Programme Area: Light Duty Vehicles

Project: Electricity Distribution and Intelligent Infrastructure

Title: Completion Report - Systems Integration and Architecture Development

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 deliverable provides an overview of the stages of analysis. The details for each stage of analysis are documented in appendices.

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/27 ETI EV Intelligent Infrastructure – Completion Report – Systems Integration and Architecture Development

Version: 2.0

SP2/IBM/27 Header Page

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Deliverable Title	ETI EV Work Package 2.4 Intelligent Infrastructure - Completion Report - Systems Integration and Architecture Development
Deliverable Reference	SP2/IBM/27 version 2.0

Interim or Final	Final Report

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Version	History
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v2.0	10/02/2011 Updated following ETI Review

IP Ownership	As defined in the ETI Technology Contract

ETI EV Work Package 2.4

SP2/IBM/27 ETI EV Intelligent Infrastructure – Completion Report – Systems Integration and Architecture Development

Section 0 – Glossary

SP2/IBM/27 – Glossary (1/6)

Architecture - Business, Application, Data, Technical	Refers to high level designs for, respectively, EV Market Business Competencies (SP2/IBM/16), Intelligent Infrastructure Software Applications (SP2/IBM/17), Intelligent Infrastructure Data (SP2/IBM/18), Intelligent Infrastructure Technologies (SP2/IBM/19)
Back Office (Systems)	Refers to sets of systems which are not involved in the front line delivery of services but without which the ability to deliver would be seriously compromised.
Bank Clearing Services - BACS and CLS	BACS - Bankers' Automated Clearing Services - is responsible for the schemes behind the clearing and settlement of automated payments in the UK and maintaining the integrity of payment related services - Direct Debit and Direct Credit. CLS - Continuous Linked Settlement - is a process by which a number of the world's largest banks manage settlement of foreign exchange amongst themselves (and their customers and other third-parties)
Budgetary Estimates	Refer to estimations of cost typically generated at the Outline Business Case Phase of a Programme or Project which are used to inform the relevant actors of the size and scale of the project.
Business Analytics	See also Management Information Systems - the use and processing of operational data to identify business/operational/system improvements
Charge-on-the-go	Associated with Inductive Charging and the future capability of receiving small bursts of electrical charge from inductive charge points when waiting at traffic lights, junctions or passing through specific facilities
Charging Infrastructure (Public)	Refers to a future network of publicly accessible charge points
Charging Infrastructure/Charge Point OEM	Manufacturer of Charging Infrastructure, including charge points
Charging Location Operator (CLO)	Refers to an organization responsible for the provision of Charging Services to a customer base - may include provision of domestic charging services
Clearing	Refers to the identification of what transactions - in this case payment transactions related to EV charging - need to occur and between whom - see also Settlement
Conceptual Design	Refers to a high level design for the Intelligent Infrastructure which allows budgetary estimates for realization to be made and to identify areas where standards are needed
Context Diagram	A diagram that represents the actors outside a system that could interact with that system and provides the highest level view of that system.

SP2/IBM/27 – Glossary (2/6)

Customer (Relationship) Management Systems - 'CRM'	Software application used to manage all aspects of an organization's interaction with customers
Demand Side Management (DSM)	Refers to the modification of consumer demand for energy through various methods such as financial incentives and education - the goal being to encourage a reduction in peak hours demand, or to move the time of energy use to off-peak times such as night time and weekends. Peak demand management does not necessarily decrease total energy consumption, but could be expected to reduce the need for investments in networks and/or generation plant.
Distribution Network Operator (DNO)	Refers to the companies responsible for the distribution of electricity. Distribution remains a monopoly business and is a licensed activity.
Electralink	Electralink is 100% owned by the UK Energy Industry. All UK electricity suppliers use the service in support of core business processes, such as settlement, change of supplier and metering
Electric Vehicle OEM	Responsible for the manufacture of Electric Vehicles
Electricity Networks Strategy Group	The Electricity Networks Strategy Group (ENSG) provides a high level forum which brings together key stakeholders in electricity networks that work together to support government in meeting the long-term energy challenges of tackling climate change and ensuring secure, clean and affordable energy.
Electricity Supply Chain	Used to refer to the superset of companies which provide electrical power to consumers - Generators, Grid Operators, Network Operators, Retailers, Settlement Companies
Electricity Retailer	The company which a consumer buys electricity from - different to Generation, Grid and Distribution Operators
Elexon	Elexon is a not-for-profit company, funded by the parties to the Balancing & Settlement Code (BSC) - the rules that govern electricity trading in Great Britain
Embedded Energy Storage	Refers to the storage of electricity on a large scale - enabling power generated when demand is low to be stored for release at peak demand periods
ERP Systems	Enterprise Resource Planning Systems are large complex applications which are used to computerize and automate the business activities of an organization, including for example sales, finance, procurement etc.
Evolutionary Phase	Development of the Intelligent Infrastructure for Electric Vehicles was modelled in SP2/IBM/16 as 3 'evolutionary' phases - Simple, Semi-Intelligent, Smart

SP2/IBM/27 – Glossary (3/6)

Flywheel	An embedded energy storage technology - storage of energy as rotational energy
Grid	The national high voltage transmission of electricity from generators for onward distribution to consumers
Home Area Network	Enables remote connection and control of digital devices throughout the home, e.g. use of a mobile phone or computer to switch appliances on or off. Smart meters will integrate with the HAN and communicate peak energy use times to your digital devices.
Hub and Spoke	Refers to a set of related systems which have a relationship with each other via a Central Hub - compare to Peer-to-Peer. Great advantages in large interconnected landscapes in terms of reducing complexity, cost and enhancing maintainability.
Imbalance	Term used in Electricity Energy Settlement Process (see Elexon) - where actors provision or use of electricity differs from contractual agreement
Inductive Charging	Inductive charging uses an electromagnetic field to transfer energy between two objects
Intelligent Infrastructure	Provide Information Technology, Data and Services which support the roll out and operational aspects of Electric Vehicle usage
Intelligent Infrastructure Operator	Refers to the future organization tasked with operating the Intelligent Infrastructure
International Energy Agency (IEA)	The International Energy Agency (IEA) is an intergovernmental organisation which acts as energy policy advisor to 28 member countries in their effort to ensure reliable, affordable and clean energy for their citizens
ITIL Processes	ITIL - Information Technology Industry Library - refers to an industry standard set of processes for the management of IT within an organization
Load Balancing	Refers to the use of various techniques by electrical power stations to store excess electrical power during low demand periods for release as demand rises
Load Limiting	Refers to the practice of imposing an upper limit on the current that may be delivered to a load. Used here in relation to Smart Meter Functionality.

SP2/IBM/27 – Glossary (4/6)

Load Shedding	Refers to an intentional electrical power outage - used as a last-resort measure used by an electric utility company in order to avoid a total blackout of the power system. They are usually in response to a situation where the demand for electricity exceeds the power supply capability of the network. Used here in relation to Smart Meter Functionality.
Management Information System	Software application which aggregates and post processes operational data to provide 'information' often used as a basis for business improvement
Market Imperfection	Market imperfections generally, mean any deviation from the assumptions of perfect competition
Master Data Model	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.
Non Functional Requirements	Non-functional requirements (NFRs) specify 'how' the system should operate, rather than 'what' the system should do
Payment by Consumption	Payment of products and services actually consumed e.g. length of time parked and energy transferred - contrast with current charging payment models which are on a subscription basis and take no account of actual consumption.
Payment Types	Types considered for EV charging transactions are Subscription ('Club'); Electricity Account; Mobile Phone Account; Electronic Purse; Other Account; Pay as you Go
Peak Clipping	The process of implementing measures to reduce peak demand - (in this case for electricity)
Peer-to-Peer	Refers to a set of related systems which have a distinct relationship with each other - compare to Hub and Spoke. In large interconnected landscapes can result in complex 'spaghetti-like' interconnections
Portal	Software application which provides a user with access to data, information and software applications - providing a consistent look and feel - typically Web browser based.
Pumped Hydro Storage	One type of embedded energy storage where off peak electricity is used to pump water uphill which can then be released at later times of peak demand to drive turbines and generate electricity - see Dinorwig Scheme North Wales
Real Time (Dynamic) Data and Information	Data captured and relayed to a user/other system in a very short period of time - typically seconds, e.g. status of a charge point, amount of energy remaining in an EV battery.

SP2/IBM/27 – Glossary (5/6)

Realization	Implementing (designing and building) the required back office and supporting systems comprising the Intelligent Infrastructure. Realization refers to the process of taking a Project from a conceptual design through the phases of Analysis, Definition, Design, Build, Implementation and Handover to Live Operations. It does NOT include the day-to-day process of operation and maintenance
Roaming	Refers to the capability to recharge an EV from infrastructure which may be owned and operated by various different parties with which the EV user may not have a relationship cf - mobile phone roaming.
Run and Maintain Costs	Refers to the continuing operational costs associated with providing and maintaining an infrastructure
SCADA Systems	Supervisory Control and Data Acquisition systems refer to computer systems which acquire data (e.g. temperature, energy consumption, health of a system component) from (often remote) assets and may provide control functions (e.g. shut-down, start-up). In this case SCADA may be used to monitor remote charging infrastructure from a central location.
Settlement	Following on from Clearing, Settlement is the processing of the resultant payments and transfers
Smart Grid	A Smart Grid is an electricity network that can intelligently integrate the actions of all users connected to it - generators, consumers and those that do both - in order to efficiently deliver a sustainable, efficient and secure supply of energy
Smart Meter	A Smart Meter is an advanced meter that records consumption in intervals of an hour or less and communicates that information at least daily via some communications network back to the utility for monitoring and billing purposes. Smart meters enable two-way communication between the meter and the central system
Super-capacitors	An embedded energy storage technology - storage of energy electrochemically
Systems Integration	Refers to the process of linking together different computing systems and software applications physically or functionally
Telemetry and Diagnostic System	In this project refers to the control and monitoring systems on the Electric Vehicle itself
Use Case	Defines 'who' can do 'what' in the Intelligent Infrastructure
V2G, V2H, V2D	Vehicle to Grid, Vehicle to Home, Vehicle to Domestic refer to the usage of the batteries in electric cars as a dynamic energy storage with the energy being sold back or made available to the electricity grid or home in particular scenarios, such as high demand from other energy uses or network supply problems.

SP2/IBM/27 – Glossary (6/6)

Valley Filling	The process of implementing measures with the aim of shifting peak demand usage to low demand periods
Variable Tariff	Technique used to implement Demand Side Management - electricity tariffs highest at peak times/max CO_2 production, lowest at opposing end of the spectra.

ETI EV Work Package 2.4

SP2/IBM/27 ETI EV Intelligent Infrastructure – Completion Report – Systems Integration and Architecture Development

Section 1 – Executive Summary

SP2/IBM/27 Executive Summary (1/3) – Intelligent Infrastructure Key Messages

- The role of the Electric Vehicle Intelligent Infrastructure is to encourage mass-market take-up of EVs without compromising the Electricity Distribution Network by:-
  - supporting the Electricity Industry in mitigating the impact and costs of EV demand on the Electricity Generation and Distribution Network
  - supporting the creation of a market for the roll-out of public charging infrastructure
  - enhancing the EV user experience by helping mitigate EV constraints

- The Intelligent Infrastructure requires investment from multiple parties across the EV "system". Timing of these investments will vary according to actors' individual investment priorities, business cases and horizons

- The market structure is still evolving, and is beyond the scope of this deliverable. The role of regulation is likely to be significant and the emergence of standards and dominant designs is critical to investment and market growth.

- The EV market can still develop with a less Intelligent Infrastructure but user constraints are likely to limit growth to a lower rate of take-up

SP2/IBM/27 Executive Summary (2/3) – What are the key benefits of the Intelligent Infrastructure?

- The functionality provided by the Intelligent Infrastructure will encourage the development of a mass market for EVs by:-
  - promoting universal services for customers, including ease of payment and access to consolidated data and information
  - consistent access to a shared public infrastructure across the UK and beyond
  - common standards
  - encouraging competition amongst Charging Location Operators and Electricity Retailers

- The Intelligent Infrastructure assists the Electricity Industry to manage the impact and mitigate the risks of the introduction of Electric Vehicles:-
  - EV Demand Management, including payment by consumption, variable tariffs, load balancing, real time/dynamic information to users, physical control of charging locations
  - Data analytics and information about EV charging demand – to support control, forecasting and investment decisions
  - ….in combination with Smart Grids and Smart Meters, the Intelligent Infrastructure will allow the Electricity Industry to make reinforcements to the Distribution Networks in such a way as to minimise costs and improve time-to-market for new demand

SP2/IBM/27 Executive Summary (3/3) – Next Steps Stage 2

- More detailed Intelligent Infrastructure Design - Stage 2
- Specify trial-specific requirements and functionality - Stage 2
- Build and implement a reduced-subset Intelligent Infrastructure to demonstrate the concept for the trials in Stages 3 to 5
- Develop Business Cases for investment in the Intelligent Infrastructure
- Engage with regulatory bodies and Government agencies to help to shape the future regulatory landscape
- Engage internationally to ensure that global investment into the UK is maximized and compatible systems and structures are created

ETI EV Work Package 2.4

SP2/IBM/27 ETI EV Intelligent Infrastructure – Completion Report – Systems Integration and Architecture Development

Section 1 - Introduction

Background to the Work (1/2)

- The ETI is supporting the Office for Low Emission Vehicles by developing and testing viable pathways to a self-sustaining mass market for Ultra Low Carbon Plug-In Vehicles.
- The ETI's £11m plug-in vehicle projects are delivering objective and robust.....
  - Analysis of vehicle technology, performance and costs
  - Modelling of consumer attitudes, behaviours and societal acceptance

    …….via 'Sub Project 1'

  - Strategic planning tools for infrastructure deployment
  - System architecture to enable integration and compatibility

    …….via 'Sub Project 2'

  - Evaluation of the long-term economics and carbon benefits
  - Optimisation of strategic investment options for market transition

    …….via 'Sub Project 3'

- This is the Completion Report for **Work Package 2.4 of Sub Project 2** which has been delivered to:-

- ……via a consortium comprising the following organizations:-

Purpose and Objective of Sub Project 2 and the focus of Work Package 2.4

- Sub Project 2 of the ETI’s Programme on the Electrification of Light Vehicles (Stage 1) is concerned with the potential mass market for Electric Vehicles in the UK.

- It focuses on the potential impacts on the existing Electricity Distribution System and on the future infrastructure which might be needed.

- Future infrastructure includes both:-
  - the electrical infrastructure for vehicle charging and
  - the IT-based intelligent infrastructure to support:-
    - charging activities,
    - business models,
    - and business activities of any future mass market.

- Work Package 2.4 within Sub Project 2 is focused on the latter - the Intelligent Infrastructure - and provides a top down analysis of the possible Requirements, Scope, Conceptual Business and Technical Architectures, Budgetary Costs, Options and Risks. Standards which would assist in realizing the Intelligent Infrastructure are also covered.

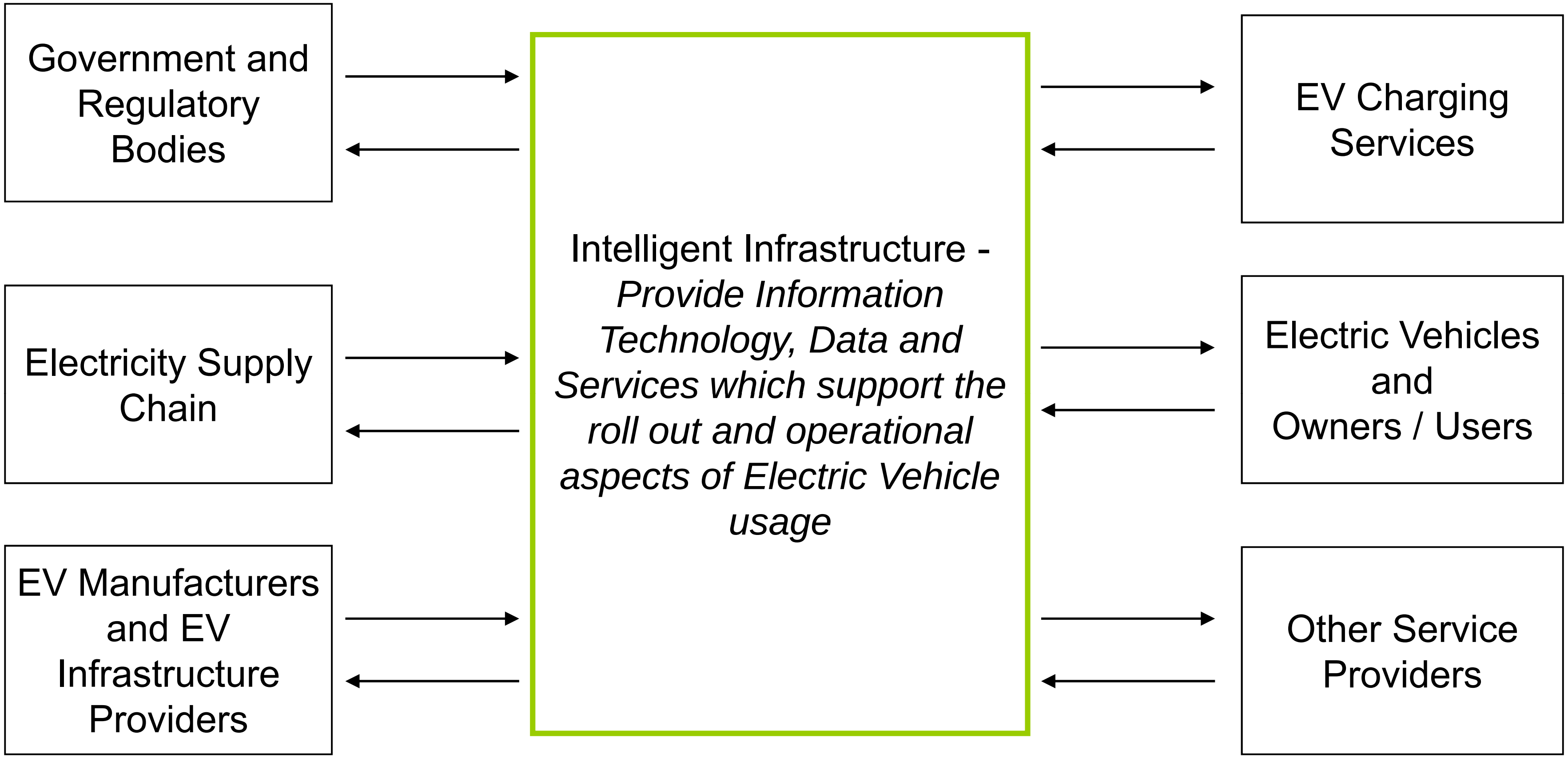
- Work Package 2.4 equates to an ‘Outline Business Case for an Intelligent Infrastructure’ looking across the newly emerging market for Electric Vehicles, and attempting to dimension the task of providing such an infrastructure.

Sub Project 2 Structure

Work Package	Description and Synopsis	Delivery Consortium Members
2.0	Lead Co-ordinator Management & Reporting – Project Management	IBM
2.1	Network Analysis - Determine what barriers may exist within the UK electricity distribution system, develop potential mitigation strategies and create a macro-level model to enable city-level planning of charging infrastructure deployment.	UK Power Networks; EDF; Imperial College London Consultants
2.2	Charging Network Requirements - To evaluate the different ways in which recharging infrastructure may be provided in the UK and recommend the requirements for the UK deployment.	e·on Engineering
2.3	Recharging Infrastructure Cost Driver Analysis - To evaluate the main cost drivers for plug-in vehicle recharging infrastructure, enabling a realistic forecast to be generated and the cost effectiveness of solutions in WP 2.1 to be evaluated.	UK Power Networks; EDF; Imperial College London Consultants
2.4	Intelligent Architecture - To determine the complexity and scope of the intelligent architecture.	IBM
2.5	Recharging Infrastructure Implementation - To determine the regulatory, legislative and commercial issues associated with recharging infrastructure and recommend how they should evolve for the UK deployment.	e·on Engineering
2.6	Consumer Testing Framework	

What is the Intelligent Infrastructure?

- The Intelligent Infrastructure provides Information Technology, Data and Services which support the roll out and operational aspects of Electric Vehicle usage.
- It lies at the centre of an ecosystem of stakeholders, partners, businesses and organizations which is described by the following context diagram:-

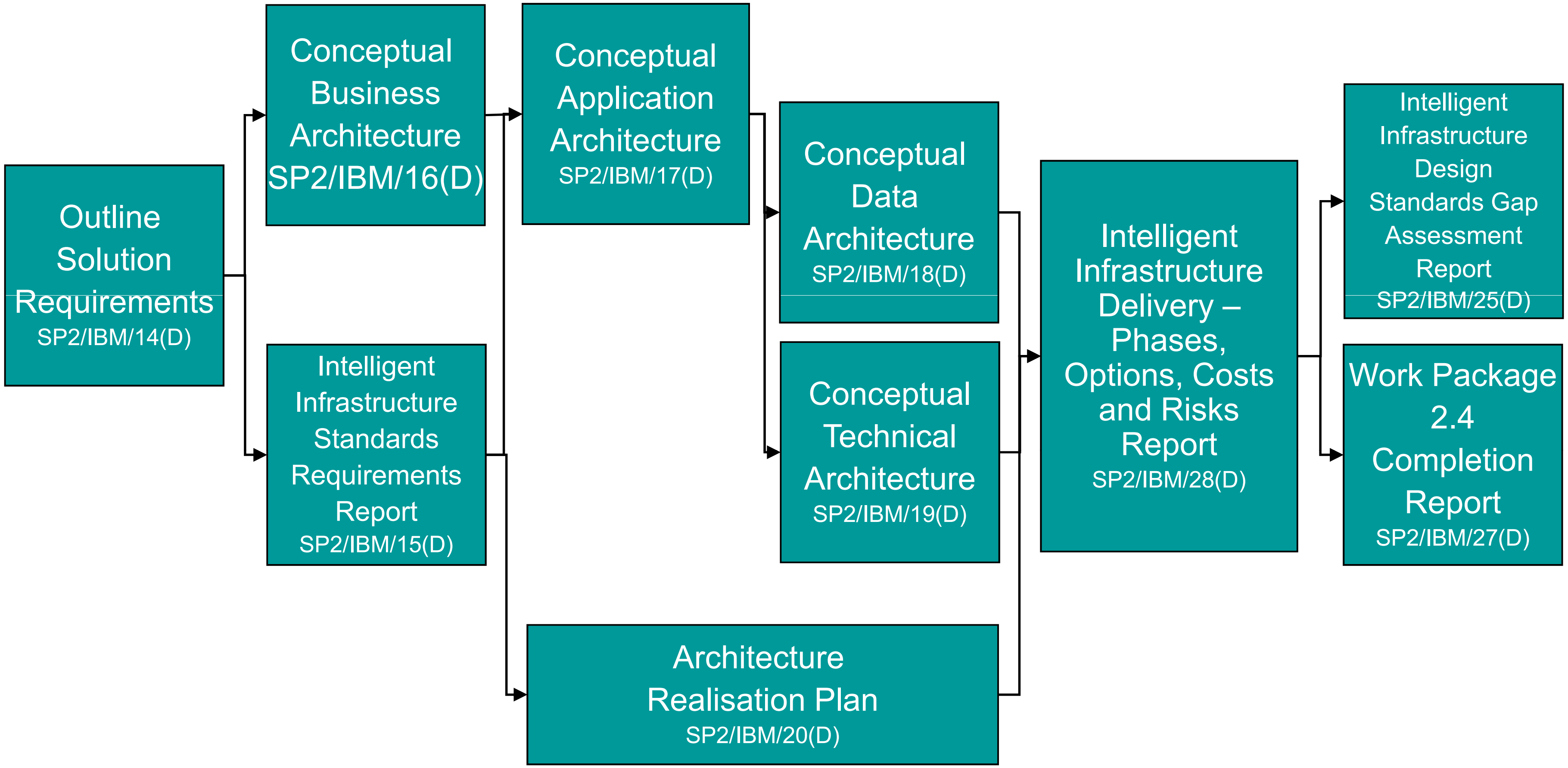


Strategic questions to be answered about the Intelligent Infrastructure by Work Package 2.4

- What are the possible requirements of an Intelligent Infrastructure?
- What sort of network of businesses and organizations might be needed to sustain and develop it?
- How might an Intelligent Infrastructure develop over time in terms of functionality and complexity?
- What might an Intelligent Infrastructure look like – high level – in terms of technology components?
- What data might an Intelligent Infrastructure have to process and store?
- What might the Systems Landscape of an Intelligent Infrastructure look like?
- How much is it likely to cost to design and build?
- What risks might be involved in realizing an Intelligent Infrastructure?
- What systems might an Intelligent Infrastructure have to integrate with?
- STANDARDS!?
- Settlement of Charging Transactions?
- There are a number of Emerging Technologies in Power Generation and Storage – what effect might they have?
- Which aspects of the Intelligent Infrastructure should be trialled by the ETI?

Answering the Strategic Questions through the Design of Work Package 2.4

- A scope and plan of work for Work Package 2.4 was designed to answer the Strategic Questions, consisting of a number linked deliverables each building on the analysis and findings of the previous. This is shown below:-



Deliverables, Descriptions and the Strategic Questions Being Answered

Area	Work Package 2.4 Deliverable	Description	Strategic Questions
Infrastructure Requirements	Outline Solution Requirements (SP2/IBM/14)	First cut analysis of the requirements of the Infrastructure through context diagrams and use cases.	What are the possible requirements of the Intelligent Infrastructure?
	Standards Requirement Report (SP2/IBM/15)	First cut analysis of where standards would be beneficial and what is currently being done by existing stakeholders.	In which areas of the infrastructure are standards necessary/beneficial?
Infrastructure Design	Conceptual Business Architecture (SP2/IBM/16)	Proposes a Business Component Model for the Electric Vehicle Market and describes an evolution path.	What sort of network of businesses and organizations might be needed to sustain and develop the infrastructure? How might it develop over time?
	Conceptual Application Architecture (SP2/IBM/17)	Provides a high level view of the technology components needed.	What might an Intelligent Infrastructure look like in terms of technology components?
	Conceptual Data Architecture (SP2/IBM/18)	Analysis of the data the Infrastructure might have to process and store	What data might an Intelligent Infrastructure have to process and store?
	Conceptual Technical Architecture (SP2/IBM/19)	A first view of the systems landscape – how components are distributed and connected across the ecosystem	What might the Systems Landscape of an Intelligent Infrastructure look like?
Infrastructure Realization	Architecture Realization Plan (SP2/IBM/20)	Plan for trialling key features of the Intelligent Infrastructure	Which aspects of the Intelligent Infrastructure should be trialled by the ETI?
	Delivery – Phases, Options, Costs and Risks (SP2/IBM/28)	Using the Conceptual Design for the Infrastructure, tackles issues around systems integration and emerging technologies. Provides estimates of cost and considers risks	How much is it likely to cost to design and build? What risks might be involved in realizing an Intelligent Infrastructure? What systems might an Intelligent Infrastructure have to integrate with? Settlement of Charging Transactions? There are a number of Emerging Technologies in Power Generation and Storage – what effect might they have?
	Design Standards Gap Assessment (SP2/IBM/25)	Firms up on the earlier Standards deliverable and recommends where standards would be beneficial wrt the conceptual design	In which areas of the infrastructure are standards necessary/beneficial?

The output of Work Package 2.4 and Input to other Sub Projects

- The budgetary estimates for designing and building an Intelligent Infrastructure coming out of Work Package 2.4 are to be combined with the electrical engineering estimates for providing intelligence (Work Package 2.5) to form the overall Network Intelligence Cost ('NIC')

- The NIC will be used by Sub Projects 1 ('Consumers and Vehicles'), and 3 ('Economics and Carbon Benefits') of the Programme to investigate:-

  – how in the case of the former, the additional cost of intelligence might affect consumer decisions, and

  – how, in the case of the latter, the cost might affect the economics of a mass market for plug-in vehicles.

- The next stages of the ETI Programme are to trial and pilot some of the concepts which have been analyzed in Stage 1 - this is planned for Stages 2 to 5 of the ETI's Programme.

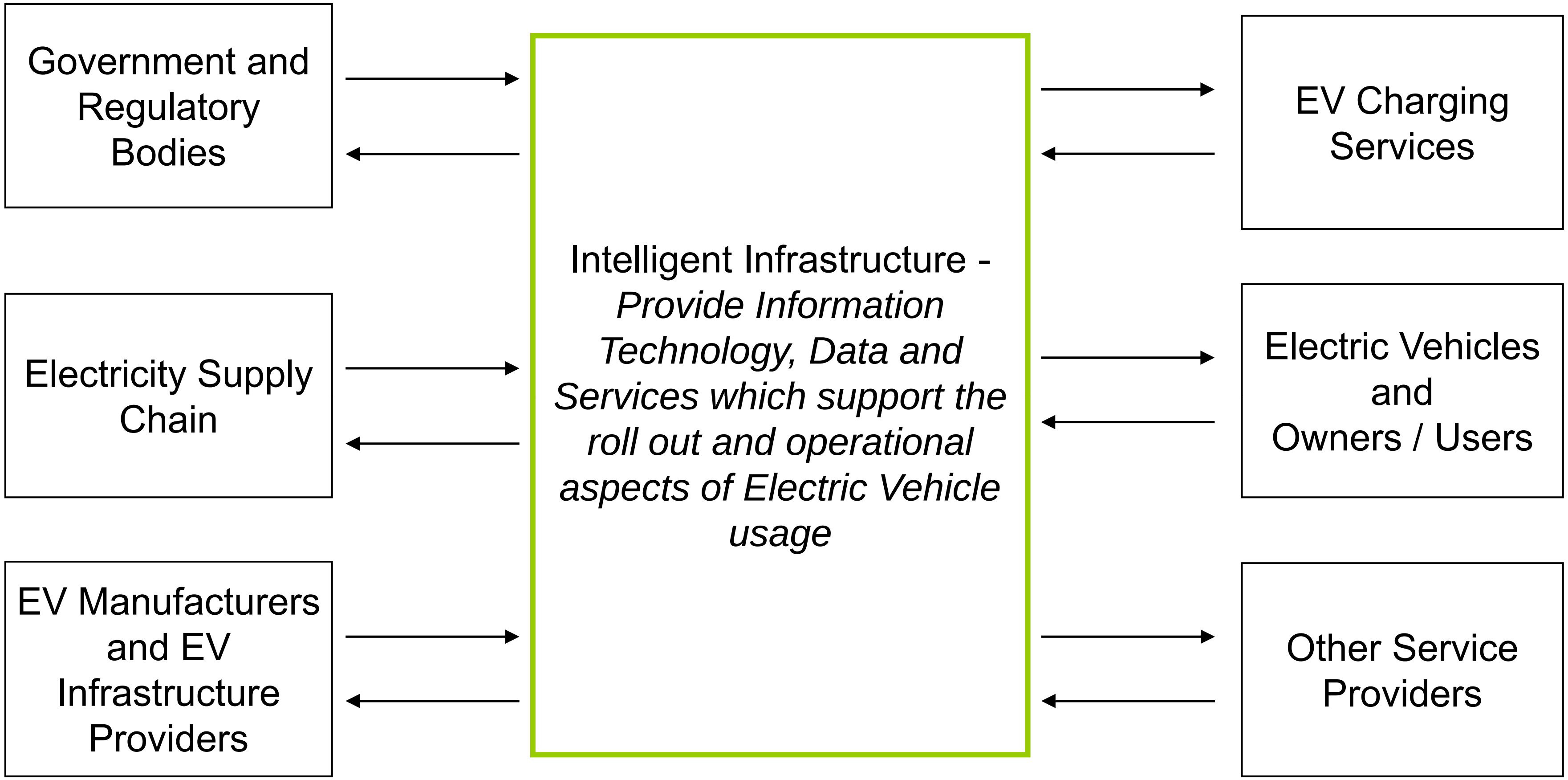
ETI EV Work Package 2.4

SP2/IBM/27 ETI EV Intelligent Infrastructure – Completion Report – Systems Integration and Architecture Development

Section 2 – Key Insights, Conclusions and Recommendations from Work Package 2.4 – *Infrastructure Requirements*

System Context Diagram for the EV Intelligent Infrastructure (SP2/IBM/14)

- The System Context Diagram for the EV Intelligent Infrastructure (below) is used to illustrate the boundary and scope of the 'system'. It identifies and depicts interaction with external interfaces and actors, and represents 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.



Context Diagram Actors' Key Motivations with respect to an Intelligent Infrastructure (SP2/IBM/14)

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

Intelligent Infrastructure Functional Requirements – ‘what the system has to do’ (SP2/IBM/14)

Provides services and information relating to registration, management and validation of a customer account where appropriate *(see notes)*

Data acquisition and management of assets - covering operational aspects status, safety alerts, maintenance, performance, firmware. Also includes telemetry and diagnostic data acquisition from vehicles

Additional functionality to aggregate and correlate events and apply rules to support decision making, optimisation and operation

Management of the settlement and clearing of billing and payments with operators and suppliers of services

Management of master reference data – both mastered in the system and when sourced from other systems of record

Services for communication and integration across components and actors – e.g. to the charging locations, between intelligent infrastructure instances, between the EV User (remote) and EV, and to external systems *(see notes)*

Intelligent Infrastructure

- Customer Management (EV Owner & User)
- Charging Location Operation
- Charging Infrastructure Management & Safety
- Demand/Supply Management
- Complex Event Processing
- Billing & Payment Services
- Settlement / Clearing
- Business Analytics
- Master Reference Data Mgt
- Security
- Integration & Interoperability Services
- Systems Mgt

Provides support for booking services, including information about availability, facilities, location and status of charging assets. Provides support for the charging activity itself e.g. charging variables *(see notes)*

Provides services which supports the management of electricity network load – e.g. impact of bookings and charging activities and the existence of any constraints

Provide support for managing payments and production of bills where eventual payment requires information from the system

Providing dynamic and static analytics – data warehousing; reports, dashboards, report generation, queries, etc *(see notes)*

Supports the provision of security controls covering users, hardware, data, applications, comms network

Management and operation of the Intelligent Infrastructure information systems making use of ITIL or similar standard processes

Intelligent Infrastructure Non-Functional Requirements (SP2/IBM/14)

- Non-Functional Requirements specify ‘how’ the system should operate, rather than ‘what’ the system should do

- 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.

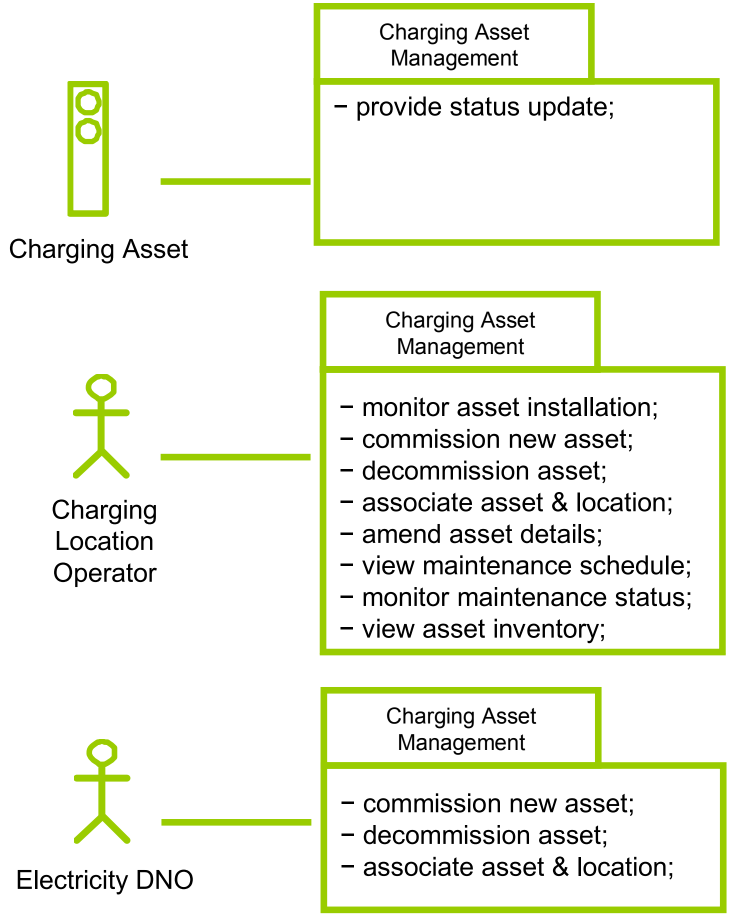
- The II should support a mechanism for enabling future trials in terms of being able to provide diagnostic and analytical information on usage, trends, etc.

Intelligent Infrastructure Use Cases (SP2/IBM/14)

- A 'Use Case' defines 'who' can do 'what' in the Intelligent Infrastructure. The following is the list of use cases defined:-
  - 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

Intelligent Infrastructure – Example Definition of a Use Case (SP2/IBM/14)

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	Operators and asset owners require 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.



EV Intelligent Infrastructure – Requirements for Standards (1) (SP2/IBM/15)

- Stakeholders in all areas of the market around vehicle electrification have indicated that the identification, definition and adoption of standards is key to enabling and accelerating wide-spread adoption of EVs. The standardisation of components such as electric plug connectors, communication protocols, billing arrangements, safety and telemetry are key areas

- Currently a wide variety of industry groups, working councils and research bodies are specifying and investigating candidate standards. For example, significant progress is being made through international bodies like SAE, ISO and IEC

- Policy makers are also aware of the need in this area - The European Union agreed in early 2010 that the European Commission should push for the standardisation of electric vehicles and lead in drafting a strategy to avoid obstacles that might delay deployment

EV Intelligent Infrastructure – Requirements for Standards (2) (SP2/IBM/15)

- Standardisation work should represent the interests of all stakeholders concerned, both producers and consumers. Having a pragmatic set of standards around the components of the intelligent infrastructure provides a number of benefits, such as:
  - encouraging investment and fostering innovation – contributing positively to the take-up of EVs;
  - providing reassurance and confidence in the quality of a product or service;
  - helping provide the EV user with a consistent recharging solution, for example, avoiding the need to carry different cables and access tokens;
  - supporting consistent and secure communication between key components and actors;
  - avoidance of serious barriers to any large scale deployment and adoption of EV's and infrastructure to support them;
  - providing useful education, presenting guidance and information to both user and manufacturer who want to make or use a new product;
  - supporting simplification and rationalisation, reducing time and material expenditures and thus allowing a conservation of energy and material resources – very relevant in the case of electric vehicles and the intelligent infrastructure;
  - contributing to future proofing, minimising the potential impact of taking decisions which might constrain the development of the industry or lead to technology and process dead ends.

Intelligent Infrastructure Requirements - Full Analysis

- The slides in Section 2 have been extracted and adapted from the following deliverables:-

Area	Work Package 2.4 Deliverable	Description	Strategic Questions
Infrastructure Requirements	Outline Solution Requirements (SP2/IBM/14)	First cut analysis of the requirements of the Infrastructure through context diagrams and use cases.	What are the possible requirements of the Intelligent Infrastructure?
	Standards Requirement Report (SP2/IBM/15)	First cut analysis of where standards would be beneficial and what is currently being done by existing stakeholders.	In which areas of the infrastructure are standards necessary/beneficial?

- These deliverables can be found in full in Appendix A.

ETI EV Work Package 2.4

SP2/IBM/27 ETI EV Intelligent Infrastructure – Completion Report – Systems Integration and Architecture Development

Section 3 – Key Insights, Conclusions and Recommendations from Work Package 2.4 – *Business Design*

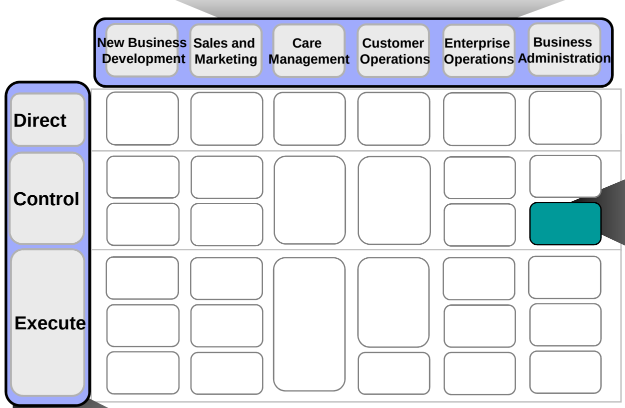
Intelligent Infrastructure – Background to the Business Design Activity

- Work Package 2.4 undertook the design of the Intelligent Infrastructure at 2 levels:-
  - Business Design
  - System Design
- …this section deals with Business Design
- Business Design used the technique of Component Business Modelling ('CBM') to describe the key business competencies and components required to support the roll out and operation of an intelligent infrastructure. Business competencies in CBM are defined as large business areas with characteristic skills and capabilities, for example 'Charging Location Infrastructure Provision', 'Charging Location Operation'. Business components are defined as a part of a competency that has a distinctive set of skills, for example 'Charging Location Construction', 'Domestic Charging Activity Control'. The model developed is concerned with competencies of the Electric Vehicle market which apply to the Intelligent Infrastructure, and not concerned with all competencies within the Electric Vehicle Market, e.g. the design and manufacture of EV regenerative braking systems. Those which feature in the model are competencies which an Intelligent Infrastructure actor may perform or competencies which fall under the provision of the infrastructure itself.
- The CBM model developed for the Electric Vehicle Market defines 10 Business Competencies needed to sustain and grow the market – they are Electric Vehicle and Battery System Delivery, Charging Location Infrastructure Provision, Charging Location Operation, Electricity System Operation, Customer Relationship Services, Payment / Billing / & Settlement Services, Intelligent Infrastructure Information Management & Analytics, Intelligent Infrastructure Provision, Beyond the Vehicle Services Provision, Strategy / Regulation & Legislation.

EV Intelligent Infrastructure – Component Business Modeling Format

A component business model is represented in the form of a grid or table as follows:-

Columns are **Business Competencies**, defined as large business areas with characteristic skills and capabilities, for example, product development or supply chain.



Cells are **Business Components** - parts of an enterprise that has a distinctive set of skills and the potential to operate independently – if sufficiently resourced, it could be a separate company or as part of another company.

Rows are structured by **Accountability Levels** which characterize the scope and intent of activity and decision-making. The three levels used in CBM are Directing, Controlling and Executing.

- Directing is about strategy, overall direction and policy
- Controlling is about monitoring, managing exceptions and tactical decision making
- Executing is about doing the work

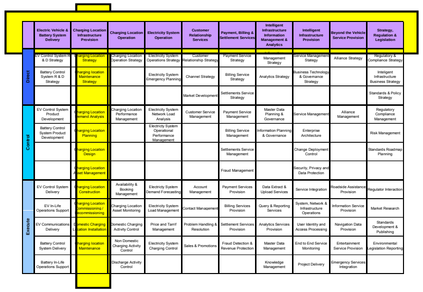
The full component model for the EV Intelligent Infrastructure is given on the next slide:-

EV Intelligent Infrastructure – Business Design - Component Business Model

	Electric Vehicle & Battery System Delivery	Charging Location Infrastructure Provision	Charging Location Operation	Electricity System Operation	Customer Relationship Services	Payment, Billing & Settlement Services	Intelligent Infrastructure Information Management & Analytics	Intelligent Infrastructure Provision	Beyond the Vehicle Service Provision	Strategy, Regulation & Legislation
Direct	EV Control System R & D Strategy	Charging Location Strategy	Charging Location Operation Strategy	Electricity System Operations Strategy	Customer Relationship Strategy	Payment Service Strategy	Information Management Strategy	Service Management Stategy	Alliance Strategy	Regulatory & Compliance Strategy
	Battery Control System R & D Strategy	Charging location Maintenance Strategy		Electricity System Emergency Planning	Channel Strategy	Billing Service Strategy	Analytics Strategy	Business Technology & Governance Strategy		Inteligent Infrastructure Business Strategy
					Market Development	Settlements Service Strategy				Standards & Policy Strategy
Control	EV Control System Product Development	Charging Location Demand Analysis	Charging Location Performance Management	Electricity System Network Load Analysis	Customer Service Management	Payment Service Management	Master Data Planning & Governance	Service Management	Alliance Management	Regulatory Compliance Management
	Battery Control System Product Development	Charging Location Planning		Electricity System Operational Performance Management		Billing Service Management	Information Planning & Governance	Enterprise Architecture		Risk Management
		Charging Location Design				Settlements Service Management		Change Deployment Control		Standards Roadmap Planning
		Charging Location Asset Management				Fraud Management		Security, Privacy and Data Protection		
Execute	EV Control System Delivery	Charging Location Construction	Availability & Booking Management	Electricity System Demand Forecasting	Account Management	Payment Services Provision	Data Extract & Upload Services	Service Integration	Roadside Assistance Provision	Regulator Interaction
	EV In-Life Operations Support	Charging Location Commissioning / Decommissioning	Charging Location Asset Monitoring	Electricity System Load Management	Contact Management	Billing Services Provision	Query & Reporting Services	System, Network & Infrastructure Operations	Information Service Provision	Market Research
	EV Communications Delivery	Domestic Charging Location Installation	Domestic Charging Activity Control	Price and Tarrif Management	Problem Handling & Resolution	Settlement Services Provision	Analytics Services Provision	User Identity and Access Processing	Navigation Data Provision	Standards Development & Publishing
	Battery Control System Delivery	Charging location Maintenance	Non Domestic Charging Activity Control	Electricity System Charging Control	Sales & Promotions	Fraud Detection & Revenue Protection	Master Data Management	End to End Service Monitoring	Entertainment Service Provision	Environmental Legislation Reporting
	Battery In-Life Operations Support		Discharge Activity Control				Knowledge Management	Project Delivery	Emergency Services Integration	

EV Intelligent Infrastructure – Business Design – Competencies and Components

- For each Competency and Component, the model provides a definition, examples:-



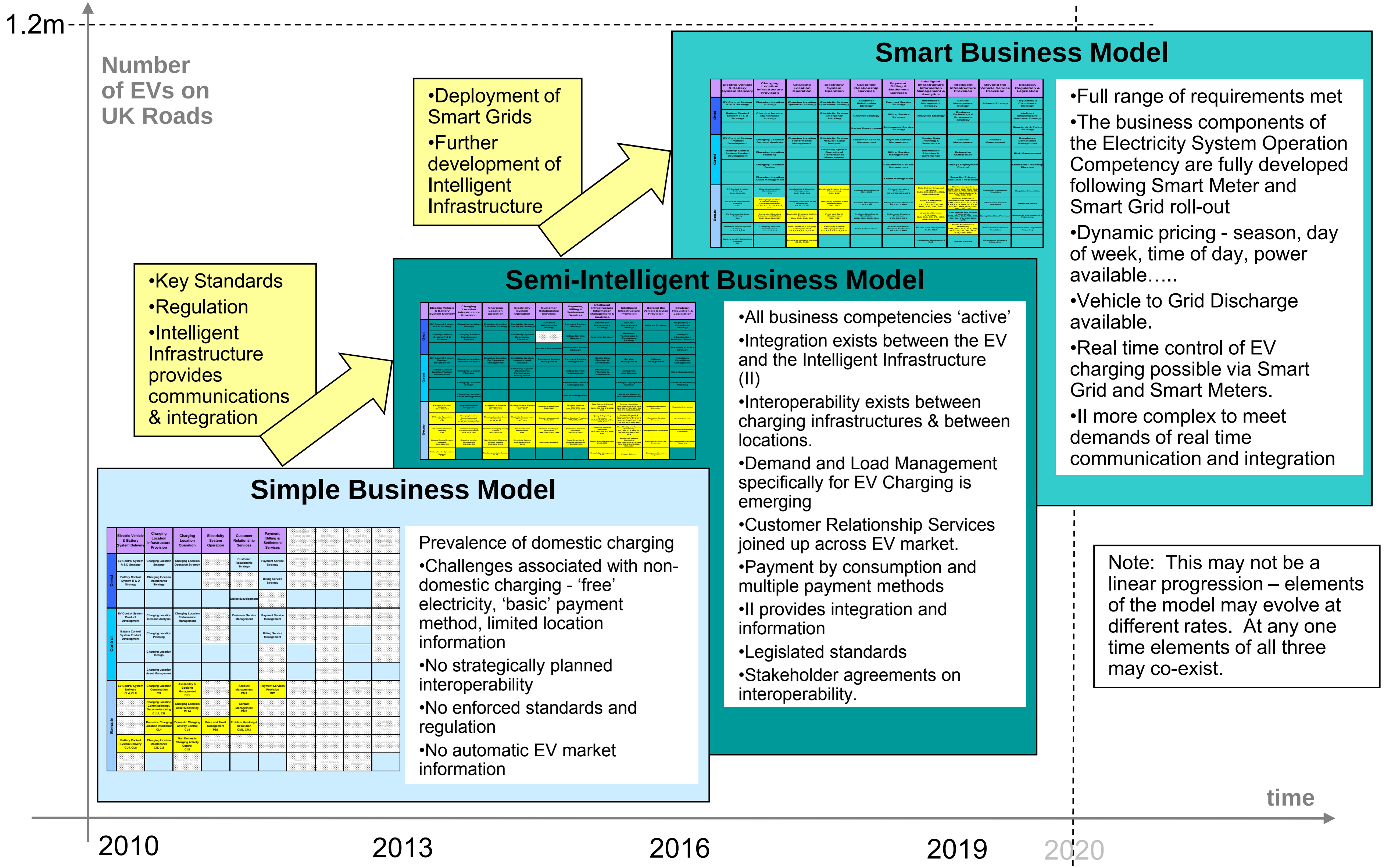
Business Competency	Business Competency Definition
Electric Vehicle & Battery System Delivery	This competency is focused on the research, design, development and subsequent operation of the control systems that will be part of electric vehicles and batteries. These control systems will be the mechanism by which the EV and battery will participate in the end to end evolution and operation of the intelligent infrastructure. This may include functionality in support of business processes and not just communication/interoperability services. Whilst this will be an area of significant differentiation between OEMs, aspects of these systems could be standard across EV and Battery providers, e.g. message protocols and functionality such as monitoring safety.
Charging Location Infrastructure	This competency is focused on the planning, construction, commissioning and maintenance of charging location infrastructure. It covers domestic, private commercial and public commercial charging locations. Charging Location Infrastructure relates to the non regulated electricity infrastructure, as against the regulated infrastructure which the DNO is responsible for.

Component	Dimension	Description
Charging Location Strategy	Direct	Charging Location Strategy establishes the strategy for the development of charging locations. Most likely to be multiple strategies across stakeholders and market segments. It creates and maintains the roadmap and approach for achieving objectives, and outlines the resources required and activities involved
Charging Location Demand Analysis	Control	Charging Location Demand Analysis concerns monitoring and identifying demand in terms of new charging locations but also at existing locations. Considering factors including trends, usage patterns, EV take up, types of charging activity and complementary developments. The latter could include establishing the potential for EV charging at new out of town commercial developments. It specifies and manages the processes, activities, rules and exception handling that will be applied to the services.
Charging Location Design	Control	Charging Location Design deals with the design of the location in terms of safety, usability, interaction, effectiveness and efficiency.
Domestic Charging Location Installation	Execute	Domestic Charging Location Installation relates to providing the assets that will manage and deliver the charging activity at the charging location. This could include installing a smart meter in the home as well as installing charging posts
Charging Location Maintenance	Execute	Charging Location Maintenance is an activity connected to the maintenance of charging locations and the assets at those locations. Enables assets to be kept operational and for information to be provided about the status of the assets

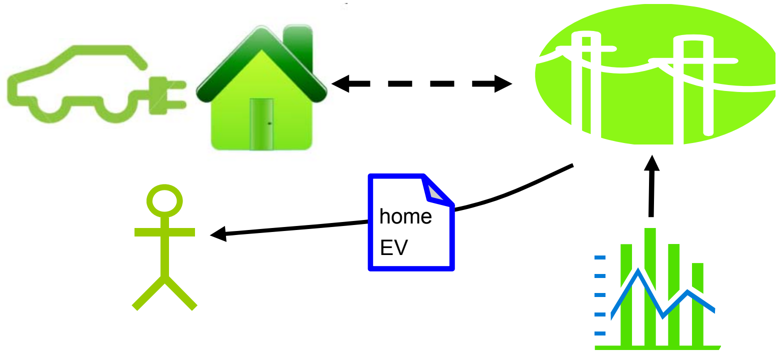
Business Design - Evolutionary Models

- There will be an evolution of the Intelligent Infrastructure – with Business Competencies and Components emerging over time. This evolution was mapped as a three phase process:-
  - Simple Phase Model
  - Semi-Intelligent Phase Model
  - Smart Phase Model
- Simple Model Summary:-
  - A contrived market (stimulated heavily by public investment) which exists on processes not sustainable for a mass market/long term (e.g. free electricity in non-domestic charging / no way to influence charging behaviour) requires only a limited number of competencies and components principally in the areas of EV Battery System Delivery and Charging Location Infrastructure Provision and Operation.
  - Movement to the Semi-Intelligent Model requires standards in key areas (see SP2/IBM/15 & 25), regulation, and the provision of market wide communication and integration via an Intelligent Infrastructure. Timing of the move to the next evolutionary model is down to the growth in the EV market driven principally by external factors (EV Price, Battery Technology, Alternative Technologies).
- Semi-Intelligent Model Summary:-
  - A market which is growing and approaching 'mass' needs all of the competencies in the Conceptual Business Architecture to a lesser or greater degree. Integration exists between the EV and the II, interoperability exists between charging infrastructures & between locations, electricity demand and load management specifically for EV charging is emerging (but not fully developed), customer relationship services are joined up across the EV market, payment by consumption and multiple payment methods are available, II provides integration and information, legislated standards exist in key areas, stakeholder agreements exist on interoperability.
  - Movement to the Smart Business Model is heavily, but not wholly, dependent on the roll out of Electricity Supply Chain Smart Technology – meters and grids. Timing of the move is dictated by the growth in the EV market and the urgency to manage electricity demand for EV charging and other purposes.
- Smart Business Model Summary:-
  - A mature market, the full range of requirements (SP2/IBM/14) met. The business components of the Electricity System Operation Competency are fully developed following Smart Meter and Smart Grid roll-out, allowing dynamic pricing – season /day of week / time of day / power available and real time control of charging possible. Vehicle to Grid Discharge is available. The II has grown in complexity to meet demands of real time communication and integration.
- The following slide provides a graphical summary

Business Design – Evolutionary Models Road Map

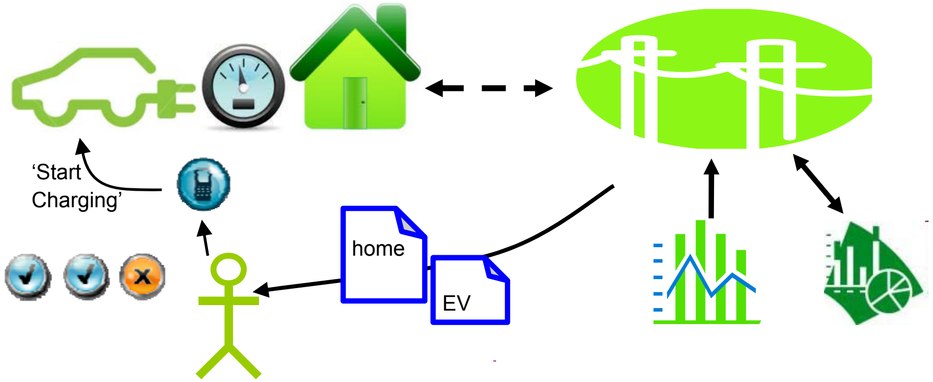


To illustrate the Evolutionary Process – a number of illustrative Process Models were developed – an example is given below for Domestic Charging (from SP2/IBM/16)



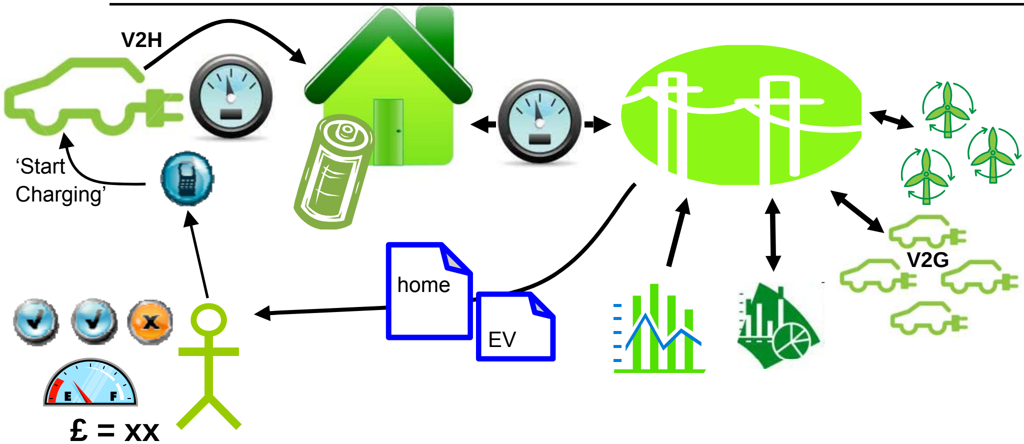
Simple Model

- EV plugged in at home
- Simple cable or specific charge point
- Start charging immediately on plugging in, or simple delay timing to start charging when off peak electricity available – either by use of a plug in timer switch or built in to the home charge point
- Normal domestic connection to LV / HV network
- Usage accounted for on existing electricity bill
- No changes to the way in which demand for electricity is managed currently - largely by historic and trend based information



Semi-Intelligent Model

- Increased use of specific charge points
- More time of use management through the car and charge point but still based around timing rather than interaction with the grid
- Ability to control charging remotely via mobile phone / internet
- Ability to specify some variables for when / how to charge
- User may have a specific tariff or separate bill for EV charging usage
- Demand for electricity managed using similar information but collected at a lower granularity and higher frequency



Smart Model

- Increased use of specific charge points
- Domestic buffer stationary storage where the 'smart' aspect is applied to the lower tech stationary store which can be used to top up the car when required ie decoupling of the vehicle and the network constraints
- Sophisticated time of use management through interactions with the smart meter and grid
- Able to specify increased range of variables including price, etc
- User likely to have flexible and specific tariff for EV charging usage
- Demand for electricity managed more dynamically with real time decisions made on demand and supply based on historical, projected and actual network loads

Intelligent Infrastructure Business Design - Full Analysis

- The slides in Section 3 have been extracted and adapted from the following deliverable:-

Area	Work Package 2.4 Deliverable	Description	Strategic Questions
Infrastructure Business Design	Conceptual Business Architecture (SP2/IBM/16)	Proposes a Business Component Model for the Electric Vehicle Market and describes an evolution path.	What sort of network of businesses and organizations might be needed to sustain and develop the infrastructure? How might it develop over time?

- This deliverable can be found in full in Appendix B.

ETI EV Work Package 2.4

SP2/IBM/27 ETI EV Intelligent Infrastructure – Completion Report – Systems Integration and Architecture Development

Section 4 – Key Insights, Conclusions and Recommendations from Work Package 2.4 – *System Design*

Background to the System Design Activity

- Having completed Business Design through deliverable SP2/IBM/16, Work Package 2.4 moved to system design and followed a standard methodology/process for the IT industry, comprising:-

- Application Architecture (SP2/IBM/17)
  - the process by which the components of the system are identified and classified. Components at this level of design are treated as technology neutral ‘things’ which, based on the requirements (from SP2/IBM/14 and SP2/IBM/15) and the business architecture (SP2/IBM/16), the system must have.

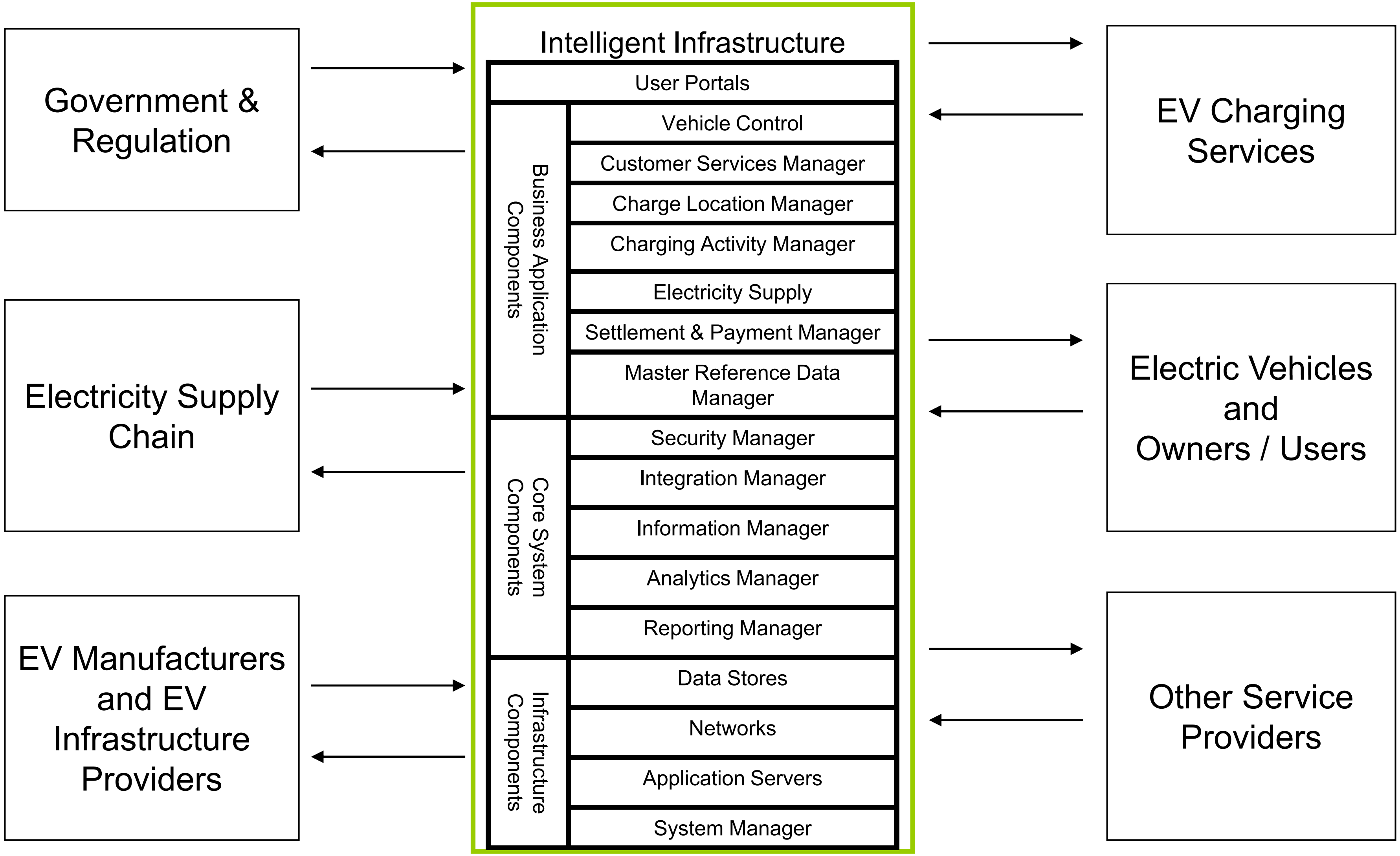
- Data Architecture (SP2/IBM/18)
  - is concerned with the data which, based on requirements, the system is likely to have to store and process

- Technical Architecture (SP2/IBM/19)
  - is concerned with moving the Application and Data Architectures into the physical world, and identifying which ‘real’ world locations will host which components.

- Combining all of the above results in a Conceptual Design for the Intelligent Infrastructure, against which, for example, very high level budgetary estimates were developed

System Design - Intelligent Infrastructure Component Model (Level 0) from SP2/IBM/17

- The technology components needed to meet the requirements of the Intelligent Infrastructure are summarized in the diagram:-



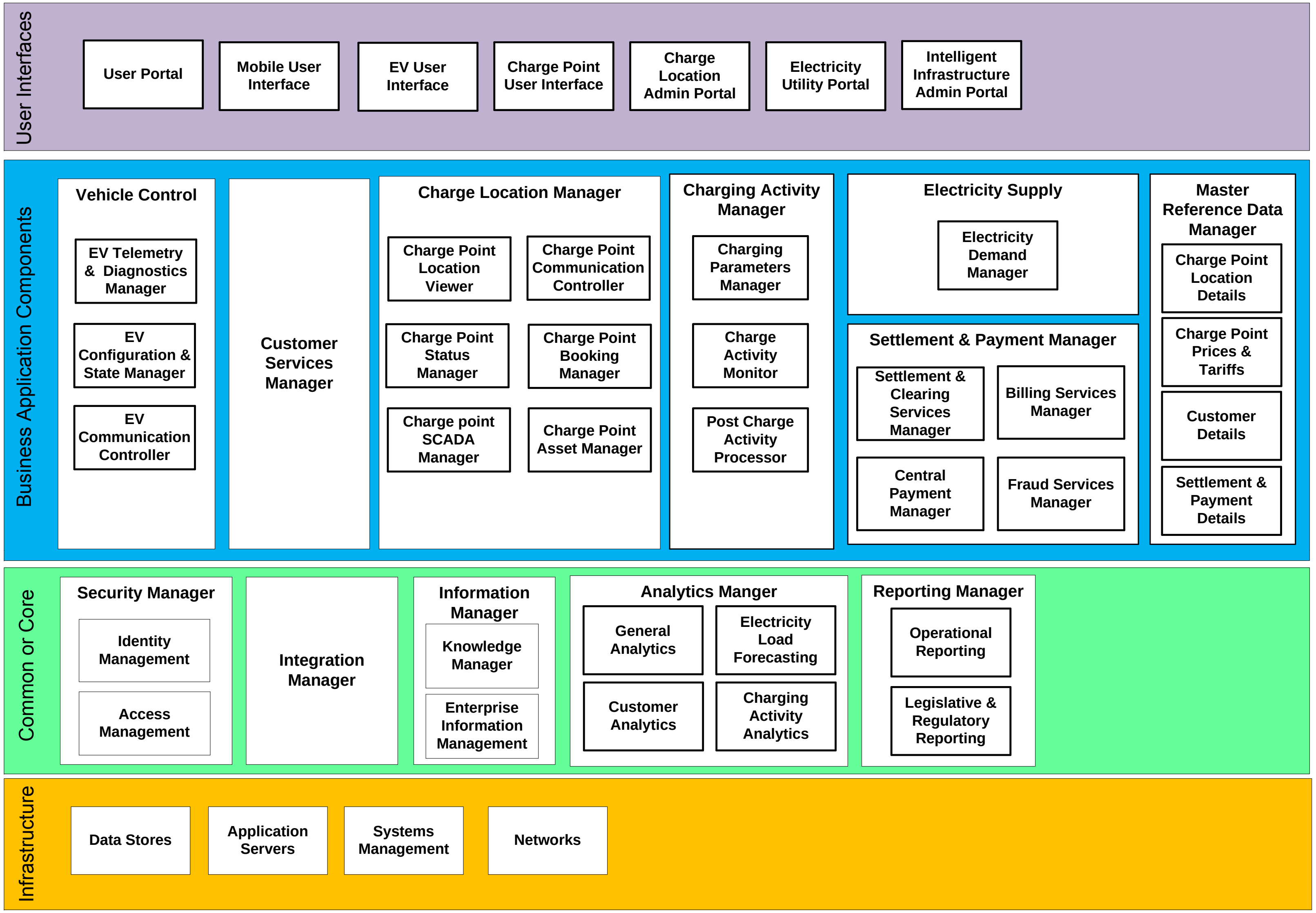
System Design – Component Description (High Level)

- The definition of each component is given in the table below:-

	Component Name	What it does
User Portals		Access for actors to relevant functionality of the Infrastructure
Business Application Components	Vehicle Control	Provides EV telemetry, EV diagnostics, EV configuration and EV state functionality
	Customer Services Manager	Provides functionality relating to Customers of the Intelligent Infrastructure= account and contact management functionality
	Charging Location Manager	Provides functionality relating to the management of Charging Locations, including Location viewer, status manager, Supervisory Control and Data Acquisition, communication, booking and asset management
	Charging Activity Manager	Provides functionality relating to the management of Charging Activity at a location, including charging parameters and activity monitoring and completion
	Electricity Supply	Electricity supply and demand management functionality
	Settlement & Payment Manager	Settlement, clearing, billing, payment, fraud services functionality
	Master Reference Data	Master data functionality – e.g. locations, assets, charging parameters and others
Core System Components	Security Manager	Functionality providing security of components and security of the overall infrastructure
	Integration Manager	Enables integration and interoperability across the Infrastructure
	Information Manager	Information and knowledge management
	Analytics Manager	Analytics and data warehousing functionality
	Reporting Manager	Preconfigured reports, bespoke reporting, ad-hoc queries
Infrastructure Components	Data Stores	Databases supporting all of the above components
	Networks	Networks supporting the Intelligent Infrastructure
	Application Servers	Application servers supporting all of the above
	System Manager	System Management of above

System Design - full conceptual application architecture model for the Intelligent Infrastructure

- Expanding the identified components yields an Application Architecture for the Intelligent Infrastructure:-



System Design - Application Architecture Definitions

- The components of the application Architecture are defined in full, examples:-

Component Name	User Portal	Classification : Foundation
Description	Allows a user to access information and services connected with the charging of vehicles, including setting up and managing an account, specification of preferences, payment services and information about charging locations and their availability. Provide self service access for users to a range of different services and information sources.	
Key Responsibilities	Allow new users to register an account	
Int		
Le		

Component Name	EV Communication Controller	Classification : Discretionary
Description	The component which concerns the interaction of the vehicle with other services external to it. This would include charging posts, wireless networks and meter devices. The services utilised here allow the EV to send and receive information across a range of transactions relevant to the Intelligent Infrastructure	
Key	Provide support for managing interactions between the vehicle and other services	

Component Name	Charging Parameters Manager	Classification : Foundation
Description	Component which supports the specification and processing of charging parameters and variables. Plays a key role in the semi and smart stages as the information about the charging required will have an impact on or be influenced by a range of factors such as location, pricing, demand for electricity, amount of charge, type of charge	
Key Responsibilities	Allow the specification of charging parameters Integrate with other components to establish implications or constraints connected with the parameters Provide some event processing and optimisation capability	
Interactions	See Section 8 – Component Interaction Matrix for a full analysis	
Levels	Simple	Basic parameters along the lines of current arrangements which is largely time switch based - charge now or charge after peak time.
	Semi	Increased parameters and variables can be specified and / or considered via interaction with the II including location, pricing, demand for electricity, amount of charge, type of charge, etc. Facilitated by the Integration, Analytics, Optimisation and event processing functionality it is anticipated an Intelligent Infrastructure could provide for the use of all
	Smart	Extended capability based on the above. Takes account of more real time, dynamic and predictive factors.

System Design – Background to Data Architecture

- 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.

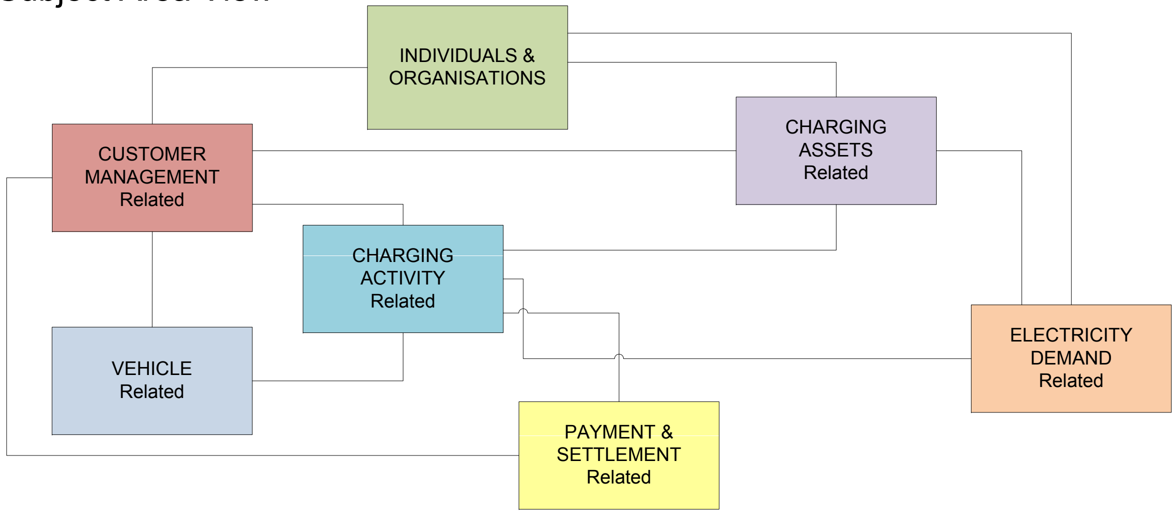
- Data architecture, leading eventually to physical databases, is concerned with the storing of large volumes of data which can be shared between a number of systems. For the systems of the Intelligent Infrastructure to be effective, and not to be tailored for one of the systems to the detriment of the 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 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).

System Design – High Level Data Architecture

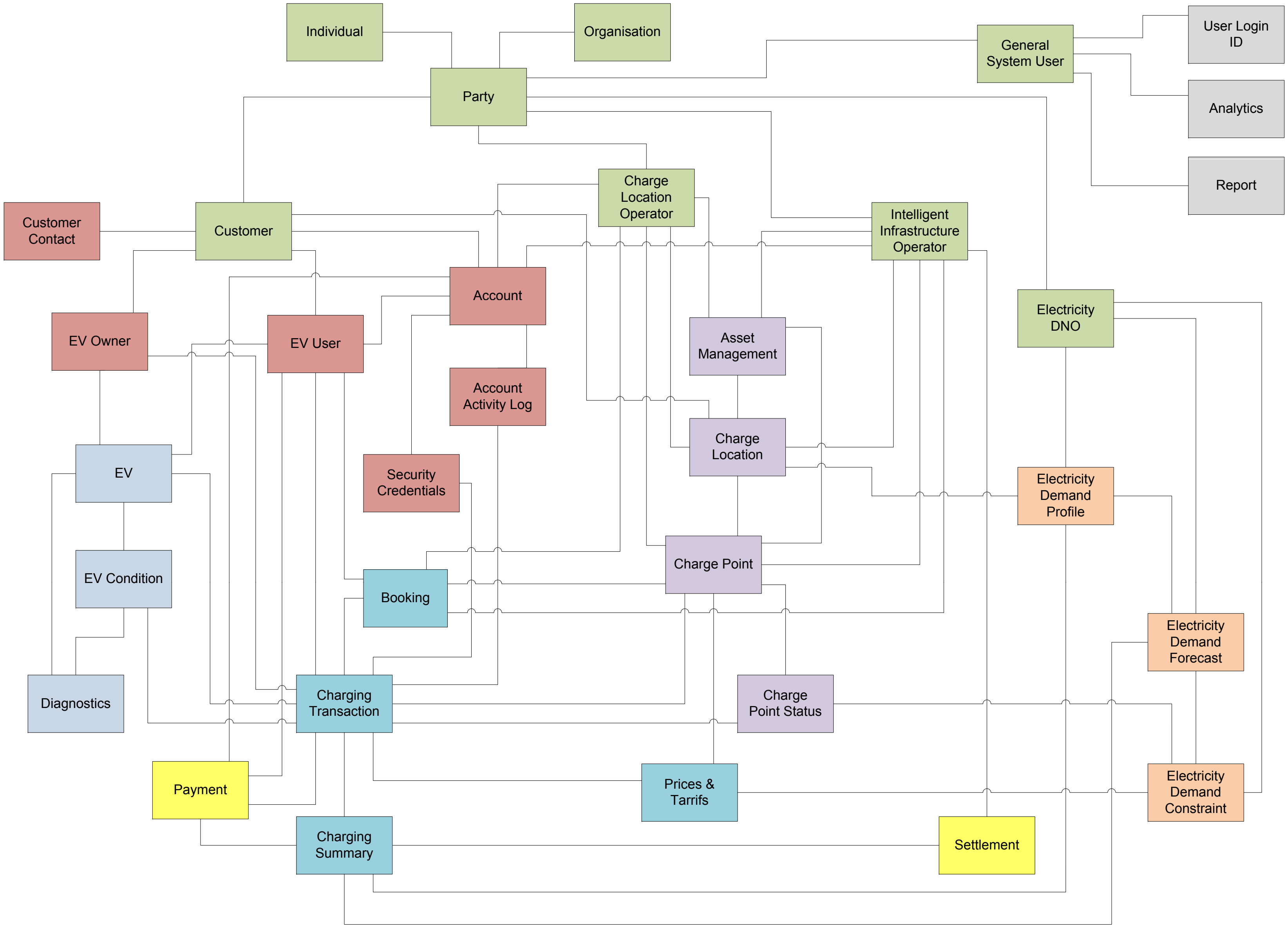
- The data to be stored and processed by the Intelligent Infrastructure can be classified at the very highest level into the following seven subject areas, which are interlinked in some way or other as indicated in the diagram by the solid lines:-

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.

System Design Data Architecture – High Level Entity Relationship Diagram



System Design - Data Architecture Definitions

- The components of the Data Architecture are defined in full, examples:-

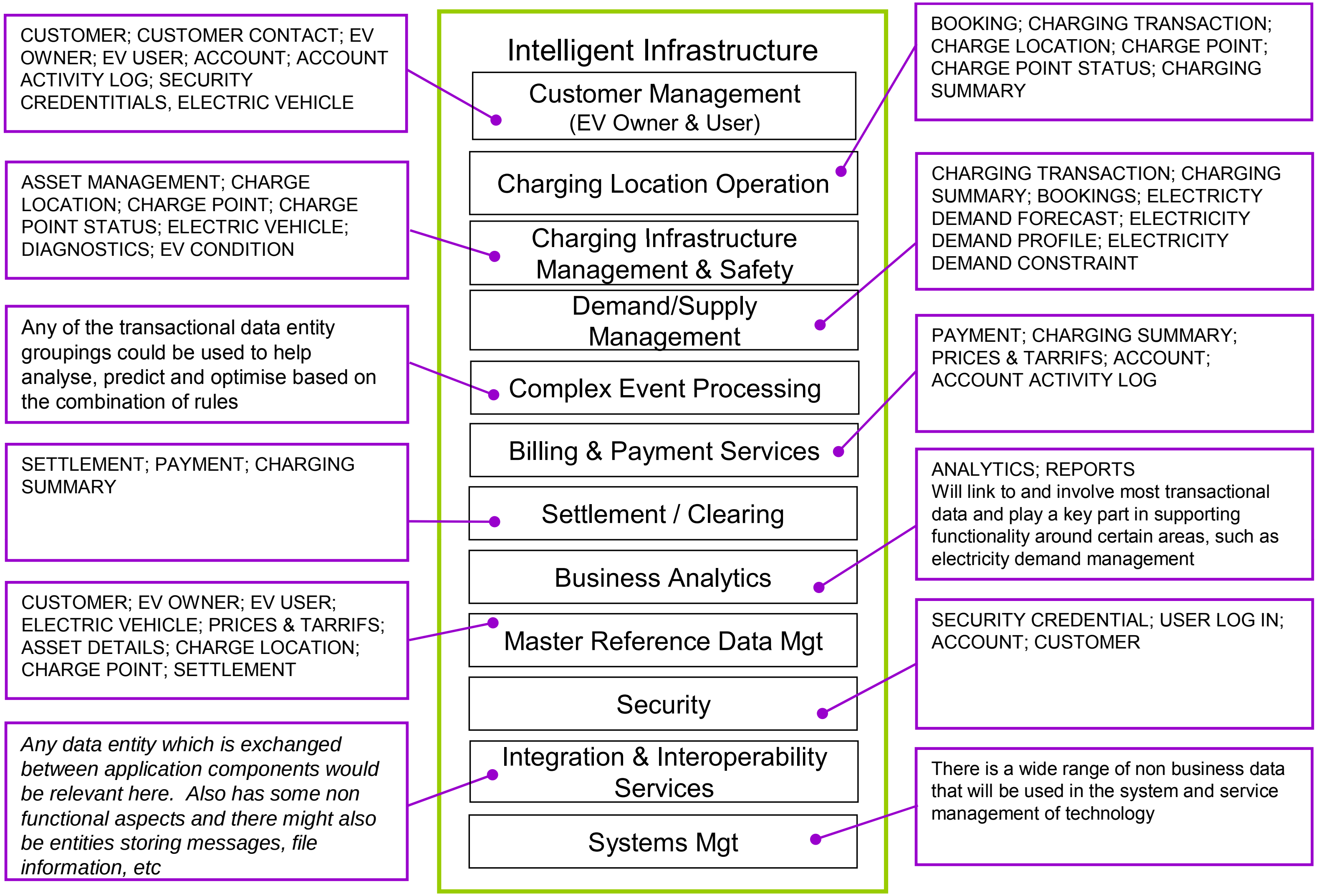
Name	General System User
Description	Refers to any Party that becomes a system user rather than a customer. This means it not only includes those specifically named in this conceptual model (DNO, Charge Location Operator, Intelligent Infrastructure Operator) but also includes other types of
Relationsh	
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
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.

System Design - Data Architecture and Intelligent Infrastructure Functionality

- 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 (SP2/IBM/14).



System Design - Technical Architecture Background

- The ‘solution’ for the Intelligent Infrastructure is not a single computer system residing in one data centre, but a set of connected capabilities which reside in a number of locations, each of which ‘host’ a number of components.

- The work covered previously on Intelligent Infrastructure Requirements and Business Design is used to identify the landscape of the Intelligent Infrastructure. The landscape is expressed in the model as a series of Locations (for example, ‘Home’, ‘Charging Location’, ‘Electricity Distribution Network Operator Technology (or Data) Centre’).

- Nodes (defined as ‘computational platforms’) are assigned to the Locations and key connections between the nodes are identified which represent the need to provide an interface for the passing of data and information.

- Using the components defined by the Application Architecture, a mapping of components to nodes is developed – i.e. which components are likely to be found on which node.

- The analysis is summarized in the following diagram and tables.

System Design - Technical Architecture Location Description and Component Mapping (1/2)

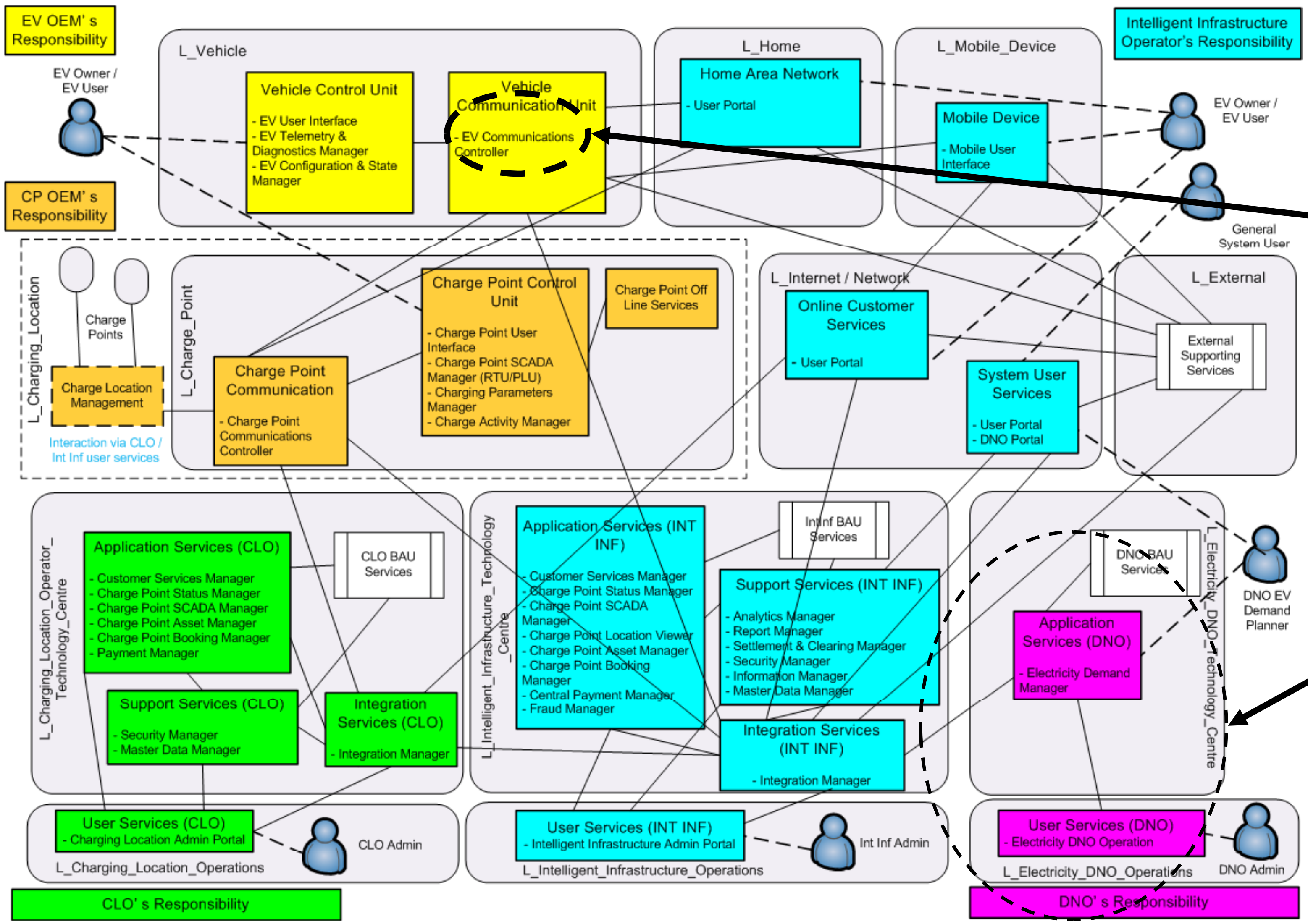
Location	Description	Component (ref: SP2/IBM/17)
Vehicle	Represents the EV in terms of a location that can host components. For example, the EV Control Unit could have Intelligent Infrastructure software deployed to it or be used to access Intelligent Infrastructure services and data.	EV User Interface EV Telemetry & Diagnostic Manager EV Configuration & State Manager EV Communications Controller
Home	Represents a domestic location at which EVs may be charged and from which services may be accessed.	User Portal Charging Parameters Manager
Mobile Device	Represents mobile device technology through which services can be accessed	Mobile User Interface
External	Represents those locations that will be the source of services external to the Charging Location operator, Intelligent Infrastructure operator and Electricity DNO operator	n/a
Charging Location	Represents a domestic or non-domestic charging location which could have a charge post deployed and be used to access II services and data.	n/a
Charge Point	Represents a charge post through which EVs are charged and services accessed.	Charge Point User Interface Charge Point SCADA Manager (RTU / PLU) Charging Parameters Manager Charge Point Communications Controller
Internet / Network	Communications using the internet and data / voice networks will be a key part of the infrastructure and therefore we are representing this as a location.	User Portal Charge Point Location Viewer Charge Point Booking Manager User Portal
Charging Location Technology Centre	Represents the location that the charge location operator runs systems from. Could be their own facility and / or third party managed facilities which they use.	Customer Services Manager Charge Point Status Manager Charge Point SCADA Manager Charge Point Asset Manager Charge Point Booking Manager Central Payment Manager Security Manager Master Data Manager The charge location operator's own application landscape

System Design - Technical Architecture Location Description and Component Mapping (2/2)

Location	Description	Component (ref: SP2/IBM/17)
Intelligent Infrastructure Technology Centre	Represents the location that the Intelligent Infrastructure operator runs systems from. Could be their own facility and / or third party managed facilities which they use.	Customer Services Manager Charge Point Status Manager Charge Point SCADA Manager Charge Point Asset Manager Charge Point Booking Manager Central Payment Manager Fraud Manager Analytics Manager Report Manager Settlement & Clearing Manager Security Manager Information Manager Master Data Manager Integration Manager The Intelligent Infrastructure Operator's own application landscape
Electricity DNO Technology Centre	Represents the location that the Electricity DNO runs systems from. Could be their own facility and / or third party managed facilities which they use.	Electricity Demand Manager Analytics Manager Report Manager The DNO's own application landscape
Charging Location Operations	Represents the locations from which charge location operators will undertake their activities.	Charge Location Admin Portal
Intelligent Infrastructure Operations	Represents the locations from which Intelligent Infrastructure operators will undertake their activities.	Intelligent Infrastructure Admin Portal
Electricity DNO Operations	Represents the locations from which Electricity DNO operators will undertake their activities	Electricity Utility Portal

System Design - Technical Architecture Conceptual Design

- Depicting the table above provides us with the following Conceptual Design for the EV Intelligent Infrastructure shown below .



Deployment Units and Components

Deployment Units represent a grouping of software components and/or sub-components implemented onto nodes. To maintain a clear link back to the conceptual application model, the deployment units used in the conceptual model match to the components in the conceptual application model.

Intelligent Infrastructure Development Responsibility

…is indicated as shown, based on geographic location.

Actors identified are:-

EV OEM (yellow)

CP OEM (amber)

Charging Location Operator (green)

Intelligent Infrastructure Operator (blue)

Distribution Network Operator (purple)

Intelligent Infrastructure System Design – Full Analysis

- The slides in Section 4 have been extracted and adapted from the following deliverables:-

Area	Work Package 2.4 Deliverable	Description	Strategic Questions
Infrastructure System Design	Conceptual Application Architecture (SP2/IBM/17)	Provides a high level view of the technology components needed.	What might an Intelligent Infrastructure look like in terms of technology components?
	Conceptual Data Architecture (SP2/IBM/18)	Analysis of the data the Infrastructure might have to process and store	What data might an Intelligent Infrastructure have to process and store?
	Conceptual Technical Architecture (SP2/IBM/19)	A first view of the systems landscape – how components are distributed and connected across the ecosystem	What might the Systems Landscape of an Intelligent Infrastructure look like?

- These deliverables can be found in full in Appendix C.

ETI EV Work Package 2.4

SP2/IBM/27 ETI EV Intelligent Infrastructure – Completion Report – Systems Integration and Architecture Development

Section 5 – Key Insights, Conclusions and Recommendations from Work Package 2.4 – *Realization*

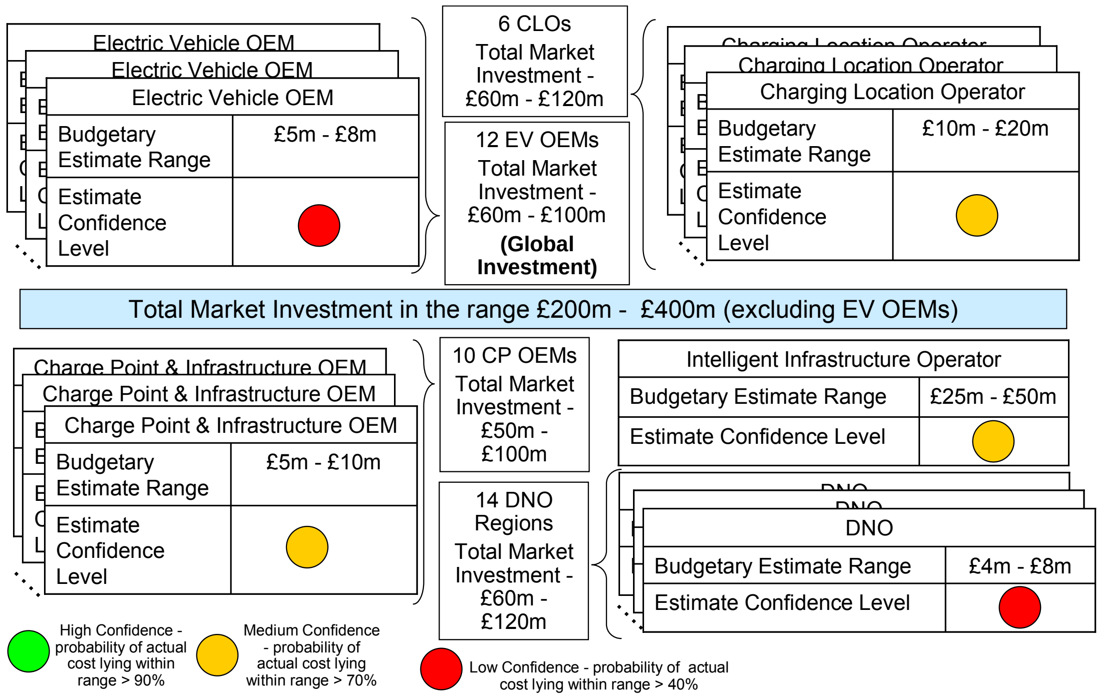
Realization of the Intelligent Infrastructure

- Realization relates to the analysis completed on Work Package 2.4 concerned with the actual design and build of the Intelligent Infrastructure. The key strategic questions to be answered are:-
- How much is it likely to cost to design and build the Intelligent Infrastructure?
- What risks might be involved in realizing an Intelligent Infrastructure?
- What systems might an Intelligent Infrastructure have to integrate with?
- How might it deal with Settlement of Charging Transactions in a complex business landscape?
- There are a number of Emerging Technologies in Power Generation and Storage – what effect might they have?
- In which areas of the infrastructure are standards necessary/beneficial for realization?
- Which aspects of the Intelligent Infrastructure should be trialled by the ETI?

Realization - How much is it likely to cost to design and build an Intelligent Infrastructure?

- The Intelligent Infrastructure will require investment of the order of:
  - < £15m (simple phase)
  - £200m (semi-intelligent phase)
  - £200-£400m (smart phase)

  (Note: These are absolute not incremental figures)
- This is not a single investment but covers the investments needed by multiple market actors to design and build the required components
- Recurring operational 'run and maintain' costs are additional. Recurring manufacturing costs are additional.



- The budgetary estimates are for the design and build of the Intelligent Infrastructure Conceptual Design and represent the approximate amount of money each of the market actors, (Electric Vehicle OEM, Charging Location Operator OEM etc.) will need to spend in order to develop the Intelligent Infrastructure functionality. For example, each Electric Vehicle OEM will spend between £5m and £8m developing the Intelligent Infrastructure components specified as residing on their EVs. Similarly each Charging Location Operator will spend between £10m and £20m developing their components, the Intelligent Infrastructure Operator will spend between £25m and £50m and so on.
- The number of different actors active in the EV Market has been estimated to provide an overall market investment total, e.g. 10 Charge Point and Infrastructure OEMs, 6 Charging Location Operators, one Intelligent Infrastructure Operator – the Assumptions Table on the next slide provides a justification for these numbers.

Realization – Behind the budgetary estimates are some critical assumptions (1/2)

Assumption Statement		Assumption Justification
Timing	Smart Phase of Evolution (see SP2/IBM/16) is assumed to begin around 2016	Primary driver is the Smart Meter Roll Out Timing – starting 2012/2013, complete by 2020. By 2016 a significant number of Smart Meters will have been rolled out and hence we will be entering into the Smart Phase.
	Semi-Intelligent Phase of Evolution is assumed to begin around 2013 and last for up to 5 years (2013 to 2018)	Key standards and regulation will be in place by 2013 to allow development of the Intelligent Infrastructure
	Simple Phase of Evolution is assumed to cover the period from the present up to 5 years from now (2010 to 2015)	We are in the Simple Phase now, EV Market Actors ramp up activities to deliver Semi-Intelligent and Smart functionality, with the Simple period ending effectively around 2015.
EV	By 2020 there will be 1.2m EVs in the UK (upper limit)	'Green Growth Model' - Provides an upper limit for the number of EVs – lowest estimate is 300,000 (Slow Growth Model), medium estimate is 600,000. Source: Sub Project 3 – Economics and Carbon Benefits
	By 2050 8m EVs in the UK	Source: Sub Project 3 – Economics and Carbon Benefits
	There will be approximately 12 EV OEMs operating in the market through to the Smart Phase of Evolution	Estimate (to provide a total market investment figure) of the number of 'volume' EV OEMs operating in the EV market by the Smart Phase– 5 EU based OEMs, 5 Japanese/Asian based OEMs, 2 US based OEMs. Based on current interest shown by OEMs in 2010. The market is uncertain and in reality there could be many more OEMs.
Charging Activity	By 2020 100% of EV owners with off street parking (= 60% of the total) = 720k will have Domestic Charge Points	Domestic Charging will be the dominant model by all commentators and analysts.
	By 2020 there will be a total of 180k Non-Domestic Charge Points (of all types - Standard, Fast, Rapid) in the UK	Source: Sub Project 3 – Economics and Carbon Benefits – Ratio of approximately 6 EVs to one Non-domestic Charge Point. Total Charge Points for the UK in 2020 = 900k
	Annual Charging Events and Resultant Core Transactions in the UK by 2020 = (1.2m EVs x 4 times/week x 52 weeks) 250m	Estimate that EV owners/users/operators will charge 4 times per week on average.
	There will be 10 Charge Point OEMs operating in the UK market.	Estimate based on current growth - The market is uncertain and in reality there could be many more OEMs and conceivably fewer. However the rationale for settling on 10 is that this will become an international market for standardized components which will attract the larger Electrical Component Manufacturers.

Realization – Behind the budgetary estimates are some critical assumptions (2/2)

Assumption Statement		Assumption Justification
Charging Location Operator	By 2020 there will be 6 Charging Location Operators (CLOs) operating across the UK.	The market is not certain and again this number is chosen with the following rationale – there are 6 big electricity retailers and 7 DNOs - likely to be a similar number of Charging Location Operators. CLOs will need to be of a size to make the business economics work (outside the remit of this deliverable).
	Each CLO by 2020 is managing an estate of 150,000 Charge Points (30,000 non-domestic, 120,000 domestic) and a population of 200,000 customers, processing 42m charging transactions annually	Based on previous assumptions – see above
	In terms of customer activity - 20% of the customer population will generate at least one call annually – 40,000 calls – 800 per week., each call taking approximately 15 minutes to resolve – 200 man hours of work	Estimate to provide a rough dimension of the sort of customer activity a Charging Location Operator may experience
	For SCADA, Asset Management sizing – maintenance events will be predominantly in non-domestic posts (30,000), assume 100 events per week	Estimate to provide a rough dimension of the maintenance activity a Charging Location Operator may experience- (*possibly high but recognizes immaturity of the technology*)
Intelligent Infrastructure Operator	By 2020 there will be one II Operator in the UK	…created either (a) as a result of regulation, or (b) as a result of shared ownership by the 6 CLOs, or (c) by a dominant player seizing the market position. Processes 250m charging transactions
	The Intelligent Infrastructure Operator is responsible for the development and implementation of interface and data content standards – without which budgetary estimates may be higher.	Based on current models in the Energy. Utilities and Other Industries.

Realization - Risks

- **Inherent Risks**, namely:
  - will it be built at all,
  - will it be built - but only with certain functionality,
  - will it be built - but too late for it to make full impact?
- …mitigated by:-
  - business case analysis to establish the benefits of the Intelligent Infrastructure
  - trialling Intelligent Infrastructure functionalities
  - establishing leadership for development of the Intelligent Infrastructure
- **Competing standards.** Slow establishment of standards for the exchange of data and information between components of the Intelligent Infrastructure will delay market growth. This risk can be mitigated by using existing standards organisations, and by establishment of industry groups, coalitions or a central body. There is a secondary risk in this area to do with international compatibility and of the UK heading down a standards path different to that followed by others. The mitigation here is engaging internationally with relevant bodies, both political and industrial.
- **Complexity risk**. Risks whilst building the Intelligent Infrastructure are likely to be significant due to the size and complexity of developments, and the number of actors involved. The mitigation here is through learning from other industries, using component-based approaches, selective piloting, and use of industry standard methodologies and tools.
- **Technology uncertainty risk**. Emergence of competing technologies to EVs, (e.g. hydrogen/fuel cell), reduces the rate of growth and market size and negatively impacts business cases for Intelligent Infrastructure investments. This risk is mitigated by studies into comparisons of different technologies (as per current ETI Programme) and component based development of the Intelligent Infrastructure over a period of time.

Realization - What systems might the Intelligent Infrastructure have to integrate with?

- The Intelligent Infrastructure is the 'glue' which integrates multiple market actors' and their diverse interests into an EV ecosystem as follows, (those systems marked in Red are 'core' to the Intelligent Infrastructure and are picked up in detail in the Conceptual Design):-

Government & Regulation

Local Gov'
- Master Data Systems
- Revenue Systems
- Management Information Systems
- Other Local Authority Transport Systems
- Planning Systems

Regulators
- Master Data Systems
- Management Info' Systems
- Elec' Supply Regulatory Reporting Systems
- Transport Regulatory Reporting Systems

Central Gov'
- Master Data Systems
- Management Information Systems
- Taxation Systems
- Transport & Vehicle Systems (DVLA, VOSA, HA, TfL)

EV Charging Services

Charg' Loc' Operator
- Cust' Management Systems
- Asset Management Systems
- SCADA Systems
- Financial/ERP Systems
- Management Info' Systems
- Availability/Booking Systems
- Billing and Payment Systems
- Charg' Activity Man' Systems

EV Charging Asset
- Asset Management Systems
- SCADA Systems
- Availability/Booking Systems
- Payment Systems
- Charging Activity Management Systems

EV Electricity Retailer
- Master Data Systems
- Pricing Systems
- Cust' Management Systems
- Financial/ERP Systems
- Management Info' Systems
- Billing and Payment Systems
- Home Area Network System

Electricity Supply Chain

Electricity DNO
- Demand and Load Man' Systems
- Graphical Information Systems
- Asset (& Workload) Man' Systems
- SCADA
- Cust' Management Systems
- Billing and Payment Systems
- Financial/ERP systems

Electricity Retailer (traditional)
- Master Data Systems
- Pricing Systems
- Cust' Management Systems
- Financial/ERP Systems
- Management Info' Systems
- Billing and Payment Systems
- Home Area Network System

Intelligent Infrastructure
- Cust' Management Systems
- Asset Management Systems
- SCADA Systems
- Financial/ERP Systems
- Availability/Booking Systems
- Billing and Payment Systems
- Charg' Activity Man' Systems
- Settlement & Clearing Systems
- Fraud Management Systems
- Analytics and Reporting Systems
- Information Man' Systems
- Management Info' Systems
- Availability/Booking Systems

Electric Vehicles & Owners / Users

EV Owner
- (Mobile Phone Apps)

EV User
- (Mobile Phone Apps)

Electric Vehicle
- Telemetry and Diagnostic Manager Systems
- EV Config' and State Systems
- II Services Access Portal

EV Manufacturers & Infrastructure Providers

EV Manufacturers & Dealers
- Master Data Systems
- Diagnostic Systems
- Man' Info' Systems

EV Maintenance Providers
- Master Data Systems
- Diagnostic Systems
- Man' Info' Systems

EV Charging Equipment Manufacturers
- Master Data Systems
- Asset Management Systems
- Diagnostic Systems
- Man' Info' Systems

Other Service Providers

Intelligent Infrastructure Operators
- (See Intelligent Infrastructure above)

Other Intelligent Infrastructure Systems
- Master Data Systems
- Roam' admin' systems
- Settlement, Billing and Payment Systems

Other Businesses
- Master Data Systems
- Billing and Payment Systems (Payment Service Providers)
- Ops' Systems (Various)
- Man' Info' Systems (Internal & data/info' for resale)

Realization – Systems Integration Conclusions

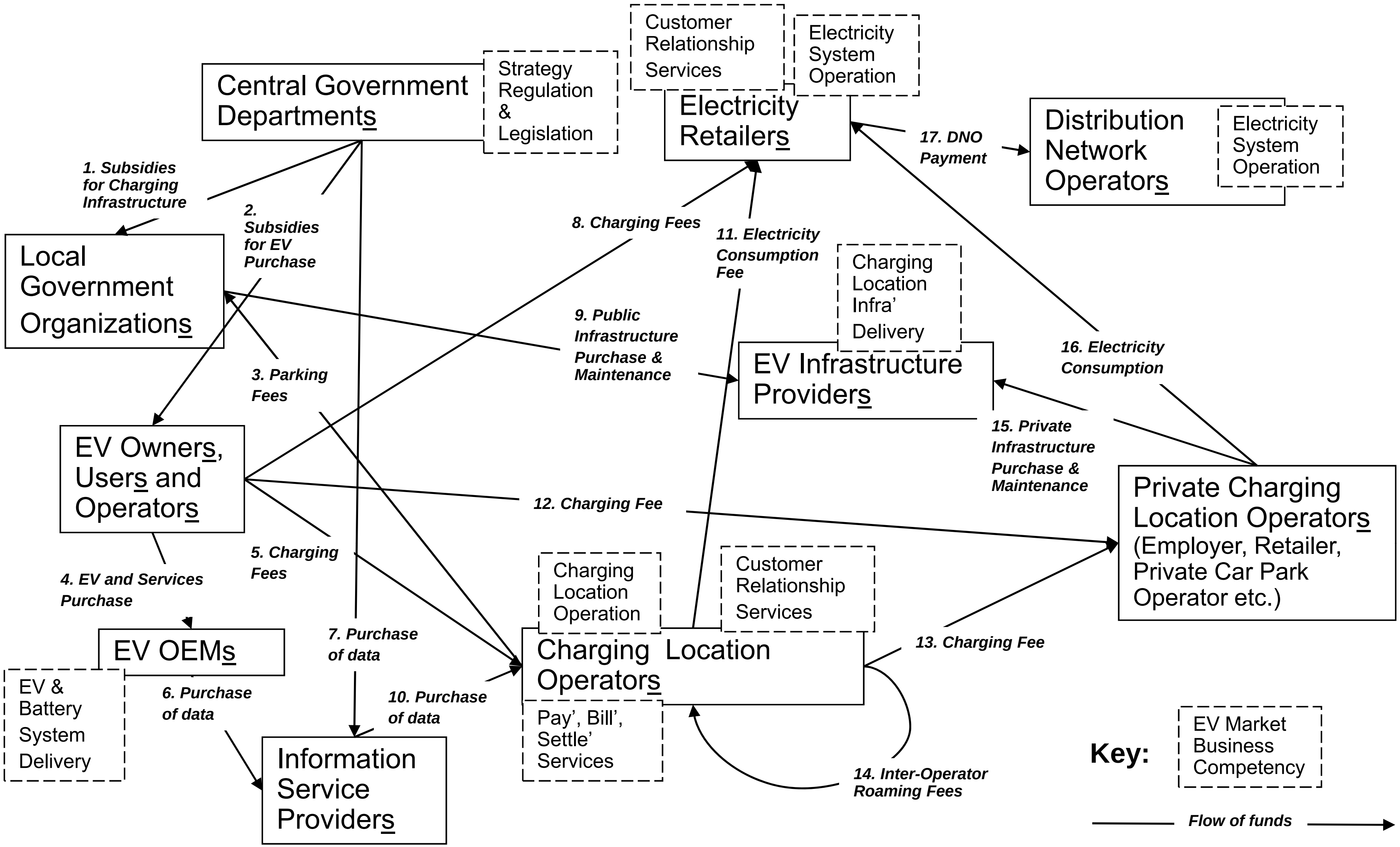
- A large number of actors and systems will be integrated by the time the Smart Phase of Evolution of the EV market has been reached, (remember the diagram on the previous slide does not show the full complexity – multiple DNOs, Charging Location Operators etc.). This level of integration will not be achieved ‘overnight’ - nor does it need to be. However. the analysis underlines the need for planning for this integrated world from the outset so that an infrastructure can be created which stimulates and actively promotes the development of a mass market for Electric Vehicles, rather than one which constrains it.

- What the analysis demonstrates is that the Intelligent Infrastructure must :-
  - be open - so that the infrastructure assists actors, known and unknown, to create and extend their portfolio of goods and services in the EV market
  - be standards based – to assist further in the creation and implementation of those new goods and services, especially in the areas of data interfaces (see SP2/IBM/25)
  - provide a cost effective service – especially making full use of the economies of scale which will materialize - amongst others this means delivering centrally those services which are universal – through a centralized Intelligent Infrastructure Operator
  - exploit appropriate technologies from the outset – especially Enterprise Integration technologies for data transfer, and Business Analytics technologies for data interpretation into information

Realization – Settlement of Charging Transactions in a Complex Business Landscape

- As an aid to understanding the possible Intelligent Infrastructure Settlement Landscape, the following slide shows the generic payments between the different EV Intelligent Infrastructure Actors. The purpose of the slide is to highlight the number of actors involved and the payments (many interrelated) that may be made. The slide is simplified as follows:-
  - Generic payments (types) are shown
  - Multiple instances of an Actor are shown as a single box (e.g. many Electricity Retailers are shown collectively)
  - ‘Indirect’ payments such as taxes are not shown.
  - Financial institutions used to facilitate the transactions are not shown.
  - Billing and settlement regimes are not depicted – these are covered later in the section
  - Different types of payment are not shown – these are covered later in the section.
- The payment landscape is based on the following set of assumptions:-
  - The EV owner/user has a customer account either with a Charging Location Operator (CLO) or with an Electricity Retailer or both for charging. The CLOs/Electricity Retailers are responsible for billing the owner/user and taking payment for the full set of services – for example in non-domestic situations the owner/user is billed once for electricity/parking and any other services consumed, the CLO is then responsible for settling that payment across the different actors.
  - Charging Location Operators serve their own public and private clients (e.g. Local Government Authorities, Retail Companies), their own EV owners and operators, and each has a relationship with one or more Electricity Retailers.
  - Private location owners (employers, retailers, private car park owners) may be represented by a Charging Location Operator, or they may operate independently – the payment landscape allows for this.
  - Interoperability agreements between each Charging Location Operator exist in order that EV Owners and Operators may ‘roam’ to use infrastructure and services from each other operator
  - The EV owner/user may have to have multiple customer accounts with various Charging Location Operators where no interoperability agreement exists and the owner/user wishes to use the respective charging facilities.
  - Charging fees may include actual electricity consumed, (we are in the Smart Phase, and Smart Meters can identify electricity used specifically for EV charging and charging points can be individually metered), and not just be subscription or ‘flat fee’ based – the landscape however allows for these latter payment options.
  - All electricity is bought from Electricity Retailers and the law has been changed to allow the Charging Location Operator to resell the electricity.
  - The payment landscape shows the situation before an Intelligent Infrastructure Operator is established to highlight the challenges that will be faced in trying to operate this market without central coordination

Realization – Generic Payments Landscape for the Intelligent Infrastructure



Realization – Generic Payments Landscape – Payment Descriptions (see key on previous slide)

No.	Payment Name	Payment Explanation (and interdependencies)
1	Subsidies for Charging Infrastructure	Funds paid by Central to Local Government for the installation of public charging infrastructure
2	Subsidies for EV Purchase	Subsidies paid by Central Government to Purchasers of EVs
3	Parking Fees	Portion of fees collected by the Charging Location Operators for public parking and charging, which is due to the Local Councils
4	EV and Services Purchase	Money paid as purchase of the EV plus any additional services
5	Charging Fees	Money paid to the Charging Location Operators for public parking by the EV users – to cover parking, charging (electricity) and any additional services. This may be a subscription payment.
6	Purchase of data	Refers to the possible purchase of data by EV OEMs from Information Services Providers
7	Purchase of data	Refers to the possible purchase of data by Central Government form the Information Services Providers.
8	Charging Fees	Payment from the EV Owners to the Electricity Retailers for domestic charging.
9	Public Infrastructure Purchase & Maintenance	Payment from the Local Councils to the EV Infrastructure Providers for Charging Infrastructure (Posts) and their maintenance
10	Purchase of data	Purchase of data by Information Service Providers from the Charging Location Operators
11	Electricity Consumption	Payment from the charging Location Operators to the Electricity Retailers for the Electricity consumed at the charging locations they operate
12	Charging Fees	Money paid direct to the Private Operator for parking by the EV user (no Charging Location Operator involvement) – to cover parking, charging and any additional services (may be nil for workplace and retail parking)
13	Charging Fees	Portion of fees collected by the Charging Location Operator which is due to the Private Operator
14	Inter-Operator Roaming Fees	Settlement of bills between Charging Location Operators under roaming agreements
15	Private Infrastructure Purchase	Payment from the Private Operator to the EV Infrastructure Provider for Charging Infrastructure
16	Electricity Consumption	Payment from the Private Operator to the Electricity Retailer for the Electricity consumed at his charging locations
17	DNO Payment	Normal payment from Electricity Retailer to DNO

Realization – Generic Payments Landscape Conclusions

- The Generic Payments Landscape highlights the landscape's complexity in terms of:-
  – the number of actors involved, and
  – the type of payments which are made and their interdependencies.
- However, this does not reflect the full complexity – especially in terms of:-
  – the number of EV Owners, Users and Operators
  – the level of EV charging activity
  – the number of Electricity Retailers
  – the number of Charging Location Operators – each requiring the capabilities to be able to settle payments across multiple actors
  – the number of clients served by each Charging Location Operator – in terms of public charging alone there 433 Local Authorities in the UK, then there are the private clients (retailers etc) to be added
- Assumptions for each of the above variables are summarized briefly in the following table:-

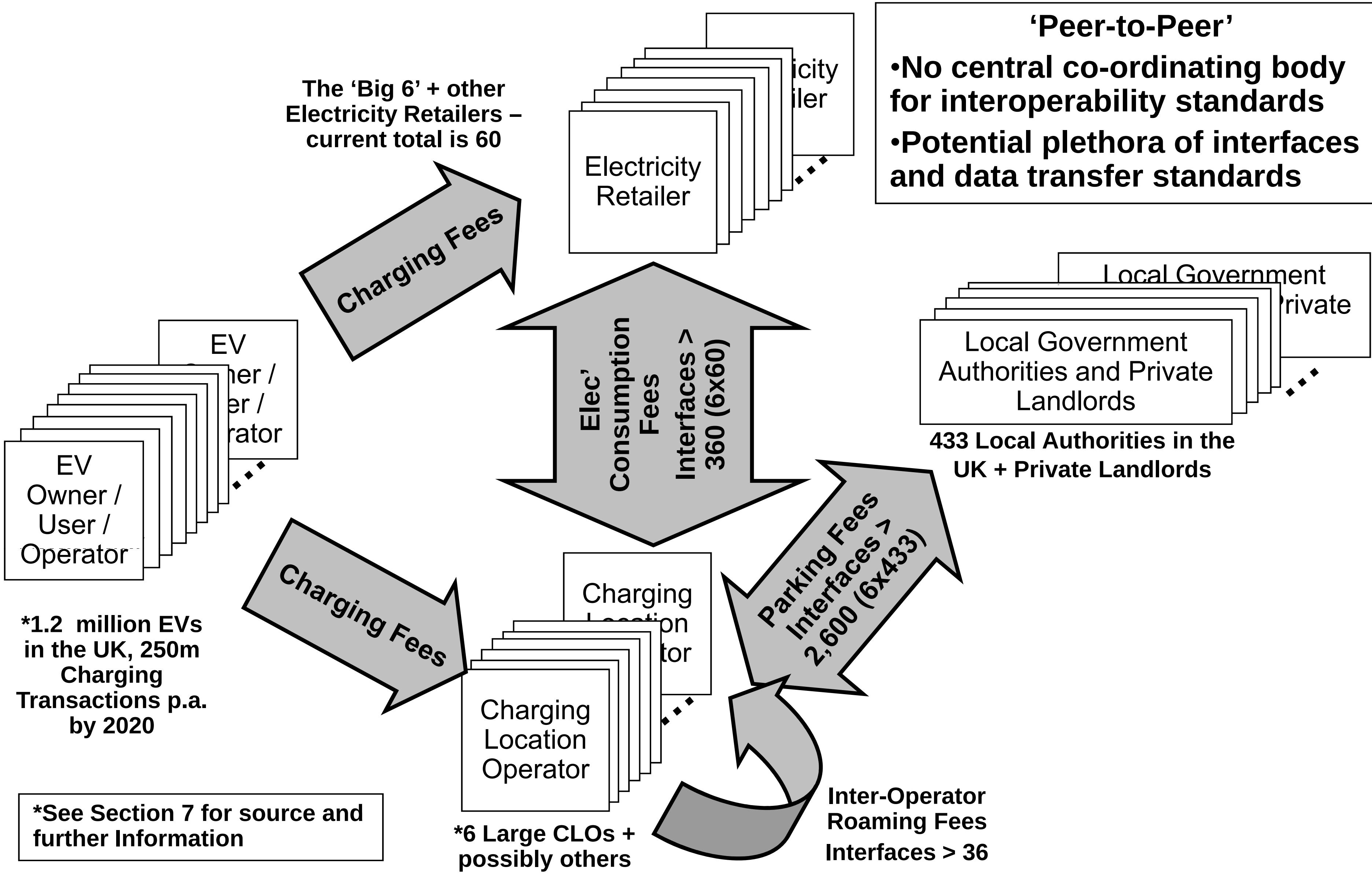
No of EVs /Owners	Charging Activity	No of Elec' Retailers	No of CLOs
1.2m	250m Charging Events and Core Transactions	60 and growing	6
Source: Sub Project 3, see Section 7 Assumptions for further details	See Section 7 for further details	Big 6 Retailers, plus others e.g. Marks and Spencer	See Assumptions in Section 7

- The following slide depicts a portion of the overall generic payment landscape, highlighting more of this complexity, in particular the number of interfaces required

Realization – Settlement Landscape – ‘Peer-to-Peer’ Model

‘Peer-to-Peer’

- **No central co-ordinating body for interoperability standards**
- **Potential plethora of interfaces and data transfer standards**

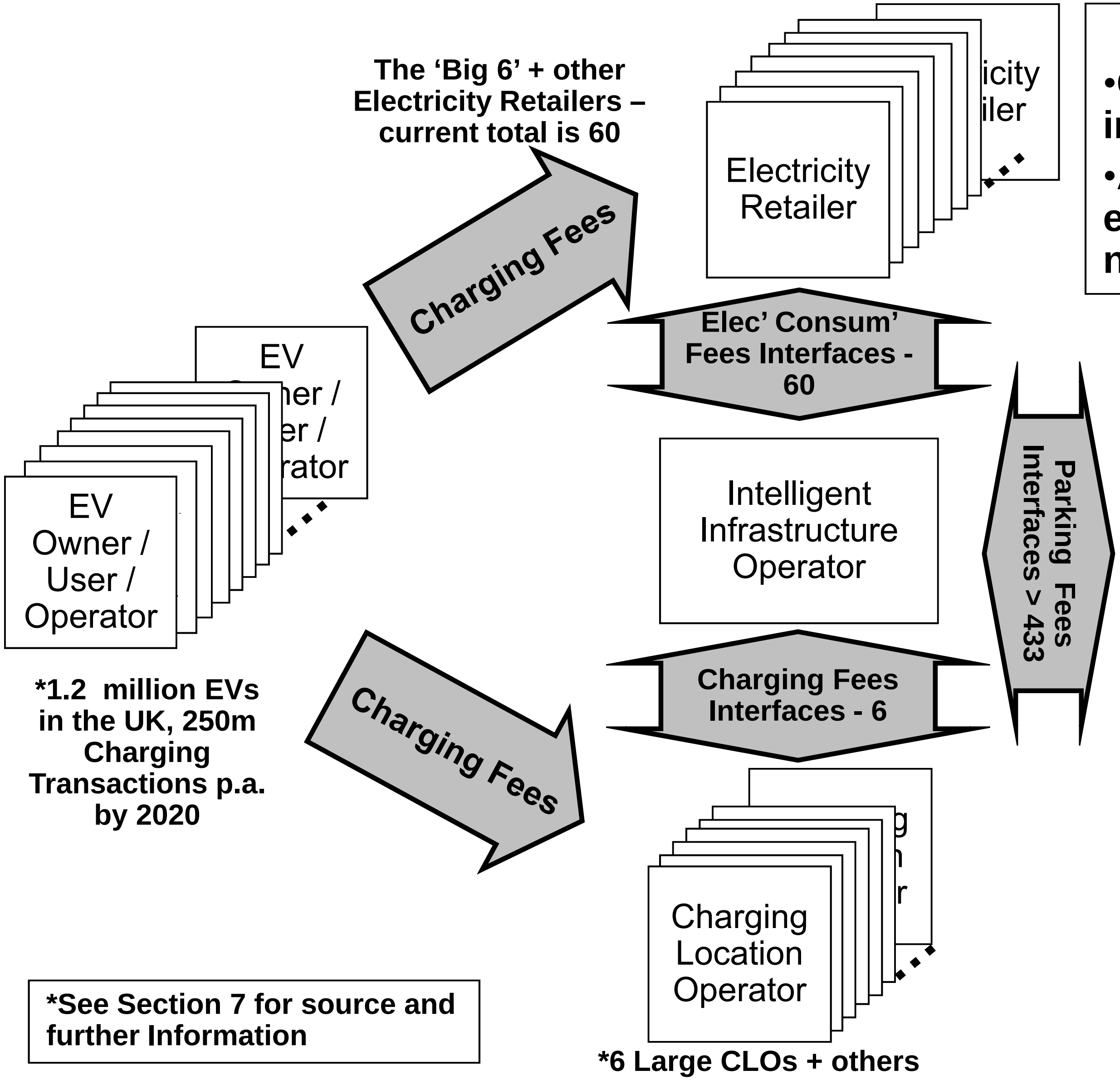


*See Section 7 for source and further Information

Realization – Settlement Landscape – ‘Peer-to-Peer’ Model Conclusions

- **This landscape highlights a number of market imperfections around billing and payment as follows:-**
  - For the EV owner/user/operator:-
    - may have to have multiple customer accounts with various Charging Location Operators where no interoperability agreement exists
    - receives bills via a complex set of processes and systems, raising questions over reliability, maintainability and traceability
    - more difficult to maintain joined up information and records about EV usage
    - the possibility of higher charging/parking fees due to duplication of services and infrastructure and the cost of processing complex transactions between operators
  - For the Charging Location Operators:-
    - each CLO would be responsible for the inter-actor billing and settlement of complex transactions requiring sophisticated processes, IT systems and sufficient personnel to provide acceptable levels of service
    - CLOs and other actors would be responsible for the development and implementation of standards for interfacing and data transfers – without which there would an unmanageable plethora of interfaces
    - it is unlikely that a viable business case could be made by the CLO for building processes and systems to operate this model – see later sections for further details
    - …and when taken across the sum total of CLOs in the market would result in expensive duplication of resources and facilities
  - For key market actors, especially the EV OEMs and Electricity Supply actors:-
    - A more complex EV user/owner experience detracts from ownership of EVs, leading to missed sales opportunities of EVs, electricity and charging infrastructure and generally constraining the market
    - Difficulty in obtaining market wide information, including, crucially, information to the Electricity Supply actors for Demand/Supply Management
- **The following slide shows the introduction of the Intelligent Infrastructure Operator providing a settlement service to serve all of the EV market actors.**

Realization – Settlement Landscape – 'Hub and Spoke' Model



'Hub and Spoke'

- **Central co-ordinating body for interoperability standards**
- **All actors must conform to enforced standards reduces number of interfaces**

***See Section 7 for source and further Information**

Realization – Settlement Landscape – ‘Hub and Spoke’ Model Conclusions

- The settlement landscape including the Intelligent Infrastructure Operator addresses the market imperfections of the earlier model as follows :-
  – For the Charging Location Operators - by providing a common settlement service across the market, it obviates the need for individual CLOs to provide this service, and hence saving investments in processes, IT systems and personnel
  – For the EV owner/user/operator - a potentially easier, faster and more transparent payment experience
  – For key market actors, especially the EV OEMs and Electricity Supply actors – a centralized service removing market duplication which supports the development of a mass market rather than constrains it.
- Settlement is one of a number of services which should be delivered centrally. Other candidates for delivery by the Intelligent Infrastructure Operator include:-
  – Certain customer management processes (e.g. single help line providing ‘Level 0/1 Services’)
  – Market-wide information (e.g. locations, tariffs, operators etc.)
  – Common access and authorization

  …bringing additional benefits to all actors, whilst retaining competition amongst Charging Location Operators and Electricity Retailers

- **Although it may seem at first sight anti-competitive, there are strong precedents for the commissioning of a central operator and supporting infrastructure – ELEXON, Electralink, Link, BACS and CLS are proven and valuable examples of where this model has been adopted successfully.**

- **It would need legislation and / or cooperation across the industry to create but the investment in doing this will create a positive stimulus to achieving a mass market.**

Realization - Effect of Emerging Technology - Background

- A large part of the work in the Realization Deliverable (SP2/IBM/28) was concerned with the impact of specific emerging technologies on the intelligent infrastructure.

- The emerging technologies which were covered are as follows:-

  - Demand Side Management;
  - Embedded Energy Storage;
  - Vehicle to Grid;
  - Vehicle to Home;
  - Inductive Charging:
  - Smart Grids
  - Smart Meters

- The analysis is a large section within SP2/IBM/28 and the reader is referred to that deliverable for background and details. The key definition and summary slides are given here.

- Note that Work Package 2.4 was tasked with assessing the impact of the technologies on the Intelligent Infrastructure – other work packages in Sub Project 2 were tasked with detailed analysis of the technologies themselves.

Realization - Effect of Emerging Technology - Definitions

Emerging Technology	Definition
Demand Side Management	Refers to the modification of consumer demand for energy through various methods such as financial incentives and education - the goal being to encourage a reduction in peak hours demand, or to move the time of energy use to off-peak times such as night time and weekends. Peak demand management does not necessarily decrease total energy consumption, but could be expected to reduce the need for investments in networks and/or generation plant.
Embedded Energy Storage	Refers to the storage of electricity on a large scale - enabling power generated when demand is low to be stored for release at peak demand periods
Vehicle to Grid Vehicle to Home	Vehicle to Grid, Vehicle to Home, Vehicle to Domestic refer to the usage of the batteries in electric cars as a dynamic energy storage with the energy being sold back or made available to the electricity grid or home in particular scenarios, such as high demand from other energy uses or network supply problems.
Inductive Charging	Inductive charging uses an electromagnetic field to transfer energy between two objects
Smart Grids	A Smart Grid is an electricity network that can intelligently integrate the actions of all users connected to it - generators, consumers and those that do both - in order to efficiently deliver a sustainable, efficient and secure supply of energy
Smart Meters	A Smart Meter is an advanced meter that records consumption in intervals of an hour or less and communicates that information at least daily via some communications network back to the utility for monitoring and billing purposes. Smart meters enable two-way communication between the meter and the central system

Realization - Effect of Emerging Technology on the Intelligent Infrastructure – Summary (1/3)

Emerging Technology (Timeframe)	Impact on II?	Addressed in Conceptual Design?	Implications for the Intelligent Infrastructure	Key Points for the EV Intelligent Infrastructure
Demand Side Management (5 – 10 yrs)	● (black)	● (black)	As the adoption of plug in vehicles and demand for recharging increases then there will be an increased desirability to deploy demand side management techniques in order to, amongst others, delay the need for network reinforcement. Allowance for DSM functionalities has been made in the design and the budgetary estimates for the Intelligent Infrastructure for the Smart Phase	Manage the impact on the energy grid of demand for vehicle recharging. Encourage vehicle recharging at times of lower demand, lower cost and lower CO2 emission. Mitigate against the need to reinforce the grid as a default option to increased demand. Balance the need to recharge an EV battery against overall network capacity and demand Needs to be implemented in a way that doesn't unnecessarily constrain the demand for vehicle recharging. The initial requirement for DSM specifically for EV's is not clear cut but it may be useful in certain locations.
Embedded Energy Storage (10 - 15 yrs)	● (grey)	● (grey)	Impacts will be in the functional areas of Demand Management, Pricing and Analytics. The proposed solution for the Intelligent Infrastructure in the Smart Phase has the capability to host the functional requirements imposed by Embedded Storage. Budgetary estimates for the development of the Intelligent Infrastructure including this functionality would be at the higher end of the budgetary estimate	Energy that has been produced cheaply or could have been wasted can be used to recharge the vehicles. Energy stored can be used to recharge the vehicles rather than having them add to the demand for electricity at peak times. Could be sited in residential and workplace locations providing a source of energy where the vehicles are expected to be most of the time. Requires investment in embedded storage infrastructure alongside the investment in recharging infrastructure. Need to match EV take up profiles with the location of embedded storage. Current activity is seeing them sited close to and in support of the generation assets which might not be the optimum for use in electric vehicle recharging. Considered a medium / long term play

Key : Black Dot = Greatly , Grey Dot = Partly, White Dot = Little/Not at all

Realization - Effect of Emerging Technology on the Intelligent Infrastructure – Summary (2/3)

Emerging Technology (Timeframe)	Impact on II?	Addressed in Conceptual Design?	Implications for the Intelligent Infrastructure	Key Points for the EV Intelligent Infrastructure
Vehicle to Grid (10 – 15 yrs)	●	●	Impacts functionality in the areas of Master Data, Demand and Supply Management, Pricing, Payment, Billing and Settlement - the likely requirements to be imposed by V2G are included in the design and the budgetary estimates for the Intelligent Infrastructure for the Smart Phase	A form of embedded storage, it makes use of energy that might otherwise not be needed. It has the potential to create a positive financial position for the vehicle owner. Would need to aggregate individual vehicles into a virtual power plant. Would need to consider the balance between taking power and leaving enough power / time to replace the energy. Considered to be a long term play in the UK – out towards 2040 on any sort of viable scale. Not clear how the battery technology which is being optimised for use in vehicles provisions for the potentially different demand of V2G
Vehicle to Home (5 – 10 yrs)	●	●	Should this become a factor, the key functionality & data impacts are largely in the areas of demand management, pricing and analytics. Integration with home energy networks and smart metering would be required. The likely requirements to be imposed by V2G are included in the design and the budgetary estimates for the Intelligent Infrastructure for the Smart Phase	Provides an obvious source of embedded storage at the home. A fully charged battery could easily provide for the basic energy needs in the home. Provides a positive financial position for the customer. Would need to consider the balance between taking power and leaving enough power / time to replace the energy. Not clear how the battery technology which is being optimised for use in vehicles provisions for the potentially different use in vehicles provisions for the potentially different demand of V2H. Will require additional infrastructure at the home to provide safe and efficient operation

Key : Black Dot = Greatly , Grey Dot = Partly, White Dot = Little/Not at all

Realization - Effect of Emerging Technology on the Intelligent Infrastructure – Summary (3/3)

Emerging Technology (Timeframe)	Impact on II?	Addressed in Conceptual Design?	Implications for the Intelligent Infrastructure	Key Points for the EV Intelligent Infrastructure
Inductive Charging (5 – 10 yrs)	Alternative to Conductive Charging: ○ (White Dot) Charge on the Go: ● (Black Dot)	● (Black Dot) Grey Dot	The introduction of inductive charging will, in functionality terms, have little impact on the Intelligent Infrastructure if inductive charging is to be used as another charging 'style' to add to the various forms of conductive charging (slow/fast/rapid). Assuming that the inductive charging infrastructure will have the same intelligent infrastructure capabilities as its conductive cousin in terms of functionality and communications, then the use cases defined for the Intelligent Infrastructure will suffice. If inductive charging is to be used as a charge-on-the-go facility then this could have a significant effect on the II in terms of transaction throughput and calculation of charges.	A more convenient recharging experience for the EV user/owner. Absence of conductive connectors removes the associated issues of interoperability, equipment wear and tear and misuse by users. Improved safety – reduced risk of electric shock, removal of trip hazard. Inductive charging equipment is less obtrusive – a 'pad' sunk into the parking bay itself. Strategically placed recharging points can facilitate recharge "on the go" - regular energy transfer from the infrastructure may enable smaller, and hence lighter and cheaper battery packs within the EV. Efficiency of inductive charging systems has been inferior to conductive charging systems. Safety concerns over stray magnetic circuits interfering with other electrical devices especially pacemakers. The additional equipment required for inductive charging and its installation is expensive, introducing additional costs in the infrastructure, and the electric vehicle.
Smart Grids (5 – 10 yrs)	● (Black Dot)	● (Black Dot)	Impact on the Intelligent Infrastructure is in the functional areas of demand management, pricing and analytics. The Intelligent Infrastructure conceptual design assumes Smart Grid Technology will be imminently deployed.	Smart Grid technologies will require underlying infrastructure which the Intelligent Infrastructure could take advantage of, and vice-versa
Smart Meters (3 – 8 yrs)	● (Black Dot)	● (Black Dot)	The Intelligent Infrastructure conceptual design assumes Smart Grid Technology will be imminently deployed.	The Intelligent Infrastructure will recognize the Smart Meter as the touch point between the Charging location and the Electricity Retailer and a means by which Smart services will be delivered

Key : Black Dot = Greatly , Grey Dot = Partly, White Dot = Little/Not at all

Realization – Importance of Standards - Background

- A critical risk to the realization of the Intelligent Infrastructure is posed by the failure to develop and promote standards in an appropriate timeframe.
- In particular, the slow establishment of standards for the exchange of data and information between components of the Intelligent Infrastructure could delay market growth. This risk can be mitigated by the establishment of standards using existing organisations, and by establishment of industry groups, coalitions or a central body.
- There is a secondary risk in this area to do with international compatibility and of the UK heading down a standards path different to that followed by others. The mitigation here is engaging internationally with relevant bodies, both political and industrial
- Work Package 2.4 assessed the need for these standards in deliverable SP2/IBM/25, the key recommendations follow.

Realization – Importance of Standards – Recommended Approach (1/2)

- Work Package 2.4 has established that the Intelligent Infrastructure exists in a disaggregated ecosystem - the exchange of data and information between disparate locations and systems is therefore key to its functioning and this is the area of the Intelligent Infrastructure where standards are key to its development.

- The recommended approach for the development of standards is:-
  - Focus on standards for the exchange of information and data between actors/locations/components,
  - whilst allowing actors the freedom to build components using standards and technologies of their choice to timescales which fit their investment priorities.

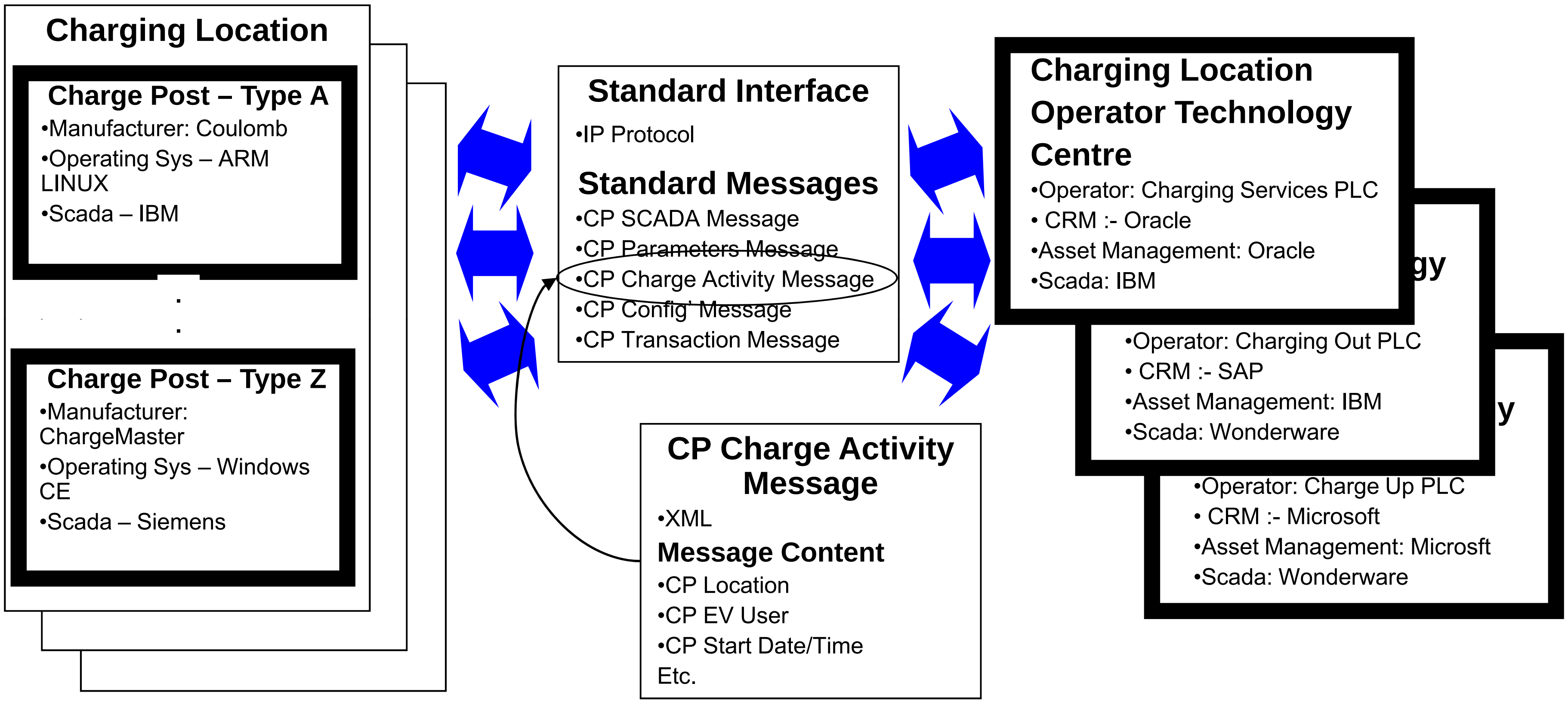
- This is a typical IT Industry approach which has been adopted in various markets, including for example in Financial Services and the Retail Industry, using various technologies including EDI (‘Electronic Data Interchange’) and XML (‘Extensible Markup Language’).

- The approach is described further on the next slide

- Note that Electrical/Safety Standards are required across the Battery, the Electric Vehicle, the Charging Location (including Domestic and Non-Domestic) and the Interface into the Electricity Distribution Network. Consideration of these standards is not within the scope of Work Package 2.4, but has been dealt with in other work streams of Sub Project 2.

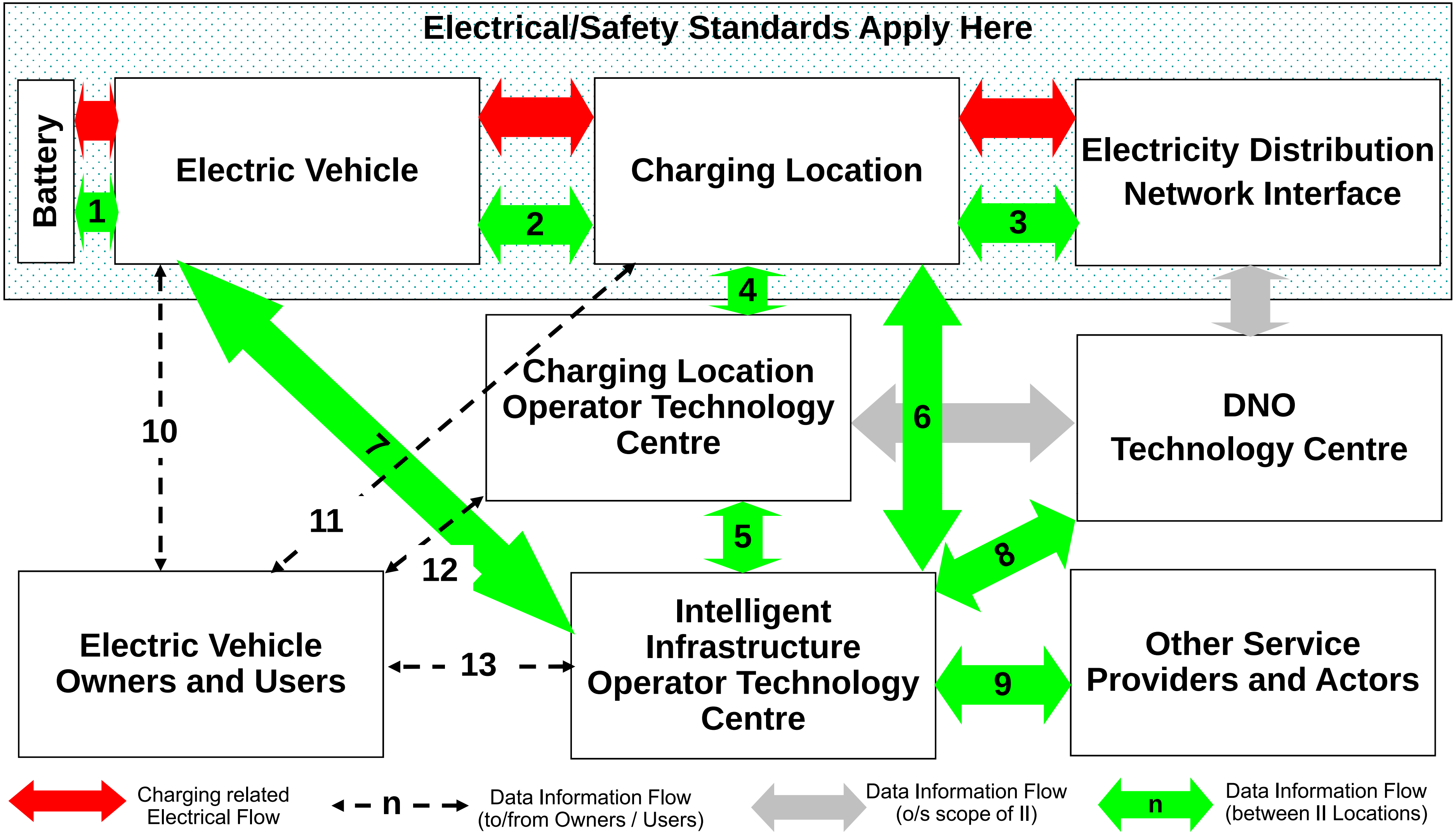
Realization – Importance of Standards – Recommended Approach (2/2)

- Following broad agreement on the overall purpose and functionality of the Intelligent Infrastructure, standards are developed for the exchange of data and information between actors/locations/components, comprising interface definitions and message types - defining how the actor/location communicates with others and what the communications (messages) contain.
- Components hosted in actors' locations are effectively treated as 'black boxes' – how that component is designed and built and how it functions internally is immaterial to the rest of the ecosystem as long at it meets the interfacing and message standards. An example would be that one Charge Post could be designed, built and operate very differently from another Charge Post built by a different OEM (using different hardware components, different software etc), but both would be able to connect to the same Charging Location Operator Technology Centre because they both adhere to the approved interface and message content standards. This example is depicted below:-



Realization – Importance of Standards – Requirements Landscape

The numbered arrows in the diagram below highlight where standards are required for interfaces and the exchange of data and information between actors/locations/components



Realization – Data, Information & Interface Standards (1/6)

From the Conceptual Design Block Diagram (previous slide), the following table describes the standards desirable for the development of the EV mass market.

Data /Information Flow Number	Actors /Locations /Components	Description	Standards Requirement (see below for further details)	Realization Priority for the Intelligent Infrastructure	Existing Related Standards
1	Battery (Control System) <> EV	Refers to the flow of data between the Battery Control System and the EV. Operational control of the battery, together with health and status monitoring information about the battery are critical to the functioning of the EV, let alone making this data available to the Intelligent Infrastructure. This is a fundamental EV engineering interface without which the EV would not be able to function.	Standards for the exchange of data between the Battery and the Electric Vehicle are driven by Vehicle OEMs and Battery Suppliers – as it is in the best interests of both to have a transparent standard which allows interoperability across OEMs and Suppliers.	High – driven by the needs of EV OEMs and Battery Suppliers	SAE J2289:2000
2	Electric Vehicle <> Charging Location	Refers to the flow of data between the Charge Point and the Electric Vehicle. The physical carrier could be either via the electrical connection or via a wireless protocol such as Bluetooth. This flow refers to the data and information being carried as opposed to any electric current, and signals implemented for safety purposes.	This flow requires standards for the following message types:- 2.1 EV Telemetry & Diagnostics Message – from the EV to the Charge Point 2.2 EV Configuration and Status Message – from the EV to the Charge Point 2.3 EV Charge Point User Interface Proxy – from the Charge Point to the EV	High – driven by the needs of EV OEMs, Charging Infrastructure OEMs and the wider needs of the Intelligent Infrastructure	SAE J1772:2010, IEC 62196 and others

Realization – Data, Information & Interface Standards (2/6)

Data /Information Flow Number	Actors /Locations /Components	Description	Standards Requirement (see below for further details)	Realization Priority for the Intelligent Infrastructure	Existing Related Standards
3	Charging Location <> Electricity Distribution Network Interface	Refers to the flow of data between the Charging Location and the Electricity Distribution Network Interface relating to data to support the Smart Meter in the Network Interface Unit	Standards are required for the exchange of data between the Charging Location and the Network Interface Unit principally to support the Smart Meter functionality. These standards should be covered by the emerging Smart Meter standards and connected devices in both Commercial and Domestic situations. The Intelligent Infrastructure is therefore not the primary driver for the definition of these standards, but rather the UK Government Smart Meter Initiative.	Medium – driven by the needs of the DNO and Regulators	Smart Meter Initiative
4	Charging Location <> Charging Location Operator Technology Centre	Refers to the flow of data between the Charging Location and the Operator's Technology/Data Centre.	This flow requires standards for the following message types:- 4.1 CP SCADA Message – from the Charge Point to the Tech Centre 4.2 CP Parameters Message – from the Tech Centre to the Charge Point 4.3 CP Charge Activity Message – from the Charge Point to the Tech Centre 4.4 CP Config' Message – from the Tech Centre to the Charge Point 4.5 CP Transaction Message – from the Charge Point to the Tech Centre	High – driven by the needs of Charging Infrastructure OEMs and Charging Location Operators	None found

Realization – Data, Information & Interface Standards (3/6)

Data /Information Flow Number	Actors /Locations /Components	Description	Standards Requirement (see below for further details)	Realization Priority for the Intelligent Infrastructure	Existing Related Standards
5	Charging Location Operator Tech Centre <> Intelligent Infrastructure Operator Tech Centre	Refers to the flow of data between the Charging Location Tech Centre and the Intelligent Infrastructure Technology Centre – commonality of requirements with messages between Charging Locations and Charging Location Operator Technology Centre need to be exploited.	This flow requires standards for the following message types:- 5.1 CLO Customer Message 5.2 CLO CP Status Message 5.3 CLO CP Asset Message 5.4 CLO CP Booking Message 5.5 CLO CP Master Data Message (…all the above are from the CLO Tech Centre to the Intelligent Infrastructure Tech Centre) 5.6 CLO Settlement Message - both directions	Medium – driven by the needs of the Intelligent Infrastructure Operator	None found
6	Charging Location <> Intelligent Infrastructure Operator Tech Centre	Refers to the flow of data between the Charging Location and the Intelligent Infrastructure Operator's Technology/Data Centre. It is not clear that these flows will exist, which result from the Intelligent Infrastructure Operator directly interfacing to the Charge Point, but the Conceptual Design allows for this.	As for standard message types for flow 4 between the Charging Location and the Charging Location Operator Technology Centre	Low – see comments	None found

Realization – Data, Information & Interface Standards (4/6)

Data /Information Flow Number	Actors /Locations /Components	Description	Standards Requirement (see below for further details)	Realization Priority for the Intelligent Infrastructure	Existing Related Standards
7	Electric Vehicle <> Intelligent Infrastructure Operator Tech Centre	Refers to the flow of data between the Electric Vehicle and the Intelligent Infrastructure Technology Centre directly – in this flow, the EV acts as any other mobile device – therefore see the flow - EV Owners and Users <> Intelligent Infrastructure Operator	As for the flow EV Owners and Users <> Intelligent Infrastructure Operator	Medium – driven by the needs of the Intelligent Infrastructure Operator and the EV Owners, Users and Operators	None found
8	Intelligent Infrastructure Operator Tech Centre <> DNO Tech Centre	Refers to the flow of data and information between the Intelligent Infrastructure Operator's Technology/Data Centre and the Distribution Network Operator's Tech Centre.	This flow requires standards for the following message types:- 8.1 II DNO Master Data Message – both directions 8.2 II DNO EV Charging Demand Management Message – from the Intelligent Infrastructure Operator Tech Centre to the DNO Technical Centre 8.3 II DNO Charging Parameters – from the DNO Technical Centre to the Intelligent Infrastructure Operator Tech Centre	High – fundamental interface for the Intelligent Infrastructure Operator – driven by the needs of the DNO, the II and Regulators	None found

Realization – Data, Information & Interface Standards (5/6)

Data /Information Flow Number	Locations / Components	Description	Standards Requirement (see below for further details)	Realization Priority for the Intelligent Infrastructure	Existing Related Standards
9	Intelligent Infrastructure Operator Tech Centre <> Other Service Providers and Actors	Refers to the flow of data between the Intelligent Infrastructure Technology Centre to the outside world	This flow requires standards for the following message types:- 9.1 II External Settlement Message (The need for additional message standards will emerge as service provision – particularly requiring EV market data – crystallizes)	High – fundamental interface for the Intelligent Infrastructure Operator – to meet its settlement responsibilities	None
10	EV Owner/User <> Electric Vehicle	Refers to the flow of data and information between the EV Owner/User and the EV via a mobile device.	This flow would benefit from standards for the following message types:- 10.1 EV User Pre-Conditioning Enquiry and Message – both directions 10.2 EV User EV Status Enquiry and Message – both directions 10.3 EV User Charging Control Message – both directions	Very low – EV OEMs may prefer to keep these flows directly between the EV and Owner proprietary to establish competitive advantage.	None found

Realization – Data, Information & Interface Standards (6/6)

Data /Information Flow Number	Actors /Locations /Components	Description	Standards Requirement (see below for further details)	Realization Priority for the Intelligent Infrastructure	Existing Related Standards
11	EV Owner /User <> Charging Location	Refers to the interface between the EV Owner and User and the Charge Point. This is a critical interface requiring standards which will allow universal access to charging infrastructure.	This interface requires the following standards:- 11.1 CP Access Token Standard 11.2 CP Electronic Purse Standard 11.3 CP Payment Card Standard 11.4 CP Payment Transaction Message 11.5 CP Home Area Network Standard	Very high – fundamental to the operation of the Intelligent Infrastructure in its widest sense.	None
12	EV Owner/User <> CLO Tech Centre	Refers to the interface between the EV Owner and User and the Charging Location Operator	Standards not required for primarily account (non-financial and financial) related messages.	N/A	N/A
13	EV Owner/User <> Intelligent Infrastructure Operator Tech Centre	Refers to the interface between the EV Owner and User and the Intelligent Infrastructure Operator	This interface requires the following standards:- 13.1 CP Location Details / Availability Enquiry and Message – both directions 13.2 CP Location Booking Enquiry and Message - both directions	Very high – fundamental to the operation of the Intelligent Infrastructure in its widest sense	None

Realization – Importance of Standards – Conclusions (1/2)

- Areas which are identified as a priority for requiring standards are :-
  - **EV User to/from Charge Point** (esp. Access Token, Electronic Purse, Payment Card) – to ensure universal access to Public Charging Infrastructure.
  - **Charge Point to/from the Charging Location Operator Technical Centre** (e.g. standards for reporting Charging Activity from the CP to the CLO) – to ensure interoperability of Charge Posts and Location Operators
  - **Charging Location Operator Tech' Centre to Intelligent Infrastructure Tech' Centre *and* Externally** (esp. standards relating to Settlement Activities) – to ensure availability of universal services within a country / region /international, and ease of use - 'roaming'

Realization – Importance of Standards – Conclusions (2/2)

- Failure to develop and deploy standards for interfaces, data and information exchange, risks:-
  - incompatibility between Intelligent Infrastructure actors and locations - vehicles, charge posts, DNOs - resulting in basic system failures e.g. failure to charge or failure to bill
  - additional costs in the market which ultimately flow through to the end user and detract from the enablement of a mass market,
  - actors locked into proprietary standards and technologies, restricting universal availability of services and competition,
  - some functionalities of the Intelligent Infrastructure become impractical to provide, for example settlement and clearance and market wide availability of data and information
- Some of the standards advocated in this report are ideally needed at a Global or European Level, in particular:-
  - standards relating to interfaces between the EV and the Charge Point
  - standards relating to interfaces between the Intelligent Infrastructure Operator and External Services/other Infrastructure Operators
- ….whilst some standards can remain as UK-only standards, for example those related to interfaces to/from Electricity Distribution Network Operators.
- Electrical and Safety Standards are being considered in other sub-project work streams, principally Work Package 2.2, and have an interdependency with Interface, Data and Information Exchange Standards in terms of underlying infrastructure, but the dependency is not critical
- A multi-disciplinary body representative of Intelligent Infrastructure actors is required to start work in this area at the earliest opportunity - the Intelligent Architecture Steering Group created by the ETI – which comprises auto-makers, charging infrastructure makers, service providers and DNOs - could provide a good basis.

Realization – What Intelligent Infrastructure functionality should be trialled by the ETI? Background

- The ETI has a vision to create a UK test bed capability for the electrification of light vehicles that will enable:-
  - the infrastructure systems to be tested at scale
  - real-world vehicle performance to be assessed, and
  - for extensive qualitative and quantitative consumer research to be undertaken with mass-market representative consumers (and not just early-adopters).

- Stage 1 , including Sub Project 2 and Work Package 2.4, conducted a number of analyses and developed a set of models, together with a Test Plan for verification and validation. Stage 1 only undertook very limited real-world trialling.

- Stage 2 will create and operate the test bed platform that will provide the extensive data-sets required by this Test Plan.

- The outputs from Stage 1 will be updated during Stage 2 using these data-sets to produce robust final outputs with extensive supporting evidence from real-world operation.

- The question posed for Work Package 2.4 is – what Intelligent Infrastructure functionality should be trialled in Stages 2 and beyond? The question was answered in deliverable SP2/IBM/20 and the key recommendations follow, including trial scenario and supporting information.

Realization - What II functionality should be trialled by the ETI? – Trial Scenario

Users Roam

Users Roam

Trial Region 1

More than 1 type of car – with communications to the Charging Post and the II

Payment on consumption and the ability to 'roam' using a single payment method / operator. Varying tariff structures

At least 2 brands of charging post – connected to a 'local' SCADA system. (Posts connected directly to the II?). Plus different charging technologies – fast, rapid, smart. Capability to receive and display different tariffs

Local SCADA

Trial Region 2

More than 1 type of car – with communications to the Charging Post and the II

Payment on consumption and the ability to 'roam' using a single payment method / operator. Varying tariff structures

At least 2 brands of charging post – connected to a 'local' SCADA system. (Posts connected directly to the II?). Plus different charging technologies – fast, rapid, smart. Capability to receive and display different tariffs

Local SCADA

Trial Region 3

More than 1 type of car – with communications to the Charging Post and the II

Payment on consumption and the ability to 'roam' using a single payment method / operator. Varying tariff structures

At least 2 brands of charging post – connected to a 'local' SCADA system. (Posts connected directly to the II?). Plus different charging technologies – fast, rapid, smart. Capability to receive and display different tariffs

Local SCADA

Stage 2 Trial

Intelligent Infrastructure

- Customer Management (EV Owner & User)
- Charging Location Operation
- Charging Infrastructure Management & Safety
- Demand/Supply Management
- Complex Event Processing
- Billing Information Services
- Settlement / Clearing
- Business Analytics
- Master Reference Data Mgt
- Security
- Integration & Interoperability Services
- Systems Mgt

Key Functionality to Trial

Key Concepts Demonstrated

- •Capability to roam
- •Capability to define and implement charging variables – e.g. charging technologies and tariffs
- •Settlement, billing and clearance of payments – by actual consumption using single payment method to a single payment operator
- •Integration and interoperability between the II and the EV, the II and the Charge Post Local SCADA
- •Provision of aggregated information to users and stakeholders e.g. charge post availability, charge post status in different regions from different manufacturers
- • Provision of management information and data warehousing functionality to all actors – Government and Regulation, Electricity Supply Chain Operators…
- •Master Data Management to enable all of the above

+Trial Specific Functionality – i.e. collection and analysis of data

Realization - What II functionality should be trialled by the ETI? – Trial Scenario

The following table provides an assessment of what functionality could be included in a Basic Trial versus an Advanced Trial:-

Broad Feature	Basic Trial	Advanced Trial
Customer Management	Register users, create accounts, handle basic contact - Simple CRM functionality	Extended CRM functionality
Charge Point Information & Management	Static location information Snapshot status information No consolidated asset view	Real time status information Consolidated asset view across all factors (supplier, operator, location, etc)
Charging Activity Management	Basic charging variables, e.g. charge after 2300, charge for 4 hours	Extended charging variables and parameters such as charge based on price, as fast as possible, until xx% then stop until time = xx. Also things like booking services, calendars, etc
Payment Management	Basic payment methods supported – account based, fee based, pay plug	Extended payment method support, including full ability of users to roam
Settlement	No settlement in a basic trial	Settlement supported to allocate payments across different providers and operators
Integration	No external real time integration required. Updates batch based or periodic polling type – such as for charging assets	Real time integration between systems, including simulated and real world external systems (e.g. pricing, demand, payment)
Analytics & Reporting	Mainly static reports. Some basic analytics	Extended analytics and looking towards optimisation
Demand Management	Not part of a basic trial	Information and analytical functionality available for demand management
Vehicle Interaction	No vehicle interaction Standard and standalone vehicle diagnostics	Extensive vehicle interaction, e.g. with charging post, external information source, etc Potential integration of vehicle diagnostics with analytics
Trial Specific Data Capture Infrastructure	As required	As required

Deliverables, Descriptions and the Strategic Questions Being Answered

- The slides in Section 5 have been extracted and adapted from the following deliverables:-

Area	Work Package 2.4 Deliverable	Description	Strategic Questions
Infrastructure Realization	Architecture Realization Plan (SP2/IBM/20)	Plan for trialling key features of the Intelligent Infrastructure	Which aspects of the Intelligent Infrastructure should be trialled by the ETI?
	Delivery – Phases, Options, Costs and Risks (SP2/IBM/28)	Using the Conceptual Design for the Infrastructure, tackles issues around systems integration and emerging technologies. Provides estimates of cost and considers risks	How much is it likely to cost to design and build? What risks might be involved in realizing an Intelligent Infrastructure? What systems might an Intelligent Infrastructure have to integrate with? Settlement of Charging Transactions? There are a number of Emerging Technologies in Power Generation and Storage – what effect might they have?
	Design Standards Gap Assessment (SP2/IBM/25)	Firms up on the earlier Standards deliverable and recommends where standards would be beneficial wrt the conceptual design	In which areas of the infrastructure are standards necessary/beneficial?

- These deliverables can be found in full in Appendix D.

ETI EV Work Package 2.4

SP2/IBM/27

End of Document

Appendices A - containing SP2/IBM/14, SP2/IBM15
B - containing SP2/IBM/16
C - containing SP2/IBM/17, SP2/IBM/18, SP2/IBM/19
D - containing SP2/IBM/20, SP2/IBM/25, SP2/IBM/28
are included in separate files due to size.