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Programme Area: Light Duty Vehicles

Project: Electricity Distribution and Intelligent Infrastructure

Title: Completion Report - Systems Integration and Architecture Development – Appendix C2

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 C2, which covers the Conceptual Data Architecture.

Context:

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

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

Deliverable Title	Conceptual Data Architecture
Deliverable Reference	SP2/IBM/18

Interim or Final	Final

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Version	History
Various 0.x	Drafts pre submission
v.1.0	Initial Submission 23 August 2010 ETI were informed of the additional working day to finalise the Report
V 2.0	14 September 2010 Report revised after ETI reviewer feedback

IP Ownership	As defined in the ETI Technology Contract for WP2.4

ETI EV Work Package 2.4
SP2/IBM/18 - Conceptual Data Architecture

Version 2.0

14 September 2010

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1. Executive Summary

1.1. Outline of the Report

An integral part of the specification of any system or set of systems is a definition of the data which must be stored and processed. For large integrated systems, such as in this case - the EV Intelligent Infrastructure, the process of specification passes through several levels, before it arrives at a point at which it can be coded into a physical computer system. These levels, essentially three – conceptual, logical and physical are outlined in Section 3.1 below. This document is the Conceptual Data Architecture Report and provides an analysis of the data at the very highest level - in keeping with the other specification documents which have been produced to date under Work Package 2.4.

Data architecture, leading eventually to physical databases, is concerned with the storing of large volumes of data which can be shared between a number of systems. For the systems of the Intelligent Infrastructure to be effective, and not to be tailored for one of the systems to the detriment of the others, the data requirements across the Intelligent Infrastructure must be carefully analysed and defined. This process is essentially one of modelling, at various levels of abstraction, those parts of the real world which are to be encapsulated into the databases of the Intelligent Infrastructure. The eventual target is to produce a complete definition of all of the information for which the databases are being constructed. Thus the most important part of the data architecture process is deciding what data must be stored in order to meet the requirements of the Intelligent Infrastructure. The Requirements Report (SP2/IBM/14) contained a simple list of the data known at that point in the analysis – this deliverable builds on that simple list, using the knowledge and experience gathered during the execution of Work Package 2.4, to produce a conceptual data architecture.

The concepts that comprise a conceptual model are that there exist some things which have certain properties and which may be related in some way, or ways, to other things. The data represent specific facts about the things. Things in data modelling are referred to as entities, (Oxford English Dictionary – 'Entity – a thing's existence as opposed to its qualities'). Entities may be objects (an EV), or events (Charge Activity), or associations (EV Owner has an Account with an Electricity Retailer).

The key components of the report are:

- a set of Entity Descriptions which shows name, description and relationship to other entities
- an Entity Relationship Diagram showing the key data entities and the relationships between them - the key entities identified have been grouped together along the lines of a subject area or contextual model.

Please see the Glossary in Section 7 for definitions of the data modelling terms used in this document.

1.2. Key Analysis

A Conceptual Data Model identifies the highest-level entities and the relationships between them. Features of the conceptual data model:

- **Includes the *important* entities and their relationships** – further levels of analysis beyond the scope of this deliverable - (Logical, Physical) - will inevitably lead to the identification of further entities

- **No attributes are specified at this level of analysis**. ('Attributes' are the facts about the entity – for example, in the case of the EV entity – EV manufacturer, date of manufacture, type of battery, size of battery. This analysis is typically performed during the Logical Modelling Phase)
- **No cardinality is expressed**. ('Cardinality' defines one aspect of the relationship between entities – for example the EV–to- Battery relationship is, in cardinality terms, a 1 to 1 relationship – for every EV there will be one battery. This analysis is typically performed during the Logical Modelling Phase)
- **No primary or foreign keys are specified**. (This refers to the way in which the data is stored and accessed and is typically defined during the Physical Modelling Phase, we do not concern ourselves with this at this stage of analysis)

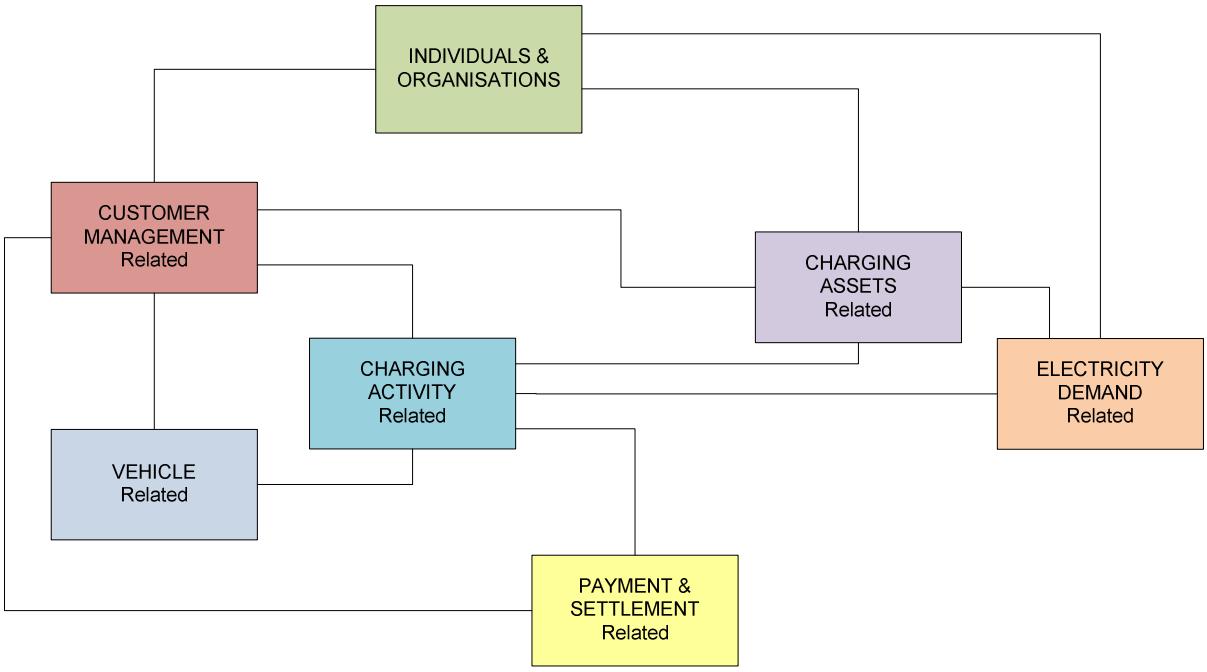
This report builds on the reports already produced and accepted as part of the Work Package 2.4 scope, including the Requirements Report (SP2/IBM/14), Conceptual Business Architecture Report (SP2/IBM/16) and Conceptual Application Architecture Report (SP2/IBM/17).

1.3. Main Conclusions

Note to reviewers - this document is a technical specification – it is not a report providing findings following some investigation. The conclusions presented below are in terms of the models which have been specified at their highest level of definition. These models will, in future phases of development of the Intelligent Infrastructure, be used as the basis for the Logical and Physical Models. As with any iterative analysis and design activity, there may be changes needed to these models as the development activity proceeds.

The data to be stored and processed by the systems of the Intelligent Infrastructure can be classified at the very highest level into the following seven subject areas, which are interlinked in some way or other as indicated in the diagram by the solid lines.

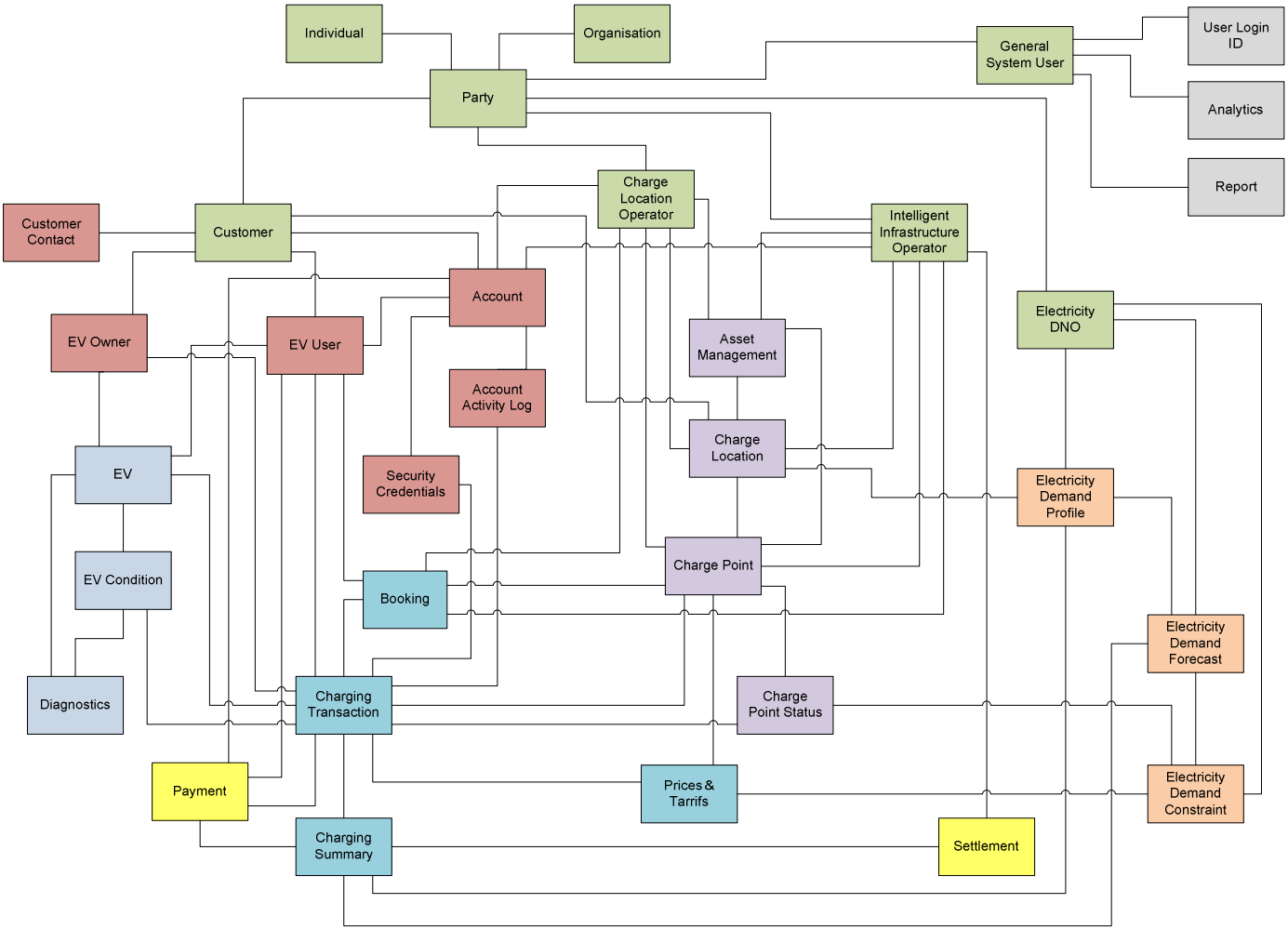
Subject Area View



- Individuals and Organizations – Grouping which relates to those who have some relationship or interaction with the electric vehicle, charging infrastructure, electricity network and other stakeholder activities.
- Customer Management – Grouping which relates to data and information about customers and users of the intelligent infrastructure, including vehicles.
- Electric Vehicle – Grouping which relates to data and information about the vehicle and the use of it. Includes static (master reference data) and transactional data.
- Charging Asset – Grouping which relates to data and information concerning the charging assets. Includes static (master reference data) and transactional information about the charging locations and the charging posts located at them.
- Charging Activity – Grouping which relates to data and information concerning the actual vehicle charging activity itself.
- Electricity Demand – Grouping which relates to data and information concerning the analysis of electricity demand and supply constraints relating to vehicle charging.
- Payment and Settlement - Grouping which relates to data and information concerning payment for vehicle charging and in the future, the potential for settlement of payments made between various actors involved in the provision of services for vehicle charging.

The entity relationship diagram explodes this subject area view into more details as shown below.

Entity Relationship Diagram



1.4. Links to previous deliverables

Following the ETI review of this document, Version 2 includes information illustrating the relationship of the key conceptual data entities to previous deliverables, including requirements and use cases (SP2/IBM/14), system context models (SP2/IBM/14 and SP2/IBM/16) and conceptual application components (SP2/IBM/17). The information to illustrate these links is:

- system context diagram overlaid with key conceptual data entities (see section 6.2 below);
- functional model overlaid with key conceptual data entities, (see section 6.3 below)
- matrix showing which key conceptual data entities are relevant to use cases (see section 6.4 below);
- matrix showing which key conceptual data entities are relevant for conceptual application components (see section 6.5 below);
- walkthrough diagrams overlaid with key conceptual data entities, (see section 6.6 below);

2. Information about this document

2.1. Purpose

This document is the Conceptual Data Architecture Report. It is one of a number of conceptual architecture reports which illustrate the shape and style of any potential architecture. Conceptual data modelling represents the initial stage in the development of the architecture and design of the persistent data and persistent data storage for the system.

This stage involves the identification of the high level key business and system entities and their relationships that define the scope of the problem to be addressed by the system. It helps to communicate a strategic overview and understanding of the major high-level groups of information needed to manage the business and support the processes in the process definitions.

As noted in the contract, the Conceptual view will not define cardinality of relationships and will not identify entity attributes which are essentially logical data model concerns.

2.2. Document Structure

This Report contains the following items:

- Executive Summary (previous section)
- Information about the document (this section)
- Context and Scope of a Conceptual Data Architecture
- High Level Subject Area Model
- Conceptual Data Model
  - Entity Relationship Diagram showing the key data entities and the relationships between them – does not include attributes or cardinality (see acceptance criteria);
  - Entity descriptions - Per data entity, showing name, description and relationship to other entities;
  - Conceptual Entity Relationship Matrix

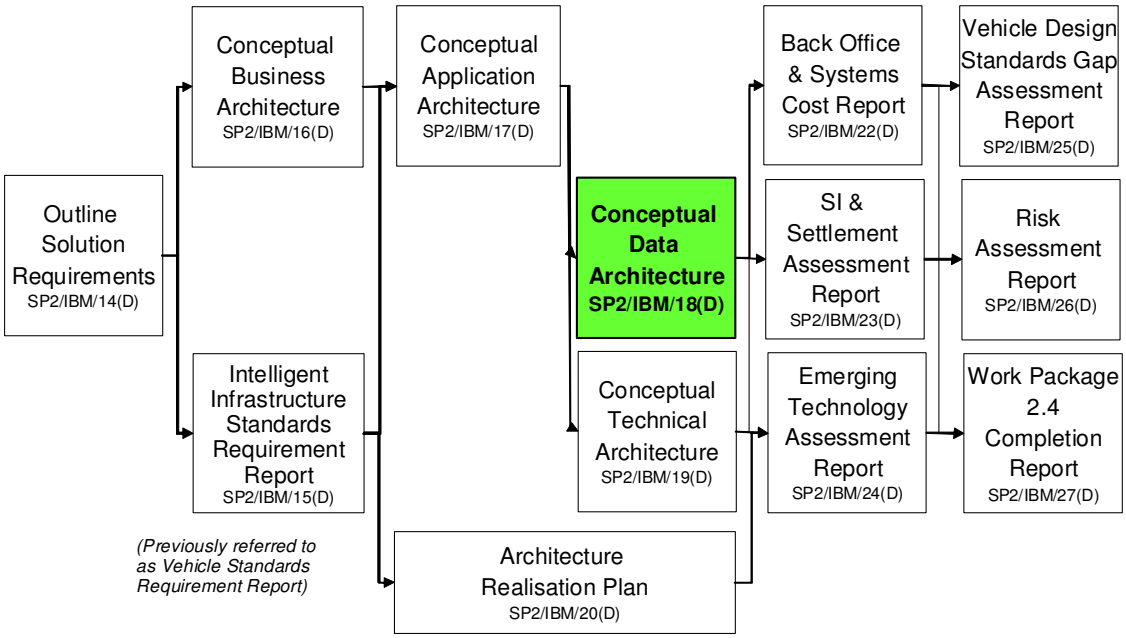
2.3. Acceptance Criteria

Complete when the final report comprises the following topics

- Document Structure - Explanation of how the documentation of the Conceptual Data Architecture is organised
- Entity Relationship Diagram - Showing the key data entities and the relationships between them. This deliverable will not define cardinalities. In a data model, entities can be related as any of: many-to-many, many-to-one, and one-to-many or one-to-one. This is said to be the cardinality of a given entity in relation to another
- Entity Descriptions - Per data entity, showing name, description and relationship to other entities. - This deliverable will not define entity attributes. Attributes are the key fields of information associated with the data entity e.g. name, address and price.

2.4. Positioning within the key Work Package 2.4 deliverables

This deliverable is shaded in both the model and table below. The table provides a brief overview of the full set of deliverables in WP2.4.



The Conceptual Data Architecture Report is one of a number of conceptual architecture reports which illustrate the shape and style of any potential architecture. As required in the acceptance criteria, it identifies the key entities and relationships between them.

The conceptual architecture reports provides information to support further activity in this phase around realisation planning and also give a foundation for the development of more detailed data architectures.

Section six of this Report illustrates the links and relationships with content in some of the other deliverables by use of diagram overlays and tables.

Deliverable	Outline
Intelligent Infrastructure Requirements Report	Outline solution requirements; High Level System Context; High Level Initial Use Case Model
Intelligent Infrastructure Standards Requirement Report	The report provides a list of areas that may require a standard; it will not attempt to define or set the actual standards.
Conceptual Data Architecture	**Entity Relationship Diagram showing the key data entities and the relationships between them and entity definitions showing name, description and relationship to other entities.**
Plan for Architecture Realisation	High-level plan defining scope, activities and deliverables required in Stage 2
Back Office and Supporting Systems	Estimate high level costs for the design and build of the back

Cost Report	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
Vehicle Design Standards Gap Assessment Report	Provides an Inventory of current vehicle design standards and a gap analysis of them against the requirements of the intelligent architecture
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

3. Context and Scope for Conceptual Data Architecture

3.1. Context

There are three levels of data architecture analysis – conceptual, logical and physical. The type of information and the complexity and depth of it increases as you move from conceptual to logical to physical.

- A conceptual data model identifies the highest-level entities and the relationships between them
- A logical data model describes the data in as much detail as possible, without any need to consider how the data will be physical implemented in databases
- A physical data model provides information that represents how the model will be built in the database.

The table below compares the different features.

Characteristic	Conceptual	Logical	Physical
Entity Name	◆	◆	
Entity Relationships	◆	◆	
Cardinality		◆	
Attributes		◆	
Primary Keys		◆	◆
Foreign Keys		◆	◆
Table Names			◆
Column Names			◆
Column Data Types			◆

The conceptual data model typically is coarse-grained and is intended to show the broad set of key entities and relationships under consideration. It is not intended to be granular enough in perspective for service specification, but rather to provide a high-level view of the information areas under consideration. This provides a foundation for any future activity in terms of logical and physical solutions and designs.

3.2. Scope of this Conceptual Model

The model describes entities at the highest level of definition which will be broken down further into sub-entities in subsequent levels of analysis.

In addition, a number of other aspects of data will need to be explored in future phases, such as:

- Master / Reference Data : Where will data be mastered; Where will data be sourced from; What approach will be taken for managing master data;

- External Interfaces : for example hooking into metering flows, customer registration, charge post implementation;
- Common Formats and Standards : across actors in different areas, for example account identifiers; ‘static’ charge post information; ‘dynamic’ status information for charge posts; identifiers to support roaming between networks

This further analysis will require close cooperation and coordination with other Intelligent Infrastructure actors and stakeholders.

4. High Level Subject Area Data Model

4.1. Introduction

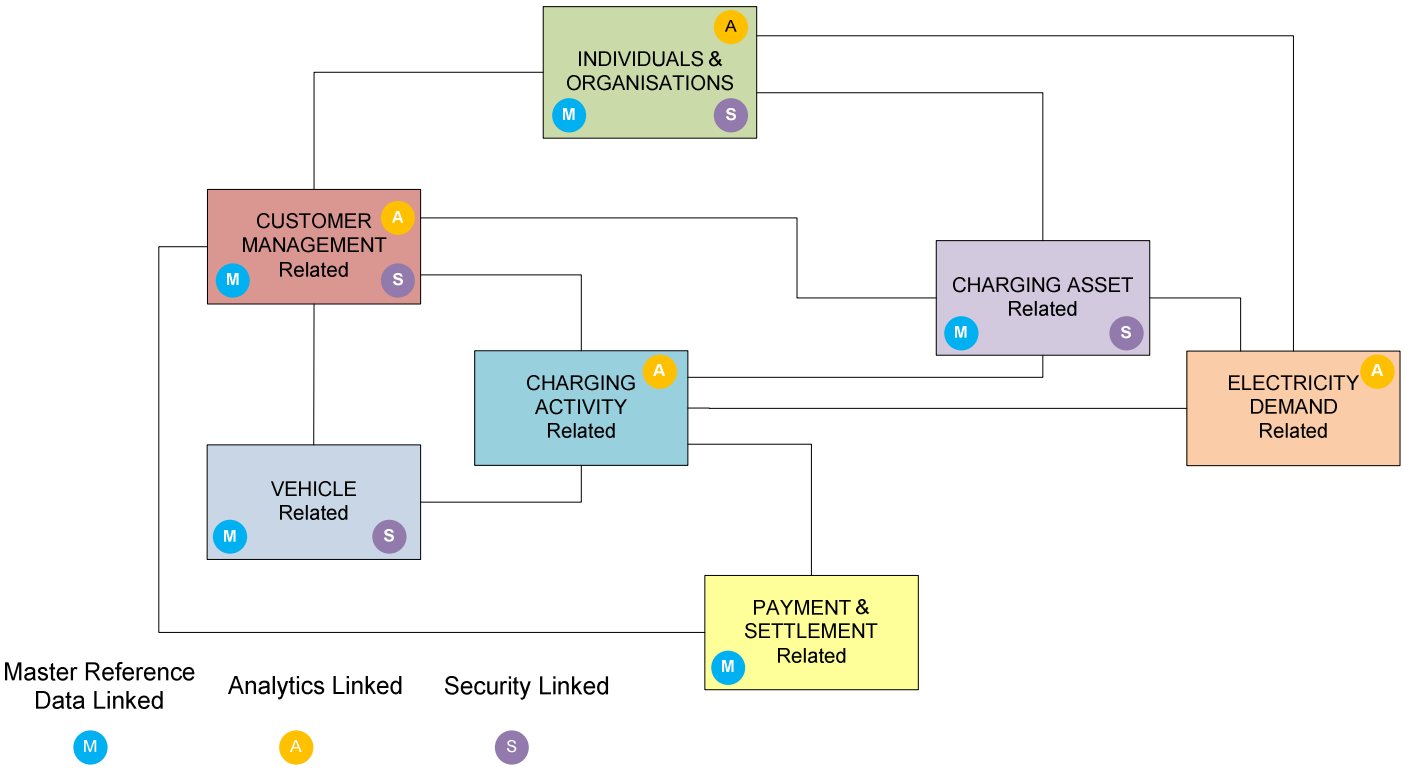
This section presents a High Level Subject Area Data Model, including:

- a diagram showing key data subject areas and the links between them;
- a set of Subject Area Entity Descriptions showing name, description and relationship to other entities.

4.2. High Level Subject Area Diagram

The diagram below illustrates the high level data subject areas. The subject areas are also annotated on the basis of:-

- having a strong element of master data,
- being key to the analytics functionality,
- being key to the security requirements.



4.3. Subject Area Definitions

The tables below provide a description of the subject areas and identify the key conceptual data entities that are related. These data entities then form the basis for the conceptual data model which follows.

Name	INDIVIDUALS & ORGANISATIONS
Description	Grouping which relates to those who have some relationship or interaction with the electric vehicle, charging infrastructure, electricity network and other stakeholder activities.
Includes	Customer; (EV Owner; EV User are sub-types) Charge Location Operator; Intelligent Infrastructure Operator; Electricity DNO; General System User (Government & Regulatory bodies, EV Manufacturers, Service Providers)

Name	CUSTOMER MANAGEMENT RELATED
Description	Grouping which relates to data and information about customers and users of the intelligent infrastructure, including vehicles.
Includes	Customer Contact EV Owner EV User Account Account Activity Log Security Credentials

Name	ELECTRIC VEHICLE
Description	Grouping which relates to data and information about the vehicle and the use of it. Includes static (master reference data) and transactional data.
Includes	Electric Vehicle EV Condition (would include battery condition information) Diagnostics (would include battery related diagnostic information)

Name	CHARGING ASSET RELATED
Description	Grouping which relates to data and information concerning the charging assets. Includes static (master reference data) and transactional information about the charging locations and the charging posts located at them.
Includes	Asset Management Charge Location Charge Point Charge Point Status

Name	CHARGING ACTIVITY
Description	Grouping which relates to data and information concerning the actual vehicle charging activity itself.
Includes	Booking Request Charging Transaction Charging Summary Prices & Tariffs

Name	ELECTRICITY DEMAND
Description	Grouping which relates to data and information concerning the analysis of electricity demand and supply constraints relating to vehicle charging.
Includes	Electricity Demand Forecast Electricity Demand Profile Electricity Supply Constraint

Name	PAYMENT & SETTLEMENT
Description	Grouping which relates to data and information concerning payment for vehicle charging and in the future, the potential for settlement of payments made between various actors involved in the provision of services for vehicle charging.
Includes	Payment (the actual payments and account, methods and types) Settlement (including statements and transactions)

Shown on the subject area diagram as annotations against the subject area entity groups are:-

Name	MASTER REFERENCE DATA
Description	Master Data is information that is non-transactional and is key to the operation of an organisation or business. Master data supports transactional processes and operations. It is not shown on the diagram as a separate subject area as there are many areas where master data is found.
Key Areas	Required in all subject areas where it is relevant, but particularly – Electric Vehicle, Individual, Charge Location, Payment, Settlement

Name	SECURITY
Description	Data relating to security will pervade areas of the data model where security considerations and information are required – the relevant subject areas are indicated.
Key Areas	Individual, Organisation, Charge Location, Electric Vehicle

Name	ANALYTICS
Description	Areas of the data model which are key to meeting the requirements of the analytics functionality are indicated against the subject areas.
Key Areas	Individual, Charge Activity, Electricity Demand

5. Conceptual Data Model

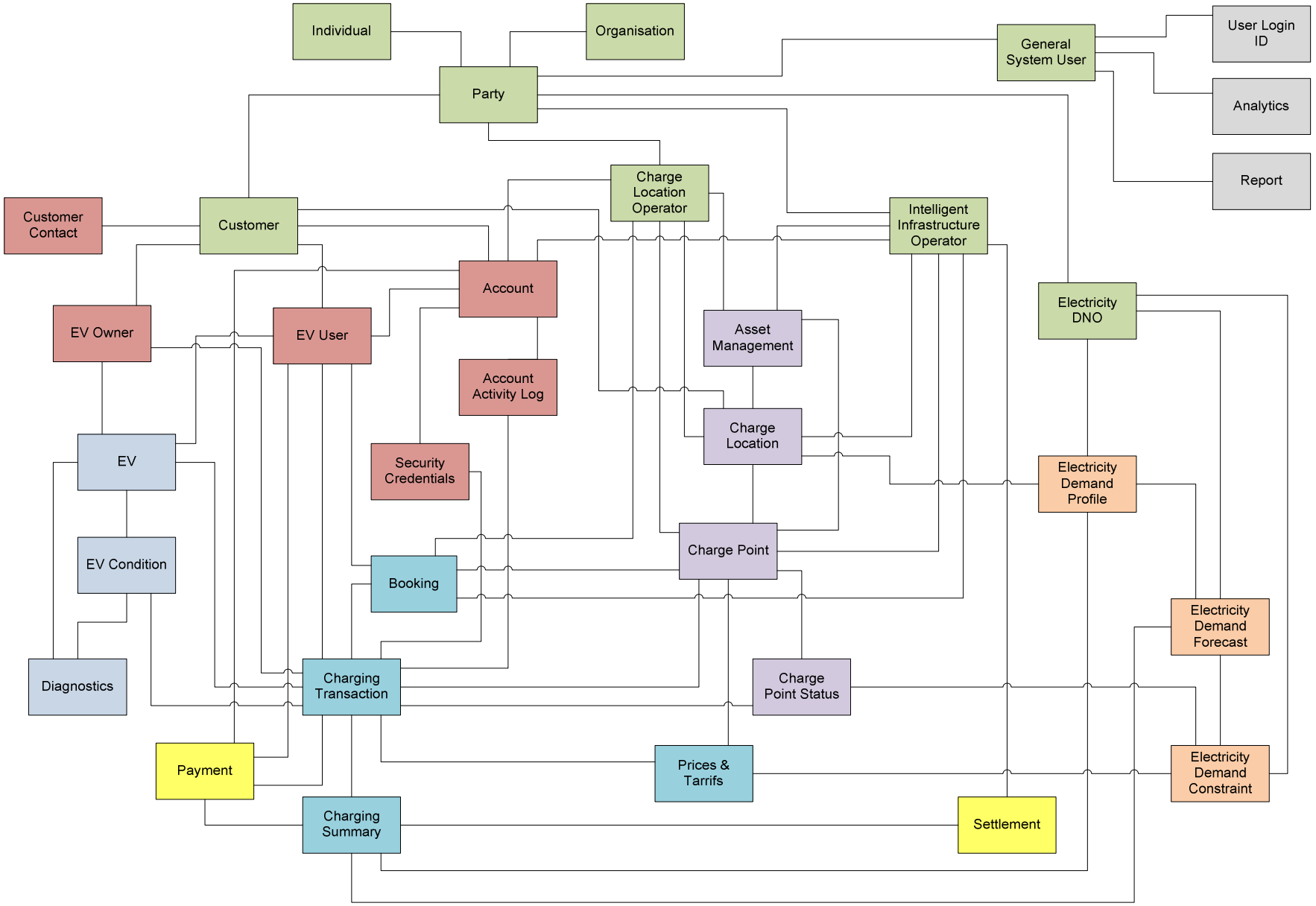
5.1. Introduction

This section presents the Conceptual Data Model which is made up of:-

- an Entity Relationship Diagram showing key data entities and the relationships between them;
- a set of Entity Descriptions showing name, description and relationship to other entities.

5.2. Entity Relationship Diagram

The figure below shows the Conceptual Data Model Entity Relationship Diagram.


Individual
Organisation
Party
General System User
User Login ID
Analytics
Report
Charge Location Operator
Intelligent Infrastructure Operator
Customer Contact
Customer
Account
Electricity DNO
EV Owner
EV User
Asset Management
Account Activity Log
Charge Location
EV
Security Credentials
Electricity Demand Profile
Charge Point
EV Condition
Booking
Electricity Demand Forecast
Diagnostics
Charging Transaction
Charge Point Status
Payment
Prices & Tarrifs
Electricity Demand Constraint
Charging Summary
Settlement

5.3. Entity Descriptions

These are the entity descriptions for the key data entities identified in the ERD.

5.3.1. Individuals & Organisations

Name	Individual
Description	Records details about a person who may be one sub-type of party
Relationships	. . is a type of Party
Notes	

Name	Organisation
Description	The details that are held for an Organisation. An Organisation may be one sub type of party.
Relationships	. . is a type of Party
Notes	

Name	Party
Description	Party is a convenient concept that allows us to deal with individuals or groups as if they were the same kind of entity. The ERD shows Party as a super-type of Individual and Organisation. The entity records details about a party who may progress into a role such as registered customer or operator
Relationships	. . can be an Individual . . can be an Organisation . . can have a role of Customer . . can have a role of Charge Location Operator . . can have a role of Electricity DNO . . can have a role of Intelligent Infrastructure Operator . . can have a role of General System User
Notes	

Name	General System User
Description	Refers to any Party that becomes a system user rather than a customer. This means it not only includes those specifically named in this conceptual model (DNO, Charge Location Operator, Intelligent Infrastructure Operator) but also includes other types of user such as Government & Regulatory bodies, manufacturers and dealers, etc. For these types of user, the main link is to analytics and reporting functionality and information.
Relationships	. . is a sub type of Party . . is owner of a User Login ID . . is a user of Analytics . . is a user of Reports
Notes	Analytics and Reporting will draw on data from across the portfolio of systems. The functionality and data available will vary from user to user based on their role.

Name	Customer
Description	Records details of customers that may be registered and have an account with an operator. The customer could be an individual or an organisation
Relationships	. . is a role of Party . . can be an EV User . . can be an EV Owner . . can have an Account . . initiates or receives a Customer Contact . . can be associated with Charging Location
Notes	Allows for a customer (a party with an account) to 'own' a charge location – the general scenario being considered here is a domestic charge point of an EV Owner / EV User.

Name	Charge Location Operator
Description	Holds information for the operator of non domestic charge locations or those providing services that supports the operation of charge locations. Intended mainly to refer to the operation of non domestic charge locations.
Relationships	. . is a role of Party . . can be operator of Account . . can be operator of Asset Management

	. . can own or operate a Charge Location . . can own or operate a Charge Point . . can manage a Booking
Notes	

Name	Intelligent Infrastructure Operator
Description	Holds information for the Intelligent Infrastructure Operator role - organisations designated as providing operational and technology services which support the roll out and operational aspects of Electric Vehicle usage
Relationships	. . is a role of Party . . can be operator of Account . . can be operator of Asset Management . . can own or operate a Charge Location . . can own or operate a Charge Point . . is administrator of Settlements . . can manage a Booking
Notes	Allows in this model for the Intelligent Infrastructure Operator to operate / manage aspects of charge locations not covered by a specific CLO

Name	Electricity DNO
Description	Hold information about the party performing the role of Electricity DNO
Relationships	. . is a role of Party . . manages Demand Forecast . . manages Demand Profile . . specifies Demand Constraints
Notes	Likely the DNO would use its own systems and data for load balancing as part of its normal activities. Information is likely to be fed in from EV charging activity as a load on the network.

Name	User ID
Description	Records the general system user identification details
Relationships	. . is associated with General System User
Notes	

Name	Analytics
Description	Represents the generation of and information about analytics. Placeholder for information about the analytics settings for particular types of users and eventually the actual analytics outputs themselves. The analytics functionality would ultimately be tailored to different types of user based on their needs and privileges
Relationships	. . is associated with General System User
Notes	Ultimately the eventual system design here would establish links to relevant data entities and attributes to allow user to undertake analytics activity.

Name	Report
Description	Represents the generation of and information about system reports. Placeholder for information about the reporting settings for particular types of users and eventually the actual reporting outputs themselves. The reporting functionality would ultimately be tailored to different types of user based on their needs and privileges.
Relationships	. . is associated with General System User
Notes	Ultimately the eventual system design here would establish links to relevant data entities and attributes to allow user to undertake reporting activity.

5.3.2. Customer Management Related

Name	Customer Contact
Description	Holds information relating to contact received or sent to a customer. Would include method of contact, subject area, a link to any original correspondence if retained in a document management system and possibly some indication of content.
Relationships	. . is associated with Customer
Notes	

Name	EV Owner
Description	Holds information about the Owner of an Electric Vehicle. The Owner could be an Individual or an Organisation. The Owner could also be a User.
Relationships	. . is owner of an Electric Vehicle . . is a type of Customer . . can be associated with a Charging Transaction
Notes	

Name	EV User
Description	Holds information about a User of an Electric Vehicle. The User could also be the Owner of a Vehicle but may also use other vehicles. A User may have an account with any charging infrastructure or scheme providers.
Relationships	. . utilises Electric Vehicle . . is a type of Customer . . can be involved in a Charging Transaction . . can hold an Account . . can be associated with Booking . . can make a / be responsible for a Payment
Notes	

Name	Account
Description	An account can be created for each Customer registered with a charging scheme or operator. An Account must be associated with exactly one Customer - typically a private individual or an organisation. This is not necessarily an account in the sense of payment but relates to the registering of a customer to a charging scheme or initiative.
Relationships	. . is held by Customer . . can be managed by Charge Location Operator . . can be managed by Intelligent Infrastructure Operator . . can be linked to an EV User . . have an Account Activity Log . . is associated with Security Credentials

	. . can be linked with a Payment
Notes	

Name	Account Activity Log
Description	Holds information relating to the activity undertaken through a registered Account concerning electric vehicle charging and use
Relationships	. . is associated with an Account . . records a Charging Transaction
Notes	

Name	Security Credentials
Description	Records information about security credentials that may be required for certain charge points and actions. Likely to include information such as user ID, serial number, type, issuer, registered account number, status, etc
Relationships	. . are registered to Account . . are associated with Charge Transaction
Notes	Can be delivered through a physical access token for example

5.3.3. Vehicle Related

Name	Electric Vehicle
Description	Records information about electric vehicles. This entity could be a placeholder for two variations of information. The first focus would be to provide a master data focused lookup of electric vehicle types, configurations, safety information, capabilities, etc. The second focus would be to provide a view of individual EV's linked to owners, user or charging schemes
Relationships	. . are registered to EV Owner . . are associated with EV User . . is informed by EV Condition . . can be associated with Diagnostics . . can take part in a Charging Transaction
Notes	

Name	EV Condition
Description	Holds information about the condition and state of the EV & Battery which can be used as part of the charge parameters
Relationships	. . relates to (an) Electric Vehicle . . can be referenced in Charging Transaction . . can inform a Diagnostic event
Notes	

Name	EV Diagnostic
Description	Holds information about diagnostics activity concerning the EV and battery system
Relationships	. . concerns (an) Electric Vehicle . . can be informed by EV Condition
Notes	

5.3.4. Charging Activity Related

Name	Booking
Description	Contains data relating to a booking that might have been made for a charging point. Would indicate things such as who the booking is for, how long and maybe things such as what type of charge is required
Relationships	. . can be made by an EV User . . is made for a Charge Point . . can be made with a Charge Location Operator . . can be made with an Intelligent Infrastructure Operator . . can be associated with Charging Transaction
Notes	

Name	Charging Transaction

Description	Contains information about all qualifying charging transaction events. This includes information prior to (parameters) and during the charging event. The parameters could include type of charge required, speed of charge required, time by when the charge must complete, price point, time period, etc. The other aspect here is the information about the active charging event – so things like when it started / stopped, current status (e.g. paused, in progress, etc), time left to complete, pricing, etc
Relationships	. . can be associated with an EV User . . can be associated with an EV Owner . . can be linked to a Booking . . can be accessed with Security Credentials . . is recorded in Account Activity Log . . takes place at a Charging Point . . updates / impacted by Charge Point Status . . references Charge Point Prices & Tariffs . . is summarised in Charging Summary . . can result in / require a Payment . . can impact / can be influenced by EV Condition . . involves an Electric Vehicle
Notes	As volumes of charging transaction increase, performance reasons may result in this information splitting – one table with more active event data (e.g. the current day) and another table with “historical” data.

Name	Charging Summary
Description	Contains information that summarises the charge transaction for use in certain processes. Could include information such as price, duration of charge, type of charge
Relationships	. . is derived from Charging Transaction . . can be linked with Payment . . can be used in Settlement . . provides information for Electricity Demand Profile . . provides information for Electricity Demand Forecast
Notes	

Name	Prices & Tariffs
Description	Contains data around the prices and tariffs relevant for charging. Can relate to a charge transaction and a particular charge point or location.
Relationships	. . can be used in a Charge Transaction . . can relate to a Charge Point . . can be affected by Electricity Demand Constraint
Notes	

5.3.5. Charging Asset Related

Name	Asset Management
Description	Contains data around the asset management activity related to charging assets – primarily locations and charging points. Used in this model to indicate the recording and use of information for things such as commissioning, planning, installation and maintenance of assets. It allows for there to be a view within the II of the activity taking place with the assets
Relationships	. . can be used in a Charge Transaction . . can relate to a Charge Point . . can be affected by Electricity Demand Constraint . . can be managed by Charge Location Operator . . can be managed by Intelligent Infrastructure Operator
Notes	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

Name	Charge Location
Description	Holds details of the charge location which is intended to refer to anywhere which has a specifically designated charge point. Can be a non domestic or domestic location. Would include the ID of any Charge Location Operator.
Relationships	. . can be managed / operated /owned by a Charge Location Operator . . can be managed / operated by Intelligent Infrastructure Operator

	. . can be owned by a Customer . . can contain Charge Points . . can be referenced by Asset Management . . can be included in Electricity Demand Profile
Notes	

Name	Charge Point
Description	Contains the static details of all specifically designated charge points recorded at charge locations.
Relationships	. . used during Charge Transaction . . can have availability recorded in Charge Point Status . . is located at a Charge Location . . can be reserved by Booking . . can be referenced by Asset Management . . can be associated with Prices & Tariffs . . can be impacted by Electricity Demand Constraint . . can be managed by Charge Location Operator . . can be managed by Intelligent Infrastructure Operator
Notes	

Name	Charge Point Status
Description	Contains data relating to the status of a charge point. Status values would indicate things such as available, in use, out of service, booked
Relationships	. . applies to a Charge Point . . is updated by a Charge Transaction . . can be updated by Electricity Demand Constraint
Notes	

5.3.6. Electricity Demand Related

Name	Electricity Demand Profile
Description	Contains data related to the profile of demand for electricity in relation to charging. Could provide historical and active information relating to a charge location.
Relationships	. . administered by Electricity DNO . . can include / relate to Charge Location . . can be updated / informed by Charging Summary . . can be used in Electricity Demand Forecast
Notes	DNO would most likely utilise information about charging events and locations within its own network management systems rather than that being replicated as part of any intelligent infrastructure provided system.

Name	Electricity Demand Forecast
Description	Contains data around the forecast for electricity demand at different locations. This is based on historical information from the DNO's own systems and from the II but could also be informed by other events that might impact the demand for electricity for charging.
Relationships	. . administered by Electricity DNO . . can be updated / informed by Charging Summary . . can be informed by Electricity Demand Profile . . can be linked to Electricity Demand Constraint
Notes	DNO would most likely utilise information about charging events and locations within its own network management systems rather than that being replicated as part of any intelligent infrastructure provided system.

Name	Electricity Demand Constraint
Description	Includes data around the nature of a demand constraint that impacts a charge location and the charge point(s) at the location. Could be time of use, amount of charge, type of charge, etc. Any constraint would be applied to the network and communicated to the charge infrastructure where relevant.
Relationships	. . administered by Electricity DNO . . can impact Charge Point Status . . can impact Prices & Tariffs

	. . can impact a Charge Location . . can be informed by Electricity Demand Forecast . . can be informed by Electricity Demand Profile
Notes	DNO would most likely utilise information about charging events and locations within its own network management systems rather than that being replicated as part of any intelligent infrastructure provided system.

5.3.7. Payment & Settlement Related

Name	Payment
Description	A record of the payment made in relation to a charging transaction. Used in this model at this point to also cover master data around payment types for example.
Relationships	. . is made by an EV User . . is related to a Charging Transaction . . can be included in Charging Summary . . can be linked with Account
Notes	

Name	Settlement Transaction
Description	Used in this model to refer to the settlement transactions and master data about settlement types, recipients and identifiers.
Relationships	. . can be generated from Charging Summary . . administered through Intelligent Infrastructure Operator
Notes	

5.4. Conceptual Entity Relationship Matrix

The table below summarises the existence of conceptual connections between the entities in the conceptual model. The information is captured in the definition tables but is presented here as a summary table.

	Individual	Organisation	Party	General System User	Customer	Charge Location Operator	Intelligent Infrastructure Operator	Electricity DNO	User Login ID	Analytics	Report	Customer Contact	EV Owner	EV User	Account	Account Activity Log	Security Credentials	Electric Vehicle	EV Condition	Diagnostics	Booking	Charging Transaction	Charging Summary	Prices & Tariffs	Asset Management	Charge Location	Charge Point	Charge Point Status	Electricity Demand Profile	Electricity Demand Forecast	Electricity Demand Constraint	Payment	Settlement
Individual			x																														
Organisation			x																														
Party	x	x		x	x	x	x	x																									
General System User			x						x	x	x																						
Customer			x									x	x	x	x																		
Charge Location Operator			x		x										x						x				x	x	x						
Intelligent Infrastructure Operator			x												x						x				x	x	x						x
Electricity DNO			x																										x	x	x		
User Login ID				x																													
Analytics				x																													
Report				x																													
Customer Contact					x																												
EV Owner					x													x				x											
EV User					x										x			x			x	x										x	
Account					x	x	x							x		x	x															x	
Account Activity Log															x							x											
Security Credentials															x							x											
Electric Vehicle													x	x					x	x		x											
EV Condition																		x		x		x											
Diagnostics																		x	x														
Booking						x	x							x								x					x						
Charging Transaction													x	x		x	x	x	x		x		x	x			x	x				x	
Charging Summary																						x							x	x		x	x
Prices & Tariffs																						x					x				x		
Asset Management						x	x																			x	x						
Charge Location					x	x	x																		x		x		x				
Charge Point						x	x														x	x		x	x		x						
Charge Point Status																						x					x				x		
Electricity Demand Profile								x															x			x				x			
Electricity Demand Forecast								x															x						x		x		
Electricity Demand Constraint								x																x	x	x	x	x					
Payment														x	x							x	x										
Settlement							x																x										

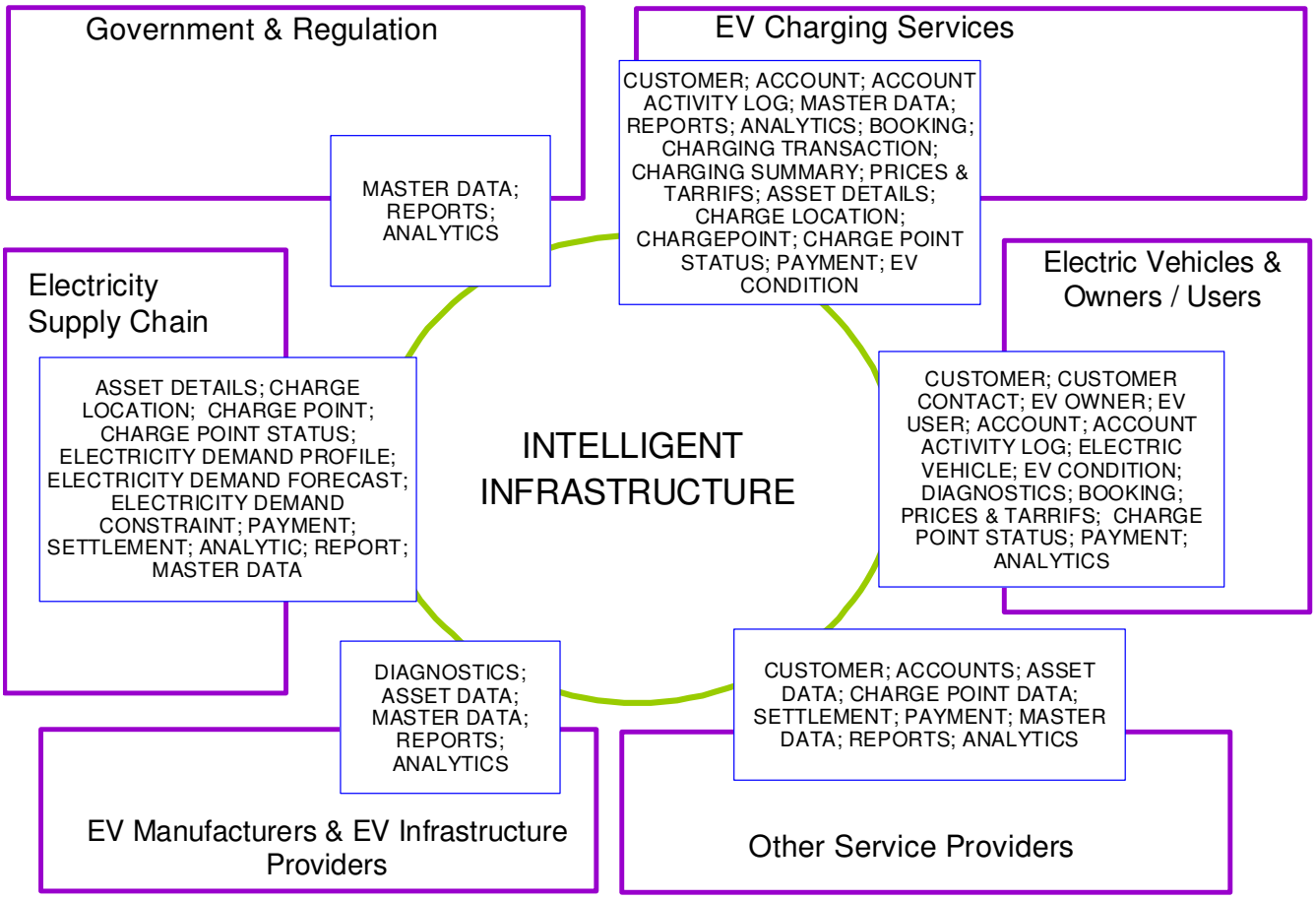
6. Relationship to other artefacts

6.1. Introduction

This section illustrates how the key conceptual data entities are related to and supportive of other intelligent infrastructure artefacts, in particular the requirements and the application components.

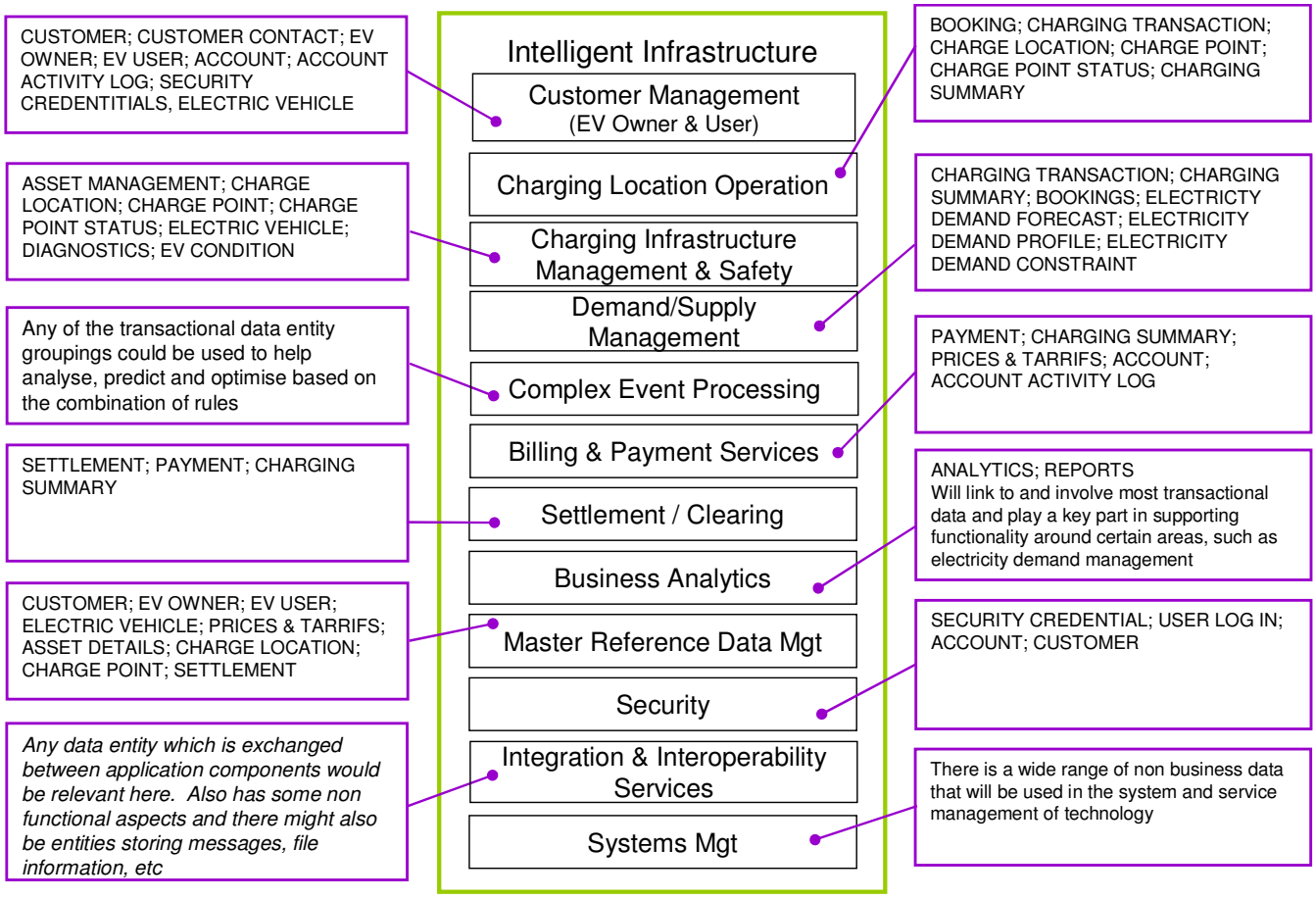
6.2. Level 1 System Context Relationship

The figure below shows the level 1 system context overlaid with key conceptual data entities. It provides a high level view of which data entities are most relevant in the relationships that exist around the intelligent infrastructure.



6.3. Conceptual Functional Description Relationship

The figure below shows the Conceptual Functional areas of the intelligent infrastructure and in each case highlights which key conceptual data entities have most relevance for the conceptual functional components that were identified in the Requirements Report.



6.4. Use Case Relationship Matrix

The matrix which follows illustrates the relationship between key conceptual data entities and the high level use cases from the Requirements Report. The dark blue cells indicate a strong connection, for example, the data is created, updated or drives the use case. A lighter blue cell indicates that the data entity is relevant to the use case but not created in it. The green cells for the three main commercial system users illustrate the use cases which are most relevant to those users.

DATA >> / High Level Use Cases	Charge Location Operator	Intelligent Infrastructure Operator	Electricity DNO	Customer	Analytics	Report	Customer Contact	EV Owner	EV User	Account	Account Activity Log	Security Credentials	Electric Vehicle	EV Condition	Diagnostics	Booking	Charging Transaction	Charging Summary	Prices & Tariffs	Asset Management	Charge Location	Charge Point	Charge Point Status	Electricity Demand Profile	Electricity Demand Forecast	Electricity Demand Constraint	Payment	Settlement
Customer Management – Account Management																												
Customer Management – Contact Management																												
Charging Location Management – Availability Management																												
Charging Location Management – Bookings Management																												
Charging Location Management – Charging Activity Management																												
Charging Location Management – Charging Activity Mgt V2G(rid)																												
Charging Location Management – Charging Activity Mgt 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																												
Master Reference Data Management																												
Business Analytics & Reporting																												
Manage Payments																												
Manage Security & Access																												

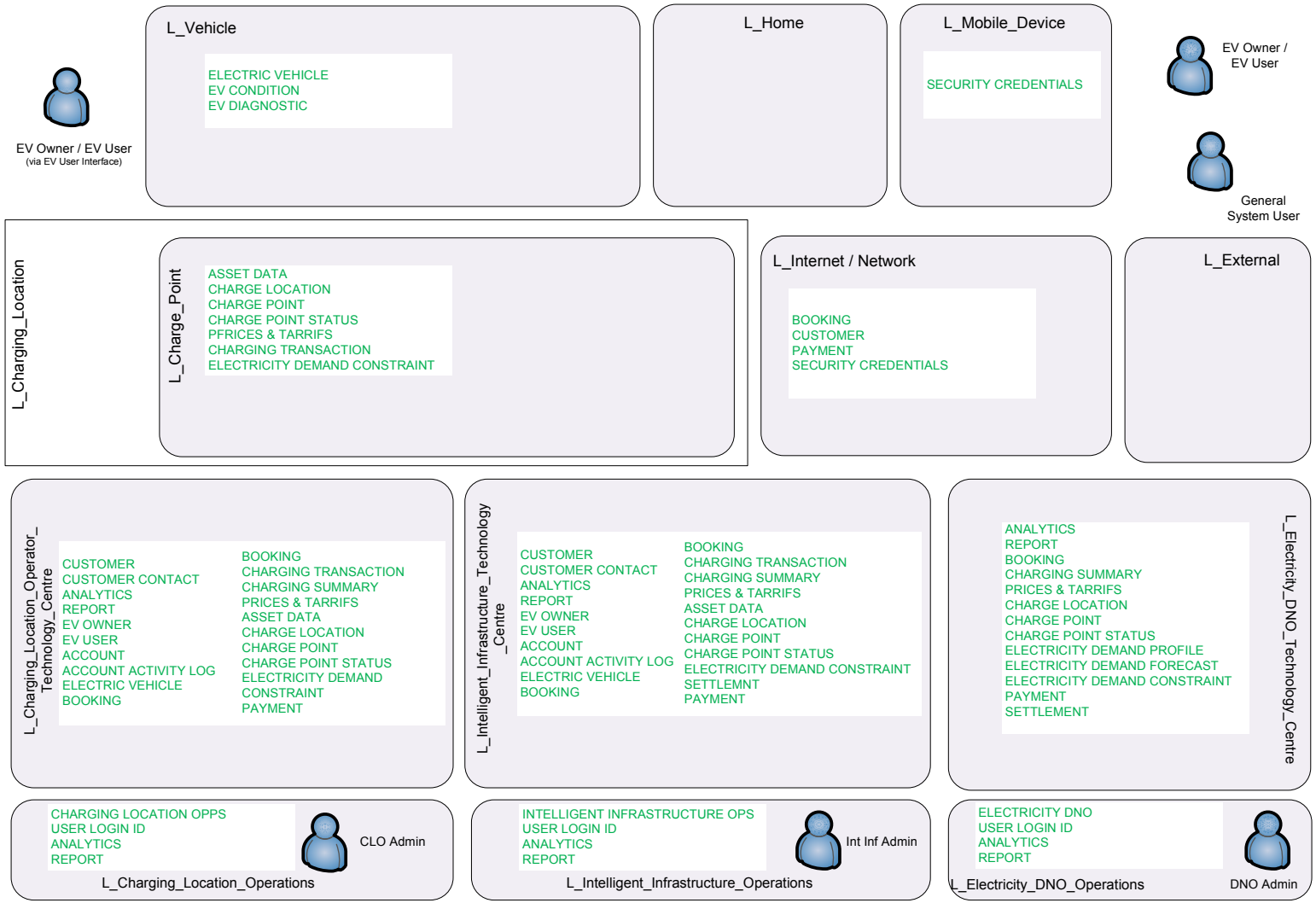
6.5. Conceptual Application Component Relationship Matrix

The matrix which follows illustrates the relationship between key conceptual data entities and the conceptual application components identified in the Conceptual Application Architecture Report. A dark blue cell indicates that the data is strongly connected with the application component, so for example, the application component might master, create or update a particular data entity. A lighter blue cell indicates that the data is used by that component.

Application Components \ DATA >>	General System User	Customer	Charge Location Operator	Intelligent Infrastructure Operator	Electricity DNO	User Login ID	Analytics	Report	Customer Contact	EV Owner	EV User	Account	Account Activity Log	Security Credentials	Electric Vehicle	EV Condition	Diagnostics	Booking	Charging Transaction	Charging Summary	Prices & Tariffs	Asset Management	Charge Location	Charge Point	Charge Point Status	Electricity Demand Profile	Electricity Demand Forecast	Electricity Demand Constraint	Payment	Settlement
User Portal		■				■	□		■	■	■	■	■	■				■	□	□	□				□				■	
Mobile User Interface		□				□						□		■				■			□		□	□	□				■	
EV User Interface						□									□	□	□		□						□					
Charge Point User Interface			■	■														□	■	□	□				■				■	
Charge Location Admin Portal	■	■	■			■	■	■	■																					
Electricity Utility Portal	■				■	■	■	■						■				□		□	■		□	□	□	■	■	■	□	□
Intelligent Infrastructure Admin Portal	■	■	■	■		■	■	■	■	■	■	■	■	■	■			■	□	□	□	■	■	■	■				■	■
EV Telemetry & Diagnostics Mgr										□	□				□	■	■													
EV Configuration & State Manager										□	□				□	■	■		■											
EV Communication Controller										□	□			□	□			□	■				□	□	□					
Customer Services Manager		■							■			■	■					■												
Charge Point Location Viewer			■	■																			□	□						
Charge Point Status Manager			■	■			■																		■					
Charge Point Comms Controller			■	■															■	■				■	■					
Charge Point Booking Manager		■	■	■					■									■								■	■	■		
Charge Point SCADA Manager			■	■																		■	■	■	■					
Charge Point Asset Manager			■	■																		■	■	■	■					
Charging Parameters Manager																■			■		■								■	
Charge Activity Monitor			■	■												■			■						■					
Post Charge Activity Processor			■	■	■		■	■											■	■						■	■	■	■	■
Electricity Demand Manager					■		■	■					□					□		■	□		□	□	□	■	■	■		
Settlement & Clearing Services Mgr				■			■	■												■	□								□	■
Payment Manager		■									■	■							■	□	■								■	
Billing Services Manager		□	□	□					□			□	□							□	□								□	□
Risk, Fraud & Compliance Manager							■	■					□							■									□	
Master Reference Data Manager		■								■	■				■						■	■	■	■					□	□
MRD - Charge Point Location Details																					■	■	■	■						
MRD - Charge Point Prices & Tariffs																					■									
MRD - Customer Details		■								■	■				■															
MRD - Settlement & Payment Details																													■	■
Security Manager	□		□			■								■																
Integration Manager	□		□																											
Information Manager	□		□																											
Analytics Manager	□		□				■																							
General Analytics																														
Electricity Load Forecasting Analytics																														
Customer Analytics																														
Charging Activity Analytics																														
Reporting Manager	□		□					■																						
Operational Reporting																														
Legislative & Regulatory Reporting																														

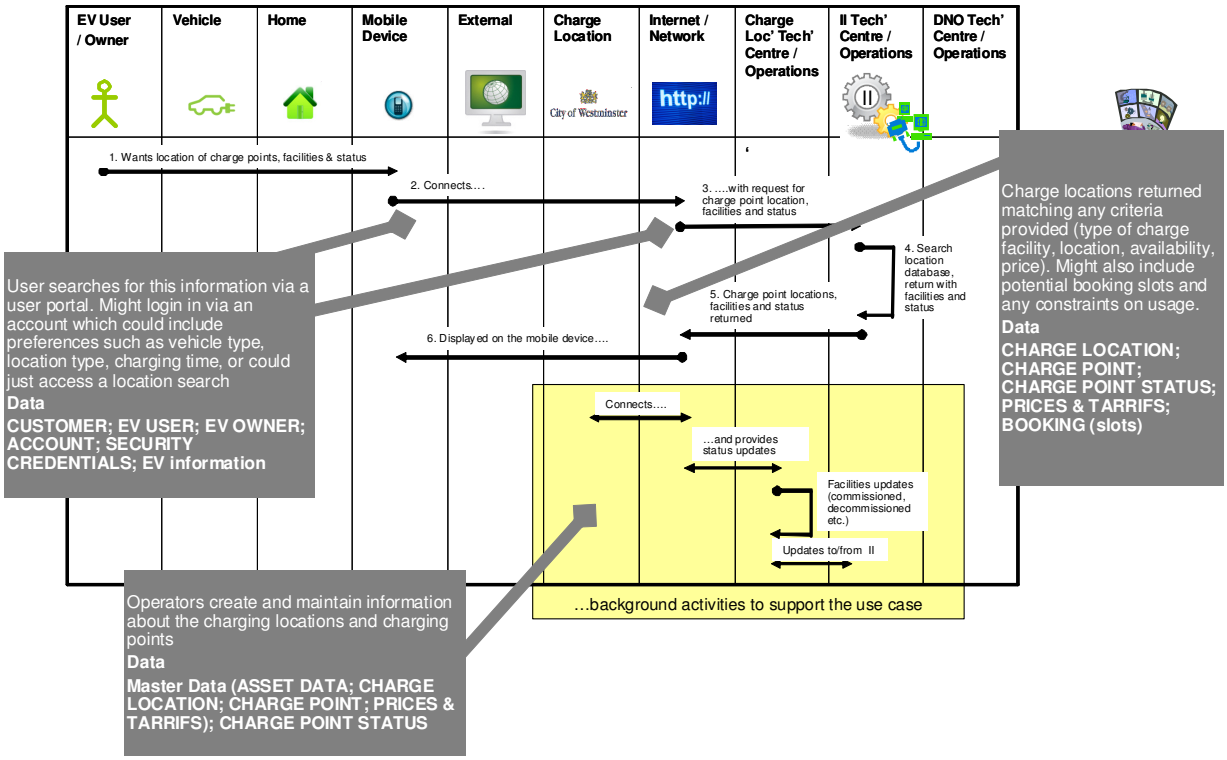
6.6. Conceptual Technical Architecture Relationship

The figures which follow indicate the relationship between the conceptual data entities and the conceptual technical architecture. The first figure illustrates where the conceptual data entities are most utilised set against the operational model.

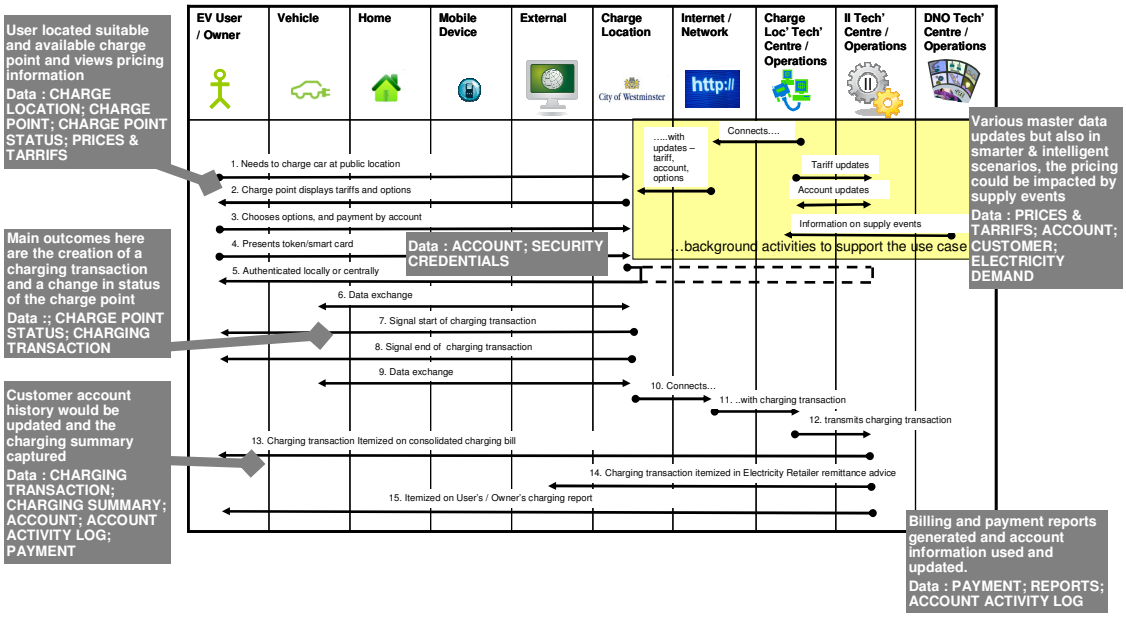


The other figures illustrate which conceptual data entities are involved in the sequence of activity shown on the walkthrough diagrams.

Locating a charging location, facilities available and current status - using a mobile device with key Conceptual Data Entities



Public Charging Location in the 'Smart Phase', payment by consumption on account – with key Conceptual Data Entities



7. Glossary

Attribute

A data item that has been defined as part of / attached to an entity. For example Surname could be an attribute of Customer entity, model could be an attribute of Electric Vehicle, etc.

Cardinality

Cardinality indicates the number of instances (one or many)of an entity in relations to another entity. The values that can be applied are:

- One-to-one : one instance of the first entity can correspond to only one instance of the second entity – for example a specific charge point and the charge location it is found at.
- One-to-many : One instance of the first entity can correspond to more than one instance of the second entity – for example a charge location can have many charge points
- Many-to-one : More that one instance of the first entity can correspond to the same instance of the second entity – for example many payments can relate to a customer
- Many-to-many : More than one instance of the first entity can correspond to more than one instance of the second entity

Conceptual Model

A conceptual data model identifies the highest-level entities and the relationships between them.

Entity

Person, place, thing or concept that has characteristics of interest to the enterprise and about which you want to store information.

Keys

- Primary – data item(s) whose values uniquely identify an instance of an entity – for example a vehicle registration number
- Foreign – data item(s) whose values are required to match a primary key in some other table – so often a foreign key matches the primary key of another table – for example Charge location ID could be a foreign key in the Charge Point entity

Logical Model

A logical data model describes the data in as much detail as possible, without any need to consider how the data will be physical implemented in databases

Physical Model

A physical data model provides information that represents how the model will be built in the database.

Relationship

A named connection or association between entities – for example EV *is owned by* EV Owner.