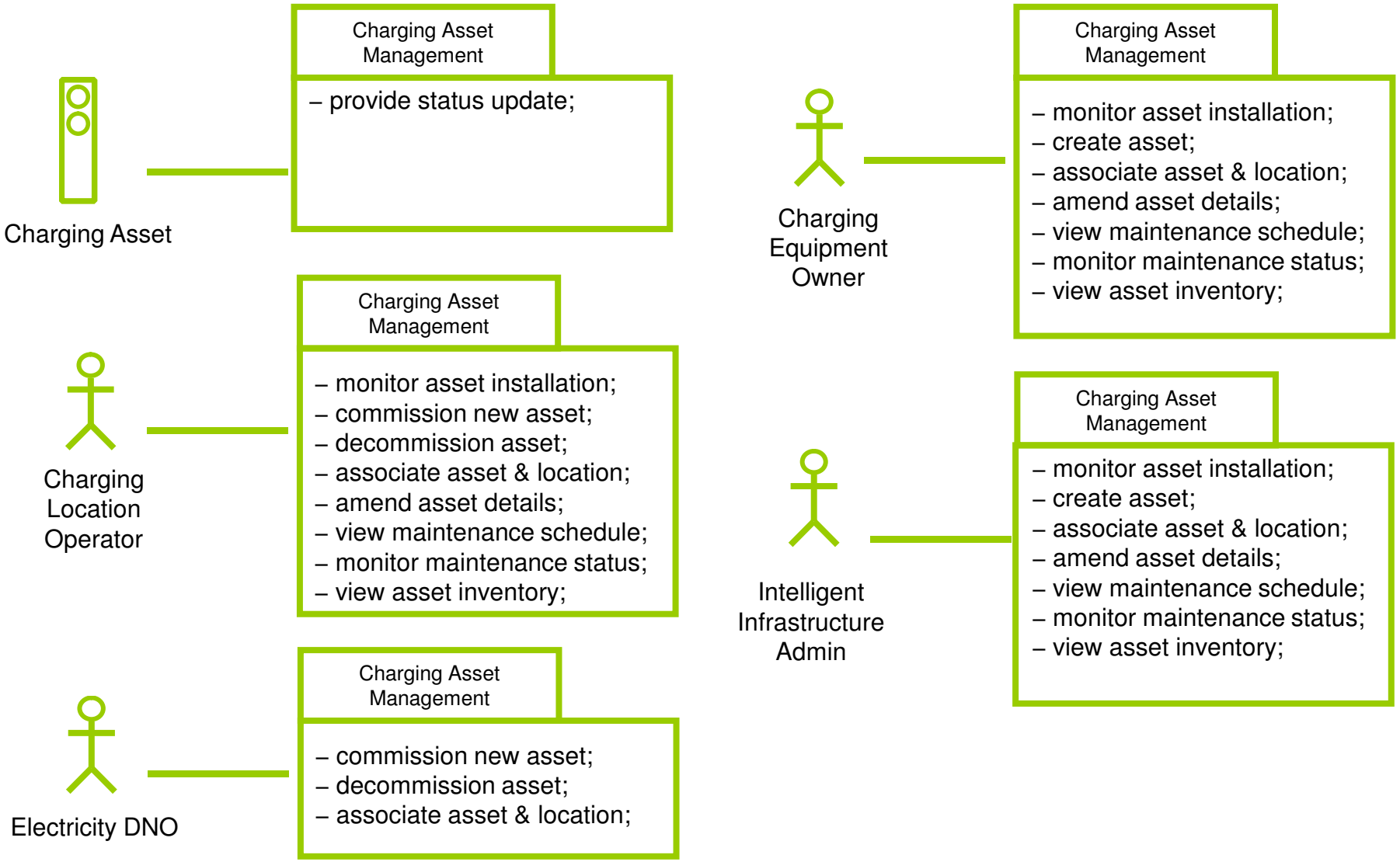
Demand / Supply Management – Supply Profile Commitments Use Case Model Diagram



Charging Infrastructure Management & Safety – Charging Asset Management Use Case Model Specification

ID Number	
Name	Charging Infrastructure Management & Safety – Charging Asset Management
Description	Allows the relevant actors to manage charging assets in terms of commissioning, planning, installation and maintenance
Use Case Functions	monitor asset installation; commission new asset; decommission asset; associate asset & location; amend asset details; view maintenance schedule; monitor maintenance status; view asset inventory; provide status update
Actors	Charging Location Operator; Charging Asset Owner; Charging Asset; Electricity DNO; Intelligent Infrastructure Operator
Pre conditions	New asset / location; Change in asset / location; Scheduled Maintenance event; Ad Hoc Maintenance required; Change in asset inventory
Post conditions	Asset details updated; Maintenance scheduled; Maintenance undertaken;
Notes	Assumes that it is likely operators and asset owners would have their own asset management systems covering detailed asset, work, service, contract, inventory, and procurement management. The II would take a feed or have a view of relevant data. This would also include things like service management and workforce management for charging asset servicing, maintenance, etc. If not true, then we need to include some of that functionality in the II.

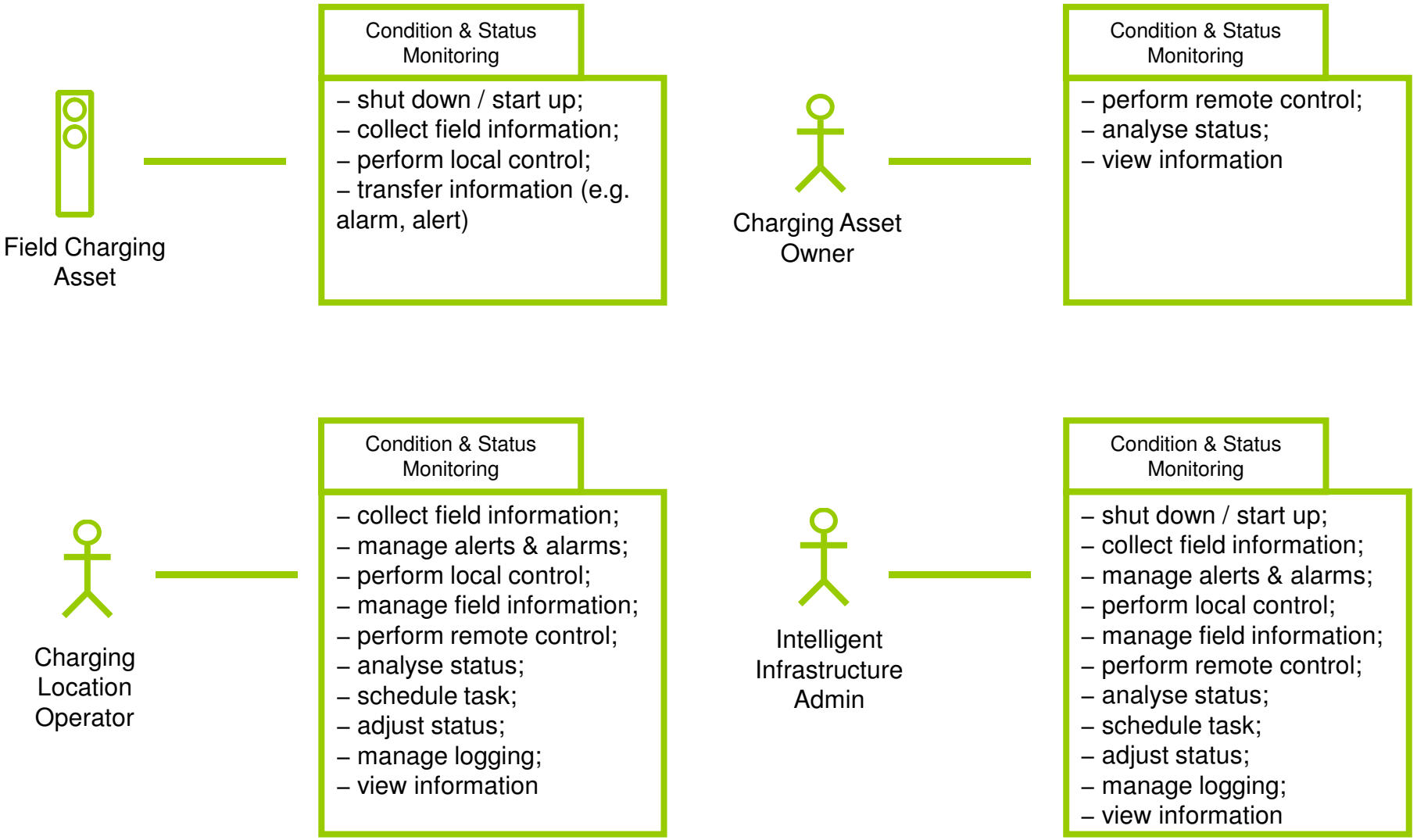
Charging Infrastructure Management & Safety – Charging Asset Management Use Case Model Diagram



Charging Infrastructure Management & Safety – Condition & Status Monitoring Use Case Model Specification

ID Number	
Name	Charging Infrastructure Management & Safety – Condition & Status Monitoring
Description	Allows the relevant actors to control and monitor the status and condition of charging assets and locations
Use Case Functions	shut down / start up; collect field information; manage alerts & alarms; perform local control; transfer field information; manage field information; perform remote control; analyse status; schedule task; adjust status; manage logging; view information
Actors	Charging Field Asset (charging asset); Charging Location Operator; Charging Asset Owner; Intelligent Infrastructure Operator
Pre conditions	Monitoring is active
Post conditions	Condition / status change detected; Response actioned
Notes	Assumes that it is likely operators and asset owners would have their own SCADA or DCS systems covering the operational functions listed above. If so, the II may take a feed or have a view of relevant data. If not true, then we need to include some of that functionality in the II.

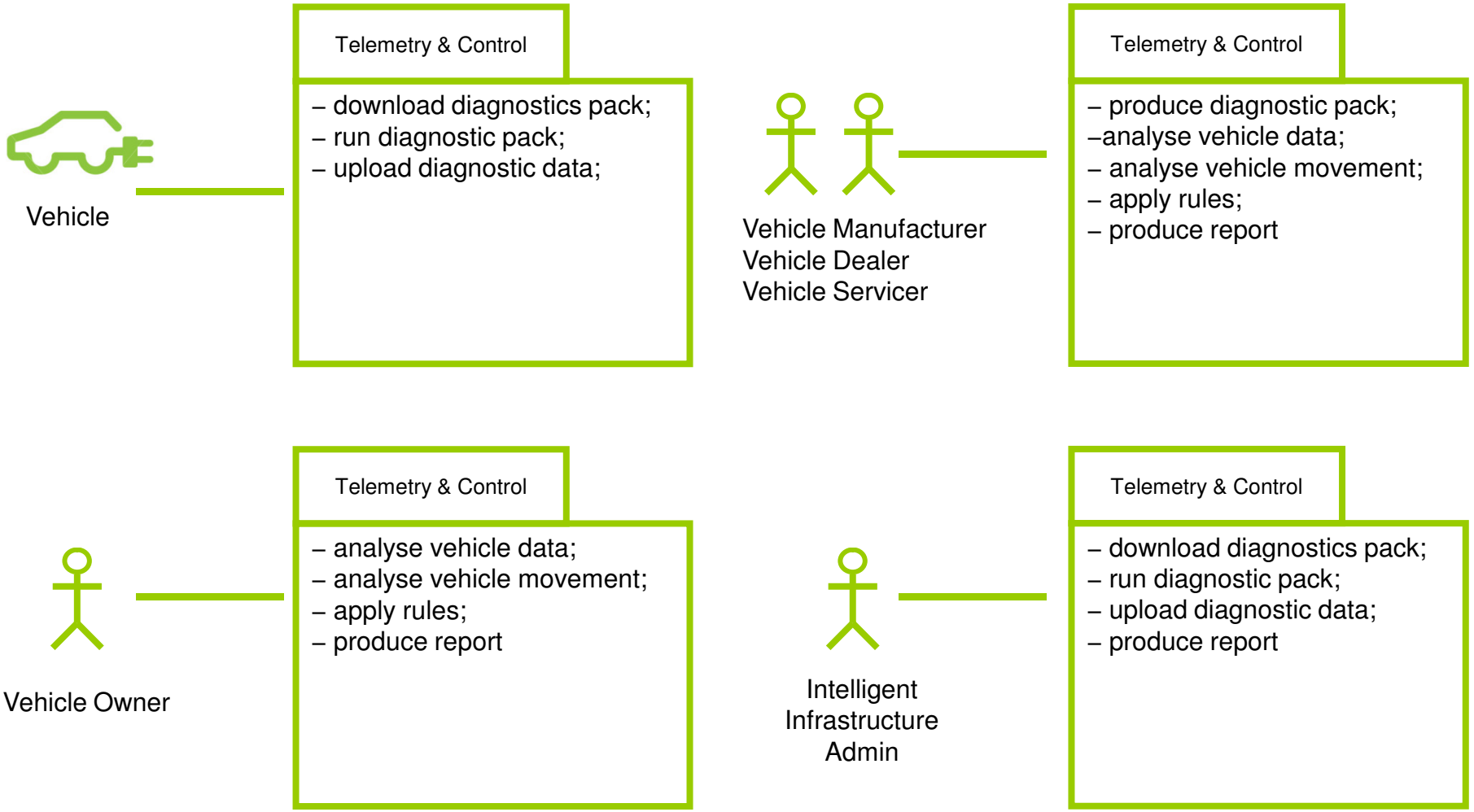
Charging Infrastructure Management & Safety – Condition & Status Monitoring Use Case Model Diagram



Charging Infrastructure Management & Safety –Telemetry & Control Use Case Model Specification

ID Number	
Name	Charging Infrastructure Management & Safety – Telemetry & Control
Description	Allows the relevant actors to monitor and manage the status and condition of electric vehicles and potentially batteries through suitable diagnostics and control system activity
Use Case Functions	download diagnostics payload; run diagnostic payload; upload diagnostic data; analyse vehicle data; analyse vehicle movement; apply rules; produce report
Actors	Electric Vehicle; Vehicle Owner (especially fleet); Vehicle Servicer / Dealer; Vehicle Manufacturer; Intelligent Infrastructure Operator
Pre conditions	Vehicle plugs into charging point; Diagnostic package available; Vehicle able to receive diagnostic package
Post conditions	Diagnostic package run; Diagnostic package not run; Report produced
Notes	Many different data sets could be monitored. The vehicle owner could have bought this service from a manufacturer or other service provider. Fleet users could have this information aggregated. Potential for this to be real time. Could be that the IIA just acts as a provider of information to enable this – e.g. relaying data from the vehicle and download of diagnostics to the vehicle. Common vehicle communication protocols are emerging (e.g. CHAdeMO) to encourage the development and roll out of telemetry and control functionality

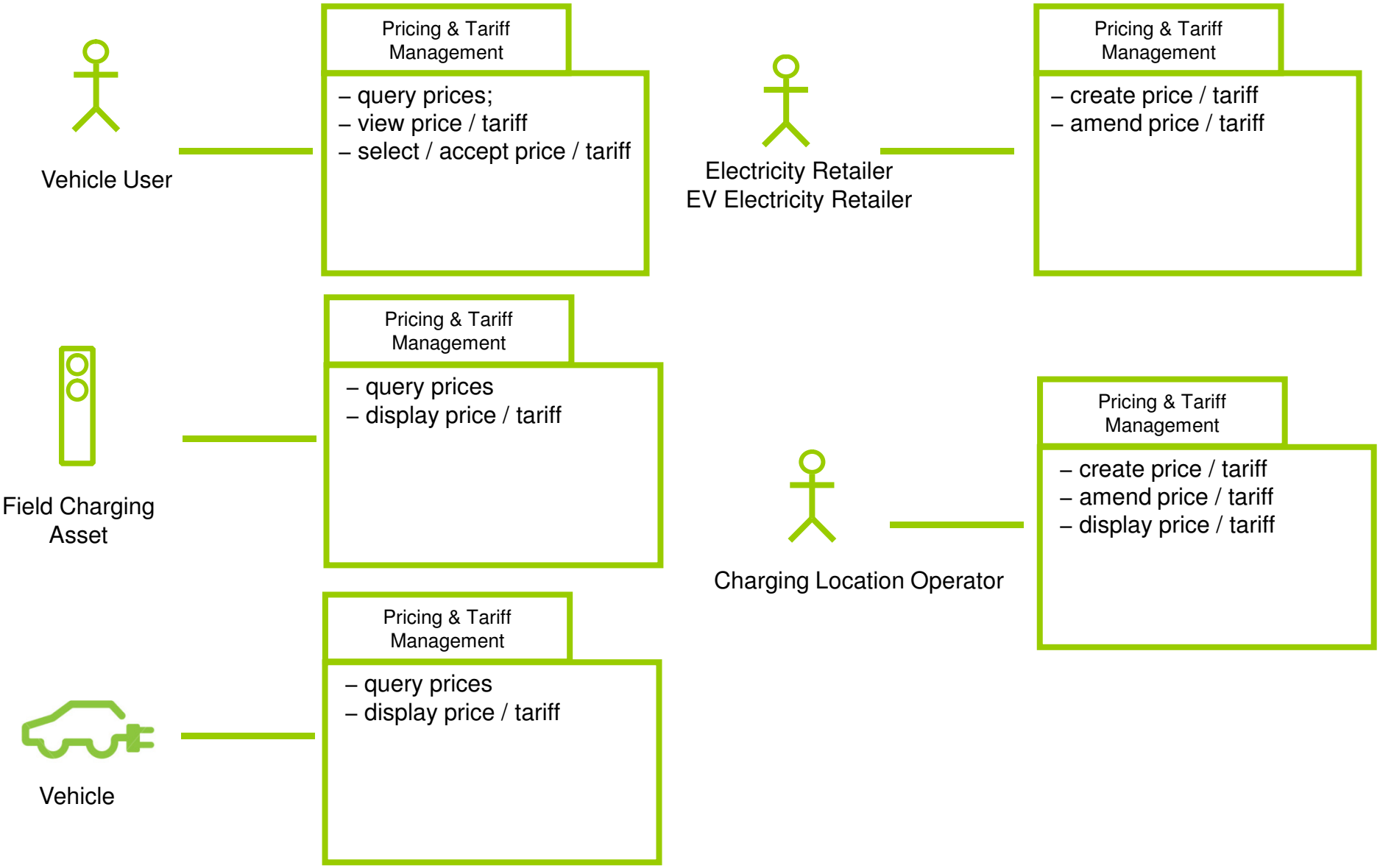
Charging Infrastructure Management & Safety – Telemetry & Control Use Case Model Diagram



Pricing & Billing Management – Pricing & Tariff Management
Use Case Model Specification

ID Number	
Name	Pricing & Billing Management – Pricing & Tariff Management
Description	To allow relevant actors to manage and view prices associated with charging activity
Use Case Functions	create prices; update prices; view prices; display prices;
Actors	Vehicle User; Vehicle Owner (e.g. individual, fleet); Charging Location Operator; EV Charging Asset; Electric Vehicle; Electricity Retailer; EV Electricity Retailer; DNO; Intelligent Infrastructure Operator
Pre conditions	New pricing details exist; Request made to view pricing
Post conditions	Price created; Price updated;
Notes	

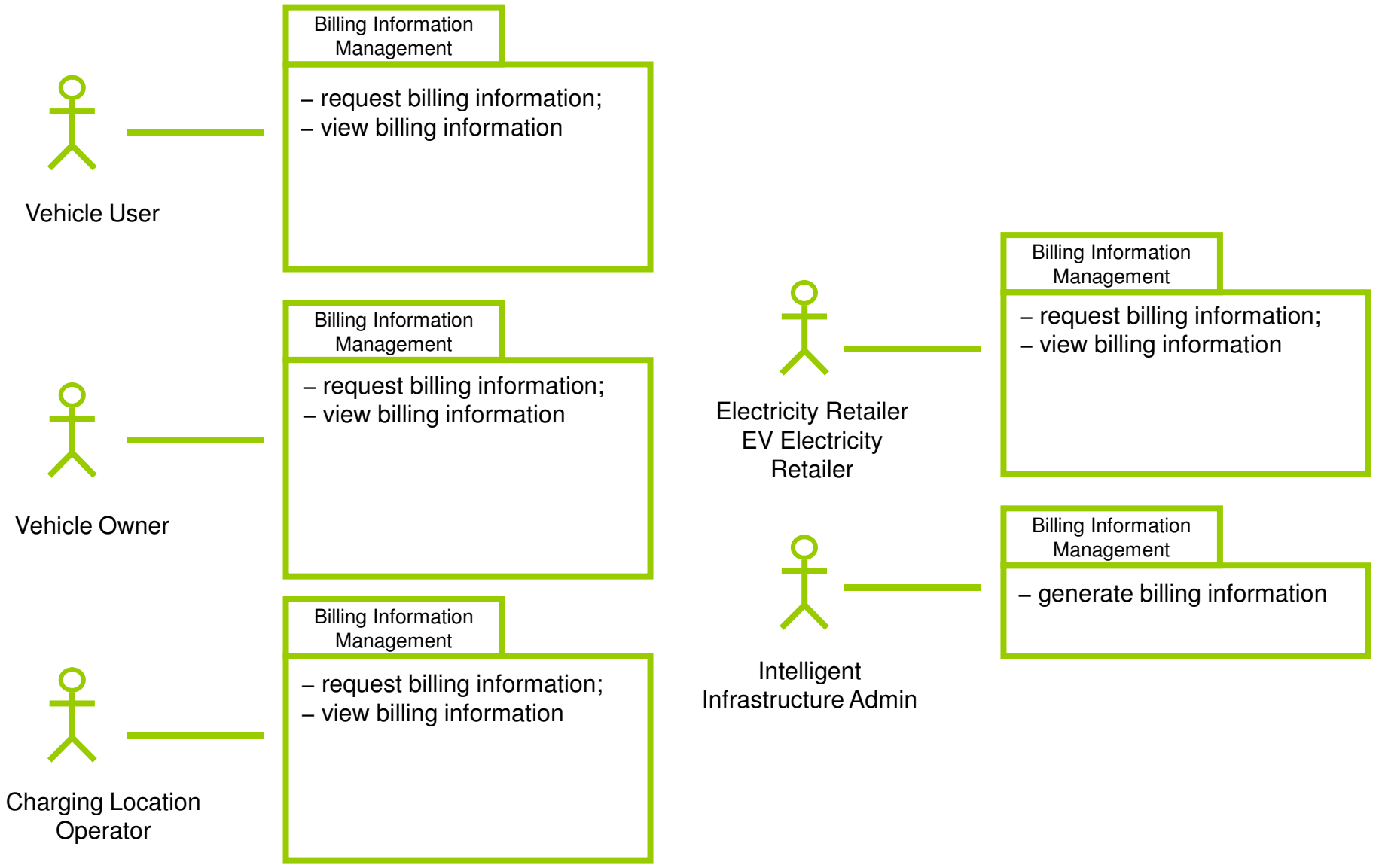
Pricing & Billing Management – Pricing & Tariff Management Use Case Model Diagram



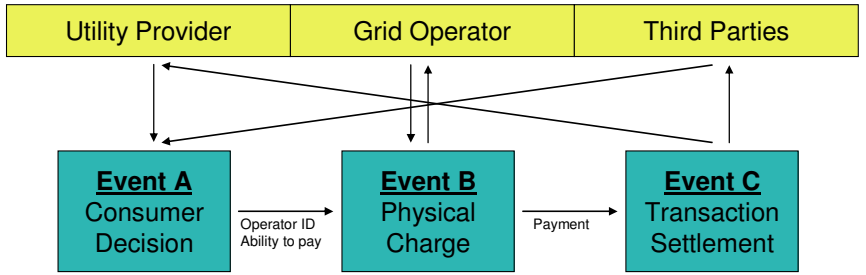
Pricing & Billing Management – Billing Information Management
Use Case Model Specification

ID Number	
Name	Pricing & Billing Management – Billing Information Management
Description	To allow relevant actors to manage the activity involved in producing a bill / statement for users of vehicle charging services
Use Case Functions	request billing information; generate billing information; view billing information;
Actors	Vehicle User; Vehicle Owner (e.g. individual, fleet); Charging Location Operator; Electricity Retailer; EV Electricity Retailer; Intelligent Infrastructure Operator;
Pre conditions	Actor requests billing information; Service consumed
Post conditions	Billing information produced
Notes	Should provide information and services which don't constrain different bill / statement options, such as individual bills, site bills *(e.g. large business customer with a small number of sites)*, consolidated bills *(e.g. large business customer with many sites and more centralised payment processing)* and different delivery methods, such as electronic bill presentment, paper billing, etc.

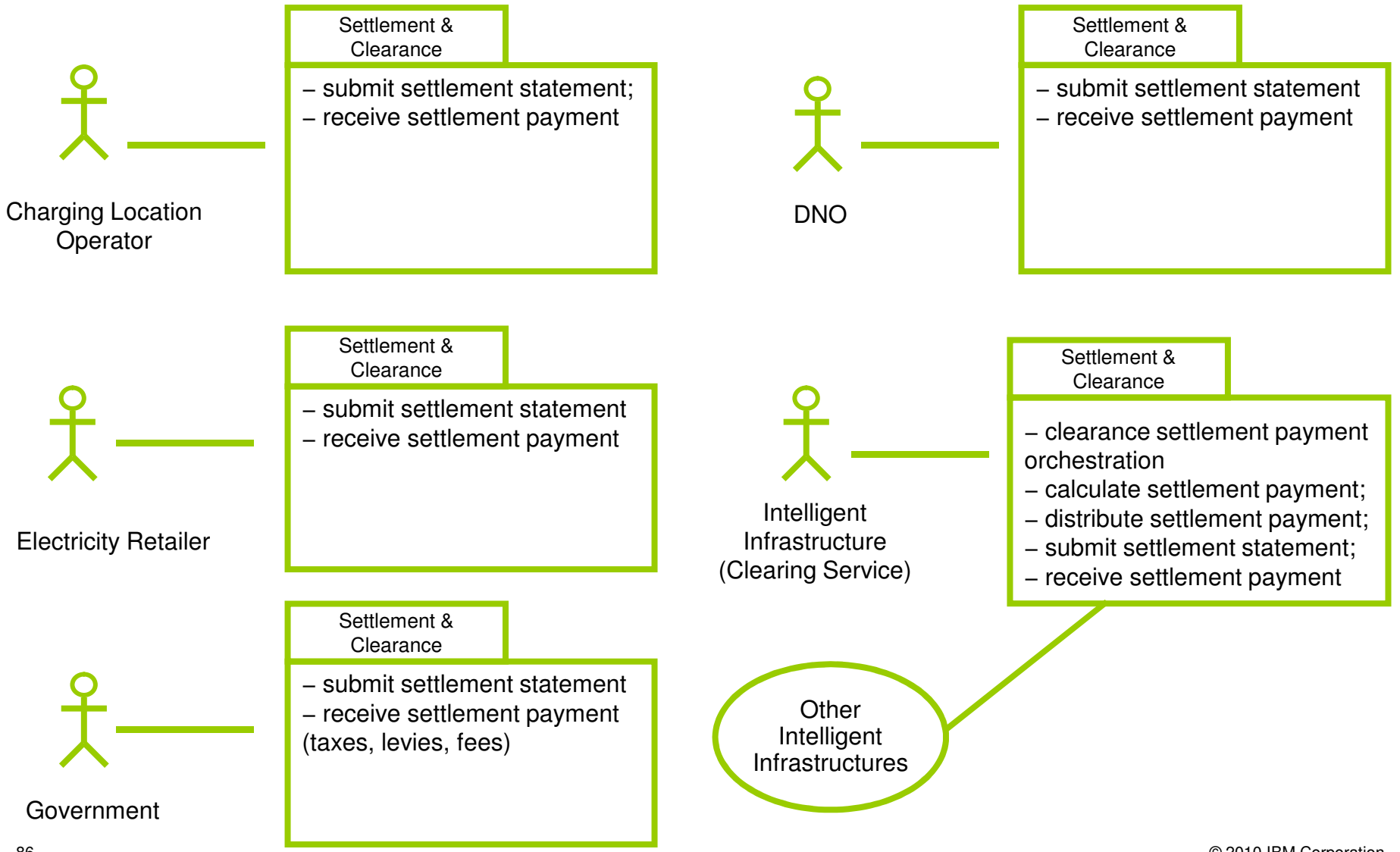
Pricing & Billing Management – Billing Information Management Use Case Model Diagram



Settlement & Clearance Services
Use Case Model Specification

ID Number	
Name	Settlement & Clearance Services
Description	To allow the relevant actors to utilise transactional clearinghouse services. Used to direct the potentially complex flow of information and funds that will be involved. Clearance (identifying what transactions need to occur and between whom); Settlement (processing the resultant payments and transfers); Ensures that participants get paid for their part in the charging event.
Use Case Functions	clearance settlement payment orchestration; calculate settlement payment; distribute settlement payment; submit settlement statement; receive settlement payment
Actors	Charging Location Operator; Electricity Retailer; DNO; Intelligent Infrastructure Operator; Government; Other Intelligent Infrastructures
Pre conditions	Payment transactions completed
Post conditions	Clearing completed; Settlement completed
Notes	Participating stakeholders will need to track and receive payment for vehicle charging, - creates a complex, dynamic flow of information and funds 

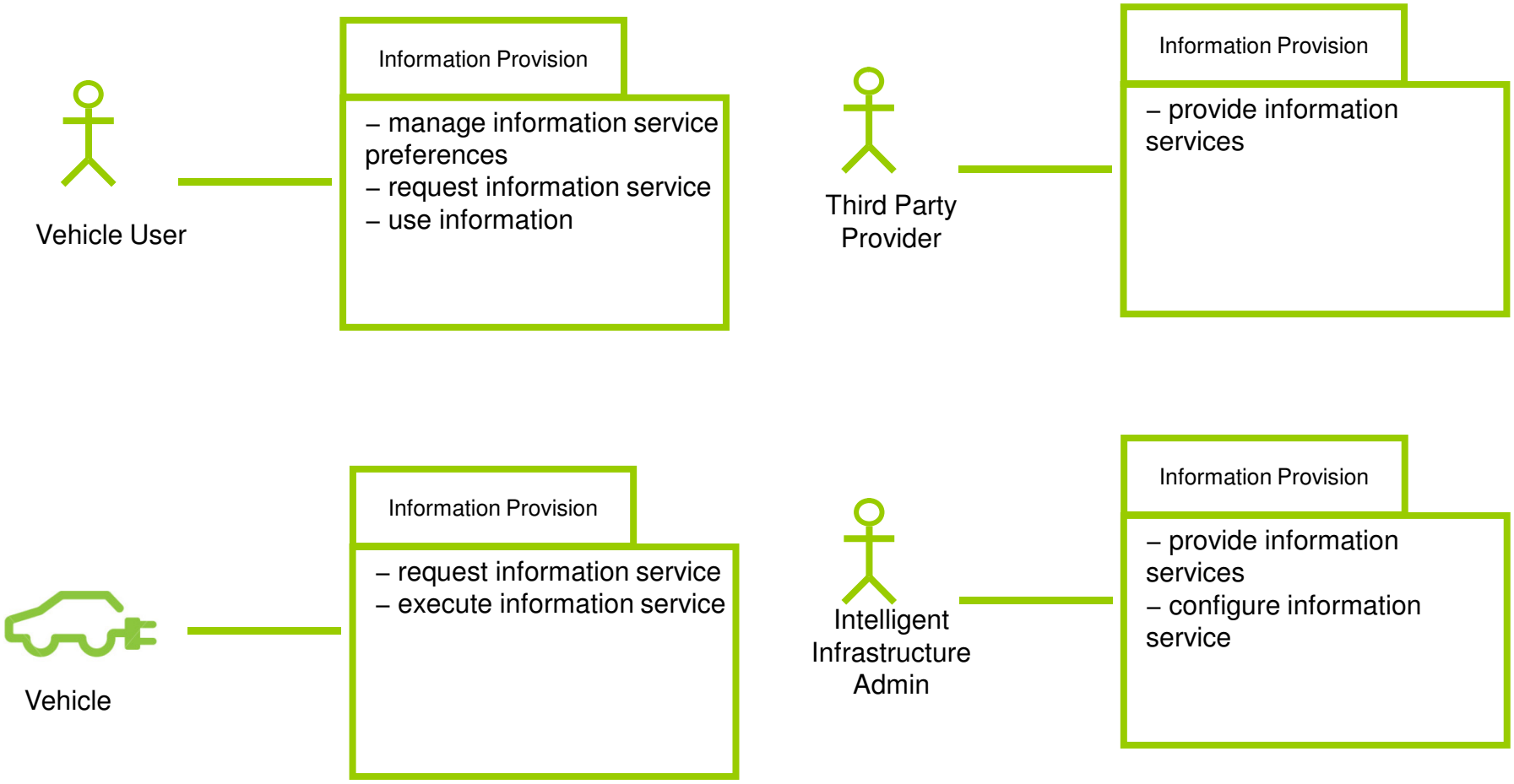
Settlement & Clearance Services
Use Case Model Diagram



Information Provision
Use Case Model Specification

ID Number	
Name	Information Provision
Description	To allow relevant actors to exchange information in the II, in terms of 'beyond vehicle' services – digital downloads, alerts, event data, weather, navigation information, etc
Use Case Functions	request information services; provide information services; manage information service preferences; display information; use information; execute information service
Actors	Vehicle User; Vehicle Owner; Electric Vehicle; Third party provider; Intelligent infrastructure operator
Pre conditions	User preferences exist
Post conditions	Information processed
Notes	Relates to the provision of information services to an EV User / Owner based on a series of preferences. Could be information alerts, point of interest details (e.g. where are the charging locations), status information (e.g. which charging locations are available / operating), etc.

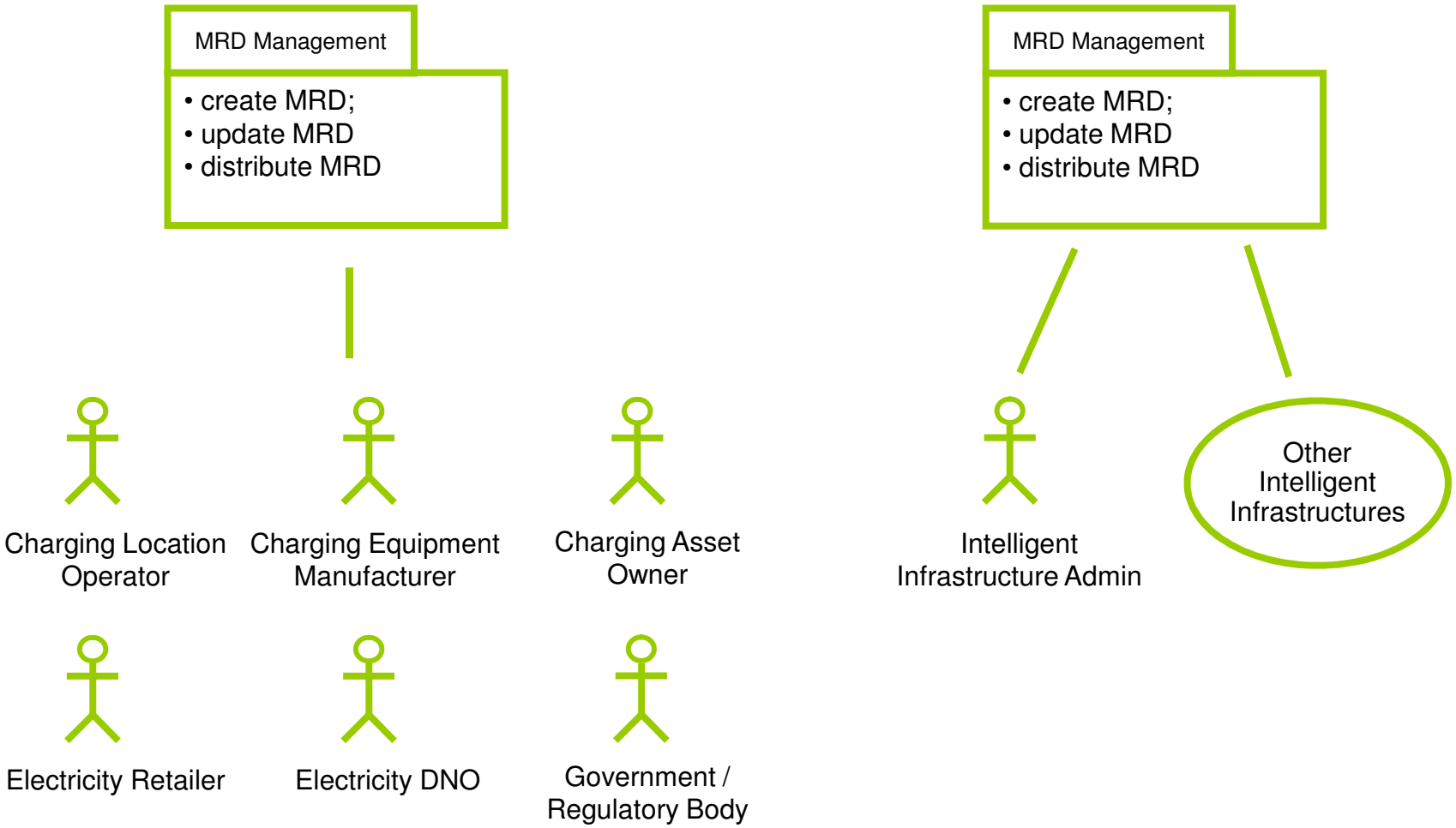
Information Provision
Use Case Model Diagram



Master Reference Data Management
Use Case Model Specification

ID Number	
Name	Master Reference Data Management
Description	To allow relevant actors to create and maintain consistent and accurate sets of master data. Excludes Location data which is in a grouping of it's own.
Use Case Functions	create MRD; update MRD; distribute MRD;
Actors	Charging Location Operator; Charging Field Asset; Charging Asset Owner; Charging Equipment Manufacturers; Electricity DNO; Electricity Retailer; EV Electricity Retailer; Intelligent Infrastructure Operator; Government / Regulatory Body; Other Intelligent Infrastructures
Pre conditions	New master data item; Change to existing master data item
Post conditions	Master data created; Master data amended; Master data distributed
Notes	The approach to managing master data will be considered further in other stages of the project. It could be different for different types of master data. Essentially, the options come down to: -'system of record' approach where data is mastered in the system most closely associated with the use of the data – this would result in multiple systems and involve managing updates and distribution either automatically or via workflow / manual; - master system which manages the data

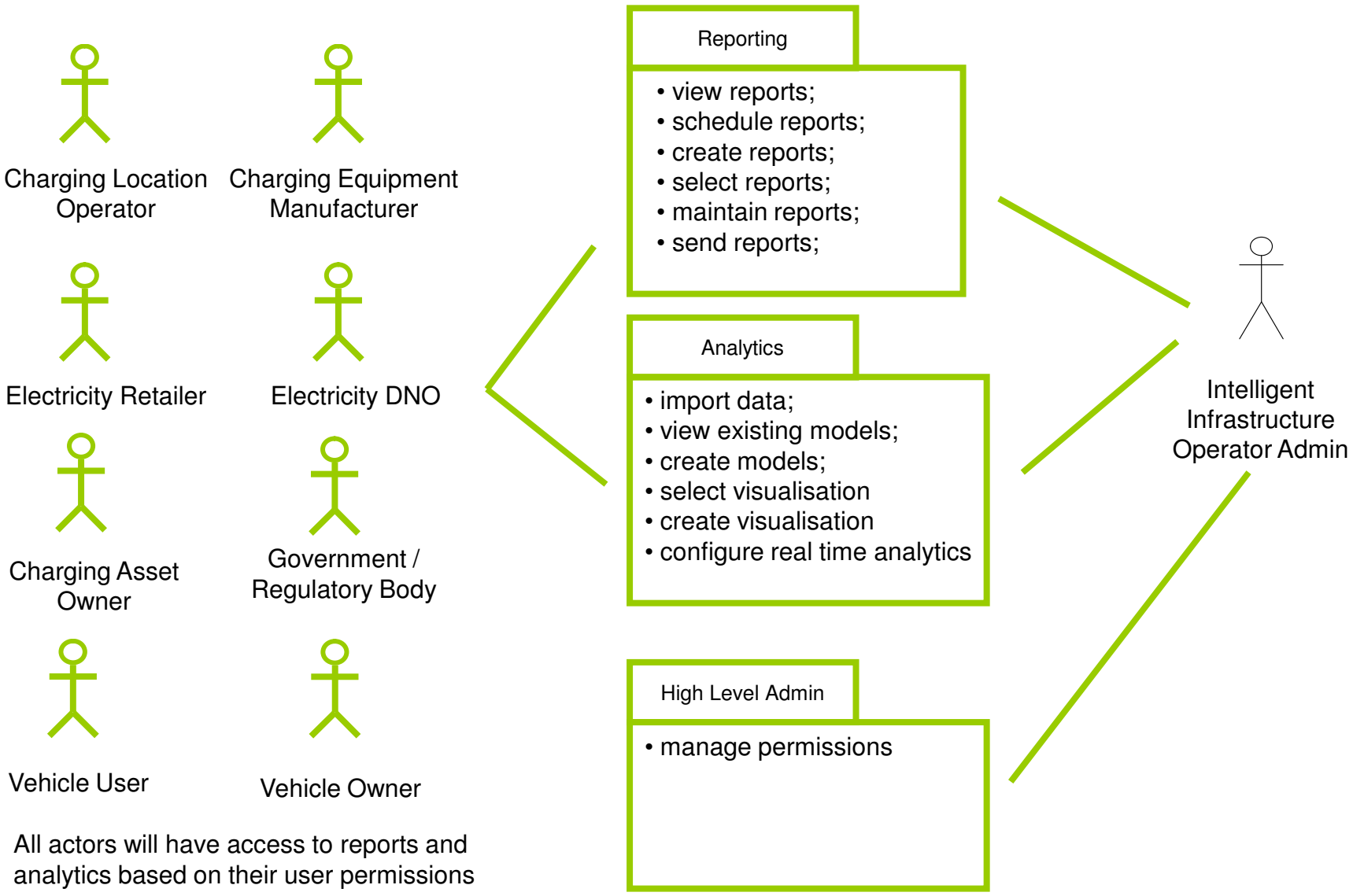
Master Reference Data Management
Use Case Model Diagram



Business Analytics & Reporting
Use Case Model Specification

ID Number	
Name	Business Analytics & Reporting
Description	To allow relevant actors access to a variety of views (both static and dynamic) of information. Provides controlled access to the information to better manage the accuracy and source of the underlying data.
Use Case Functions	view reports; schedule reports; define reports; select reports; maintain reports; send reports; create models and queries; configure real time analytics;
Actors	All actors but accessing different reports and data.
Pre conditions	Time trigger for scheduled report; User access to analytics and reporting functionality; User is authorised to request the report or perform the query
Post conditions	Reports / queries defined; Reports / queries generated
Notes	Would cover usage, performance, trends

Business Analytics & Reporting
Use Case Model Diagram

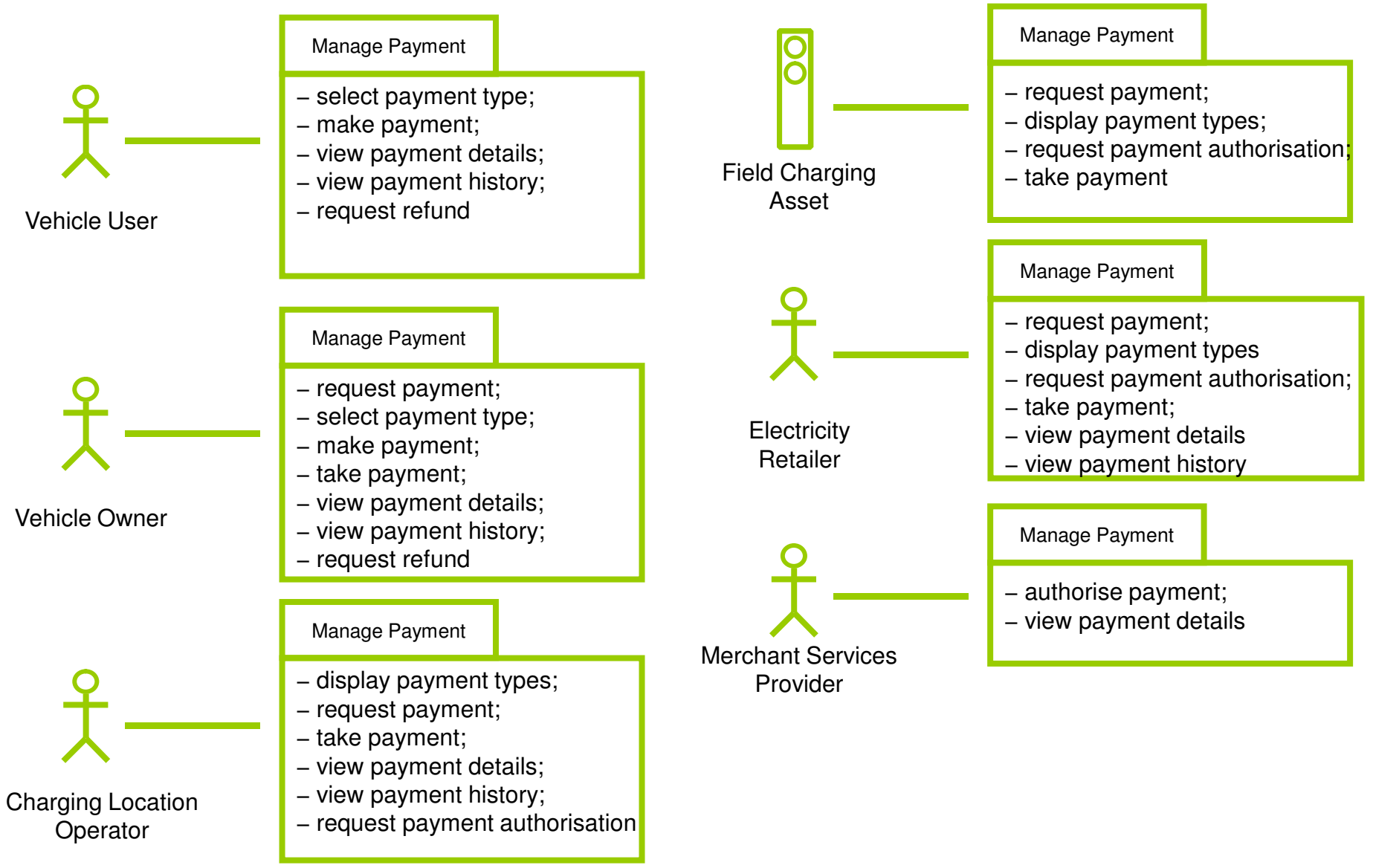


All actors will have access to reports and analytics based on their user permissions

Billing & Payment – Manage Payments
Use Case Model Specification

<table>
<tr><td>ID Number</td><td></td></tr>
<tr><td>Name</td><td>Billing & Payment – Manage Payments</td></tr>
<tr><td>Description</td><td>To allow the relevant actors to request and make payments for charging transactions.</td></tr>
<tr><td>Use Case Functions</td><td>request payment; display payment types; select payment type; make payment; request payment authorisation; authorise payment; take payment; view payment details; view payment history; request refund;</td></tr>
<tr><td>Actors</td><td>Vehicle User / Battery User; Vehicle Owner (e.g. individual, fleet); Charging Location Operator; Charging Field Asset; Electricity Retailer; Merchant Services Provider;</td></tr>
<tr><td>Pre conditions</td><td>User requests charging; Provider requests payment; Authorisation requested</td></tr>
<tr><td>Post conditions</td><td>Payment authorised; Payment made</td></tr>
<tr><td>Notes</td><td>This is the basic approach for payment which might vary in detail depending on the payment type and channel. For example:
<table>
<tr><th>Payment Type</th><th>At Location</th><th>Telephone</th><th>Web Site</th><th>SMS</th><th>Utility</th></tr>
<tr><td>Credit / Debit Card</td><td>Y</td><td>Y</td><td>Y</td><td></td><td></td></tr>
<tr><td>Pre Pay Card</td><td>Y</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Cash</td><td>Y</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Direct Debit</td><td></td><td></td><td></td><td></td><td>Y</td></tr>
<tr><td>Electricity Bill</td><td></td><td></td><td></td><td></td><td>Y</td></tr>
<tr><td>Voucher</td><td>Y</td><td>Y</td><td>Y</td><td></td><td></td></tr>
<tr><td>Season Ticket</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td></td></tr>
<tr><td>Mobile Phone Bill</td><td>Y</td><td></td><td></td><td>Y</td><td></td></tr>
</table></td></tr>
</table>

Billing & Payment – Manage Payments Use Case Model Diagram



ETI EV Work Package 2.4

SP2/IBM/14 Intelligent Infrastructure Requirements Report

Appendix 1 : Acceptance Criteria

Acceptance Criteria from the contract

Complete when the final report comprises the following topics:

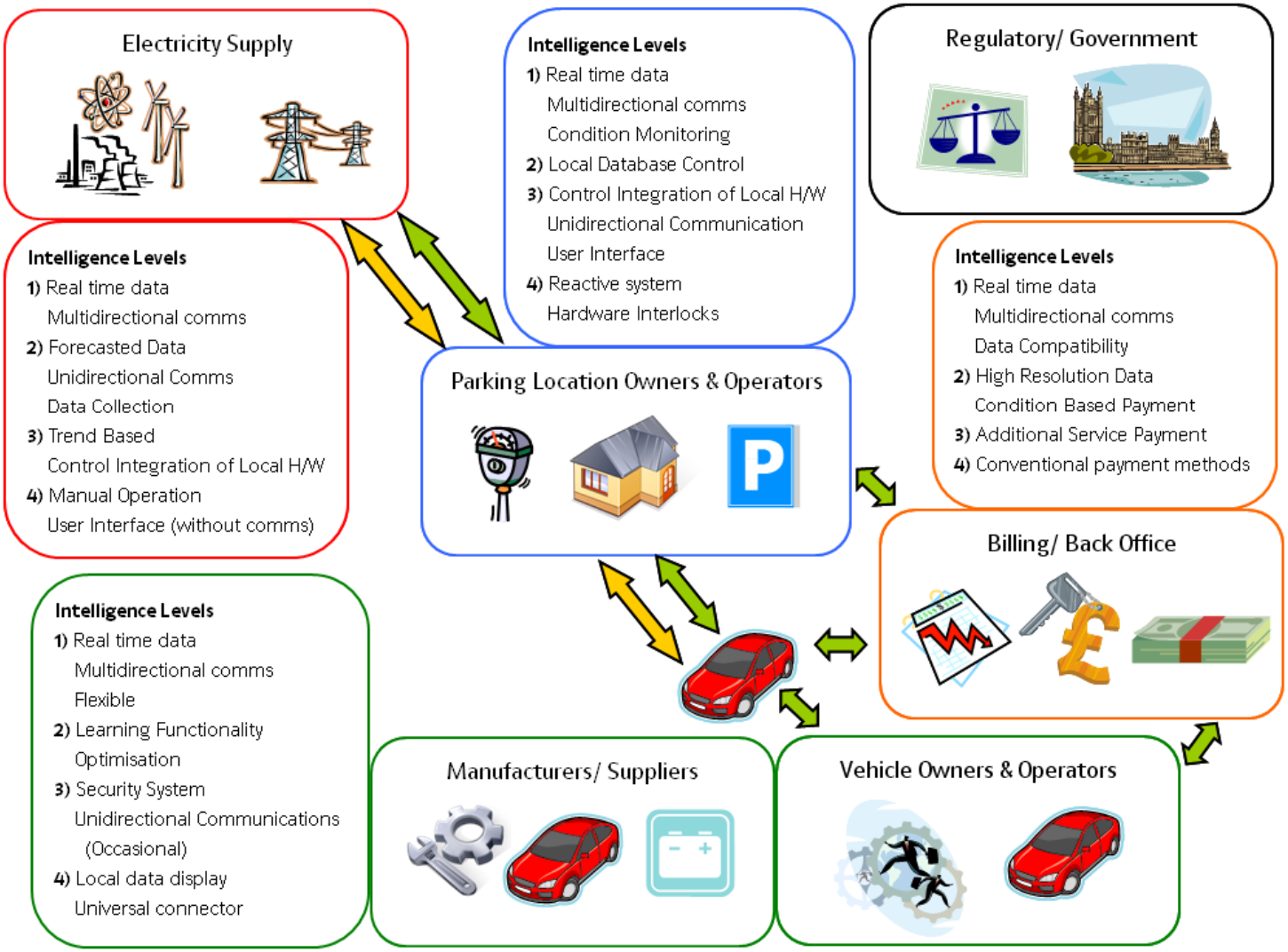
- System Context Diagram identifying the key information exchanges between actors.
  - The System Context represents the entire scope of the “intelligent architecture” and defines the key information exchanges between actors and external entities.
  - Shown as a diagram, this representation defines the key information flows.
  - The System Context highlights important characteristics of the “intelligent architecture”: users, external systems, inputs and outputs, and external devices such as charging points and smart meters.
  - It includes external events to which the “intelligent architecture” must respond e.g. a request for a meter reading from a charging point
  - Also included are events that the “intelligent architecture” generates that affect external entities e.g. a meter reading
  - Data that the “intelligent architecture” both receives and produces e.g. firmware update of a charging point.
- Use Case Model, where each use case includes name, description and actor
  - The Use Case Model describes the functional requirements of the “intelligent architecture”. The model uses graphical symbols and text to specify how users in specific roles will use the system (i.e. use cases). The textual descriptions describing the use cases are from a user‟s point of view; they do not describe how the system works internally or its internal structure or mechanisms.
  - The Use Case Model can include the following constructs: § Actors (name, description, status) § Use cases (number, subject area, business event, name, overview, preconditions, description, associations, inputs, outputs and notes)
  - Use cases for candidate actors such as the following will be analysed: § Customer/Vehicle Owner/Vehicle User/Guest; Charge Post/Public Charging Spot; Electric vehicle (EV); Plug-in Hybrid Electric Vehicle (PHEV); Charging Network Asset Owner; Charging Network Asset Operator; Pre-booking/Availability Manager; Billing Provider; Value Added Service Provider; DNO; Clearing House; Premises Owner

ETI EV Work Package 2.4
SP2/IBM/14 Intelligent Infrastructure Requirements Report

Appendix 2 : Intelligence Levels (taken from SP2/E.ON/01 Intelligence Levels Workshop Report)

see notes

Summarised Intelligence Levels for Stakeholder Groups (from SP2/E.ON/01)



Infrastructure Compatibility – ETI Plug-in Vehicle Charging System Interoperability Roadmap

see notes

1st Generation

- No capability for payment on consumption by customer
- No interoperability between charge points or locations

2nd Generation

- No capability for payment on consumption by customer
- Limited interoperability via a standard access approach (e.g. RFID tag) and shared authentication database

3rd Generation

- Capable of payment on consumption
- Interoperability between charging networks via dedicated back-office systems
- Increasing vehicle 'intelligence'

4th Generation

- Capable of payment on consumption
- Interoperability via integration with smart grids and standard electricity network back-office systems
- Full vehicle 'intelligence'

2010

2015 onwards

Derived from : Plugging-in Ultra Low Carbon Vehicles Developing and Testing the Pathways to a Self-sustaining Mass-market – ETI March 2010

Intelligence Levels Summary Tables

- These tables are taken from the SP2/E.ON/01 Intelligence Levels Workshop Report
- As previously noted, the ranking of 1 (most intelligence) and 4 (least intelligence) is different to the ETI roadmap (please keep this in mind)
- This information will be a key input in to the development and refinement of the requirements and architectures during the rest of this phase and in future phases

Summary of Intelligence Levels
Electrical Supply:

Electricity Supply		
Intelligence Level	*Description*	*Summary of Intelligence Level*
1	Real time generation mix data	**Real Time Data**
1	Communication with the charge point, vehicle and grid	
1	Smart meter with two way communications to grid	**Multidirectional Communications**
1	Smart meter with two way communications to grid	
1	Grid to car interface (Grid condition signals)	
1	Real time generation mix comms to control charging	
1	Charging data captured for forecasting	
2	Downloadable forecast of generation mix at charge point	**Forecasted Data**
2	Communication between the charge point and vehicle	
2	On-board data logger	**Unidirectional Communications**
2	Grid control of charge points (one way comms)	**Data Collection**
2	Grid control of charge points (one way comms)	
2	Local measurement of available grid parameters	
3	Integration of micro-generation at a local level	**Trend Based Data**
3	User interface to control charge patterns	
3	Trend based controlled charging	**Control Integration of Local Hardware**
3	Trend based controlled charging	
3	Onboard PFC and harmonic filtering	
3	Real time data to Area managers, processed data exchange with chargers	
4	based on presently available data (longer term historical trends)	**Manual Operation**
4	Manual operation	
4	User survey	**User Interface (without comms)**
4	Influenced through tariff structure	
4	Influenced through tariff structure	
4	Electrical modelling/studies	
4	Presently available data used to determine emssion intensity	

Summary of Intelligence Levels
Parking Location Owner and Operator: :

Parking Location Owner and Operators		
Intelligence Level	*Description*	*Summary of Intelligence*
1	Intelligent smart metering solutions. Home recognition of charge signatures & Billing on different tariffs alongside other household items	**Real Time Data**
1	Real time data, how much used, identification of pinch points, charge point abuse, tariff changes and user controls	**Condition Monitoring**
1	Real time condition monitors, Pre-emptive repair/ service based on information received	**Multidirectional Communications**
1	Built in fault detection. Mechanisms, miss use, finger-print of connectors & adaptors, Activation prevention	
1	High level system knowledge, transferred in real time. Sat Nav, I-Phone, proximity based network or management facility (Mesh Network). Condition monitoring, space occupied by conventional vehicle, post broken etc	
1	Virtual	
2	Built in knowledge of vehicle requirements/ charge point properties	**Local Database Control**
2	Fully integrated	
3	First generation smart meters	**Control Integration of Local Hardware**
3	Proactive monitoring of status for repair etc. Automated notification of status to user	**Unidirectional Communication**
3	Internet/mobile look up facilities (no knowledge of working status & compatibility)	**User Interface**
3	Database tells Sat Nav where points are (Proprietary knowledge)	
3	"some" level of integration	
4	Today. Many locations with no metering. Adhoc metering	**Reactive system**
4	Today, No knowledge of meter level data. Post analysis of utilisation	
4	Today, Routine checks, repair, reactive to complaint or request	**Hardware Interlocks**
4	Today, Plug & Play safe, charge defaults to safe mode	
4	Hardware interlocks, Failsafe disconnect, 3 pin interlock	
4	Today, Just turn up	
4	No interoperability - each charge point operator has own systems, not integrated with others	

Summary of Intelligence Levels
Manufacturers/Suppliers and Vehicle Owners/Operators

Manufacturers / Suppliers and Vehicle Owners and Operators		
Intelligence Level	*Description*	*Summary of Intelligence*
1	Battery performance optimisation	**Real Time Data**
1	Bi-directional data transfer, processing & reporting to enable value added service	**Multidirectional Communications**
1	Understands EV usage & user preferences	**Flexible**
1	Real-time, Advises user on optimising EV performance variables	
1	Supports all business models	
1	International standards for onboard EV	
2	Understands users charging patterns/preferences	**Learning Functionality**
2	Advises user on optimising battery life	**Optimisation**
2	Dynamic user database - different tariffs	
2	Multiple billing systems	
2	Supports numerous business models	
3	Where's the most appropriate charging point, is it available/ book it/ services/tariff / what other services are available there	**Security System**
3	Security authentication for user	
3	Compatible device	**Unidirectional Communications (Occasional)**
3	Static user database	
3	Single billing mechanisms	
3	Communication infrastructure to support security & authentication	
4	Vehicle manages its servicing, indicator	**Local data display**
4	Understand current battery condition, charge level & range	
4	Capability to recharge @ lowest cost & in simplest way	
4	No intelligence w.r.t. life cycle management	
4	PHEV manages battery use & recharge requirements	
4	Where's the nearest charging point	
4	Comparable plug-in	**Universal connector**
4	No integration	
4	pay as you go	

Summary of Intelligence Levels
Billing/Back Office and Government

Billing / Back Office and Government		
Intelligence Level	*Description*	*Summary of Intelligence*
1	Instantaneous, anywhere, fully integrated	**Real Time Data**
1	Sell electricity (V2G) - Variable charging	**Multidirectional Communications**
1	Fully integrated, cross-market complete set of information available to all stakeholders	
1	Real time, across market information	**Data Compatibility**
1	Regulated open access in which new manufacturers and operators can join/leave always ensuring compatibility	
2	Fully integrated with pre-existing payments (Convergence)	
2	EV Owner/ EV user / EV Fleet owner	
2	Electricity consumed by time of day, by location, by speed of charging, by carbon intensity	**High Resolution Data**
2	Incentive based tariffs (Contract by consumption)	
2	Usage based tax (Either fuel or road usage)	**Condition Based Payment**
3	Pay as you go - upfront/Instantaneous	
3	Contract - Retrospectively	
3	Post Owner	
3	Council / Retail park owner	
3	Electricity consumed	
3	Other services consumed eg downloads	**Additional Service Payment**
3	Flat rate tax (Irrelevant to usage)	
3	Model development based on real-time trials &	
3	Introduction of standards to allow market development under regulation	
4	Flat fee - Upfront	
4	Standard Payment methods (Cash, DC CC)	
4	Somebody pays the bill eg employer, council, retailer, Gov	**Conventional payment methods**
4	Bill nothing	
4	Flat rate fee (Weekly/ monthly/ annual)	
4	Aggregated charge	
4	Nothing/ aggregated current	
4	Sources of information (energy only)	
4	No tax of EV usage / Tax elsewhere	
4	Information from current generic studies	
4	No open access fragmentation	

ETI EV Work Package 2.4

SP2/IBM/14 Intelligent Infrastructure Requirements Report

Appendix 4 : Glossary

Relates to this document. Will be developed further during this phase and further phases and deliverables.

Glossary (1)

Analytics

The production of reports, the functionality available to run queries on data. The study of business data using statistical analysis in order to discover and understand historical patterns with an eye to predicting and improving business performance in the future.

Battery

Batteries store energy to be used by an electric vehicle's motor. Various battery chemistries are available, including lead-acid, nickel-metal hydride, lithium-ion, and molten salt (e.g. Zebra). Lithium-ion batteries have progressed rapidly as mobile phone and laptop computer battery technology has developed, and this is now the most common electric vehicle battery type.

Battery swap

An electric vehicle re-charging model which allows depleted batteries to be replaced by fully-charged ones at special battery swap stations. This option is being pursued by the electric vehicle venture Better Place. Battery swapping will require a degree of battery standardisation amongst vehicle manufacturers. At this point, the appropriateness of such facilities will be reconsidered, should battery standardisation emerge.

BEV / Battery Electric Vehicle

An electric vehicle whose electricity is exclusively stored in batteries rather than a fuel cell or generator.

Charging

The use of the word charging generally refers to the charging of electric vehicle batteries and not monetary charging.

Charging point / Charging Asset / Charging Station

Facility for providing electricity to an electric vehicle. Charging points include regular household sockets and more specialist designs. As the infrastructure develops, the charging point will provide a key link between the EV and the wider ecosystem and come with increased intelligence

Clearance and Settlement (of EV Charging Payments)

Clearance (identifying what transactions need to occur and between whom); Settlement (processing the resultant payments and transfers)

Glossary (2)

Discharging point / asset / station

Similar to charging but for transferring the electricity off the vehicle / battery. Likely to evolve to be part of the same physical facility as the charging asset

EV / Electric Vehicle

For simplicity, this is used to refer to a vehicle which would use the intelligent infrastructure and so includes Battery Electric Vehicle (BEV), Hybrid Electric Vehicle (HEV), Plug-in Hybrid Electric Vehicle (PHEV) and any other similar variation. Any vehicle which utilises electric power in whole or in part to drive the vehicle that is capable of being plugged into charging stations

HEV / Hybrid Electric Vehicle

A vehicle that combines conventional power production (e.g. an ICE) and an electric motor.

ICE / Internal Combustion Engine

The 'traditional' way to power a vehicle, this part is removed when converting to an electric car or complimented by an electric motor if considering a hybrid electric vehicle.

Intelligent Infrastructure

Refers to the open standards, information technology, data and supporting services that support the roll out and operational aspects of electric vehicle usage

PHEV

A hybrid electric vehicle with a substantial battery pack which is able to be charged by an external source other than its fossil fuel (i.e. plugged into household electricity). Vehicle which uses two or more power sources to drive the vehicle

SCADA

Supervisory Control and Data Acquisition. It refers to the functionality and data flows within the Intelligent Infrastructure Architecture which is responsible for the monitoring and controlling of the physical infrastructure e.g of the Charging Posts out in the field.

Glossary (3)

V2G / Vehicle to Grid

A system where the charge contained in an electric vehicle battery can be made available to the electricity grid to assist in times of peak demand for power.

V2H / Vehicle to Home

A system where the charge contained in an electric vehicle battery can be made available to the home.

ETI EV Work Package 2.4

SP2/IBM/14 Intelligent Infrastructure Requirements Report

Appendix 4 : Sources

Sources examined

- Technology Contract for Electrification of Light Vehicles - Project: Electricity Distribution & Intelligent Infrastructure
- SP2/E.ON/01 Intelligence Levels Workshop Report
- ETI Electrification of Light Vehicles – Reducing Uncertainty in Implementing a UK Vehicle Recharging Infrastructure (21 May 2009)
- Plugging-in Ultra Low Carbon Vehicles Developing and Testing the Pathways to a Self-sustaining Mass-market – ETI March 2010
- Ultra–Low Carbon Vehicles in the UK – HM Government Report – 2009
- London's Electric Vehicle Infrastructure Strategy – December 2009
- IBM Smart Grid EV Article http://www.ibm.com/smarterplanet/us/en/smart_grid/article/electric_cars.html?ca=v_electricvehicles
- IBM Research Report - Electric Vehicle Fleet Integration in the Danish EDISON Project - A Virtual Power Plant on the Island of Bornholm
- Gartner Industry Research 'The Electric Vehicle's Value Chain & Technology Evolution' September 2009