This document was prepared for the ETI by third parties under contract to the ETI. The ETI is making these documents and data available to the public to inform the debate on low carbon energy innovation and deployment.

Programme Area: Light Duty Vehicles

Project: Electricity Distribution and Intelligent Infrastructure

Title: Completion Report - Systems Integration and Architecture Development – Appendix D3

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 (ie, system design requirements) for recharging infrastructure to enable the system to be operated and managed effectively while also enabling compatibility between different business models. This is Appendix D3, providing an assessment of the phases, options, costs and risks for the implementation of an intelligent infrastructure.

Context:

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

Disclaimer:
The Energy Technologies Institute is making this document available to use under the Energy Technologies Institute Open Licence for Materials. Please refer to the Energy Technologies Institute website for the terms and conditions of this licence. The Information is licensed 'as is' and the Energy Technologies Institute excludes all representations, warranties, obligations and liabilities in relation to the Information to the maximum extent permitted by law. The Energy Technologies Institute is not liable for any errors or omissions in the Information and shall not be liable for any loss, injury or damage of any kind caused by its use. This exclusion of liability includes, but is not limited to, any direct, indirect, special, incidental, consequential, punitive, or exemplary damages in each case such as loss of revenue, data, anticipated profits, and lost business. The Energy Technologies Institute does not guarantee the continued supply of the Information. Notwithstanding any statement to the contrary contained on the face of this document, the Energy Technologies Institute confirms that the authors of the document have consented to its publication by the Energy Technologies Institute.

ETI EV Work Package 2.4

SP2/IBM/28 ETI EV Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks

Version: 2.1

© 2010 IBM Corporation

SP2/IBM/28 Header Page

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

Deliverable Title	ETI EV Work Package 2.4 Intelligent Infrastructure Delivery - Phases.Options, Costs and Risks
Deliverable Reference	SP2/IBM/28 version 2.0

Interim or Final	Final Report

Original Due Date	26/11/10
Initial Submission Date	03/12/10

Author	Simon Parker - IBM UK
Author	Nigel Baker-Brian - IBM UK
Author	

Approver	Giles Bridger - IBM UK

Version	History
v1.0	26/11/2010
v2.0	11/01/2011 - Updated following ETI Review
v2.1	Minor typos corrected

IP Ownership	As defined in the ETI Technology Contract

© 2010 IBM Corporation

ETI EV Work Package 2.4

EV Intelligent Infrastructure

SP2/IBM/28
Executive Summary

© 2010 IBM Corporation

Executive Summary (1/8) – 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.

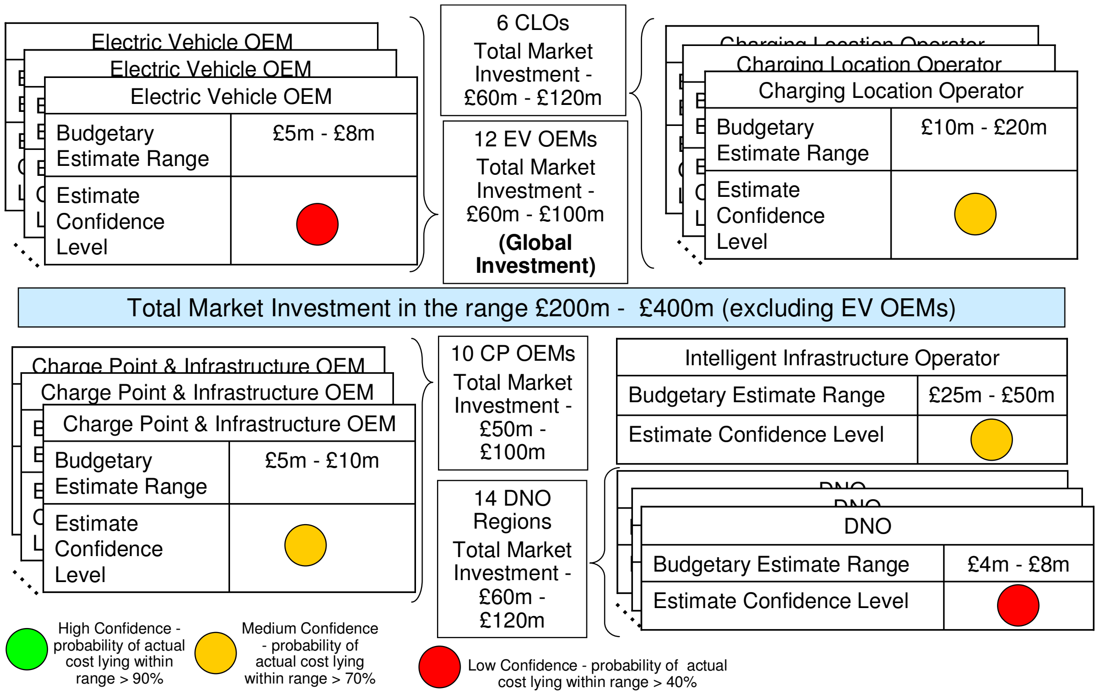
- The EV market can still develop with a less Intelligent Infrastructure but user constraints are likely to limit growth to a lower rate of take-up

© 2010 IBM Corporation

Executive Summary (2/8) – 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.



Electric Vehicle OEM	
Budgetary Estimate Range	£5m - £8m
Estimate Confidence Level	🔴

6 CLOs
Total Market Investment - £60m - £120m

12 EV OEMs
Total Market Investment - £60m - £100m
(Global Investment)

Charging Location Operator	
Budgetary Estimate Range	£10m - £20m
Estimate Confidence Level	🟡

Total Market Investment in the range £200m - £400m (excluding EV OEMs)

Charge Point & Infrastructure OEM	
Budgetary Estimate Range	£5m - £10m
Estimate Confidence Level	🟡

10 CP OEMs
Total Market Investment - £50m - £100m

Intelligent Infrastructure Operator	
Budgetary Estimate Range	£25m - £50m
Estimate Confidence Level	🟡

14 DNO Regions
Total Market Investment - £60m - £120m

DNO	
Budgetary Estimate Range	£4m - £8m
Estimate Confidence Level	🔴

🟢 High Confidence - probability of actual cost lying within range > 90%

🟡 Medium Confidence - probability of actual cost lying within range > 70%

🔴 Low Confidence - probability of actual cost lying within range > 40%

- 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 guesstimated 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 (Slide 119) in Section 7 provides a justification for these numbers.

© 2010 IBM Corporation

Executive Summary (3/8) – 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

© 2010 IBM Corporation

Executive Summary (4/8) – What are the key risks to the Intelligent Infrastructure?

- **Realisation Risk**, 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.

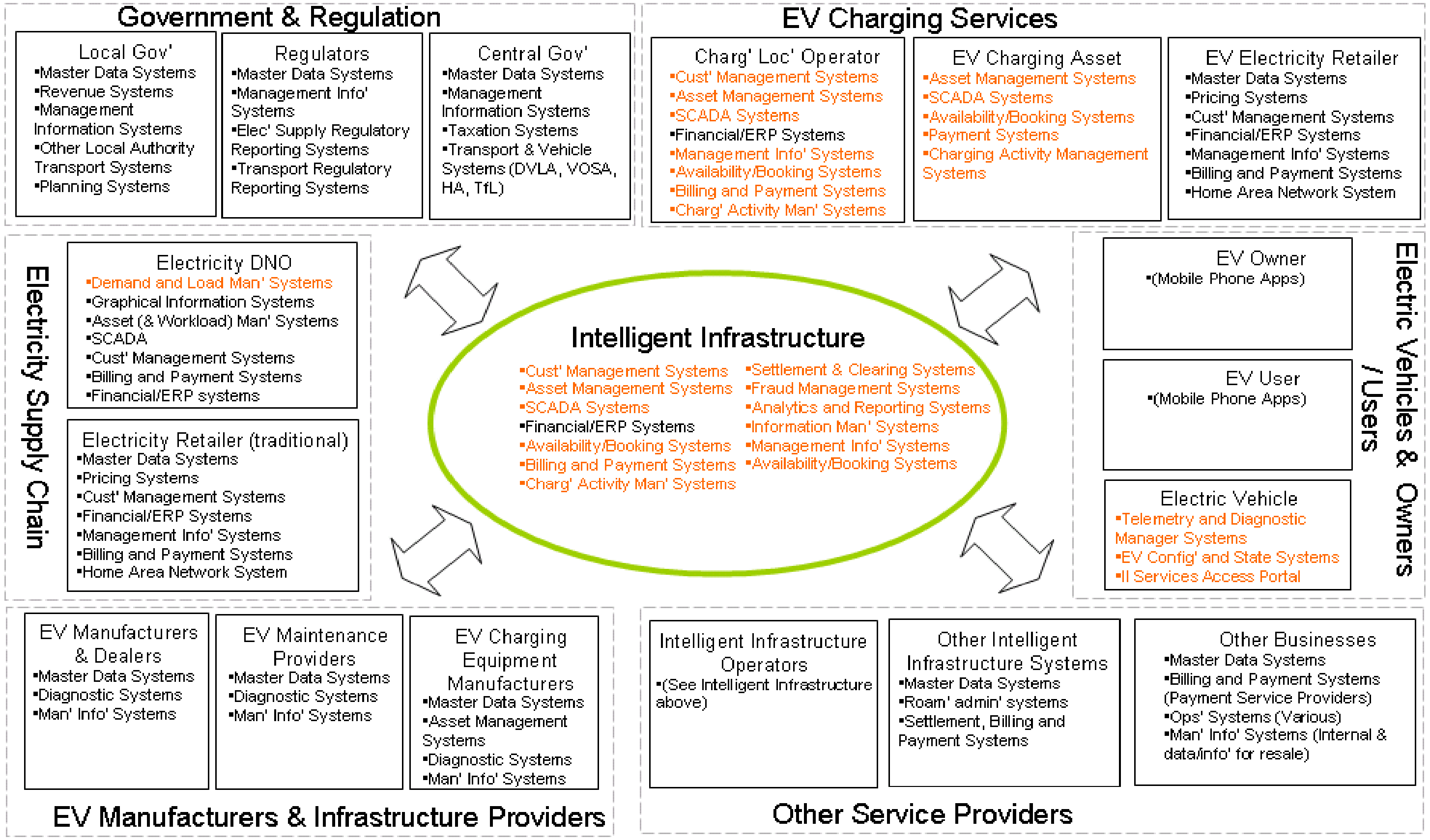
- **Complexity risk**. Risks whilst building the Intelligent Infrastructure are likely to be significant due to the size and complexity of developments, and the number of actors involved. The mitigation here is through learning from other industries, using component-based approaches, selective piloting, 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.

© 2010 IBM Corporation

Executive Summary (5/8) – Key findings from the Systems Integration and Settlement Landscape Investigations

- The Intelligent Infrastructure is the ‘glue’ which integrates multiple market actors’ and their diverse interests into an EV ecosystem, and therefore must be:
  - Open and standards based – e.g. to promote the creation and implementation of new goods and services by existing actors and new entrants
  - Cost effective – exploiting economies of scale and avoiding duplication
  - Based on appropriate technologies from the outset – e.g. to ensure it can scale upwards and meet industry requirements of robustness, ease of use and adaptability as the market develops



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)

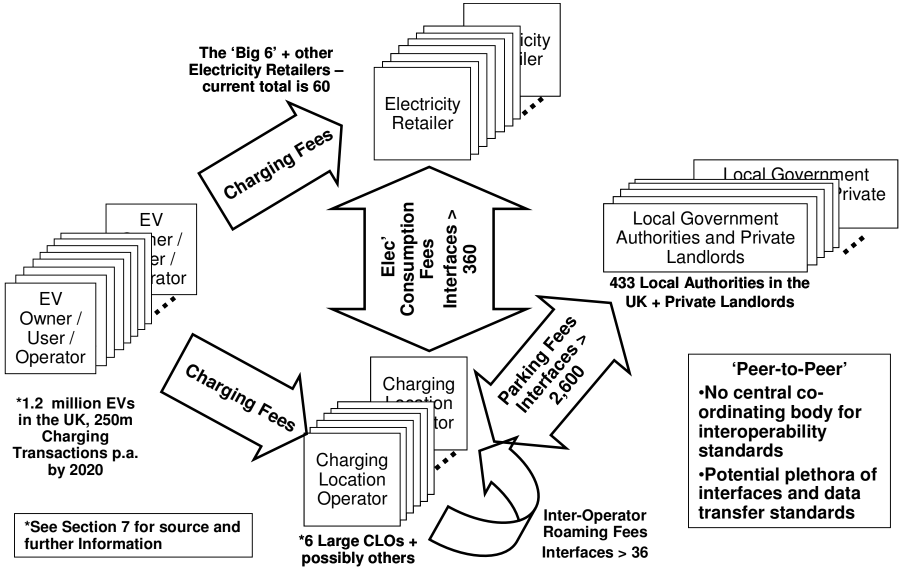
Other Intelligent Infrastructure Systems
- Master Data Systems
- Roam' admin' systems
- Settlement, Billing and Payment Systems

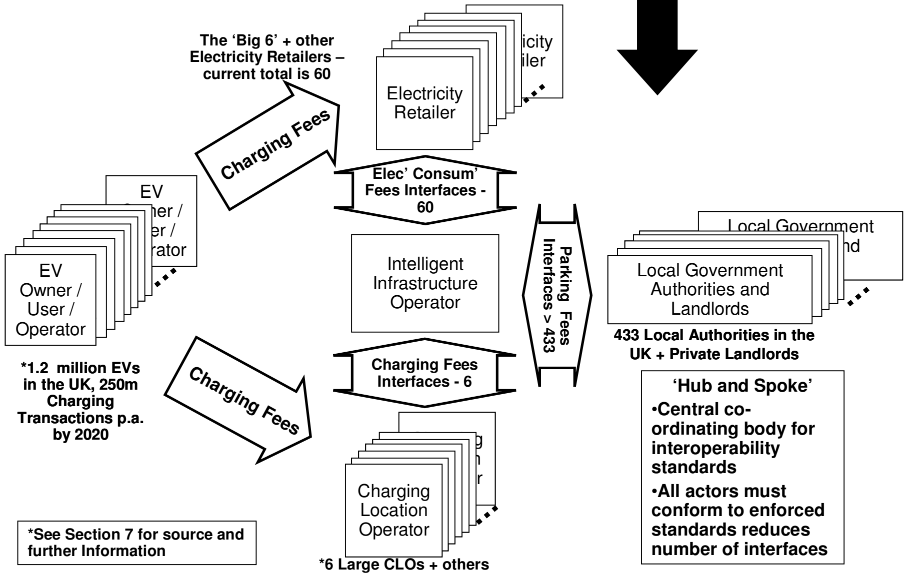
Other Businesses
- Master Data Systems
- Billing and Payment Systems (Payment Service Providers)
- Ops' Systems (Various)
- Man' Info' Systems (Internal & data/info' for resale)

© 2010 IBM Corporation

Executive Summary (6/8) – Key findings from the Systems Integration and Settlement Landscape Investigations

- A settlement landscape enables:-
  - EV users to use others' infrastructure (roaming)
  - Common billing and payments
  - Competition
- There are two models:-
  - '**Peer-to-Peer**' requires interconnect agreements to be negotiated and implemented directly between all players
  - '**Hub and Spoke**' has a central body and defined standard interface





- The hub and spoke model is recommended, based on practices used in other industries, e.g.:
  - Electricity markets: ELEXON, Electralink, DCC
  - Retail Banking ATM networks: Link
  - Bankers' clearing services: BACS and CLS.
- Governance of the central service is important to stimulate market growth rather than stifle it or create a monopoly. The above examples show precedents.
- It may emerge though commercial innovation but is more likely to require the creation of an industry body, possibly through coalition or through government or regulator intervention.

© 2010 IBM Corporation

Executive Summary (7/8) – Key findings from investigations into Emerging Technologies.

Emerging Tech' & Timeframe	Impact on II?	Addressed in Concept' Design?	Key Points for the EV Intelligent Infrastructure
Demand Side Management **(expected 5-10 yrs)**	●	●	Manage the impact on the energy grid of demand for vehicle recharging. - encourage vehicle recharging when demand lower / lower cost / lower CO2 emission. Mitigate against the need to reinforce the grid as a default reaction to increased demand. Balance need to recharge an EV battery against overall network capacity and demand
Embedded Energy Storage **(expected 10-15 yrs)**	◐	◐	Energy produced cheaply or could have been wasted used to recharge the vehicles. Energy stored used to recharge the vehicles rather than having them add to the demand for electricity at peak times. Sited in residential and workplace locations providing a source of energy where the vehicles are expected to be most of the time.
Vehicle to Grid **(expected 10-15 yrs)**	●	●	A form of embedded storage - 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.
Vehicle to Home **(expected 5-10 yrs)**	●	●	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.
Inductive Charging **(expected 5-10 yrs)**	Alternative to Conductive Charging ○ Charge on the Go ●	● ◐	More convenient recharging experience, reduced equipment wear and tear and misuse. Improved safety. Inductive charging equipment is less obtrusive. 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 – the latter use could have a significant impact on the Intelligent Infrastructure.
Smart Grids **(expected 5-10 yrs)**	●	●	Smart Grid technologies will require underlying infrastructure which the Intelligent Infrastructure could take advantage of, and vice-versa. The Intelligent Infrastructure conceptual design assumes Smart Grid Technology will be imminently deployed.
Smart Meters **(expected 3-8 yrs)**	●	●	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. The Intelligent Infrastructure conceptual design assumes Smart Meter Technology will be imminently deployed.

Conclusions: (1) All emerging technologies have a positive impact on the EV market as a whole, all have an impact on the Intelligent Infrastructure (2) All have been accounted for in the Intelligent Infrastructure Conceptual Design

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

© 2010 IBM Corporation

Executive Summary (8/8) – Next Steps

- 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 Case 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

© 2010 IBM Corporation

ETI EV Work Package 2.4

SP2/IBM/28 ETI EV Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks

Section 2 - Introduction

© 2010 IBM Corporation

SP2/IBM/28 – 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.

© 2010 IBM Corporation

SP2/IBM/28 – 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

© 2010 IBM Corporation

SP2/IBM/28 – 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.

© 2010 IBM Corporation

SP2/IBM/28 – 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.

© 2010 IBM Corporation

SP2/IBM/28 – 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.

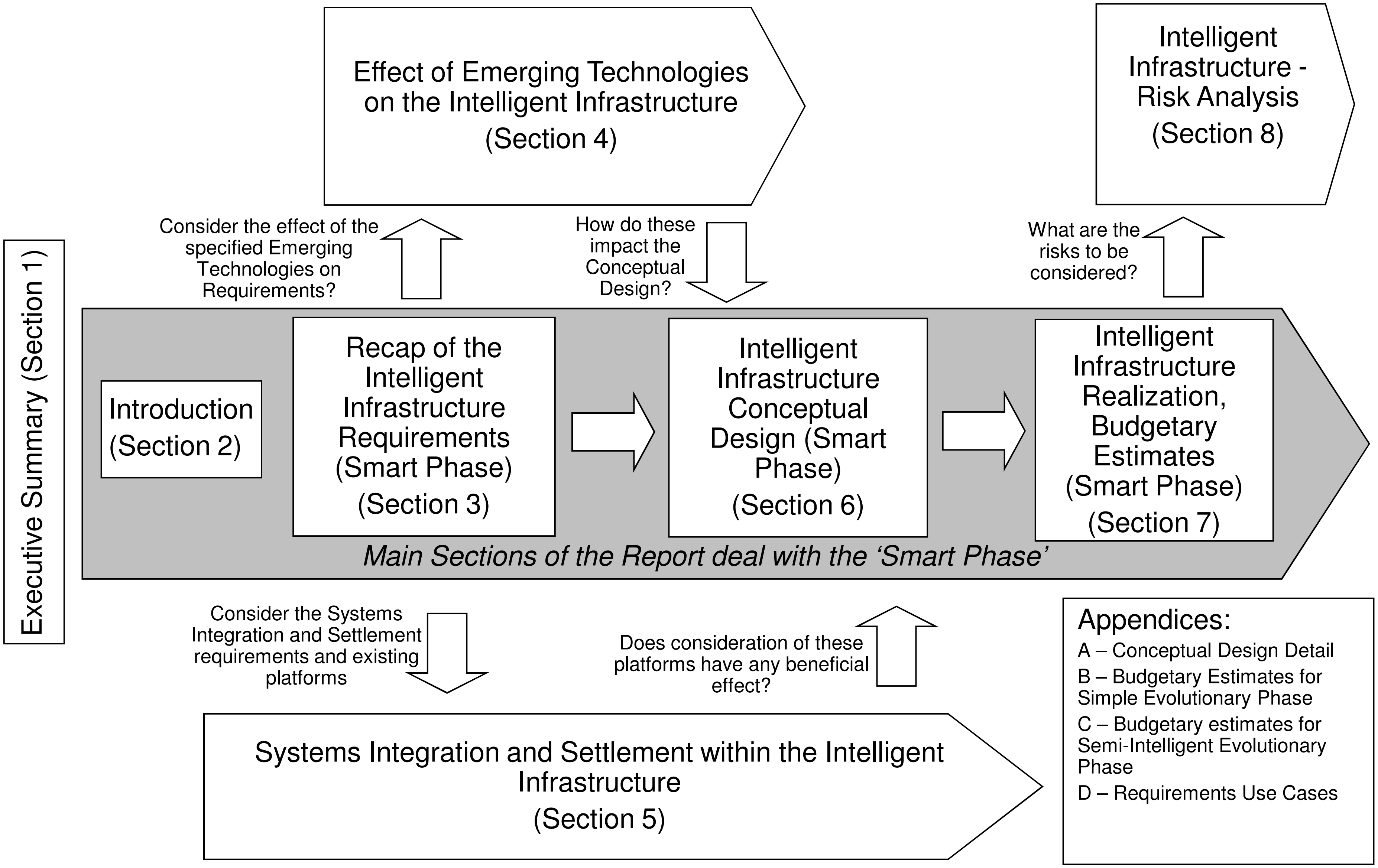
© 2010 IBM Corporation

SP2/IBM/28 – 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 CO2 production, lowest at opposing end of the spectra.

© 2010 IBM Corporation

SP2/IBM/28 – Contents and Structure



Effect of Emerging Technologies on the Intelligent Infrastructure

(Section 4)

Intelligent Infrastructure - Risk Analysis

(Section 8)

Consider the effect of the specified Emerging Technologies on Requirements?

How do these impact the Conceptual Design?

What are the risks to be considered?

Executive Summary (Section 1)

Introduction

(Section 2)

Recap of the Intelligent Infrastructure Requirements (Smart Phase)

(Section 3)

Intelligent Infrastructure Conceptual Design (Smart Phase)

(Section 6)

Intelligent Infrastructure Realization, Budgetary Estimates (Smart Phase)

(Section 7)

Main Sections of the Report deal with the ‘Smart Phase’

Consider the Systems Integration and Settlement requirements and existing platforms

Does consideration of these platforms have any beneficial effect?

Systems Integration and Settlement within the Intelligent Infrastructure

(Section 5)

Appendices:

A – Conceptual Design Detail

B – Budgetary Estimates for Simple Evolutionary Phase

C – Budgetary estimates for Semi-Intelligent Evolutionary Phase

D – Requirements Use Cases

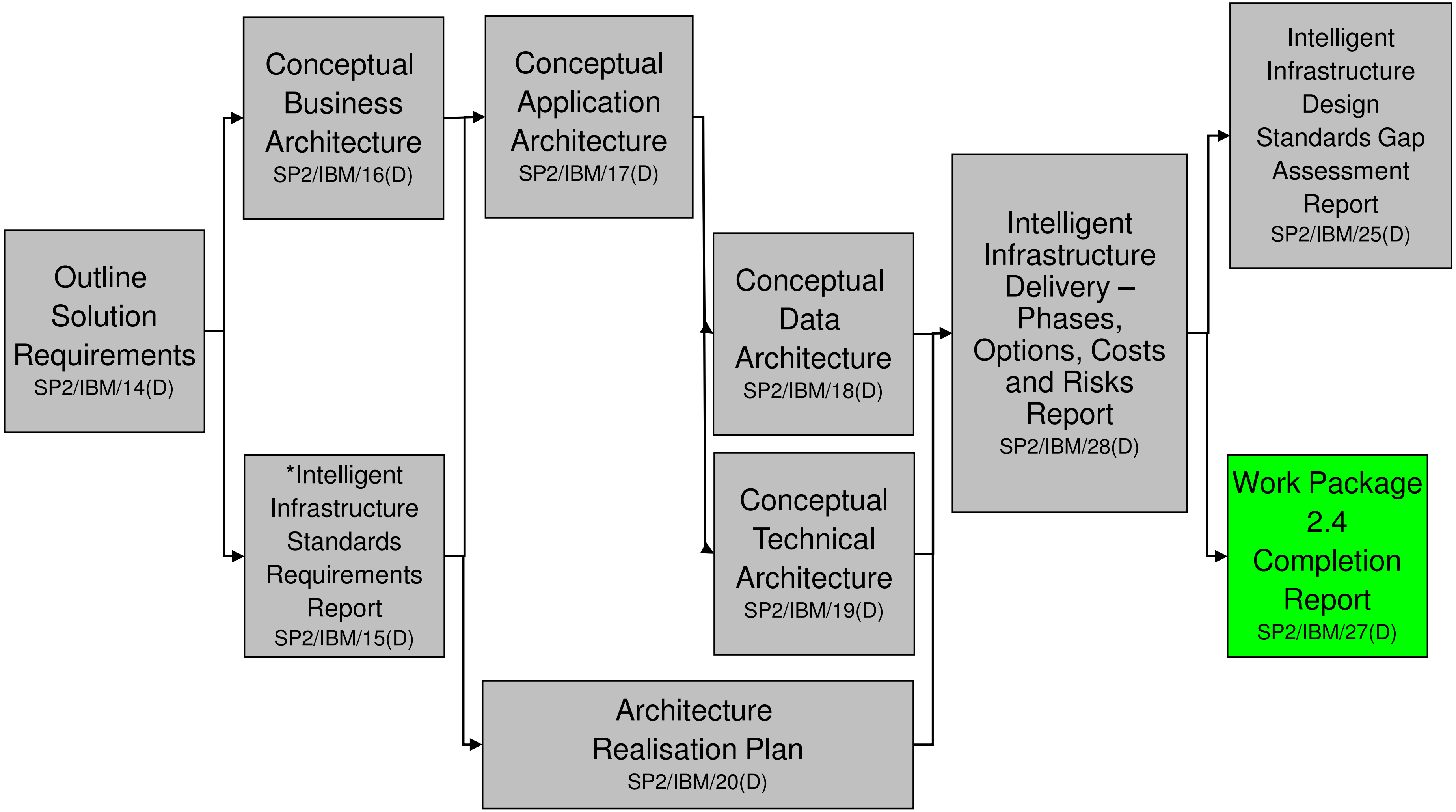
© 2010 IBM Corporation

ETI EV Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks - Purpose and Objective

- Purpose
  - This document is SP2/IBM/28, a deliverable of the ETI Technology Contract for the Electrification of Light Vehicles - Project: Electricity Distribution & Intelligent Infrastructure. It is designed to meet the objectives and requirements as set out in Var007 and Contract Schedule 7. Originally the contract requested four separate deliverables, namely SP2/IBM/22, SP2/IBM/23, SP2/IBM/24, SP2/IBM/26 which were combined via Variation Request 007 into this deliverable.
- The high level objectives of SP2/IBM/28 are to answer the following key questions:-
  1. How much is an Intelligent Infrastructure likely to cost in approximate terms? This is covered in Sections 3, 6, 7.
  2. What effect might the following emerging technologies, such as Demand Management, Embedded Storage, Vehicle-to-Grid, Vehicle-to-Domestic, Smart Grids - have on the Intelligent Infrastructure? This is addressed in Section 4.
  3. Are there existing or emerging systems which could be used as a basis for providing the Intelligent Infrastructure? This is covered in Section 5.
  4. What are the risks involved in realizing the Intelligent Infrastructure? This is covered in Section 8.
- (Specific contractual acceptance criteria, and how the deliverable has met them, are listed below).

© 2010 IBM Corporation

Work Package 2.4 – Intelligent Infrastructure – Recap of the Structure of the Work Package



Outline Solution Requirements
SP2/IBM/14(D)

Conceptual Business Architecture
SP2/IBM/16(D)

*Intelligent Infrastructure Standards Requirements Report
SP2/IBM/15(D)

Conceptual Application Architecture
SP2/IBM/17(D)

Conceptual Data Architecture
SP2/IBM/18(D)

Conceptual Technical Architecture
SP2/IBM/19(D)

Architecture Realisation Plan
SP2/IBM/20(D)

Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks Report
SP2/IBM/28(D)

Intelligent Infrastructure Design Standards Gap Assessment Report
SP2/IBM/25(D)

Work Package 2.4 Completion Report
SP2/IBM/27(D)

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks - Overview of key Work Package 2.4 Deliverables

Deliverable	**Outline**
Intelligent Infrastructure Requirements Report	Outline solution requirements; High Level System Context; High Level Initial Use Case Model
Intelligent Infrastructure Standards Requirements Report	The standards report provides a list of areas that may require a standard; it will not attempt to define or set the actual standards.
Conceptual Business / Application / Data / Technical Architectures	Decide on the overall shape and style of the architectures and evaluate alternative high-level architectures and choose between them Includes artefacts such as Component Business Model ('CBM'), component model, entity relationship diagram, operational model
Plan for Architecture Realisation	High-level plan defining scope, activities and deliverables required in Stage 2
Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks	See above
Intelligent Infrastructure Design Standards Gap Assessment Report	Provides an Inventory of current standards and a gap analysis of them against the requirements of the Intelligent Infrastructure.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks – Contractual Acceptance Criteria (1/3)

High Level Objective	Contractual Acceptance Criteria	How the report meets the criteria
Conceptual Design / Budgetary Estimates	Produce order of magnitude estimate of the costs involved in implementing (designing and building) the required back office and supporting systems of the Intelligent Infrastructure.	The contents of Section 7 are written with the aim of meeting these criteria – slides 117 – 129. Section 7 is in itself a relatively short section, but the budgetary estimates are based on a Conceptual Design developed for this deliverable and provided in Section 6. This design, in its turn, builds on the existing architectural deliverables - SP2/IBM/17, SP2/IBM/18, SP2/IBM/19. The Conceptual Design reflects the stages of evolution of the architecture (as per description in SP2/IBM/16) and the II requirements (SP2/IBM/14).
Emerging Technologies	For each of the following areas of emerging technology (Demand Management, Embedded Storage, Vehicle-to-Grid, Vehicle-to-Domestic, Smart Grids), assess the scenarios where plug-in vehicles and these technologies could be deployed and the costs / benefits / risks and uncertainties involved.	The contents of Section 4 are written with the aim of meeting these criteria. Demand Management – see slides 37 to 40 Embedded Storage – see slides 41 to 45 Vehicle to Grid – see slides 46 to 49 Vehicle to Home/Domestic – see slides 50 to 51 Inductive Charging – see slides 52 to 53 Smart Grid – see slides 54 to 59 Smart Meter – see slides 60 to 63 (Summary tables – slides 64 to 66)

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks – Contractual Acceptance Criteria (2/3)

High Level Objective	Contractual Acceptance Criteria	How the report meets the criteria
Systems Integration and Settlement	(1) Describe the Settlement Landscape of possible payment types, transactions, parties, settlement, billing and accounting regimes (2) Provide an "As-is" assessment of the industry data flows and supporting mechanisms in the energy markets and the emerging market model for Smart Metering. Evaluate the adequacy and potential of the existing power industry mechanisms for systems integration and billing (e.g. Elexon, Electralink and Smart Metering). (3) Describe the Settlement Scenarios - 5 scenarios covering the data flow landscape relating to data exchange between the various actors in alternative business models and payments and settlement between actors ("Club", Pre-payment, Pay-as-you-go, Payment on Account, Third Party payment) Assessment Criteria; Definition of the criteria for assessment of "platforms". A platform is equivalent here to an industry mechanism such as the Smart Metering Central Communications Model (4) Platform Assessment; An assessment of each platform with recommendations. The purpose of the assessment is to evaluate the adequacy and potential of the platforms. The recommendations will be relevant to future detailed design activity and will help determine the future direction of the solution architecture (5) Systems Integration Inventory - Inventory of the systems requiring integration (6) Provide an "As-is" assessment of the industry data flows and supporting mechanisms in the energy markets and the emerging market model for Smart Metering.	Criteria, (numbered left) are addressed in Section 5, as follows:- (1, 3) Slides 68 to 85 (2, 4, 6) Slides 89 to 97 (5) Slides 86 to 88

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks – Contractual Acceptance Criteria (3/3)

High Level Objective	**Contractual Acceptance Criteria**	**How the report meets the criteria**
Risks to Realization	Identification and assessment of security weaknesses in the proposed infrastructure architecture from all actors perspective Identification and assessment of operational risks Identification and assessment of points of failure Recommendations as to the areas and levels of risk mitigations / avoidance and safety / security to be pursued for further analysis and design in the Stage 2 activities.	All criteria are addressed in Section 8 – Slides 130 to 135

© 2010 IBM Corporation

ETI EV Work Package 2.4

SP2/IBM/28 ETI EV Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks

Section 3 – Intelligent Infrastructure Requirements

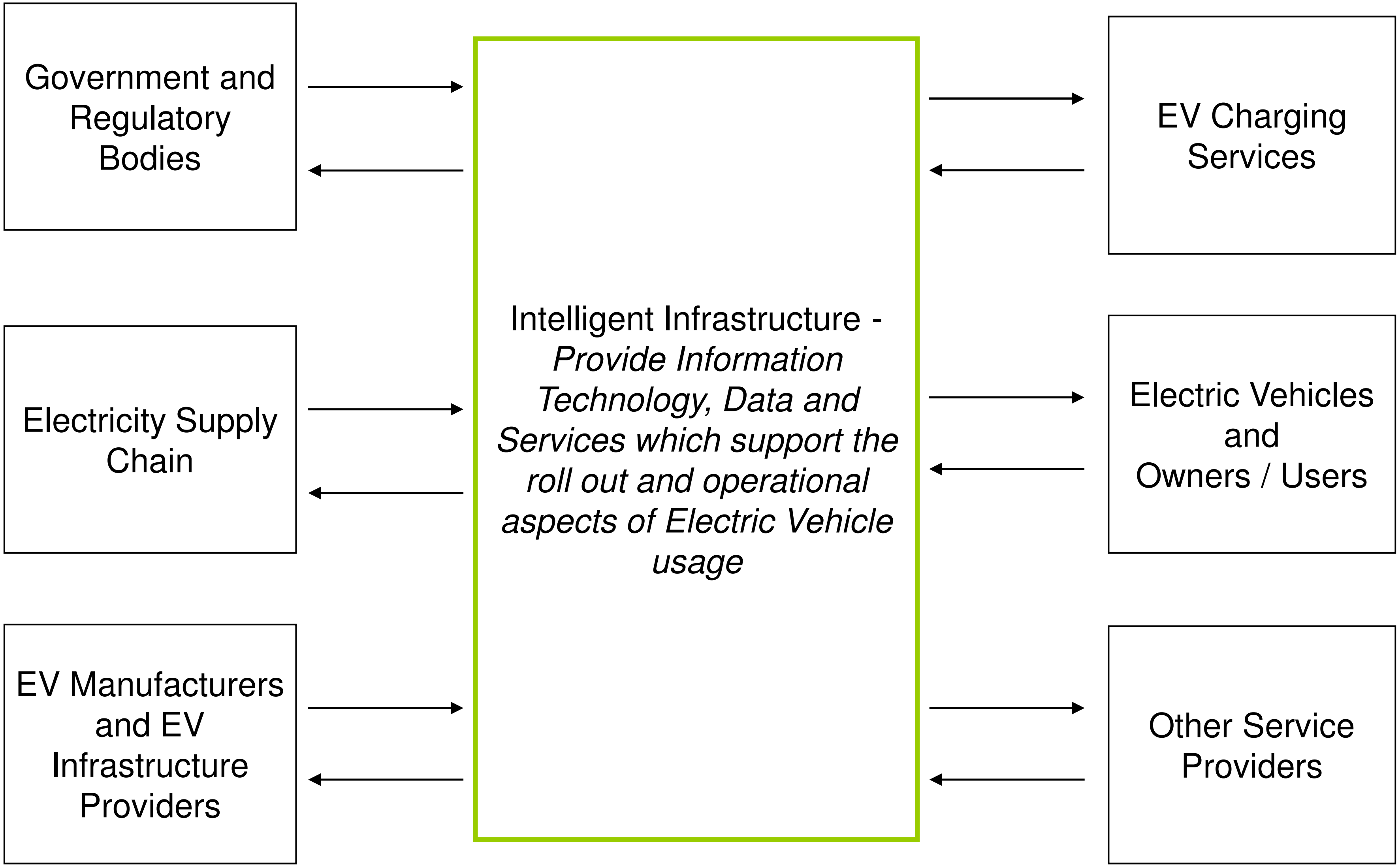
© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks – Recap of Requirements

- Budgetary estimates for the design and build of the Intelligent Infrastructure are based on a design which in turn meets the set of requirements defined in SP2/IBM/14. In order to facilitate the reading and review of this report, this section provides a recap of the Intelligent Infrastructure Requirements distilled from SP2/IBM/14. For more detail, the reader should refer to the earlier deliverable.
- The following information has been extracted and summarized from the Requirements Report:-
  - the Intelligent Infrastructure Level 0 and Level 1 Context Diagrams to remind the reader of the System Actors of the Intelligent Infrastructure
  - a definition of the System Actors
  - the Intelligent Infrastructure conceptual functional description to remind the reader of how the Intelligent Infrastructure has been decomposed into its functional components
  - the use cases which equate to the requirements of the Intelligent Infrastructure across all phases of evolution - simple, semi-intelligent and smart (see SP2/IBM/16 for further details) - the full set of use cases are to be found in Appendix D, with the summary slide included in this section.
- Also included is a slide of high level non-functional requirement statements
- Please note that budgetary estimates are required for the design and build of the Intelligent Infrastructure at the three phases of evolution – the requirements (in terms of specific use cases) at each evolutionary phase were defined in the Conceptual Business Architecture (SP2/IBM/16) – this information is reproduced in Appendix B for the Simple Evolutionary Phase and Appendix C for the Semi-Intelligent Evolutionary Phase.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap - Level 0 Context Diagram (from SP2/IBM/14)



Government and Regulatory Bodies

Electricity Supply Chain

EV Manufacturers and EV Infrastructure Providers

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

EV Charging Services

Electric Vehicles and Owners / Users

Other Service Providers

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap – Context Diagram Actors – Characteristics and Definitions (from SP2/IBM/14)

‘Government & Regulation’ comprises:-

- European Union Commission
- Core Government Departments – e.g. Department for Transport, DECC etc
- Executive Agencies – e.g. DVLA
- Non Departmental Public Bodies (Executive, Advisory) – e.g. Commission for Integrated Transport
- Public Corporations
- Regulators – e.g. Ofgem, IEC, ISO
- Local Government & Local/Regional Transport Authorities including local borough councils who are key actors in rolling out public charging infrastructure

‘Electric Vehicle Charging Services’ comprises:-

- Organisations which operate and manage the charging location - providing services which allow the EV user to complete the charging (or V2G) operation, with the capability to provide/receive data and information to/from other Service Providers
- EV Charging Assets - such as Charge Points
- EV Electricity Retailer – the actor providing electricity to the charging location which may or may not be the same as the more traditional electricity retailer

‘Electricity Supply Chain’ comprises:-

- Electricity Retailers
- Distribution Network Operators

(Electricity Generators and National Transmission Grid operators are assumed to have no direct interaction (in those roles) with the Intelligent Infrastructure but are involved in the supply chain via actors in the role of Retailer and DNO.)

‘Electric Vehicles & Owners / Users’ comprises:-

- The vehicle itself – EV, PHEV or other variation
- EV, PHEV owners and users
- Fleet owners and operators – private (retail and commercial), public

‘Electric Vehicle Manufacturers and Electric Vehicle Infrastructure Providers’ comprises:-

- Electric Vehicle (EV) and Plug In Hybrid Electric Vehicle (PHEV) manufacturers including those unique-to-EV-component manufacturers
- Charging equipment and infrastructure manufacturers – including charging posts, meters and connectors
- EV Maintenance Providers, including Breakdown Services

‘Other Service Providers’ comprises:-

- Emergency Services
- Operators of the Intelligent Infrastructures including billing, back office and settlement providers
- EV Information Service Providers
- Navigation Services Providers
- Payment Services Providers
- Other businesses – e.g. Battery Leasing

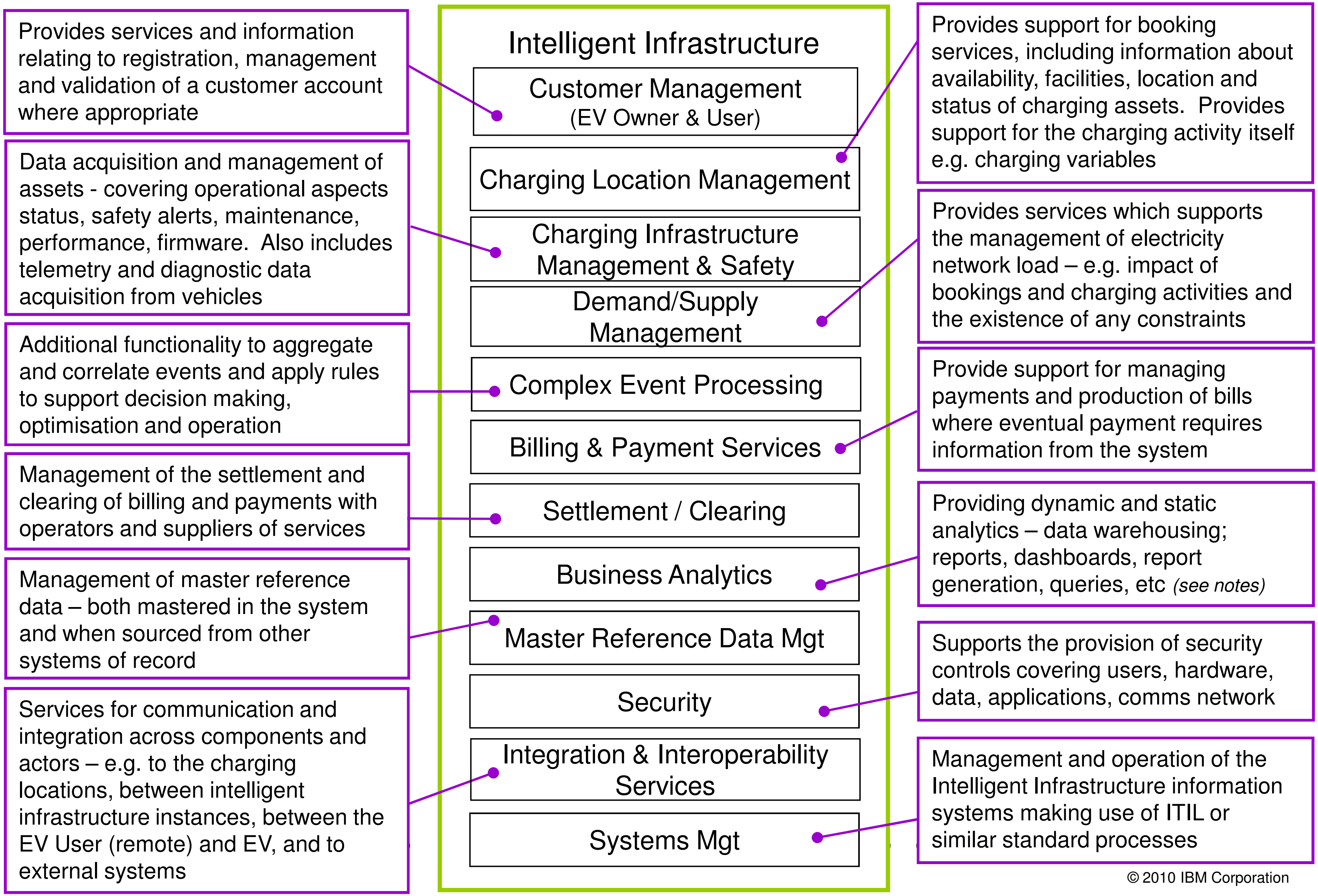
© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap - System Context Views – Assumptions concerning Actors (from SP2/IBM/14)

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

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap – Conceptual Functional Description (from SP2/IBM/14)



Provides services and information relating to registration, management and validation of a customer account where appropriate

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

Intelligent Infrastructure

- Customer Management (EV Owner & User)
- Charging Location Management
- 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

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

© 2010 IBM Corporation

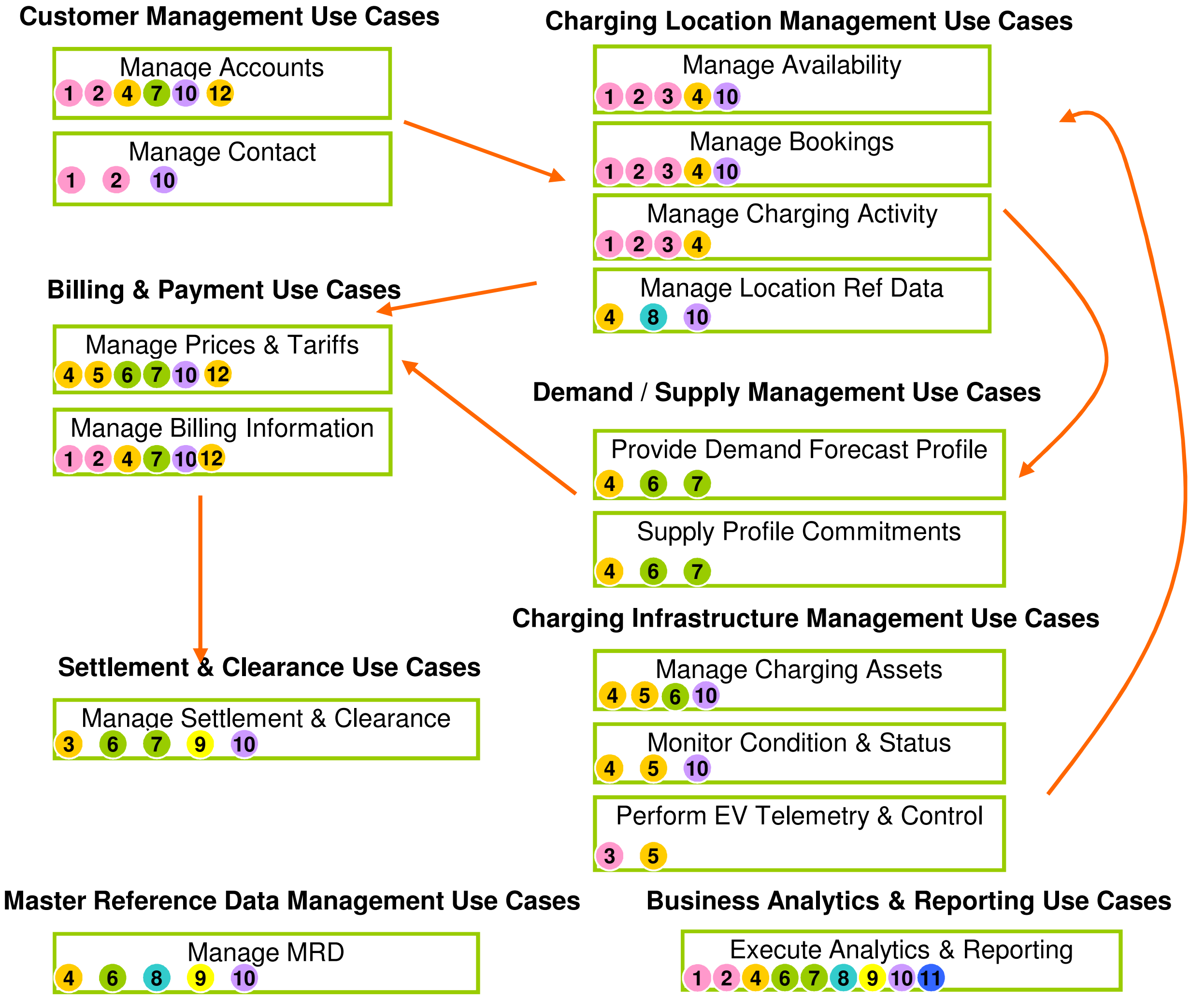
EV Intelligent Infrastructure Delivery – Requirements Recap – Initial High Level Uses Cases – Graphical View (from SP2/IBM/14)

Intelligent Infrastructure Actors

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

See Appendix D for full set of use cases

Intelligent Infrastructure – Use Cases by Conceptual Functionality, showing Actors involved and dependencies



Customer Management Use Cases

Manage Accounts ① ② ④ ⑦ ⑩ ⑫

Manage Contact ① ② ⑩

Charging Location Management Use Cases

Manage Availability ① ② ③ ④ ⑩

Manage Bookings ① ② ③ ④ ⑩

Manage Charging Activity ① ② ③ ④

Manage Location Ref Data ④ ⑧ ⑩

Billing & Payment Use Cases

Manage Prices & Tariffs ④ ⑤ ⑥ ⑦ ⑩ ⑫

Manage Billing Information ① ② ④ ⑦ ⑩ ⑫

Demand / Supply Management Use Cases

Provide Demand Forecast Profile ④ ⑥ ⑦

Supply Profile Commitments ④ ⑥ ⑦

Settlement & Clearance Use Cases

Manage Settlement & Clearance ③ ⑥ ⑦ ⑨ ⑩

Charging Infrastructure Management Use Cases

Manage Charging Assets ④ ⑤ ⑥ ⑩

Monitor Condition & Status ④ ⑤ ⑩

Perform EV Telemetry & Control ③ ⑤

Master Reference Data Management Use Cases

Manage MRD ④ ⑥ ⑧ ⑨ ⑩

Business Analytics & Reporting Use Cases

Execute Analytics & Reporting ① ② ④ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap – Non-Functional Requirements

Non-functional requirements (NFRs) specify ‘how’ the system should operate, rather than ‘what’ the system should do. NFRs define the qualities and constraints to which a system must be built. Qualities define the expectations and characteristics the system should support. Constraints are limitations or specifications imposed upon a solution.

- QUALITIES
  - Run Time
    - Capacity
    - Performance
    - Availability
    - Security
    - Usability
  - Non Run Time
    - Portability
    - Maintainability
    - Scalability
    - Data & Information Integrity
    - Safety
- CONSTRAINTS
  - Business
    - Regulatory
    - Marketplace
    - Schedule & Budget
  - Technical
    - Legacy Integration
    - Development Skills
    - Existing Infrastructure
    - Technology State of the Art
    - Standards

NFRs for the Intelligent Infrastructure will need to be developed in more detail once the requirements have reached a higher level of maturity, for the purposes of the Conceptual Design and Budgetary Estimates the following assumptions have been made around key NFRs on the next slide.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap – Non-Functional Requirements – Assumptions

Category	NFR(s)	Assumption Commentary
Run Time	Capacity	Key assumptions have been made about the number of EVs, Charge Posts and Type, number of charging transactions undertaken and others. See Section 7 – Budgetary Estimates for further details.
	Performance	No explicit assumptions possible at this time, but underlying assumption is that performance across the Intelligent Infrastructure for all actors will be comparable to existing Information Technology Services e.g. existing retail payment services when paying for a charging transaction, existing search web sites when looking for/booking a charge point/location. For future definition.
	Availability	Certain functional areas of the Intelligent Infrastructure will require 'high availability' to meet anticipated Service Levels – Customer Management, Charging Location Management, Charging Infrastructure Management. For future definition.
	Security	Security requirements are comparable to existing Information Technology Services – especially where customer details - including financial data are being processed; eg Payment Card Industry Standards will apply. For future definition.
	Usability	Usability for Intelligent Infrastructure actors will be comparable to existing Information Technology Services – existing Customer and Asset Management Web Sites. For future definition.
Non-Run Time	Portability, Maintainability etc.…	No explicit assumptions required at this stage, BUT development of the II will be based both on existing Commercial off the Shelf (COTS) Products and bespoke development using accredited development methodologies and tools, and this has been assumed in the design and hence taken into the budgetary estimates. For future definition.
Business	Regulatory, Marketplace…..	For future definition, but assumed at this stage that the Intelligent Infrastructure will operate in the current Regulatory framework (with some possible minor changes – e.g. EV Electricity Retailing). Some assumptions have been made for budgetary estimating purposes around the Marketplace e.g. number of Charging Location Operators by 2020 – see Section 7 - Budgetary Estimates for further details.
Technical	Legacy Integration, Development Skills etc.	For future definition, but the Conceptual Design assumes that the Intelligent Infrastructure will be built on, and integrate with actors' existing capabilities e.g. in the case of the EV OEM , its existing in-car development environments and systems

© 2010 IBM Corporation

ETI EV Work Package 2.4

SP2/IBM/28 ETI EV Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks

Section 4 – Effect of Emerging Technologies

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology - Introduction

- This section deals with specific emerging technologies and their impact on the intelligent infrastructure. The subjects covered are:-
  - Demand Side Management;
  - Embedded Energy Storage;
  - Vehicle to Grid;
  - Vehicle to Home;
  - Inductive Charging:
  - Smart Grids
  - Smart Meters
- This section addresses the following ETI requirements, as detailed:-
  - 2-4.3 Evaluate the potential for demand side management and embedded energy storage to overcome the constraints identified for both new and existing networks – (The electrical aspects of demand side management and embedded energy storage are addressed in task 2.3.5).
  - 2-4.8 Evaluate the cost / benefit case for practicality and timescales associated with implementation of vehicle-to-grid and vehicle-to-home. (The electrical aspects of vehicle–to-grid and vehicle-to-home are addressed in task 2.3.6)
  - 2-4.9 Determine the effect of future charging technologies such as inductive charging could have on the requirements for the system architecture. (The electrical aspects of inductive charging are addressed in task 2.2)
- *Note that this section deals with the impact of these technologies on the Intelligent Infrastructure and, as such, provides only sufficient information for that purpose. All of these technologies are investigated in more depth in terms of technical detail, economic benefits and other criteria in other Sub-Project 2 Work Packages.*

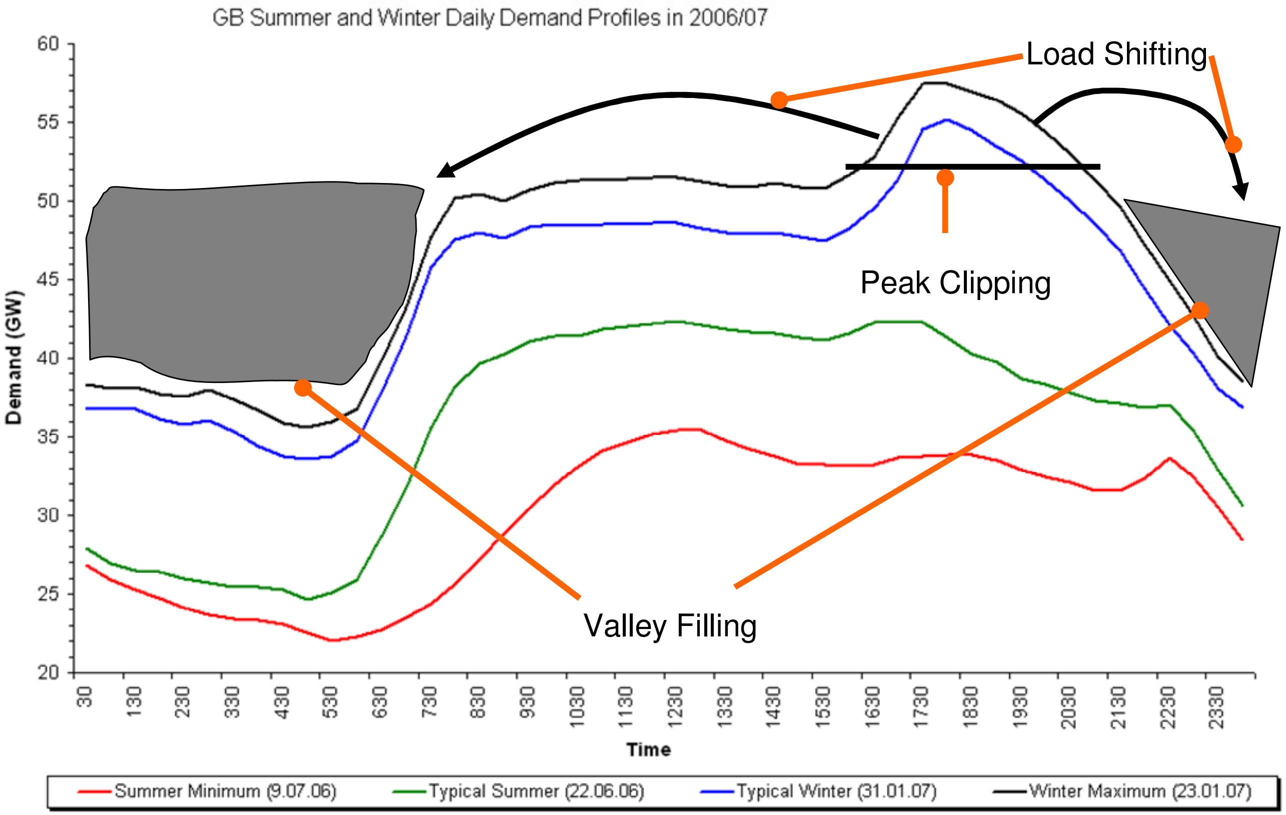
© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Demand Side Management – Description (1)

- Demand Side Management, or "DSM" is the process of managing the consumption of energy to optimise available and planned generation resources.
- DSM is an important technology area because it will assist the Electricity Supply Chain in managing vehicle recharging away from the existing peak demand periods and towards time periods where the demand can be more easily provided for. In the UK, the view is that there exists significant scope for DSM to contribute to increasing the efficiency of the system investments DNO and generators have made and will make in the future.
- The traditional rationale behind DSM came from the electricity supply chain objectives around establishing a flat and predictable load. This has altered slightly to now consider consumer and society as well as supplier based objectives, for example commitments to reduce carbon emissions and demands for cleaner air in built up areas.
- The Electricity Networks Strategy Group refer to the following drivers for DSM
  - Reduced CO2 Emissions
  - Reduced peak load
  - Improved security of supply
  - Reduced energy costs
  - Deferred network reinforcement
- The IEA talk about influencing the Load Shape and Load Level.
  - Load Shape : Tasks that seek to impact the shape of the load curve over very short (minutes-hours-day) to longer (days-week-season) time periods - taking advantage of demand valleys and mitigate demand peaks
  - Load Level : Tasks that seek to shift the load curves to lower demand levels or shift between loads from one energy system to another – focusing on factor for energy conservation and growth
- The figure below illustrates different ways of targeting the shape of a load on the network. Effectively the suppliers look to reduce excessive peaks, redistribute a peak or utilise under used areas of capacity.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Demand Side Management – Description (2)



- DSM is a term for a wide range of different tools, techniques and approaches. The International Energy Agency Demand Side Management initiative outlines the following options:
  - Reduce the demand peaks, especially when utilisation of power comes close to its limits of availability
  - Shift the loads between times of day or even seasons
  - Fill the demand valleys to better utilise existing power resources
  - Reduce overall demand (strategic saving) in the context of delivering the required energy services by use of less energy (and not a reduction in services)
  - Provide strategic growth especially to shift between one type of supply to another with more favourable characteristics, for example, making use of renewable energy generations assets and resources

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Demand Side Management – Implications for the Intelligent Infrastructure

Timing	The electricity suppliers and network operators will remain responsible for ensuring that the demand for electricity can be managed for the benefit of all consumers. The increased use of electric vehicles will need to be considered as another potential load on the network with a usage profile and so needs to be managed accordingly. In the initial phases of adoption, the volume of electric vehicles requiring recharging is unlikely to create wholesale issues for the energy grid. There is potential for localised disruption to the grid and research into identifying these areas and the extent of any issues is taking place.
Functionality	Additional specific application functionality will be required by DSM in the areas of forecasting and optimisation, and will involve the provision of ever more data and information to the electricity supplier to allow them to manage demand, including:- customer account information, electric vehicle information, recharging point information – including status, recharging transaction details and summaries, recharge booking information, pricing and tariff, analytics. The introduction of certain DSM techniques could impact on the availability of the recharging infrastructure at certain times and locations. These will need to be modelled as supply constraints and will need to include restriction of operation of certain recharging locations. For example, DSM may mean that public recharging infrastructure is rationed in some way at peak times of consumption. This information would need to be recorded in the Intelligent Infrastructure for the recharging location to advise potential customers. In the domestic charging situation, currently basic time based switching allows someone recharging their EV to select charge now / charge later - with the second option targeting the cheaper and lower demand overnight electricity for recharging. Although very simple, this does provide some management of demand away from the evening peak. This will evolve towards more sophisticated time of use pricing with the car, the domestic charge post and a home network managing the recharging based on pricing signals from the smart meter / smart grid.
Non Functional Areas (Capacity, Performance etc.)	Increased amounts of data passing through interfaces across the Intelligent Infrastructure putting more load on infrastructure including communications. More sophisticated functionality in all components of the II, namely the EV, the Charge Post, the Data Centres means more processing and data storage capacity.
Others/General	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 across the network in order to, amongst others, delay the need for network reinforcement. Use cases developed for SP2/IBM/14 and summarized here in Section 2 reflect the likely requirements to be imposed by DSM and hence are **included** in the design and the budgetary estimates for the Intelligent Infrastructure for the Smart Phase.

© 2010 IBM Corporation

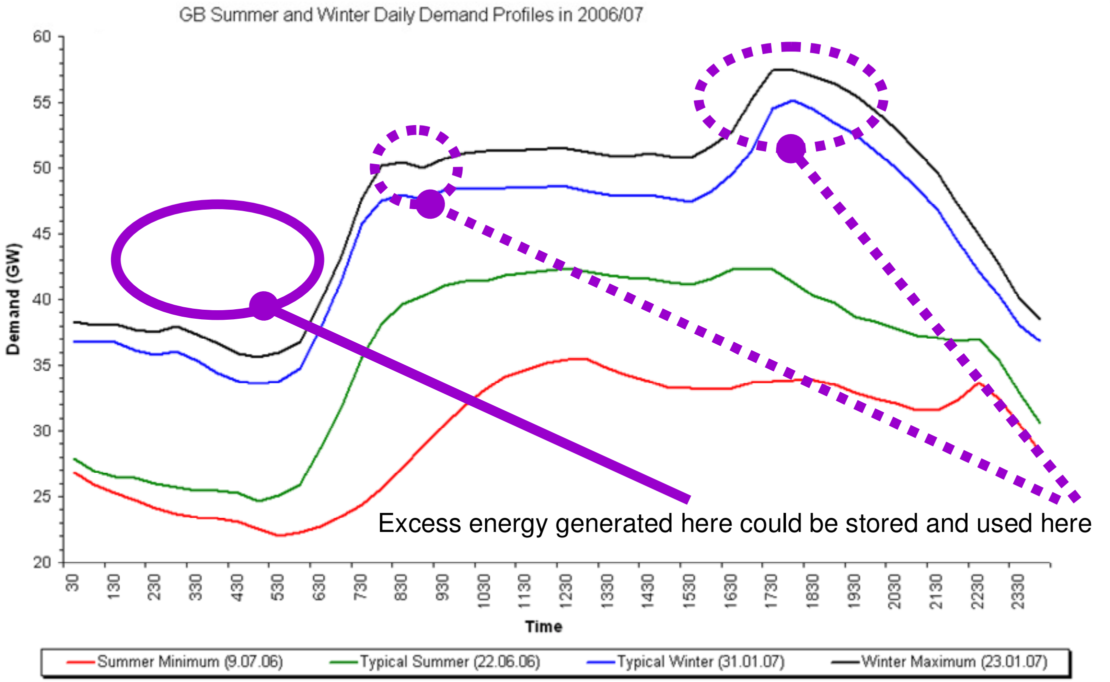
EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Demand Side Management – Positives and Cautions

Positives relating to EV use	▪Manage the impact on the energy grid of demand for vehicle recharging ▪Encourage vehicle recharging at times of lower demand, lower cost and lower CO_2 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
Cautions relating to EV use	▪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 ▪The non-functional requirements imposed by DSM on the Intelligent Infrastructure, including increased amounts of data passing, more sophisticated functionality in all components of the II, namely the EV, the Charge Post, the Data Centres means more processing and data storage capacity.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Embedded Storage – Description (1)

- Storing electricity on a large scale enables power generated when demand is low to be stored for release at peak demand periods. Storage will become more important because renewable energy sources such as wind and solar do not produce constant levels of power. Currently, techniques such as pumped storage hydro-electric stations are utilised which use potentially unused electricity to pump water into a high level reservoir which is then released to generate electricity at peak times. Currently there is much research into developing options for embedded storage – as discussed in subsequent slides.
- Renewable energy generation is variable and intermittent and thus its generation peaks may not coincide with peak demand. Without a way to store the excess energy, the only way to maintain a reliable supply when demand increases is to run a higher base load capable energy mix – coal, nuclear and gas.
- The following chart illustrates the issue:-

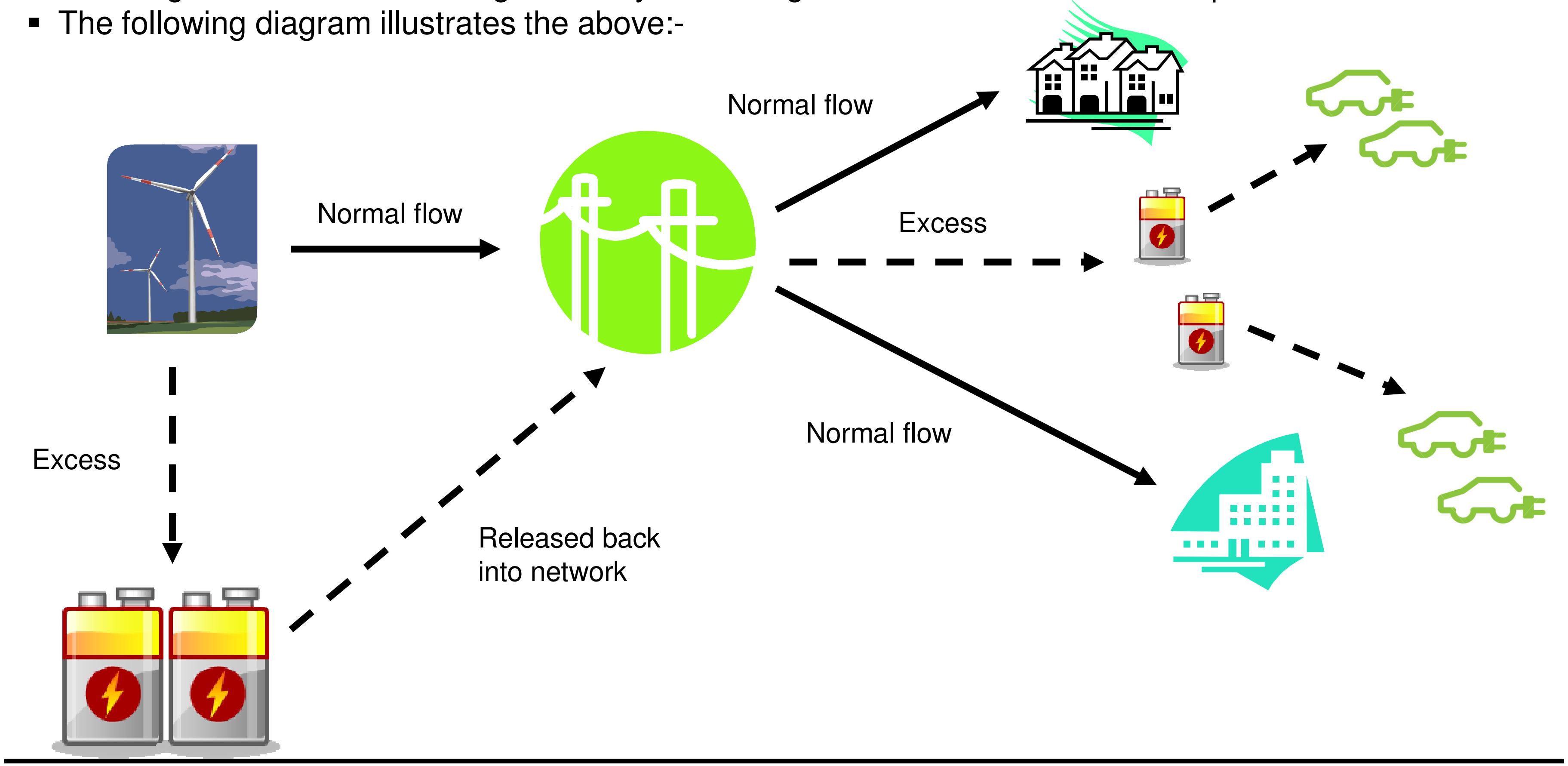


Excess energy generated here could be stored and used here

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Embedded Storage – Description (2)

- Embedded storage could be used during peak or high demand periods to supply power for electric vehicle recharging, rather than requiring them to take energy from the grid.
- Embedding energy storage in the network would allow surplus energy to be stored until there is an opportunity to use it. On-grid battery storage can reduce the peak energy load, as it is seen by the distribution system. This can improve utilisation of assets on the electrical grid and manage energy demand so it is based on average instead of peak load.
- Embedded storage at the workplace, retail site, leisure venue or home would provide a means to capture excess generation and discharge it locally to recharge electric vehicles which are parked.
- The following diagram illustrates the above:-



© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Embedded Storage – Description (3)

- There is very little energy storage currently in the UK – they can be characterized as large capital investments with long payback periods. Prompted by the drive towards renewable generation, a report in 2008 from the Parliamentary Office of Science and Technology proposed a regulatory change that would allow transmission companies to own and operate storage.
- Energy storage can provide services at the transmission level but might be more utilised going forward at the distribution level – storing energy in the network for use at peak times – and in that way, could be more cost effective than potentially expensive network re-enforcement and expansion
- The Electricity Storage Association is a trade association established to foster development and commercialisation of energy storage technologies. They have a very interesting rating chart of different types of energy storage which is derived from looking at a wide range of considerations such as capital cost, life expectancy, cycle costs, etc.

  http://www.electricitystorage.org/ESA/technologies

  http://www.electricitystorage.org/ESA/applications
- Examples of Embedded Storage:-
  - Flywheels and super-capacitors
  - Pumped hydro energy storage
  - Compressed air energy storage
  - Large scale conventional battery storage – on-grid or off grid
  - Flow Cell battery storage
  - Small scale battery storage (e.g. in the vehicles themselves)

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Embedded Storage – Implications for the Intelligent Infrastructure

Timing	Not expected to be a significant feature until the semi intelligent and smart phases given the lack of embedded storage in use. The Electricity Networks S Group (ENSG) place embedded storage in the highly uncertain category with a timeframe of between 2020 and 2050. The ENSG also bracket embedded storage with the potential for V2G and virtual power plants.
Functionality	Impacts will be in the functional areas of Demand Management, Pricing and Analytics. Demand and load management will remain the function of the DNO using their own systems but will require additional data from the Intelligent Infrastructure – for example, having views of the demand for recharging relative to the time of use and availability of pre-generated and stored energy would be useful in management of the grid. Pricing functionality will be impacted as the use of energy from embedded storage may be provided at a lower cost for recharging when compared to electricity generated in real time. EV users may be able to select the stored energy at a lower cost and even register preferences that they would use stored energy if available. Business analytics functionality may be required to provide detailed analysis of demand to determine the best physical locations to site the storage. Business analytics functionality may be required to provide information to optimise usage considering marginal system benefit and battery lifetime cost Intelligence at the location / distribution level will be required to understand the location and status of the embedded storage, and to be able to determine how much of the demand for vehicle recharging could be met from that source – the major impact will be on the Smart Grid functionality rather than on the Intelligent Infrastructure, but the latter may be affected
Non Functional Areas (Capacity, Performance etc.)	Increased amounts of data passing through interfaces across the Intelligent Infrastructure putting more load on infrastructure including communications. More sophisticated functionality in all components of the II, namely the EV, the Charge Post, the Data Centres means more processing and data storage capacity.
Others/General	The proposed solution for the Intelligent Infrastructure in the Smart Phase has the capability to host the functional requirements which will be imposed by the widespread use of embedded energy storage. If all of the possible functional requirements imposed by embedded storage were to materialize, then budgetary estimates for the development of the Intelligent Infrastructure would be at the higher end of the budgetary estimate

© 2010 IBM Corporation

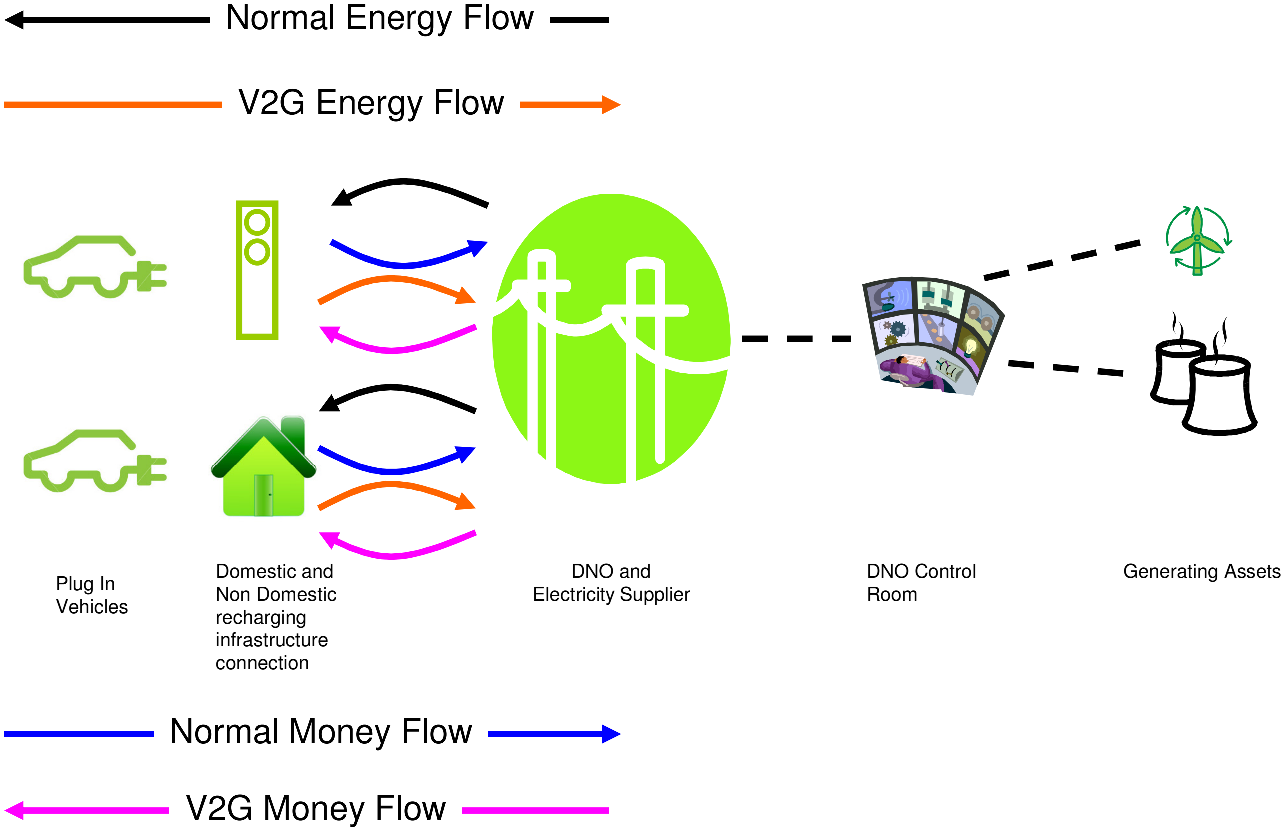
EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Embedded Storage – Positives and Cautions

Positives relating to EV use	▪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
Cautions relating to EV use	▪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

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Vehicle to Grid – Description (1)

- The vehicle to grid (V2G) idea is both incredibly simple and hugely complex. In simple terms, the batteries in electric cars are used as dynamic energy storage with the energy being sold back or made available to the electricity grid in particular scenarios, such as high demand from other energy uses or network supply problems.
- The following diagram illustrates:-



© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Vehicle to Grid – Description (2)

- Important to realising economic value from Vehicle to Grid (V2G) technology is matching demand from the grid with the ability of the vehicles to supply energy, whilst not unknowingly disrupting use of the vehicle.
- For practical purposes, grid connected electric vehicles would need to be grouped together as one electric power resource so that grid operators don't have to interact with thousands of vehicles. For example, this is a model being explored in the EDISON project in Denmark and is referred to as a virtual power plant (VPP).
- The concept currently under consideration as a Smart Grid application, particularly in the USA and Denmark, is to use suitably equipped grid connected passenger electric vehicles to provide a load levelling function for the electric utilities.
- It's key advantage over 'fixed' storage is that it is mobile and can follow the consumer/consumption.
- The basic model comprises:
  - Valley Filling – charging the vehicle's batteries when demand is low, thereby utilising excess generation capacity that cannot be used (e.g. when it is very windy) or is not normally operational (e.g. when a gas power station is under deployed) and;
  - Peak Shaving - allowing the DNO to request energy back from the battery of a grid connected vehicle for use on the wider network when demand is high, thus reducing the peak demand on the utility's capacity and providing some fallback in case of an issue with a generation asset.
- V2G is a simple and attractive theoretical concept, especially as the flow of electricity back to the grid could attract payment to the vehicle owner. In practice, however, the concept faces many challenges and the current position of the DNO community in the UK is that they have made little to no allowance for V2G as a source of power for their networks. Issues under consideration are
  - A need to devise and implement a system of aggregation to avoid dealing with individual car batteries
  - The timeframe by which the proportion of suitable grid connected vehicles is high enough to make V2G viable - the Energy Network Strategy Group (ENSG) suggested in 2009 that 2040 would be the timeframe by which V2G was realistic at scale.
  - The timeframe in which suitable recharge / discharge infrastructure will be widely implemented – the recharge infrastructure (potentially all of domestic, public, commercial) must be capable of enabling safe and reliable discharge to the mains network
  - The need for the intelligent infrastructure to monitor the charge in the batteries, control energy flow and make sure the vehicle can be provided with sufficient energy for when it is next in use
  - Sufficient financial benefits for EV owners and users to join the scheme and changes to billing systems to recompense the EV owner
  - The requirement to ensure that the EV owner's use of the vehicle is not unexpectedly disrupted.
  - The impact of regular V2G discharging on the battery condition and life.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Vehicle to Grid – Implications for the Intelligent Infrastructure

Timing	As discussed above, the timeframe by which the proportion of suitable grid connected vehicles is high enough to make V2G viable - the Energy Network Strategy Group (ENSG) suggested in 2009 that 2040 would be the timeframe by which V2G was realistic at scale..
Functionality	Impacts functionality in the areas of Master Data, Demand and Supply Management, Pricing, Payment, Billing and Settlement Significant impact in the area of master data where the data model would need extending to record who had agreements with Retailers for V2G, the conditions of the agreement (when power could be taken, how much, the threshold for power to remain in the battery etc., which locations (domestic, public, commercial) has V2G – enables recharging equipment Major impacts are in the areas of demand and supply management. Having access to a potentially vast source of stored power would need to be factored into the demand and supply calculations made by the grid operators. This would require additional data to be stored and transmitted to the DNO/Retailer. Additional functionality which handles payments, billing, settlement and pricing. The power is effectively 'sold' back to the grid and so would be paid for. Where the supply back to the grid takes place in a domestic setting, this might be achieved using similar mechanisms to the feed in tariff system and reconciled on the energy bill of the customer.
Non Functional Areas (Capacity, Performance etc.)	Increased amounts of data passing through interfaces across the Intelligent Infrastructure putting more load on infrastructure including communications. More sophisticated functionality in all components of the II, namely the EV, the Charge Post, the Data Centres means more processing and data storage capacity.
Others/General	Use cases developed for SP2/IBM/14 and summarized here in Section 2 reflect the likely requirements to be imposed by V2G and hence are **included** in the design and the budgetary estimates for the Intelligent Infrastructure for the Smart Phase

© 2010 IBM Corporation

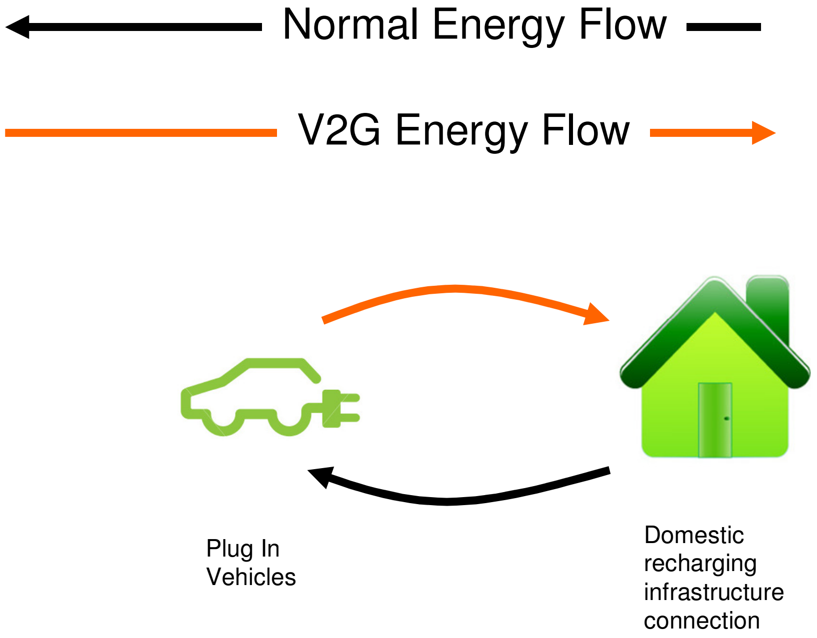
EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Vehicle to Grid – Positives and Cautions

Positives relating to EV use	▪A form of embedded storage, it makes use of energy that might otherwise not be needed ▪It’s key advantage over ‘fixed’ storage is that it is mobile and can follow the consumer/consumption. ▪It has the potential to create a positive financial position for the vehicle owner
Cautions relating to EV use	▪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

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Vehicle to Home / Domestic – Description

- Energy stored in the electric vehicle battery is made available as a power supply to the home. A situation in which use of the technology could be envisaged may be as a result of some emergency relating to the normal domestic supply. Effectively the vehicle battery is used as embedded storage.
- The following diagram illustrates:-



Normal Energy Flow

V2G Energy Flow

Plug In Vehicles

Domestic recharging infrastructure connection

- Issues which face the proposed use and introduction of this technology are:-
  - Vehicle battery technology is not optimised for this purpose though it might be expected that this situation will change as the technology improves.
  - The effect of constant recharge and discharge on battery performance and life.
- A more feasible approach may be for homes and residential areas to have larger and purpose built embedded storage topped up in time of low demand / excess generation, which could then be utilised in power supply interruption scenarios as well as for vehicle recharging

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Vehicle to Home/Domestic – Implications for the II, Positives and Cautions

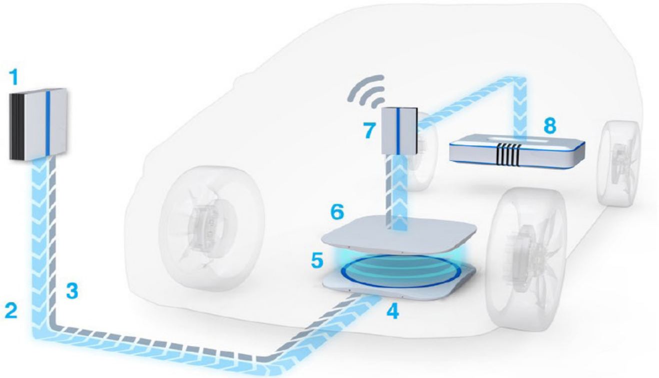
Timing	Simpler concept to Vehicle to Grid – timing is dependent on development of battery technology, domestic (dis)charging technology and its overall cost and attractiveness to consumers – but primarily EV battery technology
Functionality	Should this become a factor, the key functionality & data impacts are largely in the areas of demand management, pricing and analytics. Integration with home energy networks and smart metering would be required
Non Functional Areas (Capacity, Performance etc.)	Minimal impact, if any
Others/General	Use cases developed for SP2/IBM/14 and summarized here in Section 2 reflect the likely requirements to be imposed by V2H and hence are **included** in the design and the budgetary estimates for the Intelligent Infrastructure for the Smart Phase

Positives relating to EV use	▪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
Cautions relating to EV use	▪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 demand of V2H ▪Could require additional infrastructure at the home to provide safe and efficient operation

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Inductive Charging – Description

- Inductive charging does not have any physical coupling between the EV and the charging infrastructure, energy is transferred by forming a magnetic flux path. The following diagram illustrates:-



1. Power Supply
2. Power Flow
3. Data Flow
4. Transmitter
5. Magnetic Resonance
6. Receiver
7. Controller
8. Battery

- The lack of a physical coupling brings a number of benefits as follows:-
  - A more convenient recharging experience for the EV user/owner – no cables to plug/unplug – 'park and charge'
  - The absence of conductive connectors removes the associated issues of interoperability, equipment wear and tear and misuse by users - malicious or inadvertent
  - 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"; such as being integrated in the road at traffic lights, bus stops, drive-throughs and areas of high congestion. Regular energy transfer from the infrastructure may enable smaller, and hence lighter and cheaper battery packs within the EV
- On the down side, inductive charging brings a number of disadvantages namely:-
  - The efficiency (in terms of power loss) of inductive charging systems has been inferior to conductive charging systems, although significant improvements have been made in recent times and manufacturers now claim there is no significant difference between the two – see SP2/E.ON/04 for details.
  - 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.

© 2010 IBM Corporation

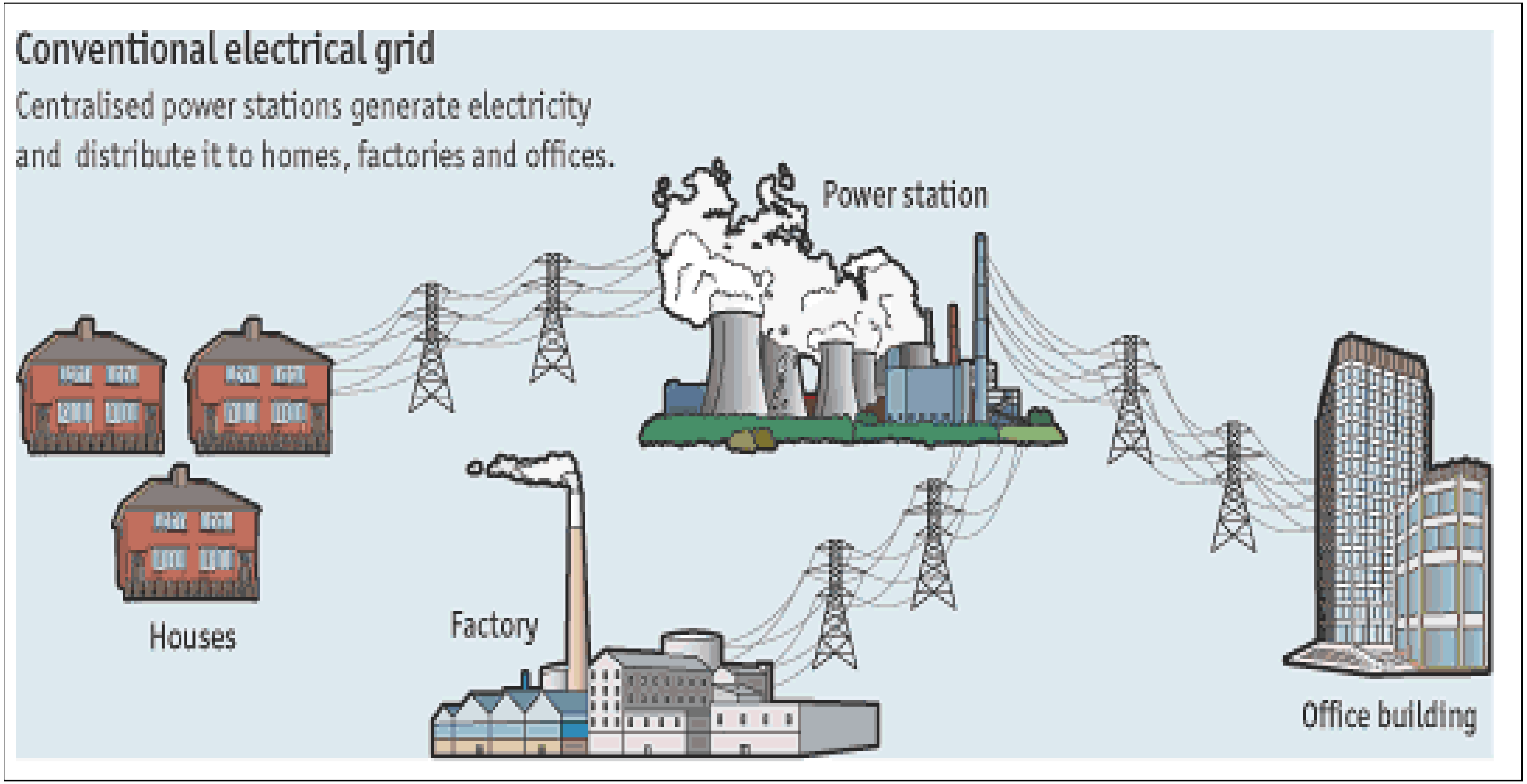
EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Inductive Charging – Implications for the II

Timing	Inductive charging is an established technology – various examples of real world installations exist, most notably a bus transport system in Italy which has run for a number of years. Recently a number of companies have launched inductive charging products and services on to the market specifically designed at the nascent EV market.
Functionality	The introduction of inductive charging will, in functionality terms, have little impact on the Intelligent Infrastructure. Simply, inductive charging is 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 in SP2.IBM/14 and the proposed conceptual design will work for both. Inductive charging by the very nature of its no physical connection to the charging infrastructure will encourage 'park and charge', meaning that in inductive charging locations, there could be very little manual intervention required from the EV user in the recharging activity. For example, authentication to charge, selection of charging variables, starting and ending the charging transaction may all be covered by an automatic protocol between the EV and the infrastructure.
Non Functional Areas (Capacity, Performance etc.)	Should inductive charging become widespread in use – and specifically be used to recharge 'on the go' – then the Intelligent Infrastructure could see a significant increase in the number of charging transactions generated due to the frequency of recharging. In turn this may require additional capacity in terms of processing, data storage and communications
Others/General	Use cases developed for SP2/IBM/14 and summarized here in Section 2 are intended to cover both conductive and inductive charging. Hence inductive charging is included in the proposed design and the budgetary estimates. It is assumed at this stage that significant extra infrastructure capacity will not be required.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Smart Grid – Description (1)

- We have an energy network which Thomas Edison (d 1931) and Nikolai Tesla (d 1943) would recognise and of which they would be proud...

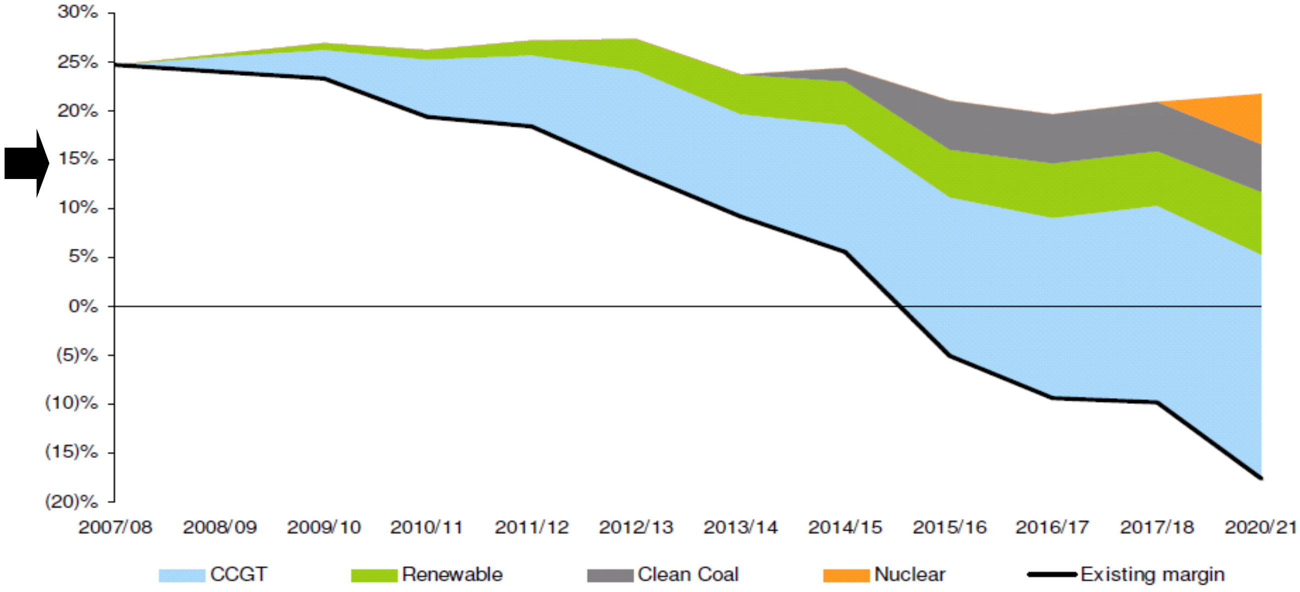


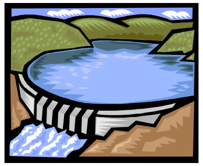
- … and while this has proved robust in the face of all the challenges of the twentieth century, there are new challenges that a new grid must face:-

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Smart Grid – Description (2)

- What is changing ……
  - A new generation mix ➡
  - New IT in the grid
  - Energy storage
  - The impact of micro-generation
  - Electric vehicles
  - Smart Homes...
  - ...including Smart Meters





© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Smart Grid – Description (3)

- ...with the upshot being a new problem of Variability in Supply and Demand

Varying Supply

Varying Demand

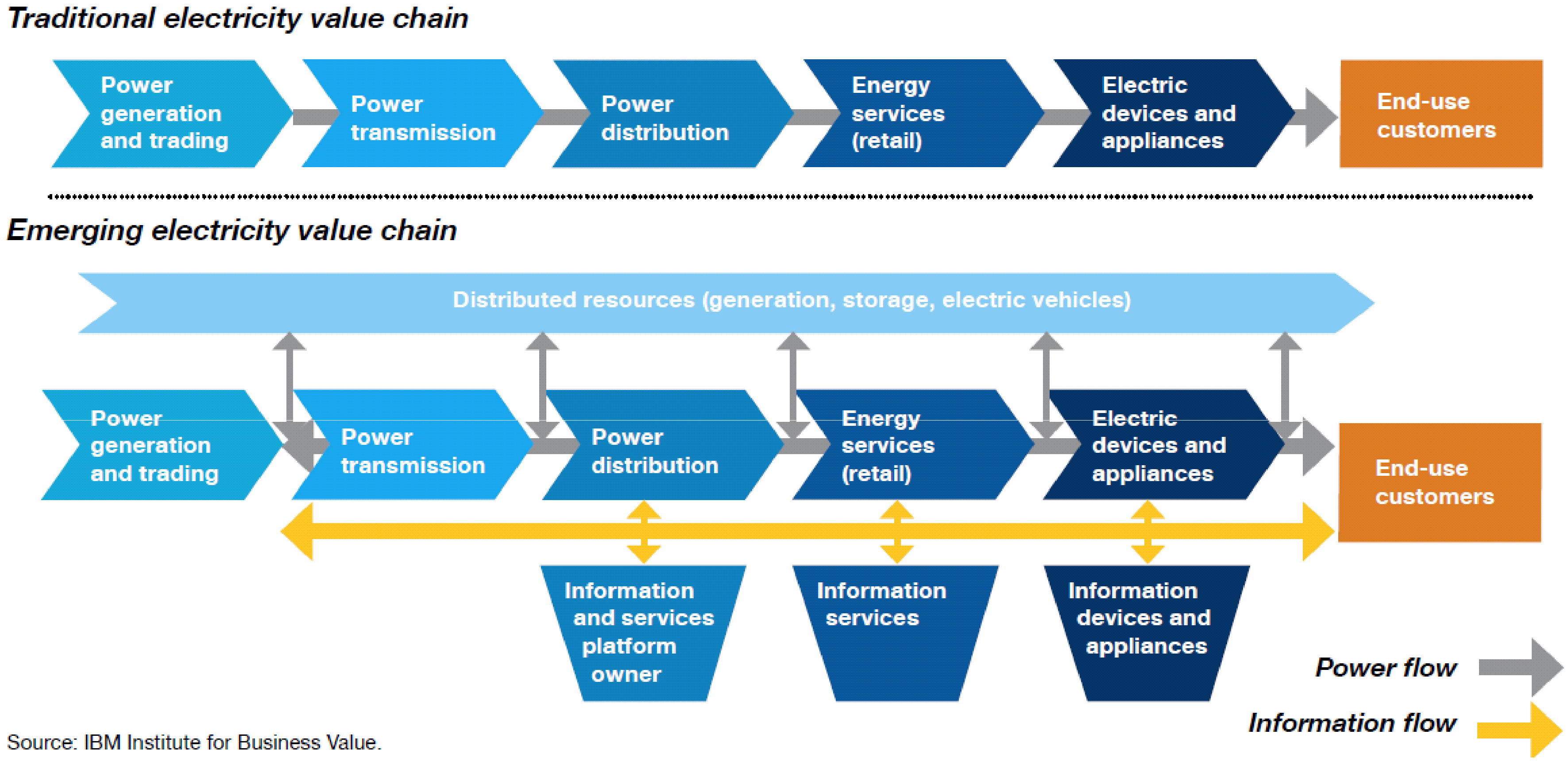
The ability to control supply is diminished...

...the opportunity to control demand is new

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Smart Grid – Description (4)

- What this means for the Grid ....

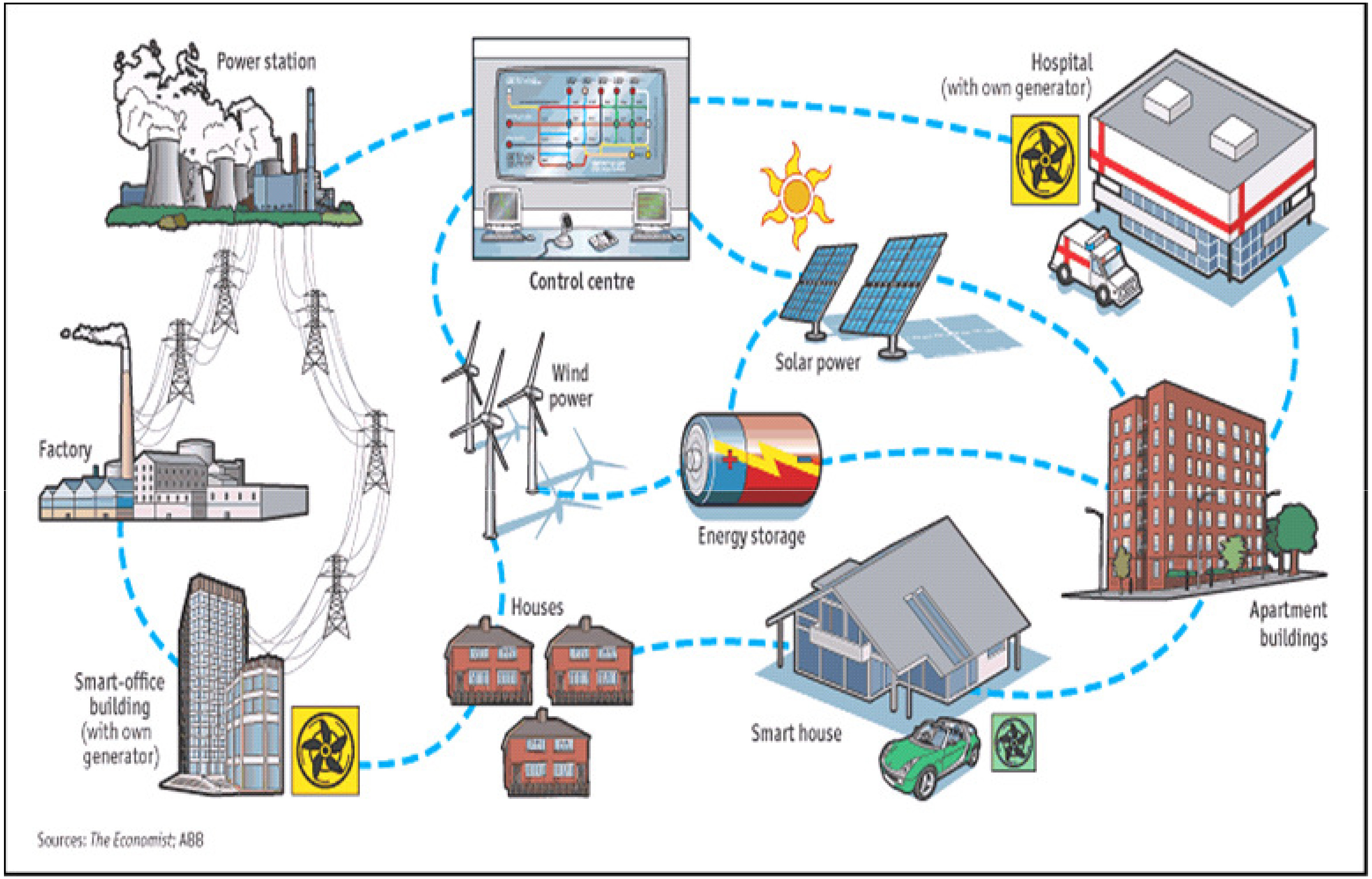


Source: IBM Institute for Business Value.

- The traditional unidirectional flow is replaced by a bi-directional flow, with more uncertainty in supply and demand and much, much more information available.
- The result is the Smart Grid…..

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Smart Grid – Description (5)



Sources: *The Economist*; ABB

‘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’ (Source: *decc.gov.uk*)

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Smart Grid – Implications for the II

Timing	The recasting of the traditional Grid into its Smart successor will be a long and gradual journey. Smart Grid initiatives have already been delivered across the World, and more are in train. In the UK, trials of Smart Grid technologies are due to start shortly as a result of the Ofgem Low Carbon Networks initiative, including Customer-led Network Revolution (submitted by CE Electric UK), Low Carbon Hub (submitted by Central Networks), Low Carbon London (submitted by EDF Energy Networks - now UK Power Networks), and LV Network Templates for a low carbon future (submitted by Western Power Distribution). For the purposes of the Intelligent Infrastructure, it is assumed that Smart Grid technologies will be realized in the next 5 to 8 years.
Functionality	▪The Intelligent Infrastructure conceptual design has been undertaken in the full knowledge and expectation that Smart Grid Technology will be imminently deployed. Impact on the Intelligent Infrastructure is in the functional areas of demand management, pricing and analytics. There is a clear distinction between the role and responsibilities of the Smart Grid, versus those of the Intelligent Infrastructure ▪Smart Grid Technologies will:- – Regard EV Charging/Discharging as just another set of demands/supplies, alongside all other demand/supply sets - – Monitor and control Electric Vehicle charging (and discharging) in terms of the electrical current supplied, alongside all other Smart Grid attached devices ▪The Intelligent Infrastructure will:- – Provide data and information to the Smart Grid Operators regarding EV Charging and Discharging to allow them to manage better keeping the balance between supply and demand, (in addition to providing all the other functionality described in Section 2) ▪ The two systems will operate side by side, with the ultimate control over charging and discharging lying with the Smart Grid and its operators. ▪Smart Grid technologies will require underlying infrastructure which the Intelligent Infrastructure could take advantage of, and vice-versa. A good example is communications networks – where the deployment of comms' infrastructure could be used by both initiatives.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Smart Meter – Description (1)

- This section will discuss Smart Meters in general and their proposed deployment in the UK specifically.
- A couple of definitions of 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” – Wikipedia
  - “Smart metering is designed to provide utility customers information on a real time basis about their domestic energy consumption. This information includes data on how much gas and electricity they are consuming, how much it is costing them and what impact their consumption is having on greenhouse gas emissions." - European Smart Metering Alliance
- In the UK, Government has completed a consultation on Smart Metering and a Central Industry Implementation Programme run by Ofgem has begun – see below for further details. One aspect of the Government’s programme which is relevant to the development of the Electric Vehicle market is the decision to create a central organization, currently named the Data Comms’ Company, which will be responsible for data communications to and from ALL Smart Meters, the processing and making available of that data to the various actors. The justification for this approach is centred on maintaining a competitive market amongst Energy Retailers (i.e. a consumer does not become locked into one type of Smart Meter and communications technology) and a cost efficient and rapid roll out programme.
  - “Data Comms Company (DCC) is defined as a single procurement and contract management entity, tasked with procuring, on a competitive basis, a number of service providers that would together deliver the full scope of the data and communications services required” - Department of Energy and Climate Change and Ofgem prospectus
- With respect to EVs, 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.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Smart Meter – Description (2)

From…

•Manual, on-site reading

- **"largest and most complex change over programme in the energy industry since North Sea Gas" (1970's)**
- **Step towards future development of a 'smart grid' – delivering improved network efficiency & responsiveness.**
- **provides consumers with better information on energy usage to encourage better energy efficiency.**
- **Without Government intervention Suppliers only likely to roll-out smart meters where a commercial case exists – 20-30% of the market.**
- **Government has chosen a central communications and data provider model (DCC) as its preferred delivery model**

To…

• On-demand, remote meter readings
•Change of tariff and payment methods
•Change in read frequency
•Load limiting / shedding
•Remote connect / disconnect
•Tamper alerts
•Messaging/direct customer comms'
•Firmware updates

52.5m - The number of smart electricity and gas meters to be installed in Britain's homes and small businesses by 2020. The programme is expected to require £9.22bn

919bn - The number of meter readings available to energy suppliers each year following the completion of deployment

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Smart Meter – Description (3)

- British Government consultation on Smart Metering is complete and a Central Industry Implementation Programme run by Ofgem has begun

2007-2009

2010-2013

2012-2020

TOWARDS A SMARTER FUTURE: GOVERNMENT RESPONSE TO THE CONSULTATION ON ELECTRICITY AND GAS SMART METERING

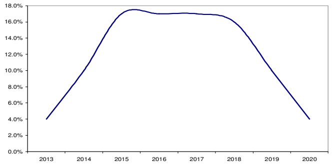
December 2009

ofgem ofgem E-Serve Promoting choice and value for all gas and electricity customers

Smart Metering Implementation Programme: Briefing Event

Robert Hull, Acting Managing Director, Commercial, Ofgem E-Serve
&
Sarah Harrison, Senior Partner, Sustainable Development, Ofgem

16 December 2009



Domestic and SME market to have mandated deployment of smart meters

Ofgem led central industry change prog to run for four years; supplier projects in parallel

Deployment of 52.5m gas and electric meters to start in 2012 and 97% to be finished by end of 2020. Energy suppliers to be responsible for deployment, and full deployment to all domestic and SME customers to cost £9.22bn.

- Programme Acceleration - New Government wants majority installation complete by 2016 (previously 2020).

Note: This relates to mainland Britain only. Different smart metering programmes cover North Ireland

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Smart Meter – Implications for the II

Timing	Completion of Smart Meter deployment in the UK has been mandated by 2020 with a possible acceleration to 2016. Therefore the design and build of the Intelligent Infrastructure is against this reality
Functionality	▪The Intelligent Infrastructure conceptual design has been undertaken in the full knowledge and expectation that Smart Meter Technology will be imminently deployed. There is a clear distinction between the role and responsibilities of the Smart Meter, versus those of the Intelligent Infrastructure ▪Smart Meter Technologies, as designed, will be responsible for the metering of the supply of electricity to the charging location, (domestic, public, commercial) and will provide additional Smart functionality – see below. ▪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. In certain charging locations, domestic especially, (but not exclusively), the EV user will be able to have direct contact with the Smart Meter for EV charging purposes. In other charging locations, where the power is being supplier through an EV Electricity Retailer then the EV user may not have direct contact with the Smart Meter – rather it will be through systems provided by the EV electricity retailer/charging location operator. ▪Currently there is no single definition of Smart Metering in terms of the functionality provided and there is a risk that the requirements of Electric Vehicles for Smart Meters may not be fully covered. The Intelligent Infrastructure assumes that Smart Meters will provide the following minimum functionality - on-demand, remote meter readings, change of tariff and payment methods definable by device type (e.g. sets of tariffs for EVs, White Applicances, Heat Pumps etc.), change in read frequency, load limiting/shedding, remote connect / disconnect by individual device, tamper alerts, messaging/direct customer communication, firmware updates. Urgent consideration should be given to undertaking a detailed study of the requirements of Smart Meters for Electric Vehicles as against the currently planned Smart Meter functionality, identifying gaps and devising strategies to cover off. ▪As with Smart Grid Technologies, Smart Meters will require underlying infrastructure which the Intelligent Infrastructure could take advantage of, and vice-versa. A good example is communications networks – where the deployment of comms' infrastructure could be used by both initiatives.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Summary (1)

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)	●	●	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)	◐	◐	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

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Summary (2)

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 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

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery - Effect of Emerging Technology – Summary (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 ○	●	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.
	Charge on the Go ●	◐		
Smart Grids (5 – 10 yrs)	●	●	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)	●	●	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

© 2010 IBM Corporation

ETI EV Work Package 2.4

SP2/IBM/28 ETI EV Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks

Section 5 – Systems Integration and Settlement

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Introduction (1)

- Overall Purpose (Source: Contract)
  - 2-4.4 Evaluate the adequacy and potential of existing power industry mechanisms for systems integration and billing (e.g. Elexon, Electralink and smart metering).
- Objectives (Source: Contract)
  - Describe the Settlement Landscape of possible payment types, transactions, parties, settlement, billing and accounting regimes
  - Provide an “As-is” assessment of the industry data flows and supporting mechanisms in the energy markets and the emerging market model for Smart Metering. Evaluate the adequacy and potential of the existing power industry mechanisms for systems integration and billing (e.g. Elexon, Electralink and Smart Metering).
  - Describe the Settlement Scenarios - 5 scenarios covering the data flow landscape relating to data exchange between the various actors in alternative business models and payments and settlement between actors (“Club”, Pre-payment, Pay-as-you-go, Payment on Account, Third Party payment)
  - Assessment Criteria; Definition of the criteria for assessment of "platforms". A platform is equivalent here to an industry mechanism such as the Smart Metering Central Communications Model
  - Platform Assessment; An assessment of each platform with recommendations. The purpose of the assessment is to evaluate the adequacy and potential of the platforms. The recommendations will be relevant to future detailed design activity and will help determine the future direction of the solution architecture
  - Systems Integration Inventory - Inventory of the systems requiring integration

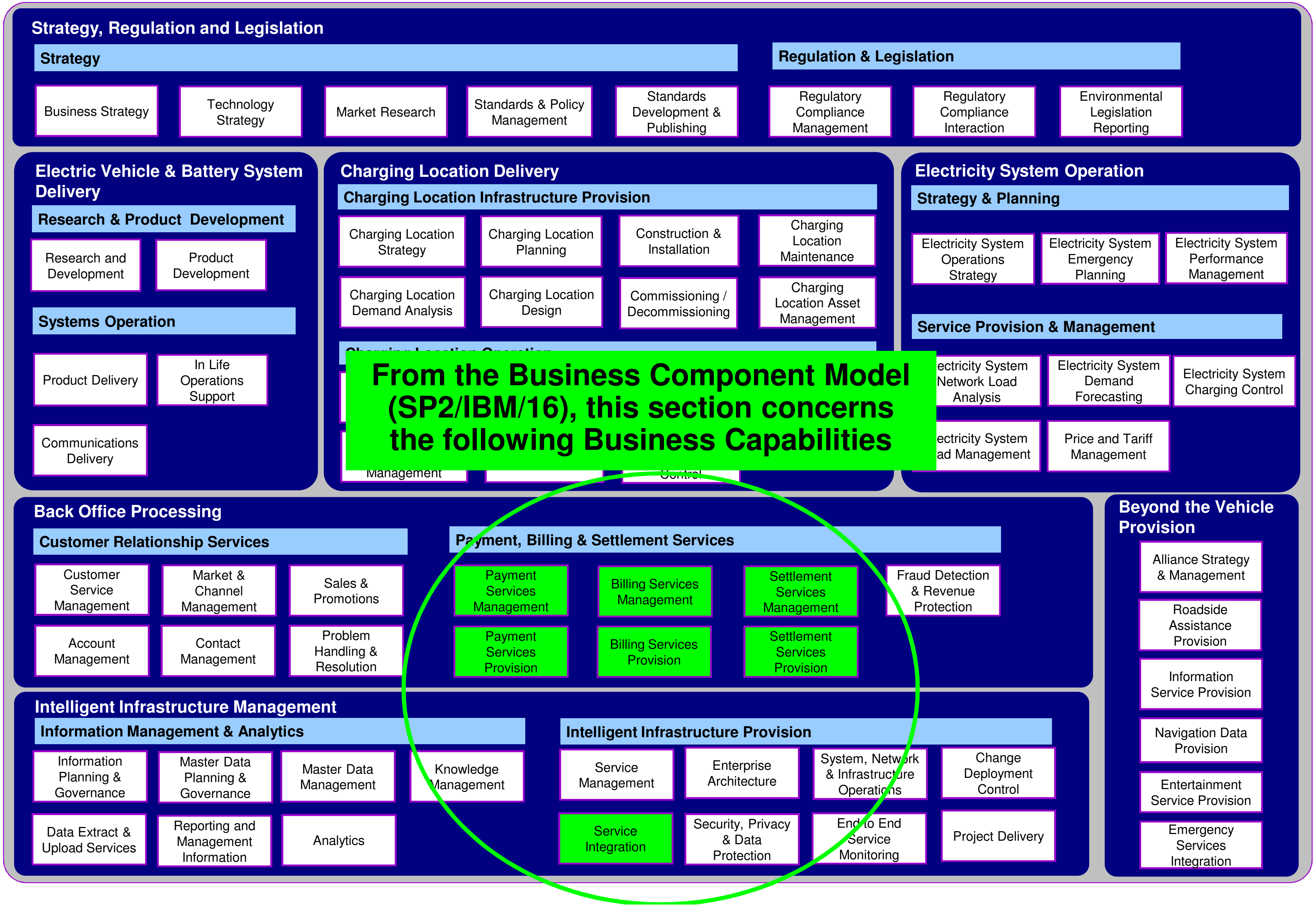
© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Introduction (2)

- ‘Settlement’ and ‘Integration’ in the EV Market are potentially complex areas and have been singled out for further discussion in this section to ensure that:-
  - The Conceptual Design and the resulting budgetary estimates adequately reflect this potential complexity
  - Assess whether existing industry capabilities can be applied in some way, directly or indirectly, to the solution
- In this section, ‘Settlement’ covers the Business Competency - Payment, Billing and Settlement Services (as defined in the Conceptual Business Architecture SP2/IBM/16), with the exception of the Fraud Detection Capability. This competency is responsible for directing the potentially complex flow of information (especially bills) and funds that will be involved in paying for charging and ensures that actors get paid for their part in the charging event.
- Also, ‘Settlement’ cannot be possible without ‘Integration’, namely the infrastructure – comprising hardware, software and services – which is capable of transporting the various transactions required around the Intelligent Infrastructure. In terms of the Conceptual Business Architecture, ‘Integration’ appears as the ‘Service Integration’ Capability within the Business Competency ‘Intelligent Infrastructure Provision’.
- The following slide provides a reminder of the Conceptual Business Architecture and the Business Competencies and Capabilities we are concerned with in this Section

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Introduction (3)



From the Business Component Model (SP2/IBM/16), this section concerns the following Business Capabilities

Strategy, Regulation and Legislation

Strategy

- Business Strategy
- Technology Strategy
- Market Research
- Standards & Policy Management
- Standards Development & Publishing

Regulation & Legislation

- Regulatory Compliance Management
- Regulatory Compliance Interaction
- Environmental Legislation Reporting

Electric Vehicle & Battery System Delivery

Research & Product Development

- Research and Development
- Product Development

Systems Operation

- Product Delivery
- In Life Operations Support
- Communications Delivery

Charging Location Delivery

Charging Location Infrastructure Provision

- Charging Location Strategy
- Charging Location Planning
- Construction & Installation
- Charging Location Maintenance
- Charging Location Demand Analysis
- Charging Location Design
- Commissioning / Decommissioning
- Charging Location Asset Management

- Management
- Control

Electricity System Operation

Strategy & Planning

- Electricity System Operations Strategy
- Electricity System Emergency Planning
- Electricity System Performance Management

Service Provision & Management

- ectricity System Network Load Analysis
- Electricity System Demand Forecasting
- Electricity System Charging Control
- ectricity System ad Management
- Price and Tariff Management

Back Office Processing

Customer Relationship Services

- Customer Service Management
- Market & Channel Management
- Sales & Promotions
- Account Management
- Contact Management
- Problem Handling & Resolution

Payment, Billing & Settlement Services

- 🟩 Payment Services Management
- 🟩 Billing Services Management
- 🟩 Settlement Services Management
- Fraud Detection & Revenue Protection
- 🟩 Payment Services Provision
- 🟩 Billing Services Provision
- 🟩 Settlement Services Provision

Beyond the Vehicle Provision

- Alliance Strategy & Management
- Roadside Assistance Provision
- Information Service Provision
- Navigation Data Provision
- Entertainment Service Provision
- Emergency Services Integration

Intelligent Infrastructure Management

Information Management & Analytics

- Information Planning & Governance
- Master Data Planning & Governance
- Master Data Management
- Knowledge Management
- Data Extract & Upload Services
- Reporting and Management Information
- Analytics

Intelligent Infrastructure Provision

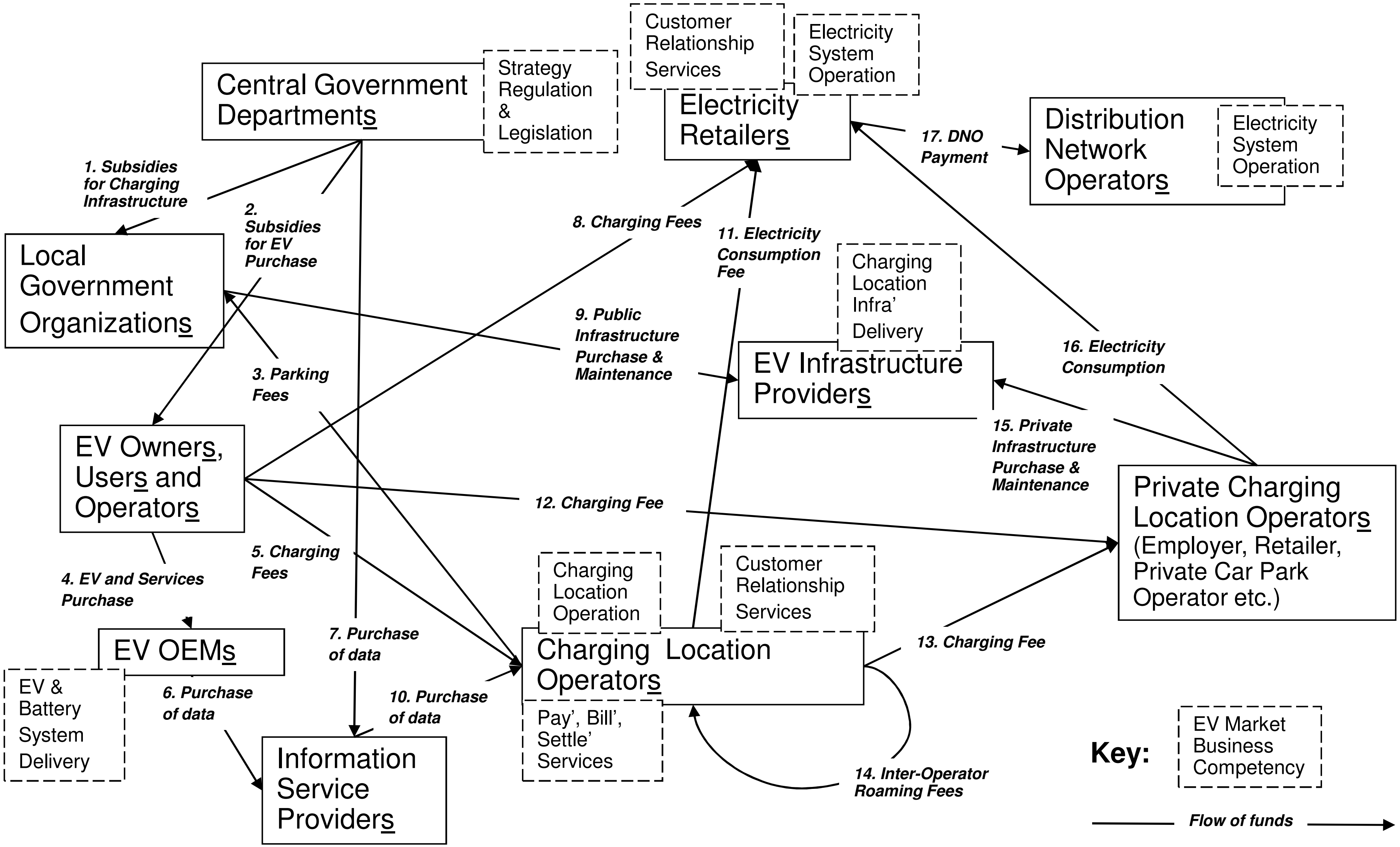
- Service Management
- Enterprise Architecture
- System, Network & Infrastructure Operations
- Change Deployment Control
- 🟩 Service Integration
- Security, Privacy & Data Protection
- End to End Service Monitoring
- Project Delivery

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Generic Payments Landscape for the Intelligent Infrastructure (1)

- 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

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Generic Payments Landscape for the Intelligent Infrastructure (2)



© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Generic Payments Landscape for the Intelligent Infrastructure (3)

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

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Settlement Landscape for the Intelligent Infrastructure (1)

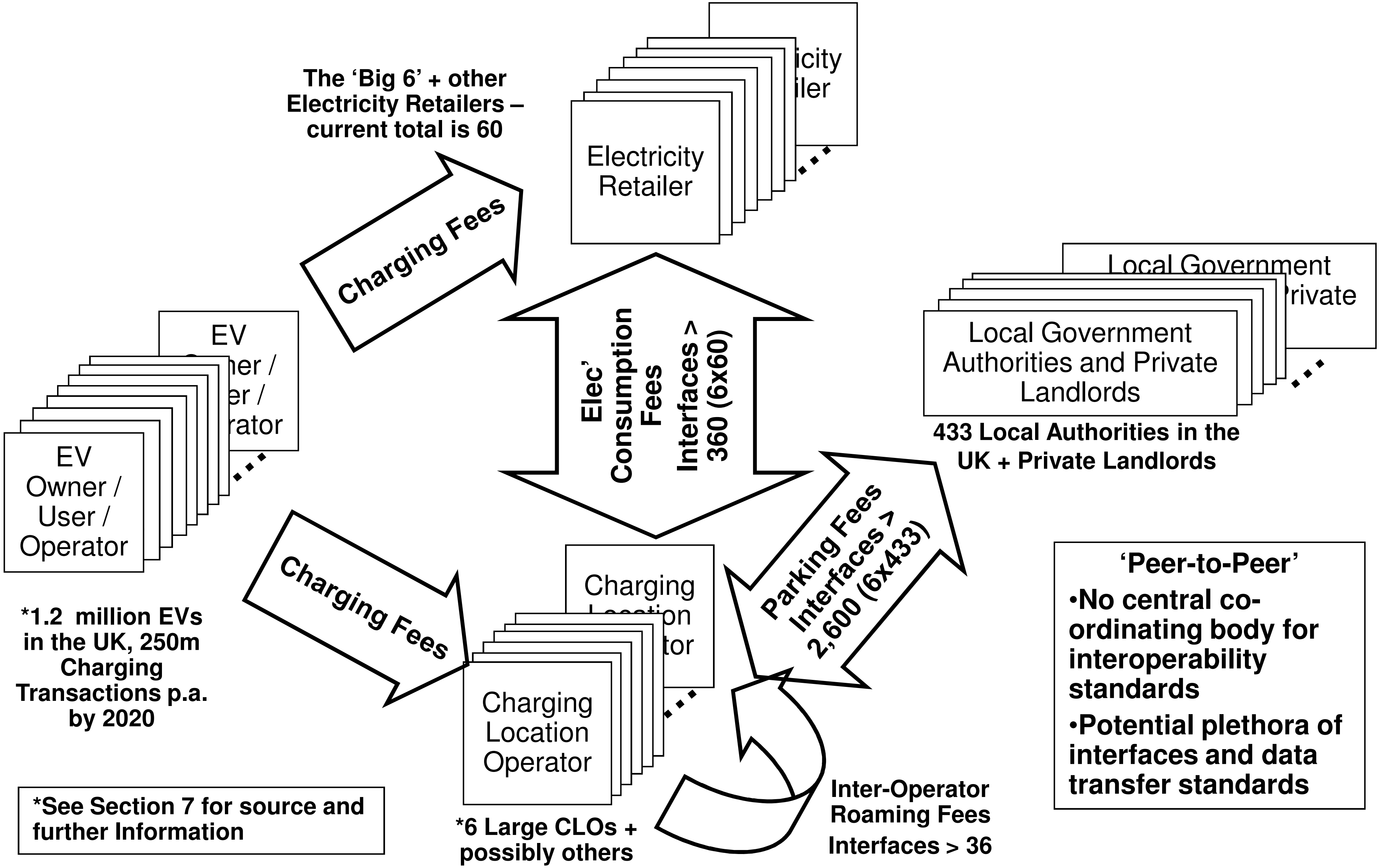
- The Generic Payments Landscape highlights the landscape's complexity in terms of:-
  - the number of actors involved, and
  - the type of payments which are made and their interdependencies.
- However, this does not reflect the full complexity – especially in terms of:-
  - the number of EV Owners, 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 presented in Section 7 and 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

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Settlement Landscape for the Intelligent Infrastructure (2)



The 'Big 6' + other Electricity Retailers – current total is 60

icity
iler

Electricity Retailer

Charging Fees

Elec' Consumption Fees

Interfaces > 360 (6x60)

Local Government
rivate

Local Government Authorities and Private Landlords

433 Local Authorities in the UK + Private Landlords

EV
ner /
er /
rator

EV Owner / User / Operator

***1.2 million EVs in the UK, 250m Charging Transactions p.a. by 2020**

Charging Fees

Charging
Location
tor

Charging Location Operator

***6 Large CLOs + possibly others**

Parking Fees Interfaces > 2,600 (6x433)

Inter-Operator Roaming Fees Interfaces > 36

'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**

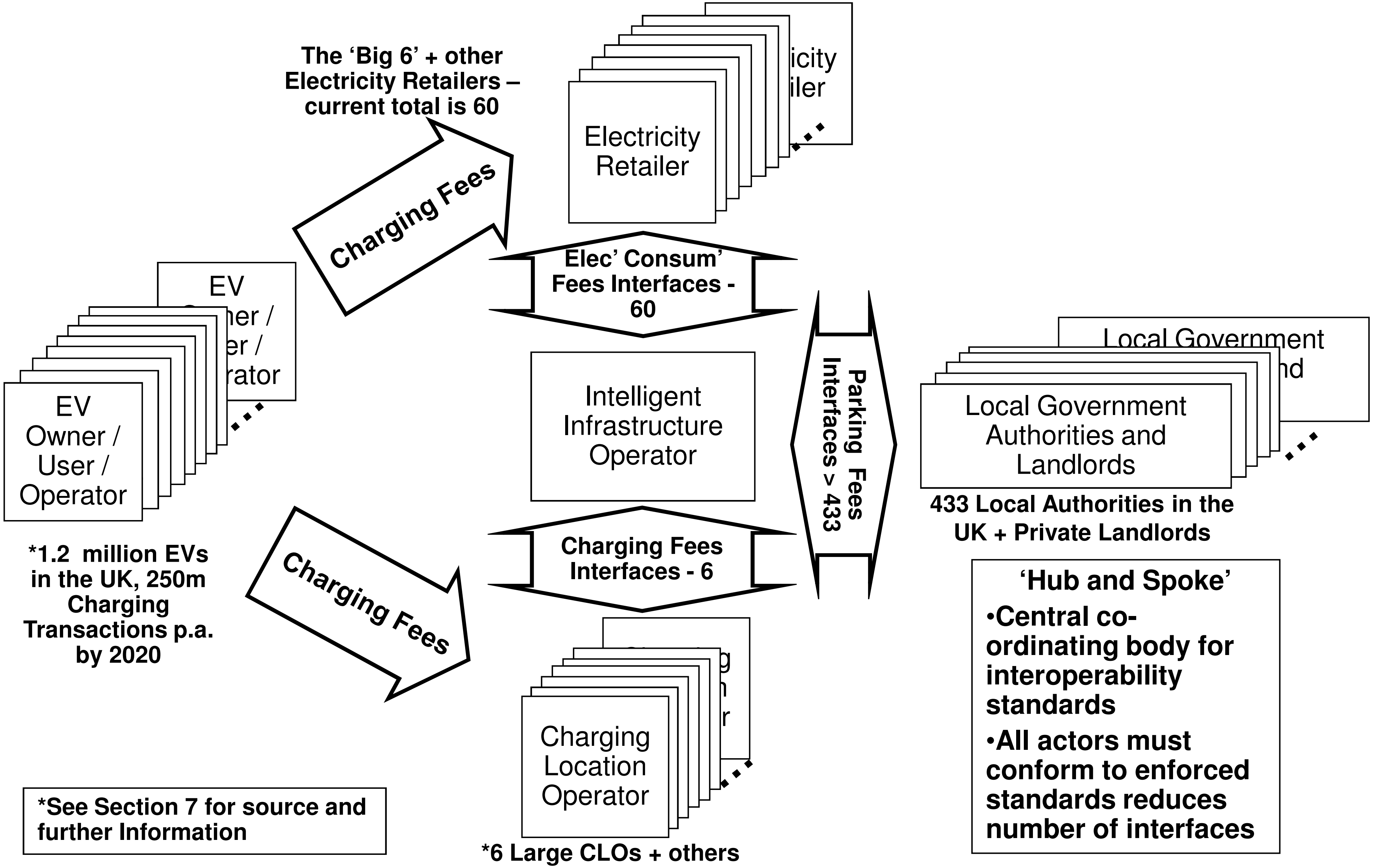
© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Settlement Landscape for the Intelligent Infrastructure (3)

- **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.**

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Settlement Landscape for the Intelligent Infrastructure (4)



The 'Big 6' + other Electricity Retailers – current total is 60

Electricity Retailer

Charging Fees

Elec' Consum' Fees Interfaces - 60

EV Owner / User / Operator

***1.2 million EVs in the UK, 250m Charging Transactions p.a. by 2020**

Intelligent Infrastructure Operator

Parking Fees Interfaces > 433

Local Government Authorities and Landlords

433 Local Authorities in the UK + Private Landlords

Charging Fees

Charging Fees Interfaces - 6

Charging Location Operator

***6 Large CLOs + others**

'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**

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Settlement Landscape for the Intelligent Infrastructure (5)

- 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.**
- **For the purposes of the remaining analysis in this document, the Landscape featuring the single Central Intelligent infrastructure Operator will be used**

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Payment Types, Payment Methods and Regimes (1)

- Possible Payment Types are Subscription (‘Club’); Electricity Account; Mobile Phone Account; Electronic Purse; Other Account; Pay as you Go
- Payment Methods
  - Cash – at a manned or unmanned charging location; at a retail outlet; at a recharge post or at a recharging location pay station (similar to a car park)
  - Direct debit - customers subscribe to EV recharging specific schemes with one of recharging operators, energy companies, Intelligent Infrastructure operator or other service provider. This subscription is serviced via a direct debit
  - Traditional credit / debit card - customers could use their credit / debit card to pay for recharging on a consumption basis. Can also be used as a way to service a direct debit. Issues with credit card could be merchant fees for what will be relatively low value transactions.
  - PayPass / PayWave enabled credit / debit card - the cards are equipped with PayPass / PayWave which uses an RFID tag embedded in the card to provide a contactless way to pay for low value transactions. This could make it suitable for use at recharging posts.
  - Pay Pass / PayWave enabled device (e.g. mobile phone, key fob, etc via near field communications) - the same PayPass / PayWave technology can be used on mobile devices, key fobs and similar. For phones this uses near field communications technology
  - SMS payment - customer uses a SMS text message to pay for recharging or potentially uses an SMS voucher.
  - Contactless Smart Card – ISO14443A compatible such as MiFARE / DESFire type (as used by Oyster cards), Calypso, PayPass or something like sQuid. For example, Oyster cards can be topped up via pay as you go or direct debit and can also be used to hold season tickets of different duration up to one year which means they could be used to hold a vehicle recharging entitlement as well as deducting on consumption from a topped up purse.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Payment Types, Payment Methods and Regimes (2)

- Possible Billing Regimes
  - Time based - length of time charging, time of use, per second / minute / hour
  - Power draw based - amount of power consumed in the charging transaction, amount of power consumed across a time period, average amount of power consumed
  - Budget based - deduction against a time or financial budget, similar to a mobile phone contract where you have a number of minutes, texts, etc and different limits – for example you could have a contract that allowed 10 chargings a month pre paid and then pay as you go after that, or any other combination
  - Location based - billing depending on where you charged
  - Subscription based – billing based on a flat fee providing charging (and possibly other services, e.g. public parking) for a fixed period

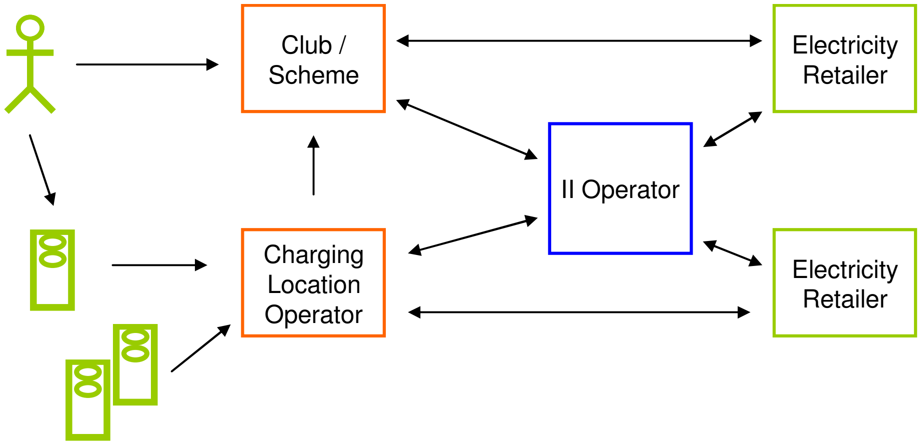
  …or any combination of the above
- Settlement Regimes
  - Instant local settlement - an element of the settlement occurs at the point the transaction takes place. For example MiFARE / DESIFIRE Oyster cards where the system is asynchronous, the current balance and ticket data being held electronically on the card rather than in the central database. The main database is updated periodically with information received from the card by barriers and validators.
  - Instant central settlement – real time communication to a centralised service for settlement against an account. Requires a connection through to the customer’s host system.
  - Pre-transaction/Post-transaction settlement – settlement occurs at some point in time after the transaction has been completed in the event that payment is to an account which is settled in arrears or by direct debit. In the case of a subscription based billing, settlement would occur prior to making (and being able to make) transactions

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Payment Types, Payment Methods and Regimes (3)

*This section explores the requested scenarios of "**Club**", Pre-payment, Pay-as-you-go, Payment on Account, Third Party payment, covering the data flow landscape relating to data exchange between the various actors.*

- 'Club' Scenario
  - Used here to cover one of the dominant models at the current time. User is a member of a scheme and pays a fee for that. They would then not pay any further for recharging at the locations covered by the scheme
  - Any payment for the energy consumed is handled by the provider of the scheme with their selected energy provider
  - Relatively simple method but might require multiple scheme memberships and would require schemes to come together to be usable via roaming arrangements
  - However, due to the way in which the energy is paid for and settled, it is not considered a sustainable option as volumes increase. Also without multi operator agreements, it does not facilitate the adoption of electric vehicles as it places hurdles for the use of infrastructure



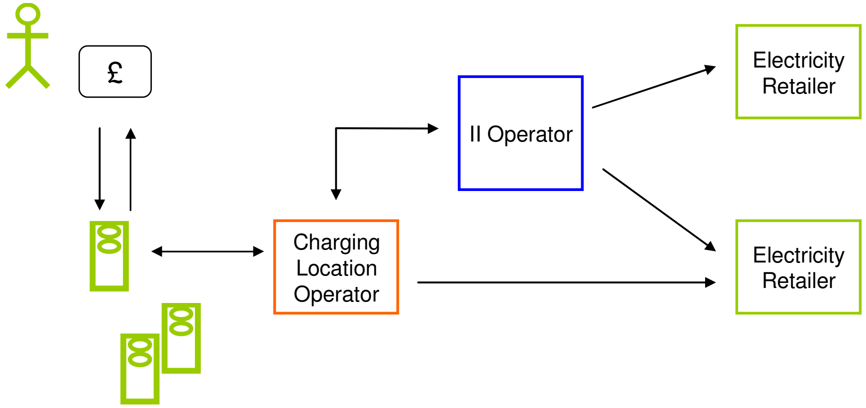
a) *Customer pays a fee to join a scheme / club*
b) *They use the charging locations with no further payment*
c) *The charging transactions are recorded by the Club / Scheme or Location Operator for all user accounts. The Club/Scheme might act as operator or utilise an operator*
d) *The electricity retailer bills the club / recharge operator*
e) *For transactions within the Club network, the Club or location operator settles with their electricity retailer for the power consumed or passes to the intelligent infrastructure operator for them to interact with the electricity actors*
f) *For other transactions, the Club or Location operator might utilise a settlement service provided by the Intelligent Infrastructure Operator*

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Payment Types, Payment Methods and Regimes (4)

*This section explores the requested scenarios of "Club", **Pre-payment**, Pay-as-you-go, Payment on Account, Third Party payment, covering the data flow landscape relating to data exchange between the various actors.*

- Pre Payment Scenario
  - Used here to mean the loading of funds onto a card or voucher or account.
  - User pays a set amount each period or loads funds onto something similar to a contactless smart card / token. Credit is purchased in advance of service use. The purchased credit is used to pay for recharging services at the point the service is accessed or consumed
  - Depending on the type of pre payment, the same card could be used to allow access to the recharging infrastructure, otherwise, an additional token would be required. The user would not then pay anything further as the fee is taken from funds already purchased, unless there are insufficient funds to undertake the transaction.
  - Settlement with the funds on the card takes place at the recharge station. Onward settlement is handled between the charging location operator, intelligent infrastructure operator and electricity retailer
  - Worth noting here are the potential implications on the financial and accounting practices of pre-paid service arrangements. In the mobile telecoms market, the company must treat prepaid services differently from postpaid (billed) services. The top up payments cannot be declared immediately as revenue but must be viewed as deferred income until the funds are actually used against services.



a) Customer loads up a card with funds – this could be a prepaid credit card or electronic purse type system. They could top up via any one of a number of different channels

b) Customer recharges vehicle, using the card at the recharging station which results in funds being deducted from the prepaid balance

c) The recharge stations and back office are synchronised at an agreed frequency

d) For transactions within the network, the location operator could settle directly with their electricity retailer for the power consumed or pass to the intelligent infrastructure service operator for them to interact with the electricity actors

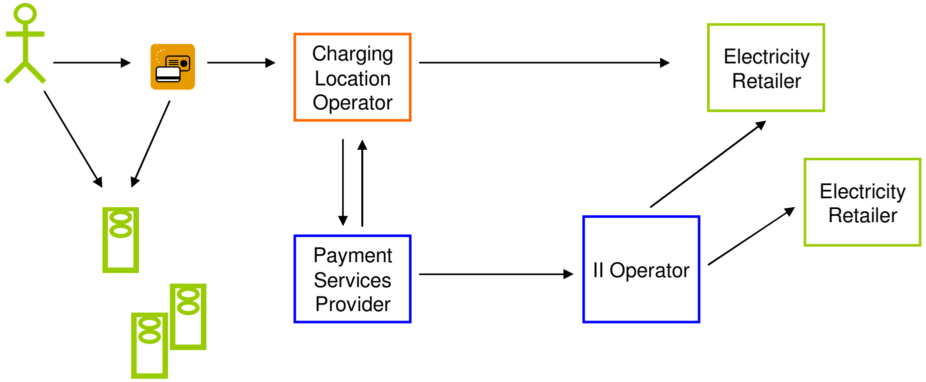
e) For other transactions, they might utilise a settlement service provided by the Intelligent Infrastructure Service Operator

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Payment Types, Payment Methods and Regimes (5)

*This section explores the requested scenarios of "Club", Pre-payment, **Pay-as-you-go**, Payment on Account, Third Party payment, covering the data flow landscape relating to data exchange between the various actors.*

- Pay-as-you-go Scenario
  - Used here to refer to the payment for charging at the transaction level at the time the charging takes place – immediately before or after the transaction – analogous to simple 'on the day' payment for car parking.
  - Most likely payment types would be credit or debit card. Practically, a pre paid payment method could also be used. User pays the operator of the charging location.
  - Could be combined with payment for parking or some other services.



a) *Customer charges vehicle at a non domestic location where a fee is payable for the charging transaction. The customer may not have an account or prepay or season ticket arrangement, or one may not be available at the location being used and so has to pay for the transaction.*

b) *Could pay before or after the transaction has taken place but assuming here that they must pay at some point by credit / debit card (potentially cash also though there are indications that this is not being specified in many cases)*

c) *Customer payment is taken and authorised at the charging location (at the post, at a pay station, by telephone)*

d) *If the payment is taken by the charging location operator then they will settle directly with their electricity retailer for the power consumed*

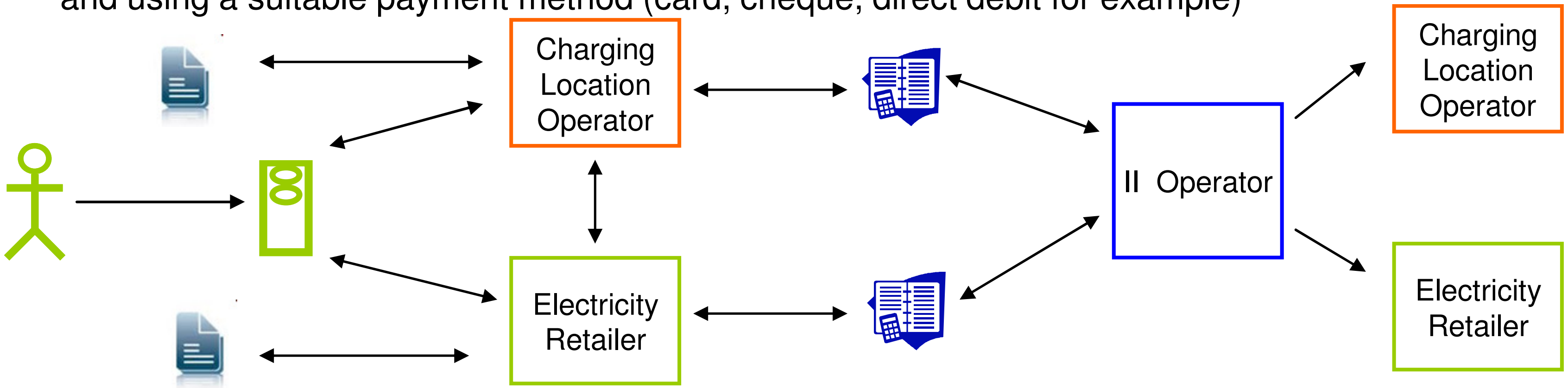
e) *If the payment is taken by a third party then this may be passed to the Intelligent Infrastructure Operator*

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Payment Types, Payment Methods and Regimes (6)

*This section explores the requested scenarios of "Club", Pre-payment, Pay-as-you-go, **Payment on Account**, Third Party payment, covering the data flow landscape relating to data exchange between the various actors.*

- Payment on Account Scenario
  - Used here to refer to the use of a 'traditional' utility type account where the value of the recharging transaction is credited to a customer account
  - The customer is then asked to settle at an agreed frequency (weekly, monthly, quarterly for example) and using a suitable payment method (card, cheque, direct debit for example)



a) *Customer has an account for charging which could be their utility bill or with a charging provider. They don't pay at the point the service is consumed but have the cost of charging recorded against their account. They will have accessed the service via some sort of token which is recognised as belonging to an account holder. One example is the RWE trial in Berlin where authentication is done via the charging cable*

b) *Customer accounts could hold information of any tariffs or plans for vehicle charging so that the customer can receive it for the transaction*

c) *The charging transaction is captured and the cost of the charging activity is calculated and applied to the customer account*

d) *Details of the charging activity are included on an invoice sent to the customer*

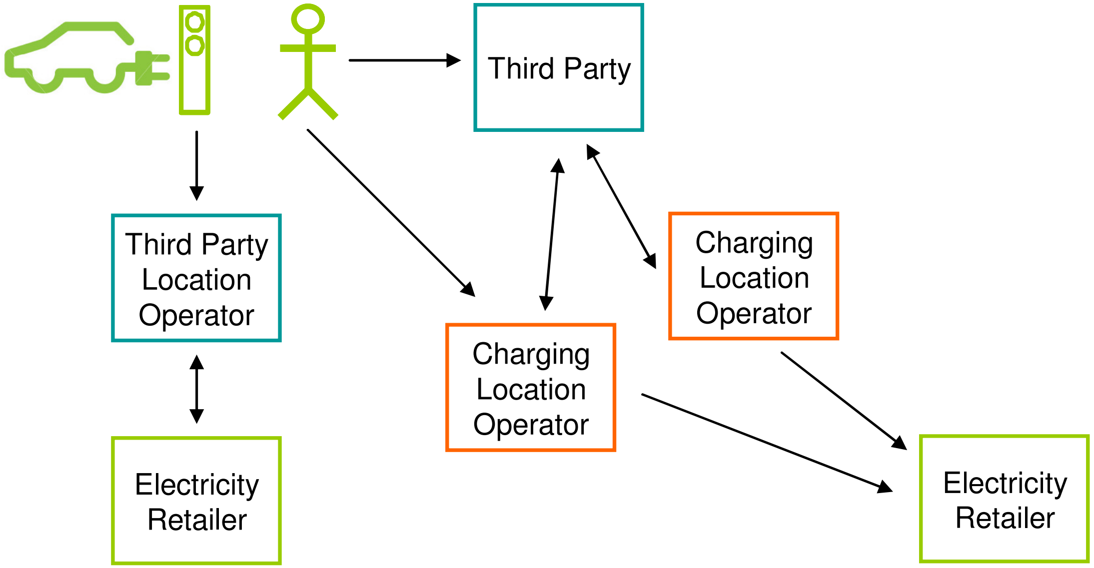
e) *Customer pays by whatever methods are allowed for their account*

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Payment Types, Payment Methods and Regimes (7)

*This section explores the requested scenarios of "Club", Pre-payment, Pay-as-you-go, Payment on Account, **Third Party payment**, covering the data flow landscape relating to data exchange between the various actors.*

- Third Party payment Scenario
  - Used here to refer to a scenario where someone else picks up the cost of the charging.
  - Could include 'free' energy as now in that many charging points involve no consumption charges – for example charging points located in supermarket car parks
  - Could also include situations where the user has hired a car, been given a benefit by the vehicle owner or other similar circumstance
  - Potentially a 'front end' for other scenarios, for example payment on account



a) *EV User charges vehicle but is not required to pay directly for the transaction*

b) *Could very simply be that the provider of the charging facility is paying for the energy consumed as part of a service to their customers – for example a retailer. The retailer would then be settling with their electricity provider*

c) *In other cases, the EV user could be driving a hire car for example where any charging costs have been incorporated into the hire cost*

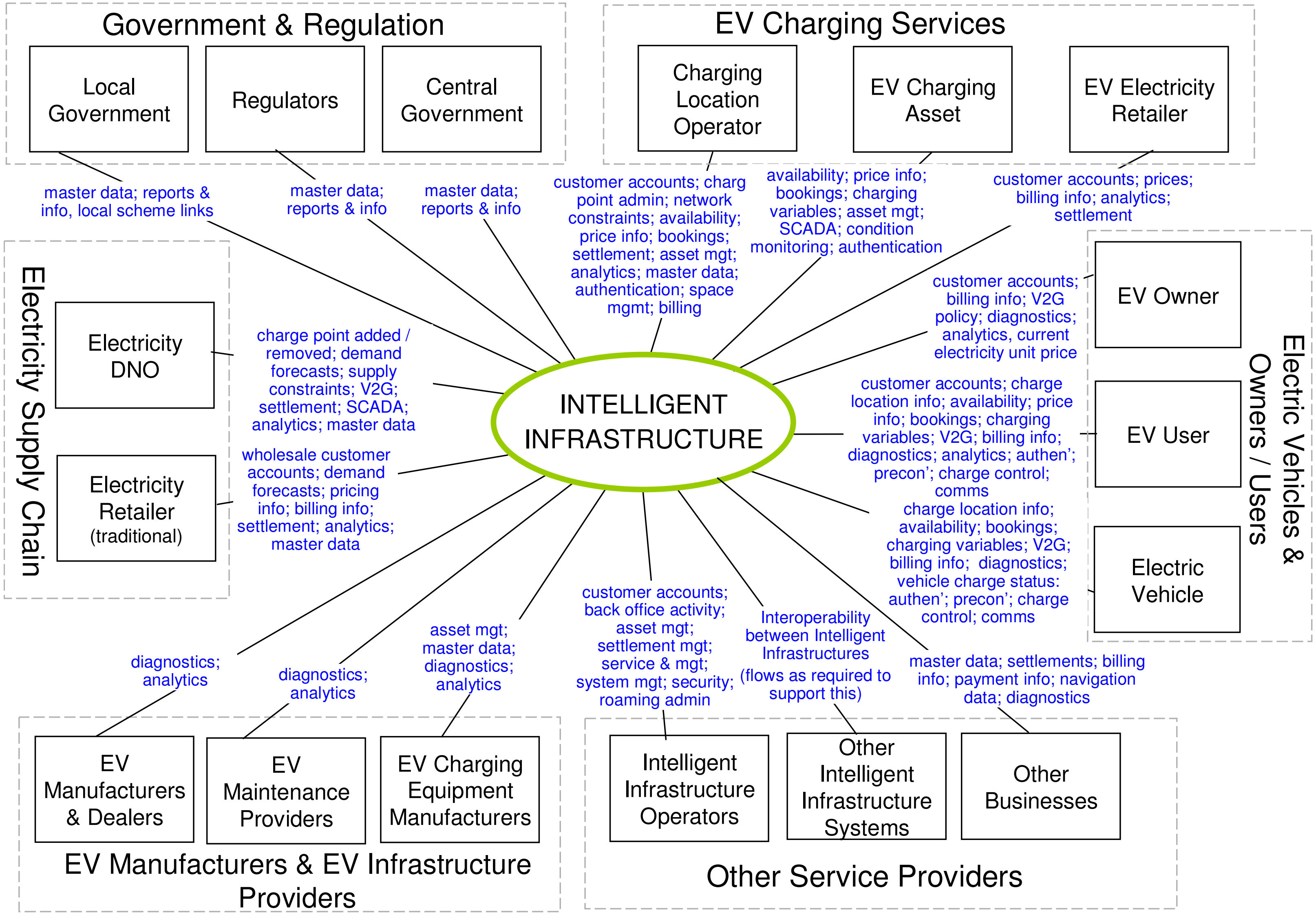
d) *In these sorts of cases, the Charging Location Operator records the details of the charging transaction and who will be paying for the transaction*

e) *Invoices are raised for those who will be paying and sent – at this point it could be similar to account type payment*

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Systems Integration - Inventory of the Systems Requiring Integration (1)

The totality of systems requiring integration can be derived from the Level 1 Context diagram shown below (from SP2/IBM/14) :-



Government & Regulation

Local Government

Regulators

Central Government

master data; reports & info, local scheme links

master data; reports & info

master data; reports & info

EV Charging Services

Charging Location Operator

EV Charging Asset

EV Electricity Retailer

customer accounts; charg point admin; network constraints; availability; price info; bookings; settlement; asset mgt; analytics; master data; authentication; space mgmt; billing

availability; price info; bookings; charging variables; asset mgt; SCADA; condition monitoring; authentication

customer accounts; prices; billing info; analytics; settlement

Electricity Supply Chain

Electricity DNO

Electricity Retailer (traditional)

charge point added / removed; demand forecasts; supply constraints; V2G; settlement; SCADA; analytics; master data

wholesale customer accounts; demand forecasts; pricing info; billing info; settlement; analytics; master data

INTELLIGENT INFRASTRUCTURE

Electric Vehicles & Owners / Users

EV Owner

EV User

Electric Vehicle

customer accounts; billing info; V2G policy; diagnostics; analytics, current electricity unit price

customer accounts; charge location info; availability; price info; bookings; charging variables; V2G; billing info; diagnostics; analytics; authen'; precon'; charge control; comms

charge location info; availability; bookings; charging variables; V2G; billing info; diagnostics; vehicle charge status: authen'; precon'; charge control; comms

diagnostics; analytics

diagnostics; analytics

asset mgt; master data; diagnostics; analytics

customer accounts; back office activity; asset mgt; settlement mgt; service & mgt; system mgt; security; roaming admin

Interoperability between Intelligent Infrastructures (flows as required to support this)

master data; settlements; billing info; payment info; navigation data; diagnostics

EV Manufacturers & Dealers

EV Maintenance Providers

EV Charging Equipment Manufacturers

EV Manufacturers & EV Infrastructure Providers

Intelligent Infrastructure Operators

Other Intelligent Infrastructure Systems

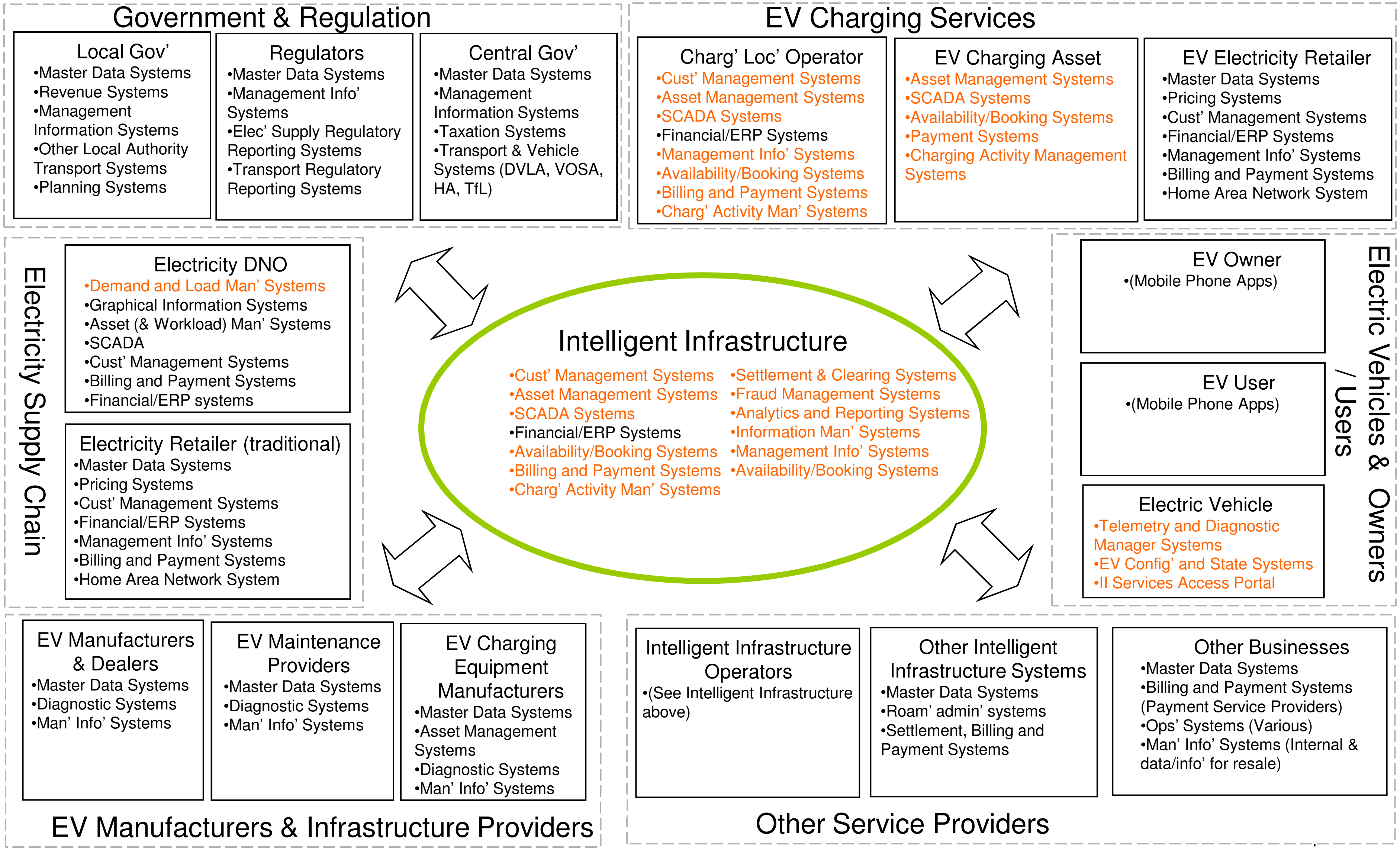
Other Businesses

Other Service Providers

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Systems Integration - Inventory of the Systems Requiring Integration (2)

Systems relating to each of the actors and the Intelligent Infrastructure which require integration in the Smart Phase of Evolution are shown below on the modified Context Diagram. Those systems marked in Red are those ‘core’ to the Intelligent Infrastructure and are picked up in detail in the Conceptual Design in Section 6.



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)

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – Systems Integration (3) - 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 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

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement - As-Is Assessment of Platforms in the Energy Markets (1)

*The purpose of this section is to provide an "As-is" assessment of the industry data flows and supporting mechanisms ('platforms') in the energy markets (**Elexon**, Electralink) and the emerging market model for Smart Metering. Evaluate the adequacy and potential of these platforms when compared to the requirements of the Intelligent Infrastructure.*

Overview of 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. The purpose of ELEXON is to provide balancing and settlement services as a key element in operating Great Britain's electricity trading arrangements. Figures from the ELEXON web site indicate that they handle over £500 million of customers' funds each year and interact with over 200 companies in the electricity industry.
- Elexon exists to square the circle of supply and demand in a market which operates in real time. The key characteristics and challenges of this market are:-
  - Electricity Retailers and other parties with demand contract ahead of time for a volume of generation to meet their demand. Generation is delivered to contracted levels and the demand is met. Generators that don't deliver to the contracted levels are penalised for non-delivery under the terms of a contract.
  - Electricity is delivered onto the Transmission System in real-time by Generators and is taken 'indiscriminately' by demand – there is no direct feed of electricity from generators to their contracted customers
  - The current grid has little storage (see discussion above), and electricity must be generated, delivered and consumed instantaneously and continuously in real-time;
  - Delivery of electricity can be impacted by system constraints;
  - Electricity is not metered in real-time, so delivery and demand, via metered volumes, must be identified after the event;
  - Demand is not fixed ahead of time - it is dynamic and responds to external factors such as the weather, so it is easy to get the required level of demand wrong and over- or under-estimate.
- These factors mean that there are two related processes needed:
  - The System Operator (the National Grid) needs to balance the system, i.e. match supply to demand and alleviate transport constraints, and;
  - Imbalance settlement – see next slide

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement - As-Is Assessment of Platforms in the Energy Markets (2)

*The purpose of this section is to provide an "As-is" assessment of the industry data flows and supporting mechanisms ('platforms') in the energy markets (**Elexon**, Electralink) and the emerging market model for Smart Metering. Evaluate the adequacy and potential of these platforms when compared to the requirements of the Intelligent Infrastructure.*

Elexon and (Imbalance) Settlement in this context means:-

- Where a Supplier has used more electricity than they contracted for, they must buy additional electricity from the grid to meet the amount used;
- Where a Generator has generated less than they were contracted to, they must buy additional electricity from the grid to meet their contracted levels;
- Where a Supplier has contracted for more electricity than they used, the Supplier must sell that additional electricity to the grid;
- Where a Generator has generated more electricity than they were contracted for, then they must sell that additional electricity to the grid.

- ,,,,then these differences are referred to as **imbalances**, and **settlement** is the process of calculating the volumes of imbalance and the prices to be paid for these imbalances. Settlement also works out other related charges and payments.
- Imbalances are settled centrally, via a set of systems called the BSC Central Systems which are designed to perform this role. Imbalance settlement is a closed system for the money paid in and out, i.e.:
  - Any surplus cash is redistributed amongst all Parties; and
  - Any deficit is charged proportionally to all Parties.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement - As-Is Assessment of Platforms in the Energy Markets (3)

Elexon Platform Assessment – Applicability to the Intelligent Infrastructure

Intelligent Infrastructure Functional Area	Adequacy & Potential	Rationale/Comments
Customer Management (EV Owner & User)	🔴	Elexon deals with a relatively small number of customers with high value transactions. Intelligent Infrastructure is the antithesis of this situation.
Charging Location Management	🔴	No equivalent functionality in BSC Central Systems
Charging Infrastructure Management & Safety	🔴	No equivalent functionality in BSC Central Systems
Demand/Supply Management	🔴	No equivalent functionality in BSC Central Systems
Complex Event Processing	🔴	No equivalent functionality in BSC Central Systems
Billing and Payment Service	🟡	Elexon processes bills and payments, but compared to the Intelligent Infrastructure requirement, these are low volume, high value and money is recycled within the system. Not hugely applicable.
Settlement & Clearing Services	🔴	The meaning of Settlement (see above) for Elexon is different to that required in the Intelligent Infrastructure
Business Analytics	○	Not assessed – Intelligent Infrastructure functional requirements are specific
Integration and Interoperability Services	○	Not assessed – no functional fit
Master Reference Data, Security, Systems Management	○	Not assessed – no functional fit
Overall Assessment	🔴	**No functional fit, no value in pursuing this option**

🔴 Little/No potential

🟡 Some potential for use

🟢 Promising potential

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement - As-Is Assessment of Platforms in the Energy Markets (4)

The Purpose of this section is to provide an "As-is" assessment of the industry data flows and supporting mechanisms ('platforms') in the energy markets (Elexon, ***Electralink****) and the emerging market model for Smart Metering. Evaluate the adequacy and potential of these platforms when compared to the requirements of the Intelligent Infrastructure.*

Overview of 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. The service processes approximately 20 million files, and delivers over 575 Gbytes of data per year. With the deregulation of metering services in 2004, Electralink introduced gas metering data onto the service.
- It was established in 1998 following Electricity Deregulation in Great Britain for the specific task of creating and operating an infrastructure for data communications in the competitive electricity market. Competing companies were required to work together in order to interchange information about domestic customers, and it was recognized that the key to success would be the agreement of a common set of data interchange requirements and the production of a centralised interoperability service.
- Electralink established a Data Transfer Service (DTS) for the use of Settlement Bodies, Distribution Network Operators, Suppliers, Metering Services Companies and Data Aggregators based on the provision of a data network and central data processing infrastructure (DTN).

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement - As-Is Assessment of Platforms in the Energy Markets (5)

Electralink Platform Assessment – Applicability to the Intelligent Infrastructure

Intelligent Infrastructure Functional Area	Adequacy & Potential	Rationale/Comments
Customer Management (EV Owner & User)	🔴	No equivalent functionality in Electralink Systems, data transfer only
Charging Location Management	🔴	No equivalent functionality in Electralink Systems
Charging Infrastructure Management & Safety	🔴	No equivalent functionality in Electralink Systems
Demand/Supply Management	🔴	No equivalent functionality in Electralink Systems, data transfer only
Complex Event Processing	🔴	No equivalent functionality in Electralink Systems
Billing and Payment Service	🔴	No equivalent functionality in Electralink Systems
Settlement & Clearing Services	🔴	No equivalent functionality in Electralink Systems, data transfer only
Business Analytics	⚪	Not assessed – Intelligent Infrastructure functional requirements are specific, but Electralink may provide some underlying Analytics capability
Integration and Interoperability Services	🟢	Electralink provides directly appropriate services in this area
Master Reference Data, Security, Systems Management	🟢	**With the exception of Master Reference Data** (no provision for this in Electralink Systems), provides directly appropriate services in this area.
Overall Assessment	🔴	**Limited value in pursuing this option - for integration and infrastructure services only.**

🔴 Little/No potential
🟡 Some potential for use
🟢 Promising potential

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement - As-Is Assessment of Platforms in the Energy Markets (6)

The Purpose of this section is to provide an "As-is" assessment of the industry data flows and supporting mechanisms ('platforms') in the energy markets (Elexon, Electralink) and the emerging market model for ***Smart Metering****. Evaluate the adequacy and potential of these platforms when compared to the requirements of the Intelligent Infrastructure.*

Smart Metering

- Smart Metering has been introduced above in Section 4 – Effect of Emerging Technologies. This section builds on that introduction and describes the infrastructure proposed and its applicability to the Intelligent Infrastructure.
- The Central Communications Model for Smart Metering introduces a market function to implement and manage the communication infrastructure and data carriage. This communications provider, ('Data Comms' Company), will be organised on a national basis and all electricity suppliers will be obliged to use the central communications function via licence conditions. In order to offer this service to suppliers, the central communications provider will have the following responsibilities:
  - Set-up (where applicable) **a communication(s) infrastructure** to support smart metering services;
  - Select and procure in-home WAN communication devices;
  - Provide **all data retrieval services to and from the smart meters on behalf of the suppliers** (or third parties where applicable);
  - To **maintain communication assets** (both infrastructure and in-home).
- Within this model the supplier will continue to be responsible for metering services outside the remit of the communications provider, including
  - The support of all existing legacy meters (such as meter operation and reading);
  - The purchase / provision, installation and maintenance of smart meters.
  - The deployment of the in-home WAN communications device on behalf of the central communications provider. (The supplier drives the deployment strategy and is empowered to make independent commercial decisions although any variations in meter specification will be limited by the communication protocol(s) set by the communications provider). There may also be a dependency on the availability of the communications infrastructure that may influence the supplier's roll-out strategy.
- A central body will have the responsibility for selecting and managing the communications infrastructure provider and maintaining commercial pressure on this provider through the re-tender process.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement - As-Is Assessment of Platforms in the Energy Markets (7)

The Purpose of this section is to provide an "As-is" assessment of the industry data flows and supporting mechanisms ('platforms') in the energy markets (Elexon, Electralink) and the emerging market model for ***Smart Metering****. Evaluate the adequacy and potential of these platforms when compared to the requirements of the Intelligent Infrastructure.*

- One of the key objectives of Smart Metering is to simplify Industry processes with, amongst others, the introduction of a Centralized Provider of services (the Data Communications Company) – see earlier section on Emerging Technologies. Smart Metering Proposals and the responsibilities of the Data Communications Company have not yet been finalized, but the table below summarizes the latest position:-

Deployment and Metering System Ownership	Communications Provision and Ownership	Data Management	Customer Interaction and Installation
•Home communications equipment (and any Real Time Display - RTD) owned by the Data Comms' Company (DCC), likely to be installed by the supplier / agent • Commercial interoperability required	• Fixed-term contract for operation of the Communications Network • Choice of communications infrastructure made as part of selection of the DCC • Infrastructure, home communications equipment device, (including RTD) provided and maintained by DCC	• DCC manages data carriage, and so manages registration and standing data • Data retrieval and meter interaction managed by DCC • Data processing, aggregation & history managed by supplier (or agent), with opportunities for DCC to take on some or all of these roles • Third parties (e.g. DNOs) to receive data directly from DCC	• All customer contact by supplier • Assume home comms' devices as part of first meter installation • Supplier use of installation visit • Supplier drives products and services

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement - As-Is Assessment of Platforms in the Energy Markets (8)

Smart Metering DCC Platform Assessment – Applicability to the Intelligent Infrastructure

Intelligent Infrastructure Functional Area	Adequacy & Potential	Rationale/Comments
Customer Management (EV Owner & User)	🔴	Customer Management will be the responsibility of the Supplier, but some data and management will be needed by the DCC
Charging Location Management	🔴	No equivalent functionality in the DCC
Charging Infrastructure Management & Safety	🟢	Management of Remote Assets (Home Comms' Equipment) similar to management of Charge Posts
Demand/Supply Management	🔴	No equivalent functionality proposed in the DCC
Complex Event Processing	🔴	No equivalent functionality proposed in the DCC
Billing and Payment Service	🔴	No equivalent functionality proposed in the DCC
Settlement & Clearing Services	🟡	No directly equivalent functionality proposed in the DCC, but some B2B (but not B2C) aspects of settlement covered.
Business Analytics	🟡	Analytics functionality possibly provided by the DCC
Integration and Interoperability Services	🟢	Will be a major part of the proposed DCC functionality – **national communications network especially**
Master Reference Data, Security, Systems Management	🟢	Will be a fundamental part of the proposed DCC functionality – Data management functionality especially
Overall Assessment	🟡	**High probability that the Smart Metering Infrastructure (DCC) will provide comms' infrastructure and some data processing functionality which could be applied to the Intelligent Infrastructure.**

🔴 Little/No potential 🟡 Some potential for use 🟢 Promising potential

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Systems Integration and Settlement – As-Is Assessment of Platforms in the Energy Markets - Key Messages

- Elexon Settlement Services and Systems
  - The concept of settlement (resolving supply and demand imbalances) is one completely different to that required in the Intelligent Infrastructure.
  - Overall, Elexon and its systems are designed for relatively low volumes of data (customers, transactions) with high values, whilst the Intelligent Infrastructure (in the Smart Phase) will be handling high volumes (customers, transactions, locations) with relatively low value.
  - Therefore no real directly applicable value to the Intelligent Infrastructure. Indirectly however, Elexon clearly has expertise in the areas of Demand/Supply balancing and its expertise might be useful when developing the Demand/Supply Management and Complex Event Processing functionality in the Intelligent Infrastructure.
- Electralink
  - This is a small business providing central infrastructure and expertise for data transport, processing and management to the Utilities – functionality which is also at the core of the Intelligent Infrastructure and therefore would be directly applicable. However, Electralink has nothing to offer in the other services and functionalities defined for the Intelligent Infrastructure (Customer Management, Charging Location Management). Using Electralink's core services would result in a delivery model with a split between infrastructure and applications/services in a landscape which is already delivered by multiple parties (EV OEM, Charging Location Operators, Intelligent Infrastructure Operatorer etc.). The type of organizations capable of being the Intelligent Infrastructure Operator would be able to deliver both infrastructure and applications/services with associated economies of scale. Hence the viability of a separate Electrlink provided infrastructure might be difficult to justify. Not an attractive option
- Smart Metering
  - This looks promising for the Intelligent Infrastructure, with strong commonalities in infrastructure and to some extent in applications and services provided by the Data Communications Company. The creation of a national communications infrastructure down to each Smart Meter is an initiative which the Intelligent Infrastructure should exploit. Smart metering is a mandated, high profile, priority initiative – what are the practical, realistic chances of proposing additional requirements for an EV Intelligent Infrastructure and having them accepted?

© 2010 IBM Corporation

ETI EV Work Package 2.4

SP2/IBM/28 ETI EV Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks

Section 6 – Conceptual Design of the Intelligent Infrastructure

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Conceptual Design – Background and Context

- This section contains the Conceptual Design of the Intelligent Infrastructure in the Smart Phase of Evolution (see SP2/IBM/16), it presents a Conceptual Design which:-
  - Meets the requirements described in the Uses Cases outlined in Section 2;
  - Builds heavily on previous architectural deliverables, namely:-
    - Conceptual Application Architecture (SP2/IBM/17);
    - Conceptual Data Architecture (SP2/IBM/18);
    - Conceptual Technical Architecture (SP2/IBM/19);
  - Provides a blueprint for an order of magnitude estimate of the costs involved in implementing (designing and building) the required back office and supporting systems, which is covered in the next section.
- This section presents the Conceptual Design of the Intelligent Infrastructure at a summary level – more detail is to be found in the embedded document in Appendix A. The section is structured as follows:-

Derive the Top-Level Conceptual Design, confirming Components, Locations and which Actors are responsible for development

(Slides 100 – 104)

Brief description of how the Conceptual Design is used to generate Budgetary Estimates – categorizing components into 'Bespoke' or 'COTS'

(Slide 105)

Assessment by Actor of Components & Locations

(Slide 106 – 107 Electric Vehicle OEM)

(Slide 108 – 110 Charge Point OEM)

(Slide 111 – 112 Charging Location Operator)

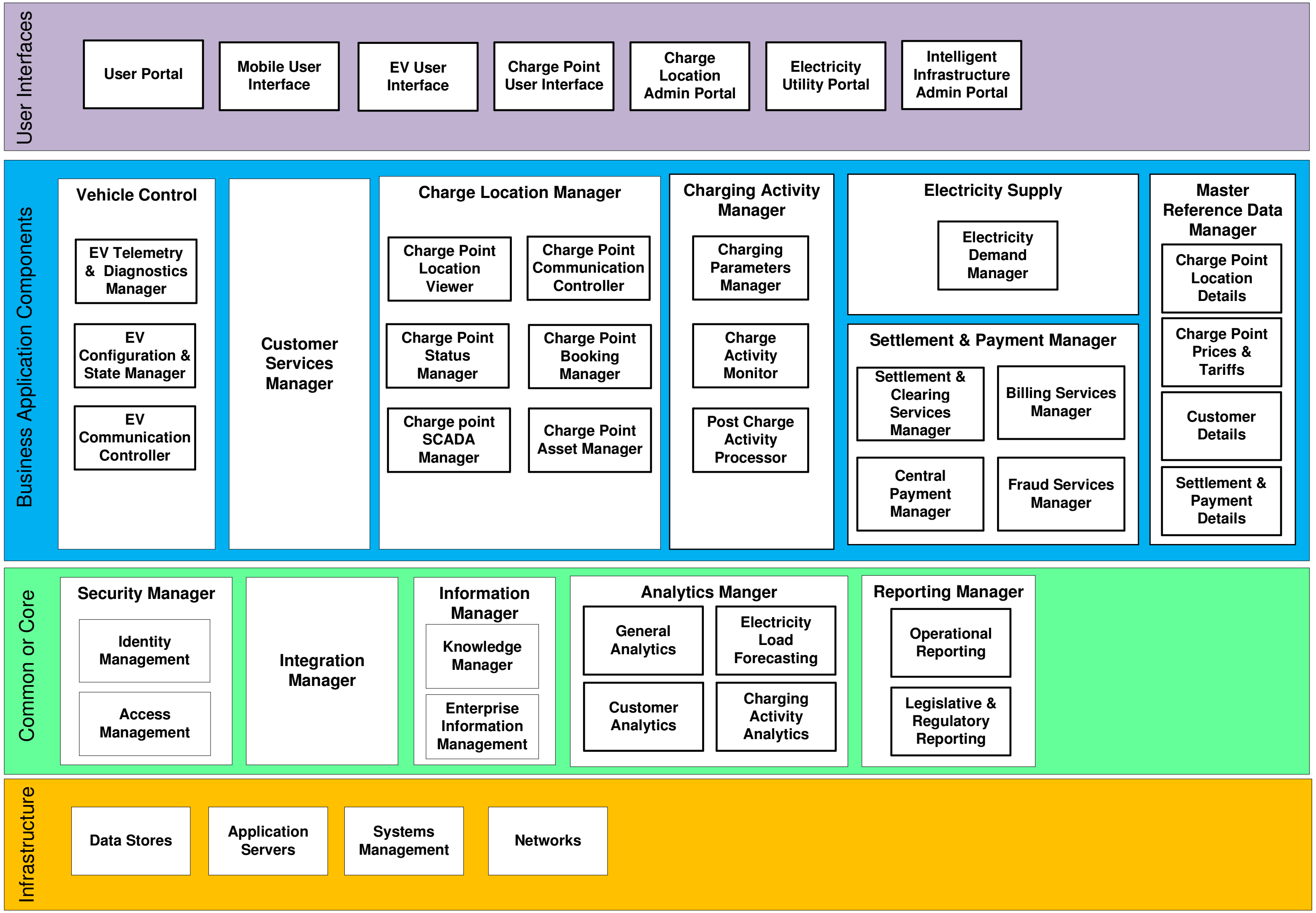
(Slide 113 – 115 Intelligent Infrastructure Operator)

(Slide 116 Distribution Network Operator)

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Conceptual Design – Deriving the Design (1/5)

- The Conceptual Design for the Intelligent Infrastructure has been derived using the Components defined in the Conceptual Application Architecture (see SP2/IBM/17 for further details) as follows:-



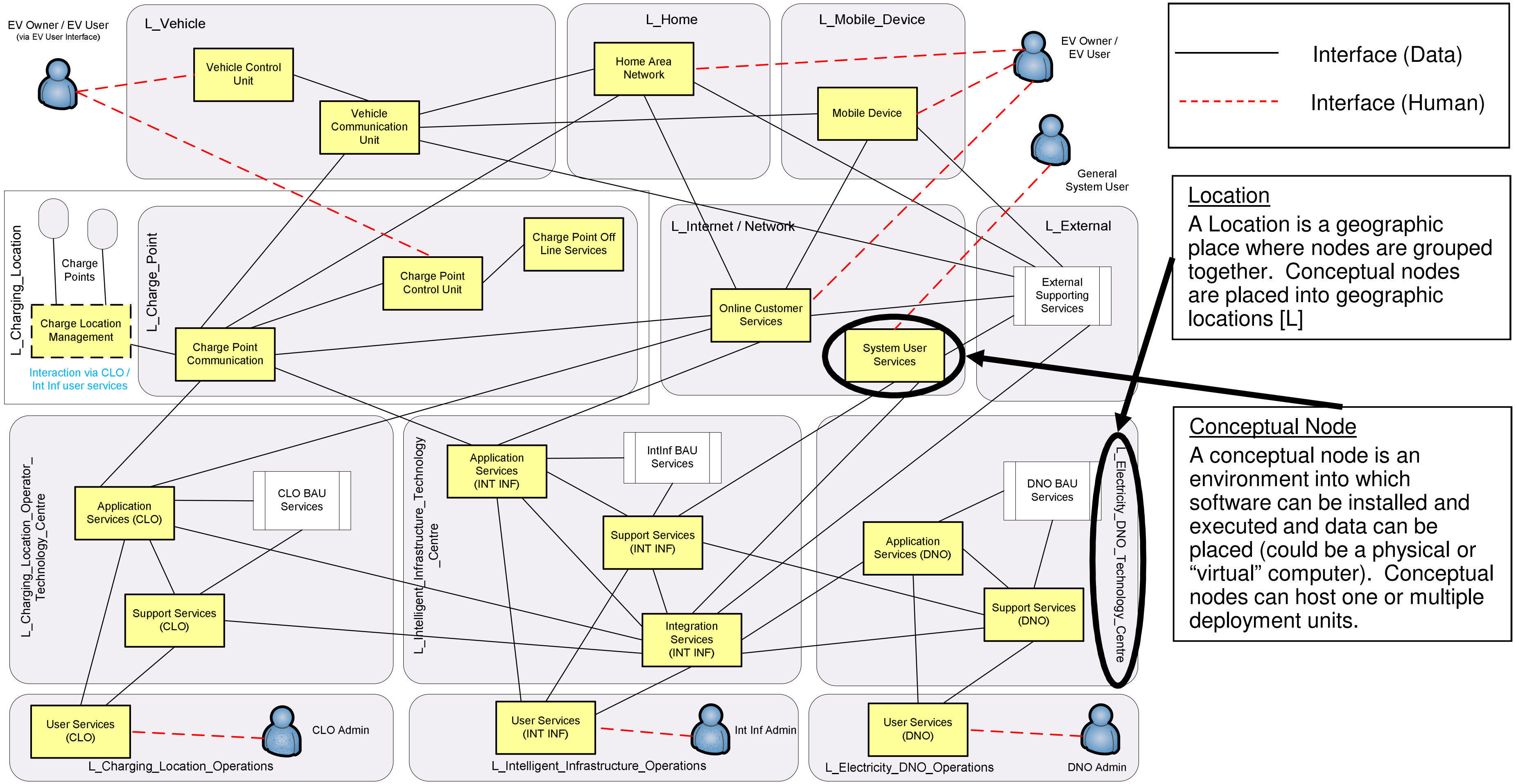
This model illustrates the full conceptual application architecture model for the Intelligent Infrastructure based on the requirements and business architecture as currently described.

The model splits the components into layers showing user interaction, the main business application components, supporting common / core components and infrastructure.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Conceptual Design – Deriving the Design (2/5)

- The Conceptual Design uses the Locations defined in the Conceptual Technical Architecture (see SP2/IBM/19 for further details) as follows:-



Location
A Location is a geographic place where nodes are grouped together. Conceptual nodes are placed into geographic locations [L]

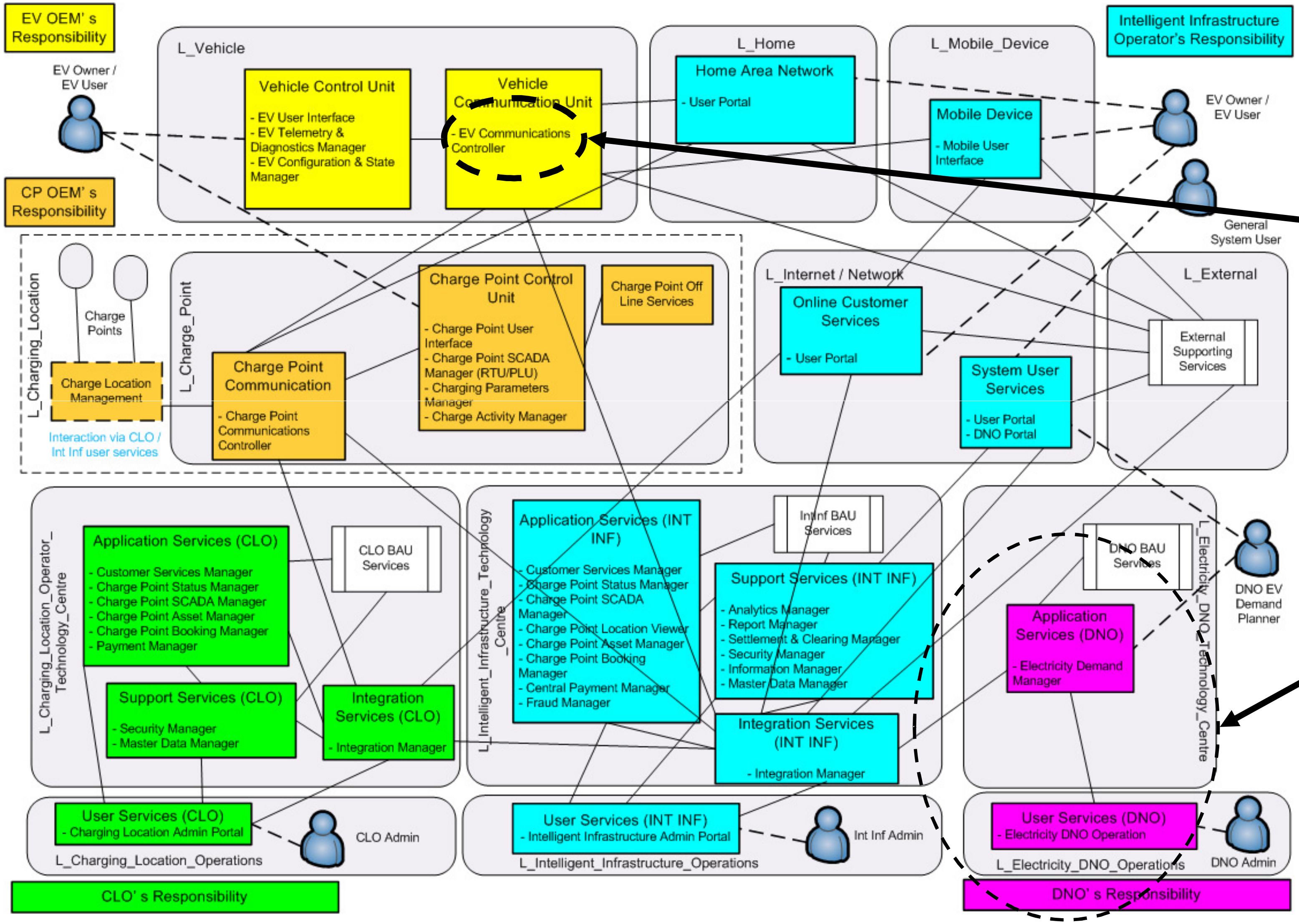
Conceptual Node
A conceptual node is an environment into which software can be installed and executed and data can be placed (could be a physical or "virtual" computer). Conceptual nodes can host one or multiple deployment units.

The 'solution' for the Intelligent Infrastructure is not a single computer system residing in one data centre. The Intelligent Infrastructure is a set of connected capabilities which reside in a number of location, each of which 'host' a number of components (see below).

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Conceptual Design – Deriving the Design (3/5)

- The Conceptual Design is shown below, including identifying which actors are responsible for the development of which components.



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 - (see next slide for discussion)

…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)

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Conceptual Design – Deriving the Design (4/5)

- The Conceptual Design identifies five Intelligent Infrastructure actors as being ‘responsible for the development’ of the Intelligent Infrastructure. They are:-
  - Electric Vehicle OEMs - will develop the components specified as residing on their EVs and will integrate them with existing EV systems and capabilities.
  - Charge Point/Equipment OEMs - responsible for the development of the specified components at the Charging Location – domestic and non-domestic – and integrating them into their Charging Assets (principally posts, but also other associated equipment)
  - Charging Location Operators – will develop the components which are specified to reside in the their technology or data centres.
  - Intelligent Infrastructure Operator – will be responsible for development of the central components specified to reside in its technology or data centres, including interfaces from the Intelligent Infrastructure to other actors (Government, Other Service Providers) and will be responsible for overall integration of the Intelligent Infrastructure – using well defined standards to ensure interoperability – see SP2/IBM/15 and SP2/IBM/25.
  - Electricity DNOs – will develop interfaces from the Intelligent Infrastructure and will develop the Electricity Demand Manager component.
- ‘Responsible for development’ means the analysis, design, development, testing and implementation. The specified actors may use third parties to deliver some or all of the components, but do retain ultimate responsibility.
- In general, each actor has a distinct set of business capabilities to deliver in the EV Market which lead directly to a distinct set of applications being required within their locations. In the cases of the Charging Location Operator and of the Central Intelligent Infrastructure Provider there are a number of component applications which appear in both their locations. A list of those ‘replicated’ application components in question and an explanation for this situation is given on the next slide. (NB support services (e.g. Security), as opposed to applications, will, and should appear in all locations).

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Conceptual Design – Deriving the Design (5/5)

Replicated Application Component	Headline Description (see SP2/IBM/17)	Explanation/justification (for their appearance in both locations)
Customer Services Manager	'..to manage customer services within the intelligent infrastructure covering general customer relationship functionality. Specific areas include account management, contact management, customer problem and issue management, managing promotional or marketing activity.'	In all phases of evolution, it is assumed that customers (EV owners/users) will be 'owned' by CLOs and ERs (Electricity Retailers, including EV Electricity Retailers), and managed via their own Customer Services Manager components. However, by the Smart phase of evolution, it is assumed that the II Operator will provide a one stop shop for EV owners for **some** services due to market growth and a push for universality. A Customer Service Manager component for the II Operator is the result, containing specific customer data from the CLOs' and ERs' systems providing specific functionality
Charge Point Status Manager	'Component which processes information about the status of charging locations and make it available for use by different types of user and other components.'	By the Smart Phase it is assumed that the Intelligent Infrastructure will be the prime disseminator of information about the status of charging locations. Some of this information will be received directly from the CLOs, but some will have to be derived by the II Operator itself – hence the component exists at both CLO and II locations.
Charge Point SCADA Manager	'Component which provides support in the II for the control and monitoring of the status and condition of charging assets and locations.'	(1) It is assumed that CLOs will have their own SCADA systems and that the II may take a feed or have a view of relevant data to support a consolidated view, i.e. SCADA at the II Operator Location will provide data acquisition (DA), but not supervisory control (SC) functionality. (2) Some CLOs may not have a SCADA system in which case the II could provide the component for those locations and assets (3) It is assumed that by the Smart phase the II Operator will be able to offer SCADA services as an alternative to those being offered by individual CLOs.
Charge Point Asset Manager	'Component which enables the II to have a view of / manage charging assets in terms of commissioning, planning, installation and maintenance.'	(1) It is assumed that CLOs will have their own asset management systems covering detailed asset, work, service, contract, inventory, and procurement management and that the II may take a feed or have a view of relevant data to support a consolidated view. (2) It is assumed that by the Smart phase the II Operator may offer some asset management services, especially around maintenance, with commissioning, planning and installation retained by the CLO
Charge Point Booking Manager	'Component which allows relevant actors to make a charging location booking.'	Functionality which can be accessed either via individual CLOs or via the Intelligent Infrastructure Operator with resultant exchange of data.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Conceptual Design – Using the Conceptual Design to generate Budgetary Estimates

- The next stage in the process of producing the Conceptual Design is to assess each component in the context of its location, and decide if the component is delivered best by building a 'bespoke' component or by utilizing a commercially available package or service, (COTS = Commercial-Off-The-Shelf), configured to meet the specific requirements of the Intelligent Infrastructure. Use of COTS is the IT industry's preferred approach as there are distinct advantages in terms of capital costs, risks and maintainability.
- For bespoke components, an assessment of the following key aspects is made:-
  - is the component to be built from scratch or built on an existing capability
  - is the design/build 'complex', 'medium' or 'simple'
  - the number and complexity of interfaces to other components
  - any particular special features
- For COTS components, an assessment of the following key aspects is made:-
  - complexity of configuration – complex, medium, simple
  - complexity of customizations and interfaces – complex medium simple.
- The analyses are captured in a table – example below for the EV User Interface:-

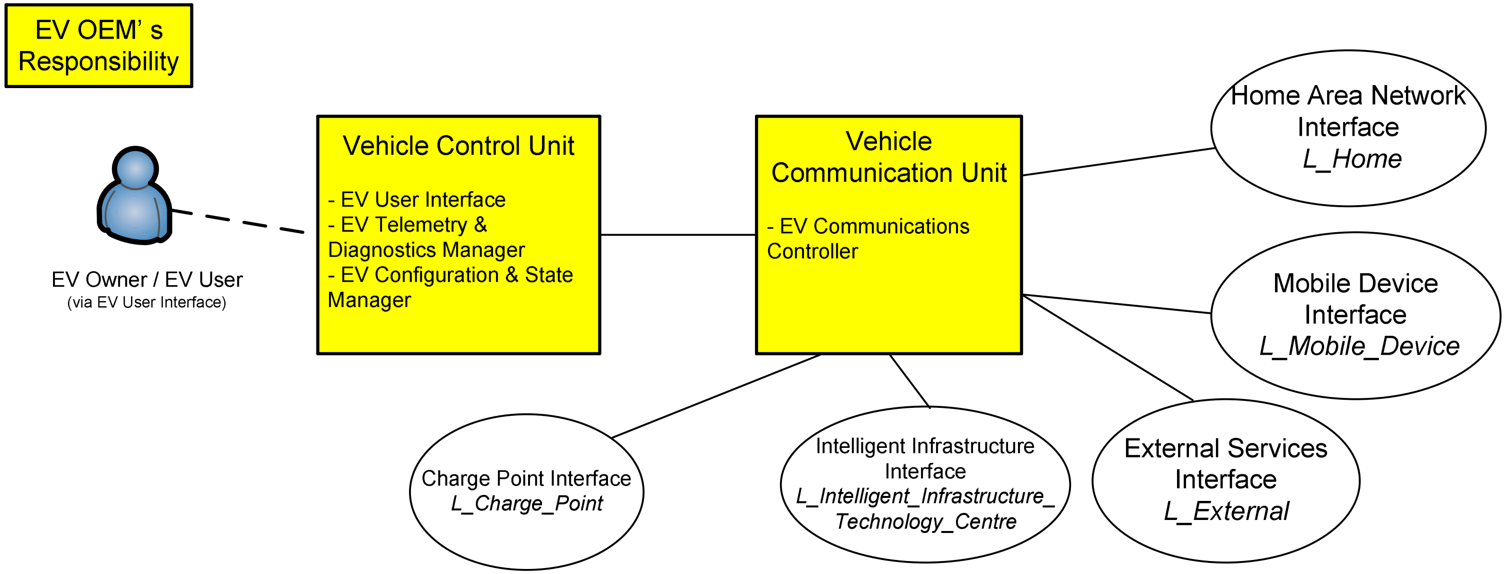
Component Name	EV User Interface
Functional Description (based on SP2/IBM/17 with additions)	Component which supports access to services and information in the intelligent infrastructure from the EV. Initially this would be initiated by the user, though it could evolve to include interaction initiated and managed by the vehicle. Services and information include – Charge Point location, availability and booking, and when co-located at a charge point, the user interface should provide functionality close to that available at the Charge Point User Interface itself, including Charging Variables (e.g. EV pre-conditioning), Charging Operation Security – Authentication and Authorization, Charging Control – start/stop, Payment. When the EV is co-located at a domestic charge point then the user interface will reflect the reduced set of options available.
Component Interfaces	Using the Vehicle Communication Unit which handles all interfacing into and out of the EV, this component drives interfaces to the Intelligent Infrastructure and to the Charge Point.
Hardware	User interface device located within the EV – touch-screen, simulated keyboard, voice recognition. Usable for all standard EV functions e.g. audio and not just services related to the II. Connected to an on-board computer which is standard supply within the EV.
Software	Software is bespoke to meet the requirements, building on developments and components of vehicle information systems already developed by the OEM.
Assessment	Bespoke component. Built on existing hardware and software capabilities. Design and build is complex – interfaces to Intelligent Infrastructure and Charge Point – both domestic and commercial.

- For all components in the Intelligent Infrastructure, this becomes a large volume of information, so these tables have been captured in Appendix A and summary information is presented in this section.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Conceptual Design – EV Components Assessment (Smart Phase)

This slide assesses the components and interfaces which the EV OEM is responsible for realizing.



EV OEM' s Responsibility

EV Owner / EV User
(via EV User Interface)

Vehicle Control Unit
- EV User Interface
- EV Telemetry & Diagnostics Manager
- EV Configuration & State Manager

Vehicle Communication Unit
- EV Communications Controller

Home Area Network Interface
L_Home

Mobile Device Interface
L_Mobile_Device

External Services Interface
L_External

Intelligent Infrastructure Interface
L_Intelligent_Infrastructure_Technology_Centre

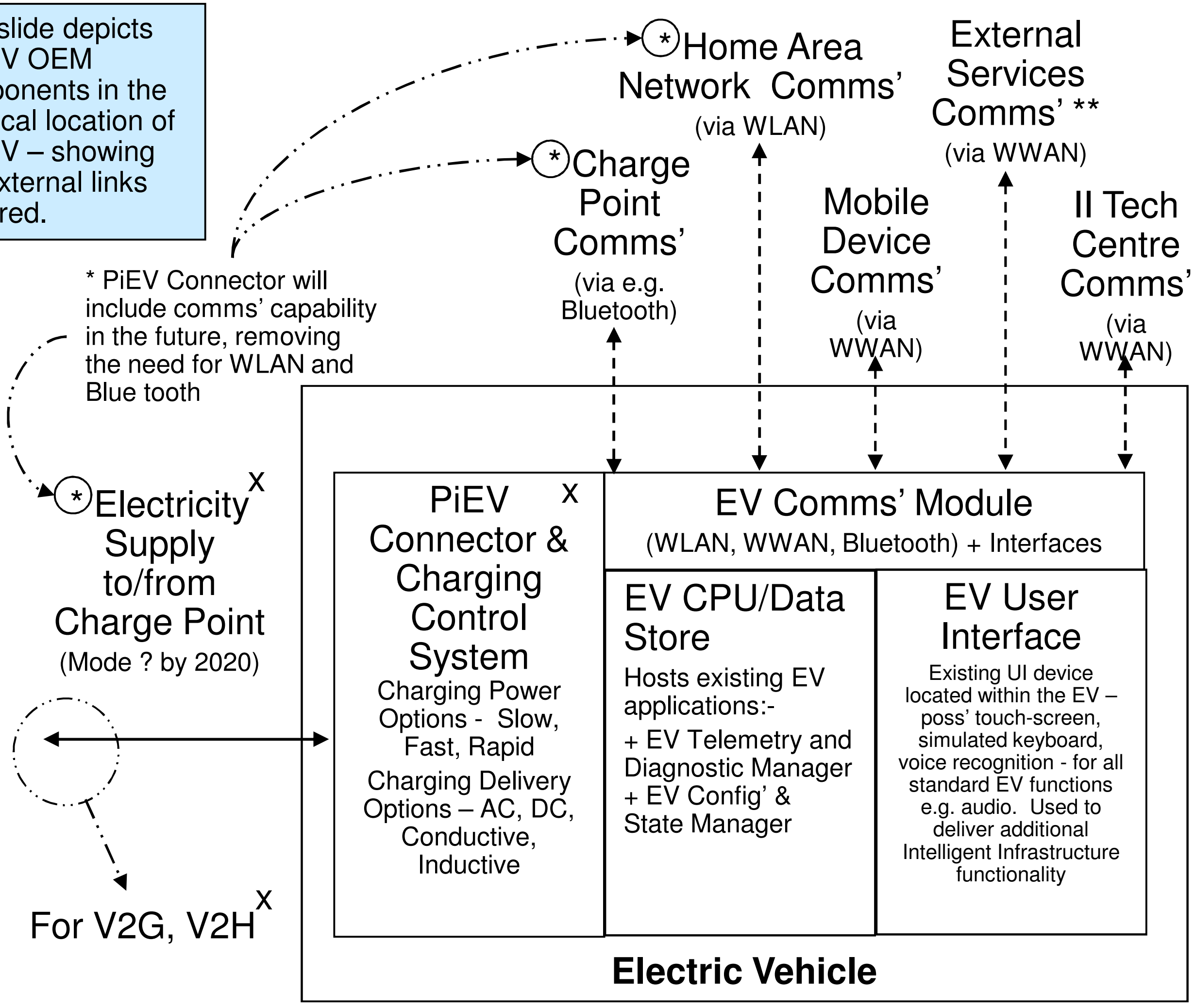
Charge Point Interface
L_Charge_Point

Component	**Component Type**	**Assessment Headline**
EV User Interface	Bespoke build on existing hardware and software capabilities provided by the EV OEM	Complex interface based component
EV Telemetry and Diagnostic Manager	Bespoke build on existing hardware and software capabilities provided by the EV OEM	Simple interface based component, assuming telemetry and diagnostic data and information already available in digital form
EV Config' & State Manager	Bespoke build on existing hardware and software capabilities provided by the EV OEM	Medium complexity interfaced based component – supplying and receiving data to and from the Charge Point and the Intelligent Infrastructure
EV Comms' Controller	Bespoke build on existing hardware and software capability of communications provided by the EV OEM	Medium complexity – gateway device for EV to II related external components

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Conceptual Design – EV Design Detail (Smart Phase)

This slide depicts the EV OEM components in the physical location of the EV – showing the external links required.



* Home Area Network Comms' (via WLAN)

External Services Comms' ** (via WWAN)

* Charge Point Comms' (via e.g. Bluetooth)

Mobile Device Comms' (via WWAN)

II Tech Centre Comms' (via WWAN)

* PiEV Connector will include comms' capability in the future, removing the need for WLAN and Blue tooth

* Electricity X Supply to/from Charge Point (Mode ? by 2020)

For V2G, V2H X

PiEV X Connector & Charging Control System

Charging Power Options - Slow, Fast, Rapid

Charging Delivery Options – AC, DC, Conductive, Inductive

EV Comms' Module (WLAN, WWAN, Bluetooth) + Interfaces

EV CPU/Data Store

Hosts existing EV applications:-

+ EV Telemetry and Diagnostic Manager
+ EV Config' & State Manager

EV User Interface

Existing UI device located within the EV – poss' touch-screen, simulated keyboard, voice recognition - for all standard EV functions e.g. audio. Used to deliver additional Intelligent Infrastructure functionality

Electric Vehicle

Key Functionality & Interfaces:-

- Access to the II from within the EV
- Automatic EV comms' with the II
- II info' available through the EV UI – Charging Locations, Availability, Booking, Charging Variables
- Access to EV from mobile devices for charge status enquiry, preconditioning of vehicle
- Authentication/authorization by the EV, automatic payment (with safeguards)
- EV telemetry/diagnostics provided to the II
- EV and battery configuration and status provided to the II

See Section 2 Use Cases for full list

Key Assumptions, (by the Smart Phase):-

- Availability and cost of wireless comms' – no barrier to inclusion in EV
- Computer/UI devices feature even in EV base models
- Mode ? is mandated standard for electricity supply and higher power options/modes of delivery are available
- Standards exist to allow interconnection at the infrastructure and data/application levels

X = Electrical infrastructure – covered in SP2/EON/04, SP2/EDF/05, SP2/EDF/06

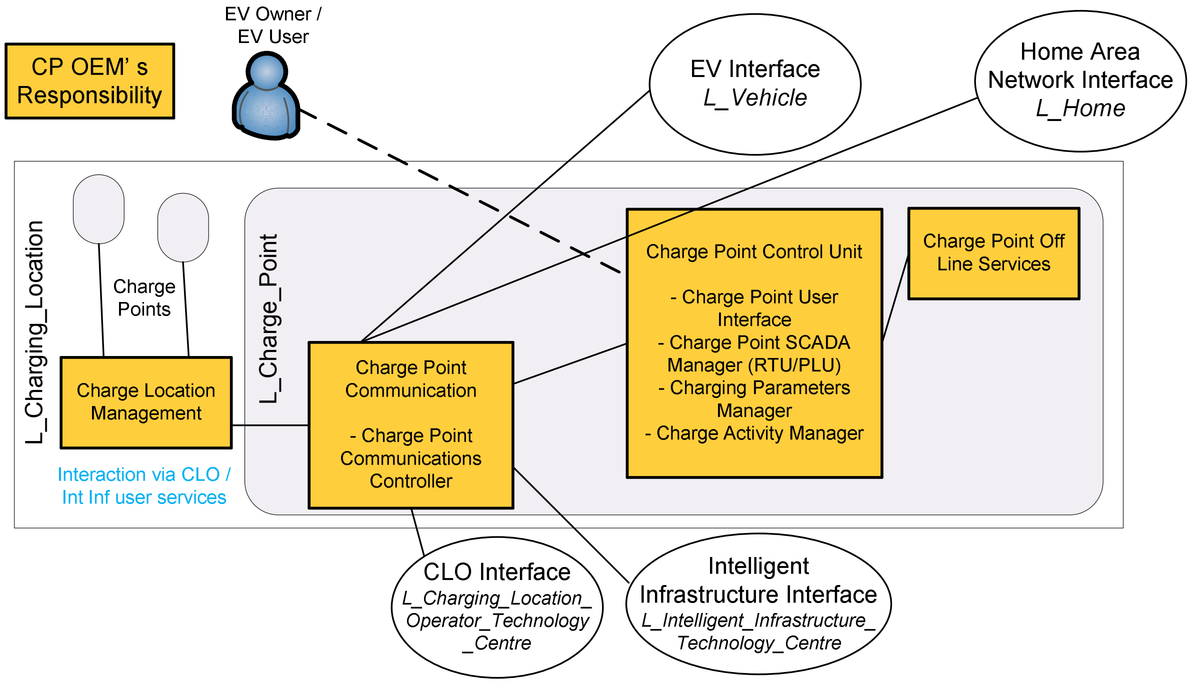
◄- - - -► Data

◄——► Power

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Conceptual Design – CP OEM Components Assessment (Smart Phase)

This slide assesses the components and interfaces which the Charge Point OEM is responsible for realizing.

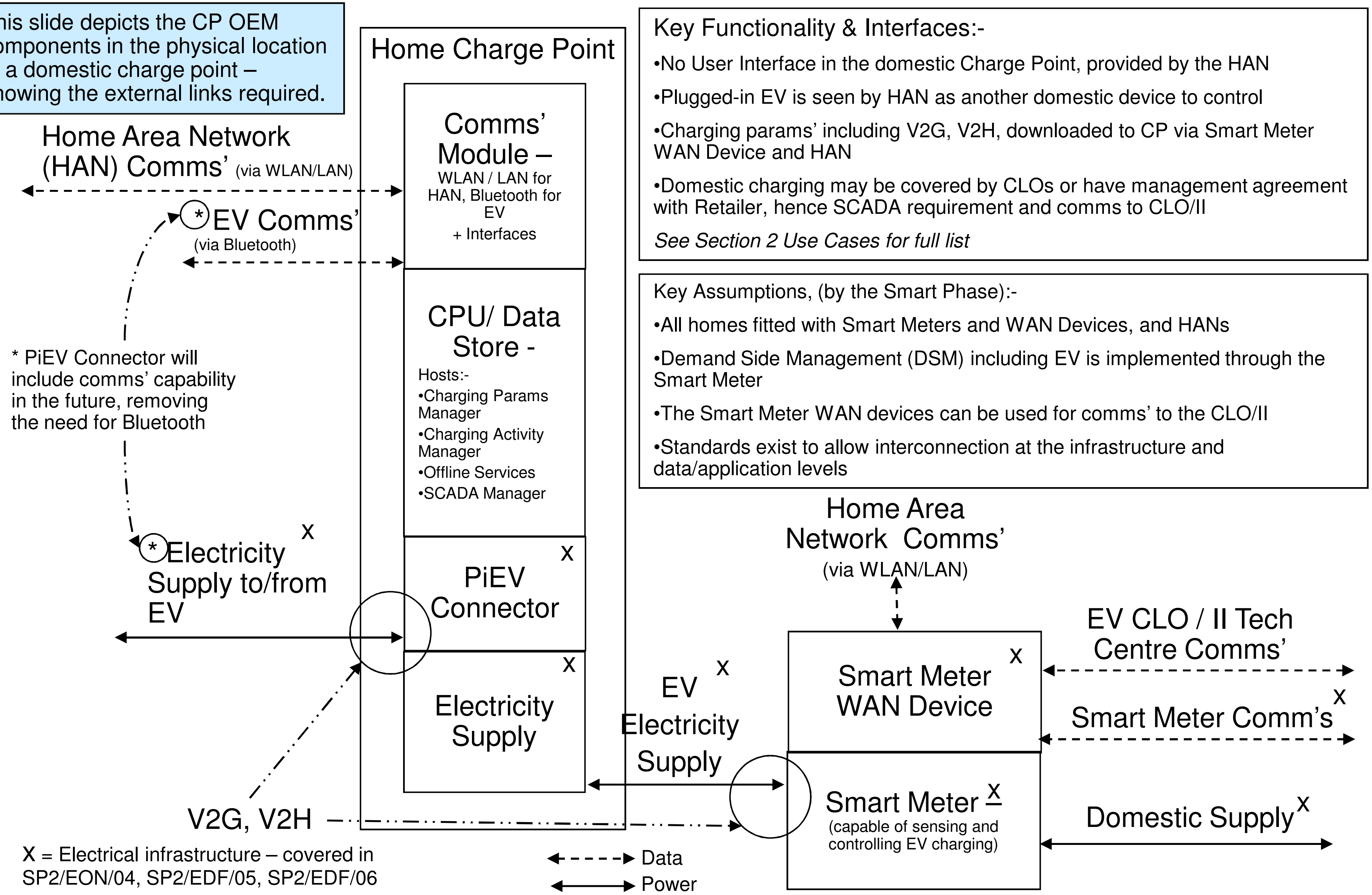


Component	**Component Type**	**Assessment Headline**
User Interface	Bespoke build on existing hardware and software capabilities provided by CP OEM	Complex component
SCADA Manager	Bespoke build on existing hardware and software capabilities using COTS SCADA agent	Complex component
Charging Parameters Manager	Bespoke build on existing hardware and software capabilities provided by CP OEM	Medium complexity component
Charging Activity Manager	Bespoke build on existing hardware and software capabilities provided by CP OEM	Medium complexity component
Offline Services	Bespoke build on existing hardware and software capabilities provided by CP OEM	Medium complexity component
Communications Controller	COTS build and configuration – communications drivers, Middleware agents	Medium complexity component

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Conceptual Design – Domestic Charge Point Design Detail (Smart Phase)

This slide depicts the CP OEM components in the physical location of a domestic charge point – showing the external links required.



Home Area Network (HAN) Comms' (via WLAN/LAN)

*EV Comms' (via Bluetooth)

* PiEV Connector will include comms' capability in the future, removing the need for Bluetooth

*Electricity Supply to/from EV X

V2G, V2H

Home Charge Point

Comms' Module – WLAN / LAN for HAN, Bluetooth for EV + Interfaces

CPU/ Data Store -

Hosts:-
- Charging Params Manager
- Charging Activity Manager
- Offline Services
- SCADA Manager

PiEV Connector X

Electricity Supply X

EV Electricity Supply X

Home Area Network Comms' (via WLAN/LAN)

Smart Meter WAN Device X

Smart Meter X (capable of sensing and controlling EV charging)

EV CLO / II Tech Centre Comms'

Smart Meter Comm's X

Domestic Supply X

Key Functionality & Interfaces:-

- No User Interface in the domestic Charge Point, provided by the HAN
- Plugged-in EV is seen by HAN as another domestic device to control
- Charging params' including V2G, V2H, downloaded to CP via Smart Meter WAN Device and HAN
- Domestic charging may be covered by CLOs or have management agreement with Retailer, hence SCADA requirement and comms to CLO/II

See Section 2 Use Cases for full list

Key Assumptions, (by the Smart Phase):-

- All homes fitted with Smart Meters and WAN Devices, and HANs
- Demand Side Management (DSM) including EV is implemented through the Smart Meter
- The Smart Meter WAN devices can be used for comms' to the CLO/II
- Standards exist to allow interconnection at the infrastructure and data/application levels

X = Electrical infrastructure – covered in SP2/EON/04, SP2/EDF/05, SP2/EDF/06

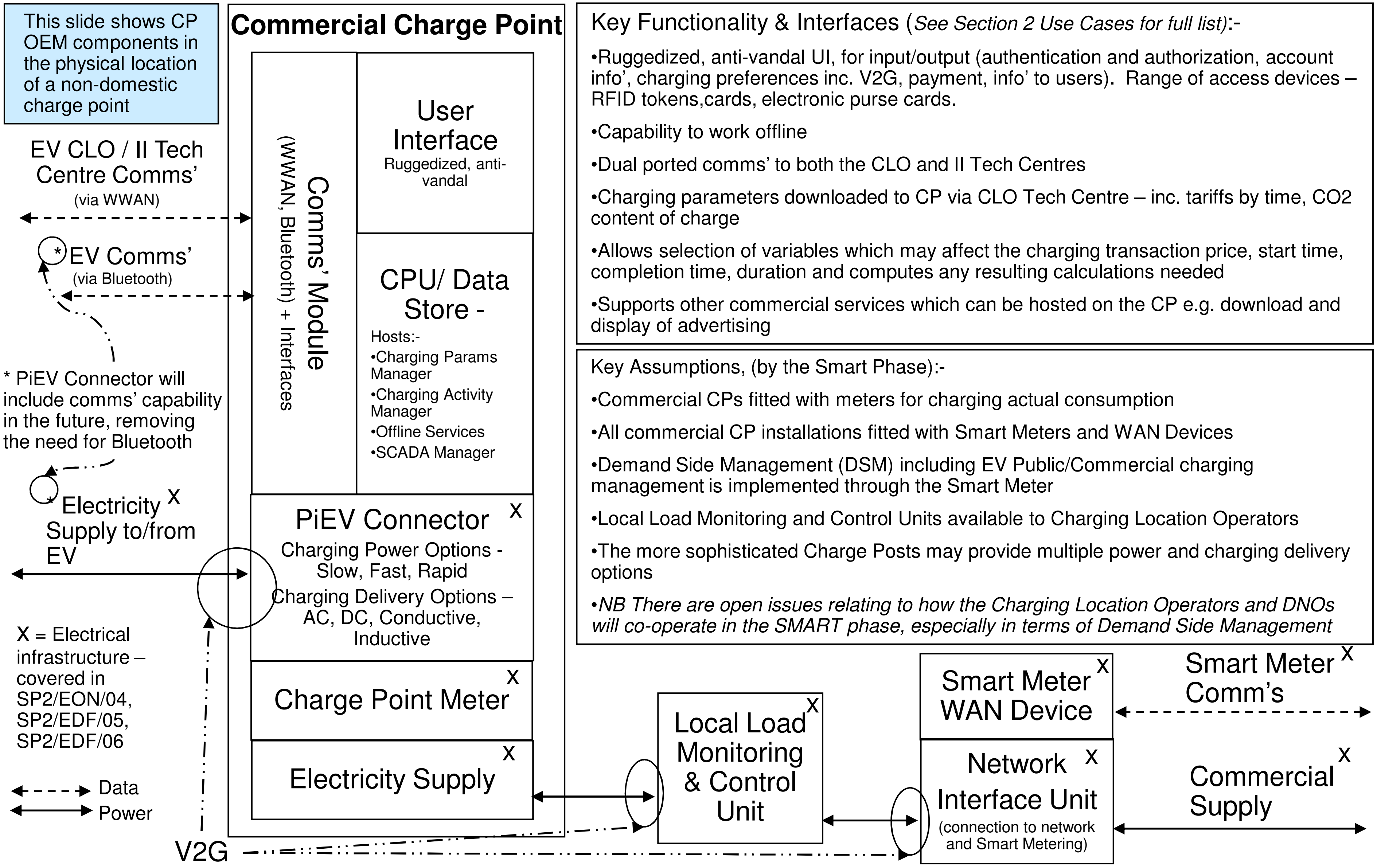
◄- - - -► Data

◄——► Power

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Conceptual Design – Public/Commercial Location Charge Point Design Detail (Smart Phase)

This slide shows CP OEM components in the physical location of a non-domestic charge point



Key Functionality & Interfaces (*See Section 2 Use Cases for full list)*:-

- •Ruggedized, anti-vandal UI, for input/output (authentication and authorization, account info', charging preferences inc. V2G, payment, info' to users). Range of access devices – RFID tokens,cards, electronic purse cards.
- •Capability to work offline
- •Dual ported comms' to both the CLO and II Tech Centres
- •Charging parameters downloaded to CP via CLO Tech Centre – inc. tariffs by time, CO2 content of charge
- •Allows selection of variables which may affect the charging transaction price, start time, completion time, duration and computes any resulting calculations needed
- •Supports other commercial services which can be hosted on the CP e.g. download and display of advertising

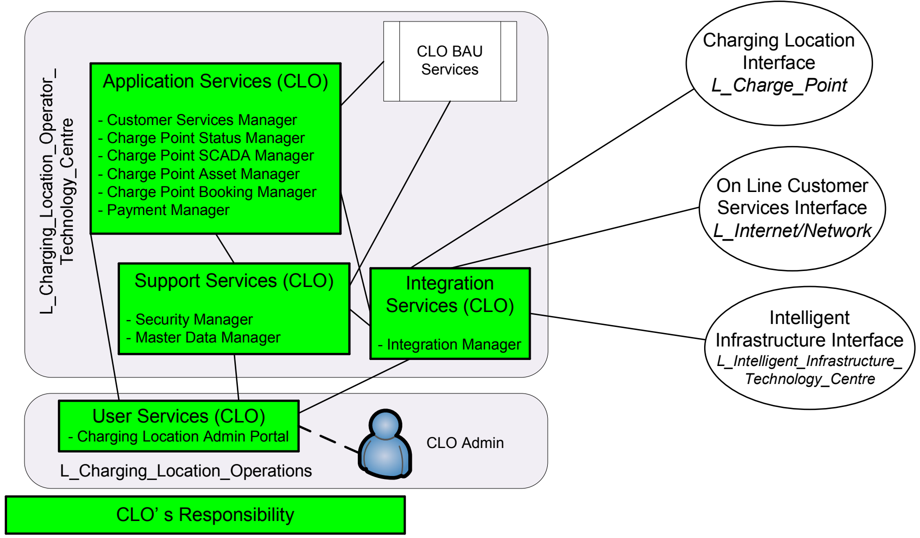
Key Assumptions, (by the Smart Phase):-

- •Commercial CPs fitted with meters for charging actual consumption
- •All commercial CP installations fitted with Smart Meters and WAN Devices
- •Demand Side Management (DSM) including EV Public/Commercial charging management is implemented through the Smart Meter
- •Local Load Monitoring and Control Units available to Charging Location Operators
- •The more sophisticated Charge Posts may provide multiple power and charging delivery options
- •*NB There are open issues relating to how the Charging Location Operators and DNOs will co-operate in the SMART phase, especially in terms of Demand Side Management*

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Conceptual Design – Charging Location Operator Components Assessment (Smart Phase)

This slide assesses the components and interfaces which the Charging Location Operator (CLO) is responsible for realizing.



L_Charging_Location_Operator_ Technology_Centre

Application Services (CLO)
- Customer Services Manager
- Charge Point Status Manager
- Charge Point SCADA Manager
- Charge Point Asset Manager
- Charge Point Booking Manager
- Payment Manager

CLO BAU Services

Support Services (CLO)
- Security Manager
- Master Data Manager

Integration Services (CLO)
- Integration Manager

Charging Location Interface
L_Charge_Point

On Line Customer Services Interface
L_Internet/Network

Intelligent Infrastructure Interface
L_Intelligent_Infrastructure_ Technology_Centre

User Services (CLO)
- Charging Location Admin Portal

CLO Admin

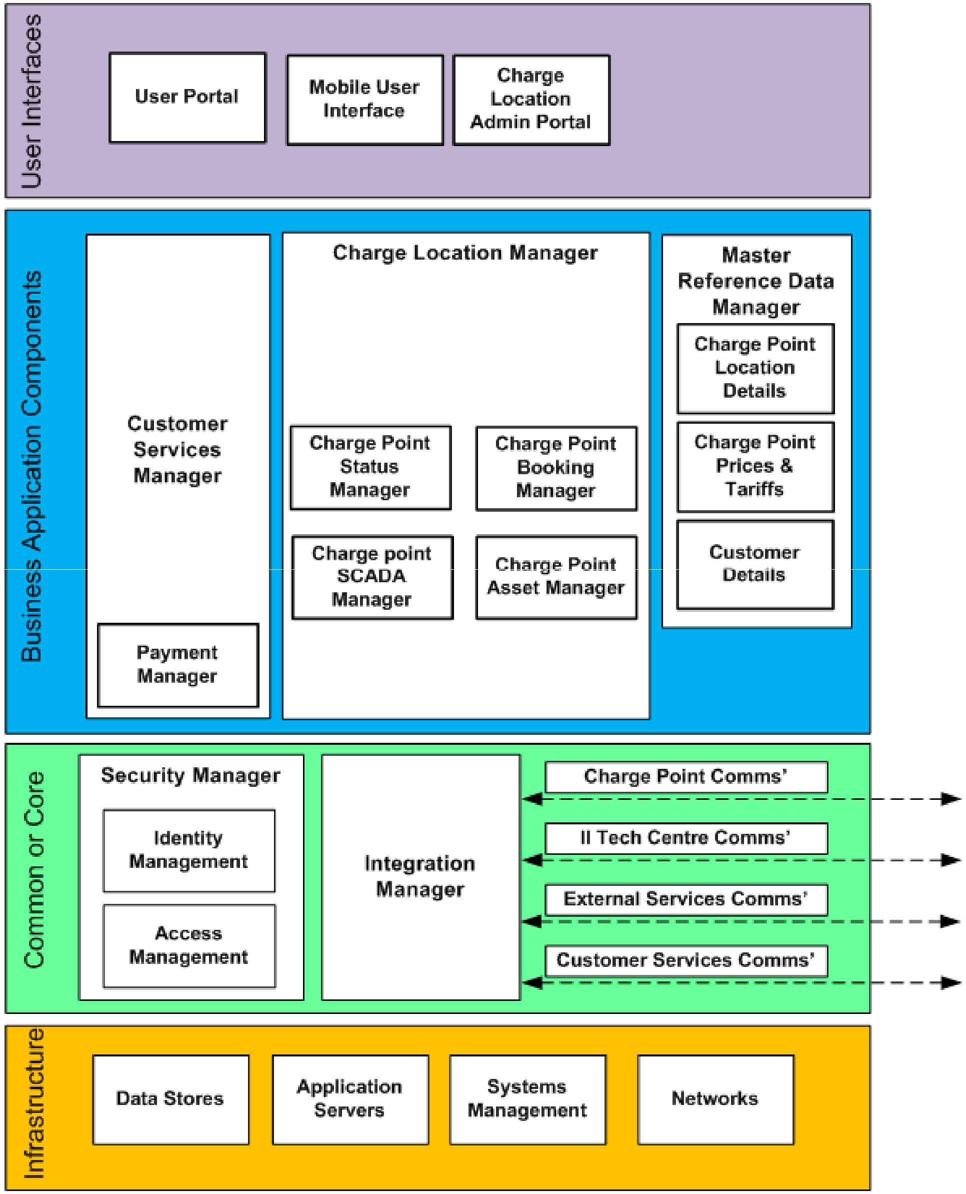
L_Charging_Location_Operations

CLO' s Responsibility

Component	Component Type	Assessment Headline
Customer Services Manager	COTS configuration – Customer Relationship Management System	Medium complexity component
Charge Point Status Manager	Bespoke build on hardware/software platform provided by another (larger) package	Simple component
Charge Point SCADA Manager	COTS configuration – Supervisory Control and Data Acquisition	Medium complexity component
Charge Point Asset Manager	COTS configuration – Asset Management System	Medium complexity component
Charge Point Booking Services	Bespoke build on hardware/software platform provided by another component	Simple component
Payment Manager	COTS configuration – Payment application	Simple component
Security Manager	Included in all of the above components	Included in all of the above components
Master Data Manager	Bespoke – modifications to existing applications.	Simple component
Integration Manager	COTS configuration of middleware package	Simple component
Charging Location Admin Portal	Bespoke – modifications to existing applications	Simple component

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Conceptual Design – Charging Location Operator Technology Centre (Smart Phase)



Key Functionality, Interfaces and Assumptions:-

- Design reflects the focus on:-
  - The ownership and management of Customers (EV Owners & Operators and Users) and the service offerings provided to them
  - The management of charging assets through SCADA and Asset Management systems
- Assumes that the Intelligent Infrastructure Operator provides some customer and asset services as a result of the need for universal services.
- …resulting in a need for some aspects of Customer and Asset data to be shared with the Intelligent Infrastructure Operator.
- Assumes that by the Smart Phase, Charging Location Operators and EV Charging Equipment Manufacturers will be separate organizations – so that a CLO will have equipment from multiple OEMs in their managed estate.

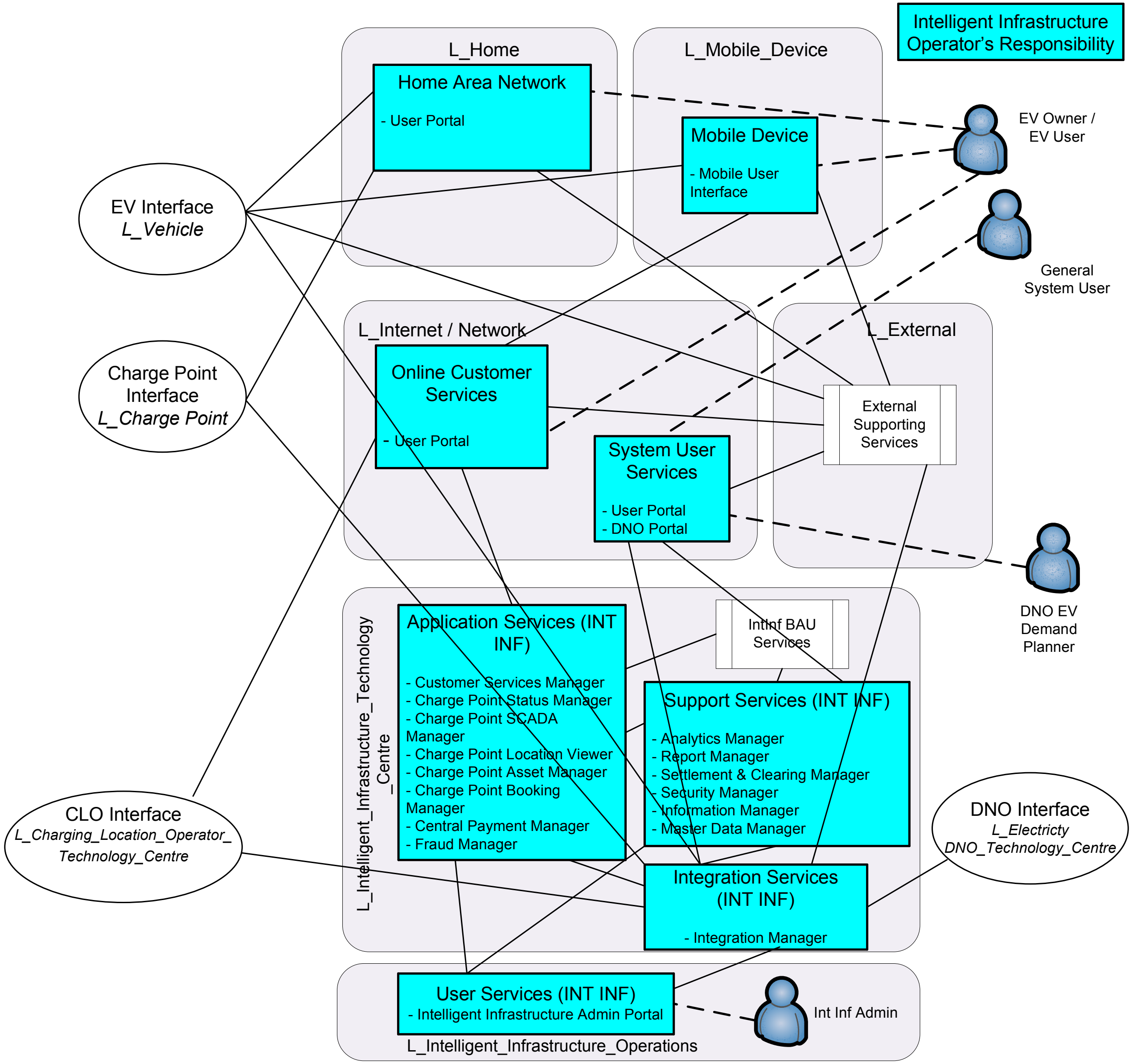
See Section 2 Use Cases for full list of functionality

This slide depicts the Charging Location Operator (CLO) Components in the physical location of CLO's Technology Centre.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Conceptual Design – Intelligent Infrastructure Operator Components Assessment (1/2) (Smart Phase)

This slide and subsequent slide assess the components and interfaces which the Intelligent Infrastructure (II) Operator is responsible for realizing.



Component Assessment Table – next slide

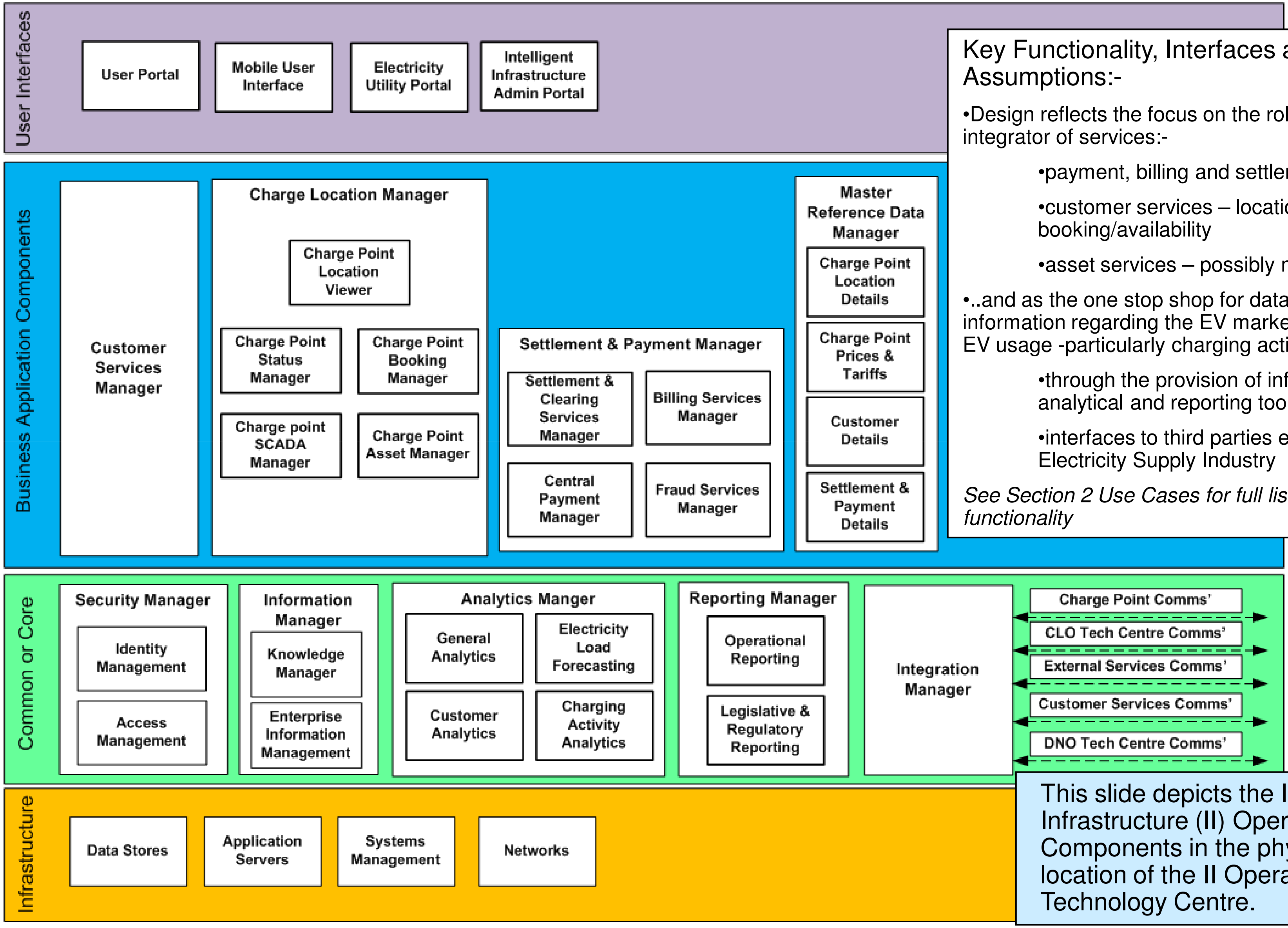
© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Conceptual Design – Intelligent Infrastructure Operator Components Assessment (2/2) (Smart Phase)

Component	Component Type	Assessment Headline
Home Area Network - User Portal	Bespoke build for Home Area Network	Medium complexity component
Mobile Device – Mobile User Interface	Bespoke build	Simple component
Internet -Online Customer Services – User Portal	Bespoke portals build	Medium complexity component
Internet – Systems User Services – User Portal	Bespoke build on existing hardware and software	Simple component
Internet - Systems User Services DNO Portal	Bespoke build on existing hardware and software	Complex component
II Tech’ Centre – Customer Services Manager	COTS config of CRM Package	Medium complexity component
II Tech’ Centre – Charge Point Status Manager	Bespoke build on hardware/software platform	Simple component
II Tech’ Centre – Charge Point SCADA Manager	COTS config of SCADA Package	Medium complexity component
II Tech’ Centre – Charge Point Location Viewer	Bespoke small application	Simple component
II Tech’ Centre – Asset Manager	COTS configuration – Asset Management System	Medium complexity component
II Tech’ Centre – Booking Manager	Bespoke build on hardware/software platform	Simple component
II Tech’ Centre – Central Pay’ Manager	COTS configuration – Pay/Bill App’ or Service	Medium complexity component
II Tech’ Centre – Billing Services Manager	COTS Billing System or Service	Medium complexity component
II Tech’ Centre – Fraud Manager	COTS Fraud application	Medium complexity
II Tech’ Centre – Analytics Manager	COTS Suite of Analytical Tools, built and configured	Complex component
II Tech’ Centre – Report Manager	COTS Reporting Package	Medium complexity component
II Tech’ Centre – Sett’ / Clearing Manager	COTS application	Medium complexity component
II Tech’ Centre – Security Manager	Included in all of the above components	Included in all of the above components
II Tech’ Centre – Info’ Manager	COTS application	Medium Complexity
II Tech’ Centre – Master Data Manager	Bespoke interfaces	Medium complexity component
II Tech’ Centre – Integration Manager	COTS configuration of middleware package	Medium Component
II Tech’ Centre – Admin’ Portal	Bespoke – modifications to existing applications	Simple component

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Conceptual Design – Intelligent Infrastructure Operator Technology Centre (Smart Phase)



User Interfaces

- User Portal
- Mobile User Interface
- Electricity Utility Portal
- Intelligent Infrastructure Admin Portal

Business Application Components

- Customer Services Manager
- Charge Location Manager
  - Charge Point Location Viewer
  - Charge Point Status Manager
  - Charge Point Booking Manager
  - Charge point SCADA Manager
  - Charge Point Asset Manager
- Settlement & Payment Manager
  - Settlement & Clearing Services Manager
  - Billing Services Manager
  - Central Payment Manager
  - Fraud Services Manager
- Master Reference Data Manager
  - Charge Point Location Details
  - Charge Point Prices & Tariffs
  - Customer Details
  - Settlement & Payment Details

Common or Core

- Security Manager
  - Identity Management
  - Access Management
- Information Manager
  - Knowledge Manager
  - Enterprise Information Management
- Analytics Manger
  - General Analytics
  - Electricity Load Forecasting
  - Customer Analytics
  - Charging Activity Analytics
- Reporting Manager
  - Operational Reporting
  - Legislative & Regulatory Reporting
- Integration Manager
  - Charge Point Comms'
  - CLO Tech Centre Comms'
  - External Services Comms'
  - Customer Services Comms'
  - DNO Tech Centre Comms'

Infrastructure

- Data Stores
- Application Servers
- Systems Management
- Networks

Key Functionality, Interfaces and Assumptions:-

•Design reflects the focus on the role as integrator of services:-

- •payment, billing and settlement
- •customer services – location search, booking/availability
- •asset services – possibly maintenance

•..and as the one stop shop for data and information regarding the EV market in terms of EV usage -particularly charging activity:-

- •through the provision of information, analytical and reporting tools,
- •interfaces to third parties especially the Electricity Supply Industry

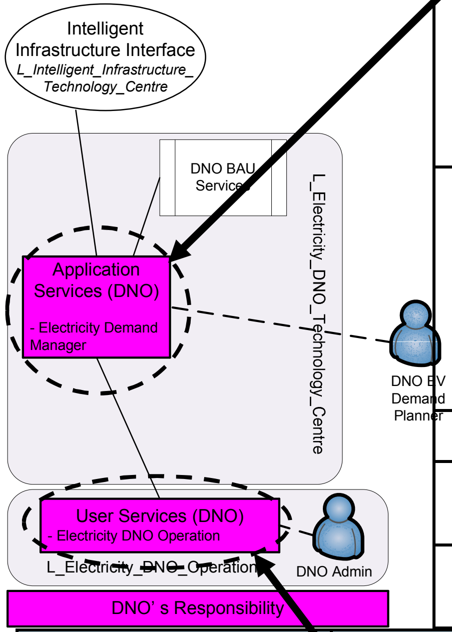
See Section 2 Use Cases for full list of functionality

This slide depicts the Intelligent Infrastructure (II) Operator Components in the physical location of the II Operator's Technology Centre.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Conceptual Design – DNO Technology Centre – Component Assessment (Smart Phase)

This slide assesses the components and interfaces which the Distribution Network Operator is responsible for realizing.



Component Name	DNO Tech' Centre – Electricity Demand Manager
Functional Description (SP2/IBM/17)	Component which supports the management of the demand and supply of electricity relating to EV charging. It provides the following functionality (1) support of constraints and rules to be factored into the use of charging locations and provision of that information to the intelligent infrastructure and external actors (e.g. electricity retailers), (2) electricity price and tariff management in relation to the provision of electricity for charging an electric vehicle or battery – (from an initial price which does not differentiate from the 'normal' price of electricity to dynamic pricing which would take into factors such as time of day, location, availability, network load, over / under supply, etc and provision of these prices to the intelligent infrastructure and external actors, e.g. electricity retailers), (3) management of prices for vehicle to grid transactions, (4) communications with DNOs and electricity retailers.
Component Interfaces	1.Upload of II-mastered data and electric vehicle charging data, which is output from the II Analytics and Report Components – from the Intelligent Infrastructure 2.Download of DNO-mastered data, prices and charging constraints to the Intelligent Infrastructure (subsequently passed to the CLO and Charge Points) 3.Download of data to other DNOs and external II actors, such as electricity retailers 4.Download of EV charging data to other BAU systems responsible for Demand-Supply balancing across the entire electricity market, and not just EVs.
Hardware	Application server and connectivity
Software	Bespoke application – likely to be developed on the existing DNO platforms alongside existing planning applications
Assessment	**Bespoke application. Built using existing hardware and software capabilities. Complex component**

Component Name	DNO Tech' Centre – Electricity DNO Operation
Functional Description (SP2/IBM/17)	The portal through which the Electricity Demand Manager component is managed by suitably authorized personnel.
Component Interfaces	Electricity Demand Manager Portal
Hardware	Assumed to be existing hardware on which these portals can reside
Software	Bespoke developed portals – assumed that many will be in existence
Assessment	**This is a bespoke component. Building on existing hardware and software capabilities This is a simple component**

© 2010 IBM Corporation

ETI EV Work Package 2.4

SP2/IBM/28 ETI EV Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks

Section 7 – Intelligent Infrastructure Realization including Budgetary Estimates

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Realization – Background and Context

- Purpose and Objective (Source: Contract)
  - Provide an order of magnitude estimate of the costs involved in implementing (designing and building) the required back office and supporting systems.
  - The cost estimate will reflect the stages of evolution of the architecture (as per description in SP2/IBM/16). There will therefore be three separate cost estimates, one for each of the stages of evolution. This will not involve solicitation of costs or proposals from any potential bidders.
- Definitions and Terminology
  - ‘Order of magnitude estimates of costs’ are, for the purposes of this deliverable labelled ‘**Budgetary Estimates**’. Budgetary Estimates are 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.
  - ‘implementing (designing and building) the required back office and supporting systems’ is for the purposes of this deliverable labelled ‘**Realization**’. 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.
- This section provides budgetary estimates for realization of the Intelligent Infrastructure in the Smart Phase of Evolution; budgetary estimates for realization in the Simple Phase are given in Appendix B and those for the Semi-Intelligent Phase are given in Appendix C.
- Although possibly viewed as somewhat back-to-front, it is the total investment which the Intelligent Infrastructure actors need to make to achieve realization which is the key question being considered at this stage of the Programme and hence why budgetary estimates for the Smart Phase are covered in this main section.
- The budgetary estimates presented in this section are:-
  - for the realization of the conceptual design presented in the previous section based on assumptions presented in the following slides

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Realization – Background and Context – Key Assumptions (1/4)

	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	Guesstimate (to provide a total market investment figure) of the number of 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.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Realization – Background and Context – Key Assumptions (2/4)

	Assumption Statement	Assumption Justification
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.	Guesstimate - 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.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Realization – Background and Context – Key Assumptions (3/4)

	Assumption Statement	Assumption Justification
Charging Location Operators	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	Guesstimate 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	Guesstimate to provide a rough dimension of the maintenance activity a Charging Location Operator may experience- (*possibly high but recognizes immaturity of the technology*)

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Realization – Background and Context – Key Assumptions (4/4)

	Assumption Statement	Assumption Justification
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.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Realization – Budgetary Estimates for Realization in the Smart Phase - Summary

Electric Vehicle OEM

Electric Vehicle OEM

Electric Vehicle OEM	
Budgetary Estimate Range	£5m - £8m
Estimate Confidence Level	🔴

12 EV OEMs
Total Market Investment - £60m - £100m
(Global Investment)

6 CLOs
Total Market Investment - £60m - £120m

Charging Location Operator

Charging Location Operator	
Budgetary Estimate Range	£10m - £20m
Estimate Confidence Level	🟡

Total Market Investment in the range £200m - £400m (excluding EV OEMs)

Charge Point & Infrastructure OEM

Charge Point & Infrastructure OEM

Charge Point & Infrastructure OEM	
Budgetary Estimate Range	£5m - £10m
Estimate Confidence Level	🟡

10 CP OEMs
Total Market Investment - £50m - £100m

Intelligent Infrastructure Operator	
Budgetary Estimate Range	£25m - £50m
Estimate Confidence Level	🟡

14 DNO Regions
Total Market Investment - £60m - £120m

DNO

DNO

DNO	
Budgetary Estimate Range	£4m - £8m
Estimate Confidence Level	🔴

🟢 High Confidence - probability of actual cost lying within range > 90%

🟡 Medium Confidence - probability of actual cost lying within range > 70%

🔴 Low Confidence - probability of actual cost lying within range > 40%

© 2010 IBM Corporation

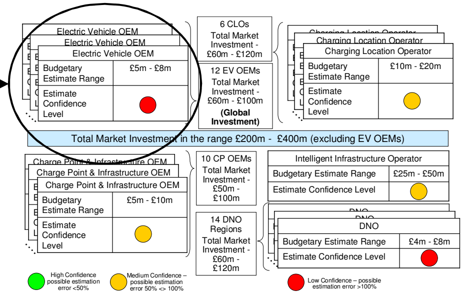
EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Realization – Budgetary Estimates Commentary

- The Budgetary Estimates have been developed:-
  - ‘bottom-up’, estimating the cost of development for each component plus overheads, and,
  - ‘top-down’, considering the overall functionality required, the size of the task and comparing these against existing developments and implementations – please see the following slides
- The Budgetary Estimates constitute up-front investment required by each actor and do not include Run and Maintain Costs and do not include any Technology Refresh Costs.
- The time frame over which the investment is required will vary depending on actor, but the following comments apply :-
  - The Smart Phase is assumed to start around 2016, but much of the investment is required for the Semi-Intelligent Phase which is assumed to start around 2013 – i.e. investment by individual actors could start anywhere between 2013 and 2016
  - The Electric Vehicle OEM and Charge Point & Infrastructure OEM investments are estimated to be over an 18 month to 2 year period – see below
  - The Charging Location Operator and Intelligent Infrastructure Operator investments are estimated to be over a 2 to 3 year period – see below
  - The DNO investment is estimated to be over 18 month to 3 year period – see below.
- Confidence levels for the heavily bespoke developments of the EV OEM and the DNO are ‘low’ as bespoke development is the riskiest type of activity to estimate. Also crucially these developments are heavily dependent on existing facilities and expertise – it is outside the remit of this deliverable to know what the capabilities of these actors are at this stage of the Programme.
- Confidence levels for the CP & Infrastructure OEM developments are set as medium – as the developments are believed to be based on standard commercially available operating systems and components, and OEMs are believed to have appropriate existing facilities and expertise.
- Likewise confidence levels for the CLO and II Operator developments are set as medium – these businesses require standard components, but the major unknown here is the extent to which these businesses will have existing components which can be re-used and extended.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Realization – Budgetary Estimates for Realization of EV OEM Components (Smart Phase)

Basis of the £5m - £8m Range Estimate for each Electric Vehicle OEM



Basis of Budgetary Estimates

Bottom Up Estimation:-

- Bespoke Development of Components-
  - EV User Interface - Complex
  - EV Config' & State Manager- Medium
  - EV Comms' Controller - Medium
  - An 18 month to 2 year Programme. Skills required - (1) in-car systems development, (2) EV diagnostics, (3) EV battery control systems, (4) communications, plus (5) requirements analysis/testing including extensive integration testing with external capabilities, (6) project and programme management. Assume 4 personnel in each skill area for the life of the Programme. So 18 months x 24 people > 400 man months

Top-Down Estimation:-

- Similar developments of embedded systems.

Sense Checking of the Budgetary Estimates

Cost of Development:-

- Assumed that these developments are global investments and that costs of £8m can be recouped over global sales.

Sensitivity of the Estimates:-

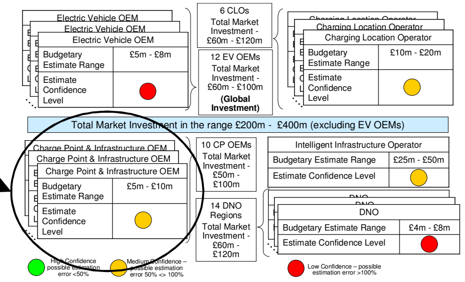
- OEMs will have their own development plans which may already include some of these components – may reduce budgetary estimates
- The estimates assume existing platforms which these components can be added to – non-existent or radically different then the estimates will rise
- The estimates assume existing development facilities and resources – non-existent or radically different then the estimates will rise

Budgetary estimates have been developed 'bottom-up' estimating the cost of development for each component plus overheads, and 'top-down' – considering the overall functionality required, the size of the task and comparing these against existing developments and implementations

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Realization – Budgetary Estimates for Realization of Charge Point OEM Components (Smart Phase)

Basis of the £5m - £10m Range Estimate for each Charge Point & Infrastructure OEM



Basis of Budgetary Estimates

Bottom Up Estimation:-

- Bespoke Development of Components-
  - User Interface - Complex
  - SCADA Manager - Complex
  - Charge Params' Manager - Complex
  - Charging Activity Manager - Medium
  - Offline Services - Medium
  - Comms' Manager - Medium
  - An 18 month to 2 year Programme. Skills required - (1) charge post hardware/ firmware/ software integration, (2) charge post application development, (3) charge post communications development, (4) requirements analysis/testing esp. integration testing with external capabilities, (5) project and programme management. Assume 3 personnel in each skill area for the life of the Programme. So 18 months x 15 people = 270 man months

Top-Down Estimation:-

- Similar developments of standalone, remotely deployed assets

Sense Checking of the Budgetary Estimates

Cost of Development:-

- Each OEM sells 60,000 units (30,000 non-domestic, 30,000 domestic (with intelligence))
- Development costs of £10m means £300 added to the cost of each post (plus cost of additional hardware components etc.) to recoup
- Also costs can be spread internationally, assuming international standards and a large proportion of the component (>90%) is compatible – costs to recoup would then be around £30.

Sensitivity of the Estimates:-

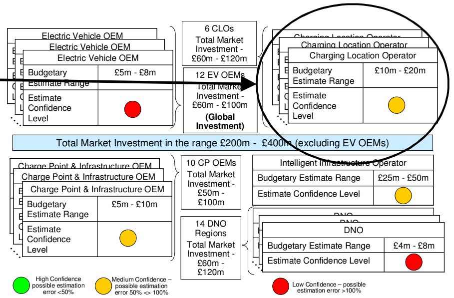
- OEMs will have their own development plans which may already include some of these components – may reduce budgetary estimates
- The estimates assume existing platforms which these components can be added to – non-existent or radically different technology, then the estimates will rise
- The estimates assume existing development facilities and resources – non-existent or radically different then the estimates will rise

Budgetary estimates have been developed 'bottom-up' estimating the cost of development for each component plus overheads, and 'top-down' – considering the overall functionality required, the size of the task and comparing these against existing developments and implementations

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Realization – Budgetary Estimates for Realization of Charging Location Operator Components (Smart Phase)

Basis of the £10m - £20m Range Estimate for each Charging Location Operator



Basis of Budgetary Estimates

Bottom Up Estimation:-

- Bespoke Development / Implementation of COTS Components-
  - Customer Services Manager (CRM) - Complex (£4m-£8m)
  - CP Status Manager - Complex (inc in SCADA)
  - CP SCADA Manager - Complex (£2m-£4m)
  - CP Asset Manager - Medium (£3m-£6m)
  - CP Booking Services - Medium (inc in CRM)
  - Payment Manager - Medium (inc in CRM)
  - Security/MDM/Integration/Admin - Medium (£1m-£2m)
  - A 2 to 3 year programme of projects.

Top-Down Estimation:-

- Various implementations of CRM/Asset Management/Monitoring in Medium Sized businesses (DNOs, Telecomm' Startups) used as comparators

Sense Checking

Cost of Development:-

- Each CLO has 200,000 customers, there are 6 CLOs operating in 2020
- Development costs of £20m means £100 per customer to be recovered to recoup investment

Sensitivity of the Estimates:-

- ***These estimates assume that the IT build is from scratch. CLOs may be built on existing businesses and capability and hence estimates would reduce – potentially by a large proportion***
- ***Consolidation to fewer than 6 CLOs would reduce the overall cost***
- ***Centralization of functionality to the Intelligent Infrastructure Operator would also reduce cost***

Observations:-

- Further economic evaluation required – are 6 full-blown implementations economic (without, either heavy use of existing facilities or central consolidation)?

Budgetary estimates have been developed 'bottom-up' estimating the cost of development for each component plus overheads, and 'top-down' – considering the overall functionality required, the size of the task and comparing these against existing developments and implementations

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Realization – Budgetary Estimates for Realization of Intelligent Infrastructure Operator Components (Smart Phase)

Basis of the £25m - £50m Range Estimate for the Intelligent Infrastructure Operator

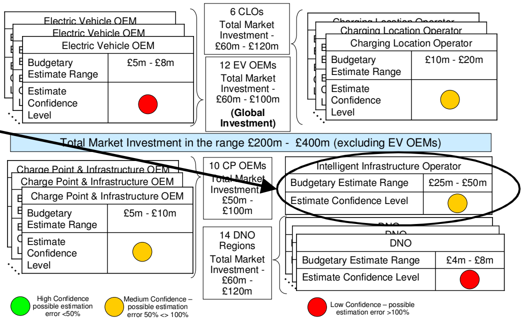
Basis of Budgetary Estimates

Bottom Up Estimation:-

- Bespoke Development / Implementation of COTS Components-
  - Portals - Complex (£2m-£3m)
  - Customer Services Manager - Complex (£4m-£8m)
  - CP Status Manager - Complex (£3m-£7m, includes SCADA, Asset. Bookings Manager)
  - CP SCADA Manager - Complex (inc above)
  - CP Asset Manager - Medium (inc above)
  - CP Booking Services - Medium (inc above)
  - Analytics/Reporting - Complex (£3-£6m)
  - Setttlement Manager - Complex (£10m-£20m)
  - Security/MDM/Integration/Admin - Medium (£3m-£6m)
  - A 2 to 3 year programme of projects

Top-Down Estimation:-

- Various implementations of CRM/Asset Management/Integration/Analytics in national and multi-national businesses used as comparators



Sense Checking

Cost of Development:-

- One Intelligent Infrastructure Operator processing 250m transactions annually
- Development costs of £50m – 20p added to each transaction over 1 year, or 10p added to each transaction over 2 years, or 4p added to each transaction over 5 years to recoup investment.

Sensitivity of the Estimates:-

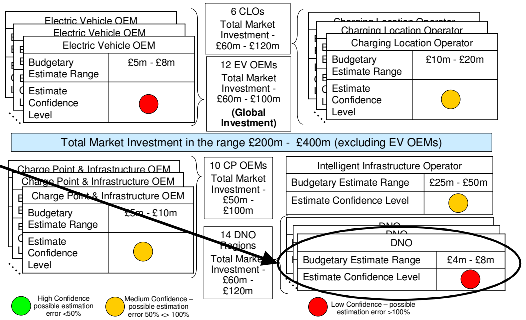
- ***Assumes that the IT build is from scratch. Intelligent Infrastructure Operator Functionality may be built on existing business and capability and hence estimates would reduce.***

Budgetary estimates have been developed ‘bottom-up’ estimating the cost of development for each component plus overheads, and ‘top-down’ – considering the overall functionality required, the size of the task and comparing these against existing developments and implementations

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Realization – Budgetary Estimates for Realization of DNO Components (Smart Phase)

Basis of the £4m - £8m Range Estimate for each Distribution Network Operator



Basis of Budgetary Estimates

Bottom Up Estimation:-

- Bespoke Development of Components-
  - Electricity Demand Manager - Complex
  - Electricity Demand Manager Portal - Complex
  - An 18 – 36 month Project. Team of 12 people >200 man months

Top-Down Estimation:-

- Various bespoke developments of large mission critical/analytical/forecasting applications

Sense Checking

Cost of Development:-

- £4m - £8m recovered by each DNO regional operator in their price review and statutory charges

Sensitivity of the Estimates:-

- Dependent on complexity of functionality
- Dependent on complexity of integration with existing DNO applications

Observations:-

- Needs more design work

Budgetary estimates have been developed ‘bottom-up’ estimating the cost of development for each component plus overheads, and ‘top-down’ – considering the overall functionality required, the size of the task and comparing these against existing developments and implementations

© 2010 IBM Corporation

ETI EV Work Package 2.4

SP2/IBM/28 ETI EV Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks

Section 8 – Risk Analysis

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Risks Analysis – Purpose and Objectives

- Purpose (Source: Contract)
  - 2-4.1 Consider the issues associated with access to, security and protection of data within a future network based heavily on communications.
  - 2-4.2 Consider the potential for disruption caused by intelligent systems and how failsafe provisions can be made
- Objectives (Source: Contract)
  - Security Weaknesses - Identification and assessment of security weaknesses in the proposed infrastructure architecture from all actors perspective.
  - Operational Risks - Identification and assessment of operational risks.
  - Points of Failure - Identification and assessment of points of failure
  - Recommendations - Recommendations as to the areas and levels of risk mitigations / avoidance and safety / security to be pursued for further analysis and design in the Stage 2 activities.
- The Risk Analysis will cover the above requirements and is broken down into three parts, namely:-
  - Risks envisaged prior to realization of the Intelligent Infrastructure
  - Risks envisaged during realization of the Intelligent Infrastructure
  - Risks envisaged post-deployment of the Intelligent Infrastructure

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Risks Analysis – Prior to Intelligent Infrastructure Realization

Period and Assumptions

This risk analysis covers the **key** risks envisaged during the period from the present up to the start of realization of the Intelligent Infrastructure. The analysis assumes EV market growth and development of the market through the evolutionary phases as presented in previous sections

Key Risks

- The Intelligent Infrastructure is not realized at all – in Simple, Semi-Intelligent or Smart forms
- The Intelligent Infrastructure is only partly realized
- The intelligent Infrastructure is realized too late to make a positive impact on the development of the mass market

Impacts of Key Risks

- The market develops in a fragmented way – islands of infrastructure develop along both geographic lines and between individual groups of actors constraining the development of the market and adding time and cost to realization
- Universal standards for information and data exchange are not developed, resulting in competing technologies and incompatibilities for the EV market actors
- The Electricity Industry Supply Chain actors are forced into more extensive network reinforcement than would otherwise be necessary if were supported by an Intelligent Infrastructure
- The Electricity Supply Chain actors do not have access to market consolidated data and information regarding EV usage – relying on information coming from the islands of infrastructure
- Overall - the potential for the Intelligent Infrastructure to facilitate the development of a mass market is lost and the market is constrained by the lack of universal standards, universal services and market consolidated data and information.

Mitigating Actions

- **Further business case analysis** - for the development of the Intelligent Infrastructure functionality highlighting which actors groups benefit from which functionalities and therefore suggesting ownerships for realization
- **Trial functionalities** - of the Intelligent Infrastructure early to establish their potential impact on the development of a mass market
- **Establish leadership** – governmental/regulated/market driven – for the development of the Intelligent Infrastructure and in particular to drive the development and adoption of universal standards to reduce the probability of discrete islands of infrastructure

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Risks Analysis – During Intelligent Infrastructure Realization

Period and Assumptions

This risk analysis covers the **key** risks envisaged during the period of realization of the Intelligent Infrastructure (covers all phases of evolution – Simple, Semi-Intelligent, Smart)

Key Risks

- Lack of agreement on the definition, development and implementation of standards for data and information exchange
- Lack of effective prioritization of Intelligent Infrastructure functionality for development and implementation
- Lack of coordination and control of federated actors / groups of actors each developing pieces of the Intelligent Infrastructure

Impacts of Key Risks

- Timescales and costs are extended for realization – actors go off and do their 'own thing' in order to meet timescales to protect commercial investments and commitments – risks in the pre-realization phases (see above) then apply.
- Realization time, money and effort are spent on developing functionalities of lower priority, again risks that actors will go off and do their own thing in order to fill urgent requirements – which potentially need to be replaced at some point in the future

Mitigating Actions

- **Establish leadership** – for controlling the development of the data and information exchange standards and overseeing adherence, and for coordinating and controlling development of the Intelligent Infrastructure
- **Communication** – set up new, or use existing, (for example, EV OEM developments controlled by the SAE, DNO developments controlled by the ENA) bodies through which the development of the Intelligent Infrastructure can be coordinated.
- **Prioritization** – through leadership and communication establish clear priorities and timescales for different aspects of Intelligent Infrastructure Functionality.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Risks Analysis – Post Intelligent Infrastructure Realization

Period and Assumptions

This risk analysis covers the **key** risks envisaged after the Intelligent Infrastructure has been deployed.

Key Risks

- Security risks – the loss of **integrity** – improper modification of data and information held within the Intelligent Infrastructure, the loss of **confidentiality** – improper access to data and information held within the Intelligent Infrastructure
- Risks re points of failure – the loss of **availability** of the Intelligent Infrastructure to actors
- Operational risks – emanating from the day-to-day provision of the Intelligent Infrastructure across a widely distributed network of devices, components and locations

Impacts of Key Risks

Security – the Intelligent Infrastructure holds data about Individuals & Organizations, Customers/Users/Vehicles, Charging Assets, Charging Activities, Electricity Demand, and Payments & Settlement (see SP2/IBM/18 for further details). Loss of integrity or confidentiality to this data may result in impacts such as damage to the revenues of the Charging Location Operators/Electricity Retailers, use of personal and vehicle data in acts of fraud, use of confidential charging location data for commercial espionage and anti-competitive acts.

Points of failure – examples include (i) failure of the comms' between the Charging Post and the Charging Location Operator/Intelligent Infrastructure Operator rendering the post unusable with loss of revenue, (ii) failure of the Payment, Billing and Settlement component again resulting in loss of revenue, (iii) failure of information services to customers resulting in wasted journeys/user anxiety.

Operational Risks – failures in management and operational processes may result in limited services being provided with the impact to actors being increased cost, loss of revenue or poor customer experience. A critical example might be the failure of operational processes to notify EV users of electricity capacity and availability problems in a certain area and the need for them to be redirected elsewhere to charge

Mitigating Actions

The Intelligent Infrastructure is ***an*** example of a system of a widely distributed network of devices, components and locations - of which there are several examples in existence in the Finance, Telecommunications and Transport industries. With the increased size and sophistication of such systems and particularly driven by the widespread use of the Internet, the IT industry has developed tools and methodologies for the management of risks and the development of risk mitigation strategies – either built into the design of the system components itself or by use of additional functionality (e.g. Fraud Management component in the Intelligent Infrastructure Operator Technology Centre) or through business process design. These industry-standard approaches must be used during the realization and post realization of the Intelligent Infrastructure. There are components of the Intelligent Infrastructure which will fail from time-to-time and a full analysis of the effect of a component failing should be undertaken during detailed design so appropriate and effective mitigation strategies can be devised.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Risks Analysis – Key Messages and Conclusions

- The most significant area of risk is to the *realization itself* of the Intelligent Infrastructure – the risk here is whether the Intelligent Infrastructure will:-
  - be built at all
  - be built, but only with limited functionalities
  - be built but too late to make the sort of impact in terms of efficiency and effectiveness it could.
- The risk is mitigated by three sets of actions:-
  - undertake further business case analysis which can clearly demonstrate the benefits of the Intelligent Infrastructure to actors
  - trial critical Intelligent Infrastructure functionalities, (as specified in SP2/IBM/20), and feedback into the design and the business case
  - establish leadership for developing the Intelligent Infrastructure
- The second most significant area of risk is the definition, development and implementation of standards for the exchange of data and information between components of the Intelligent Infrastructure which will be built by numerous Intelligent Infrastructure actors at different points in time.
- This risk is mitigated by the creation of an organization or use of an existing organization with the responsibility and appropriate powers to define and implement standards.
- The building of an Intelligent Infrastructure will be achieved through a set of activities with inherent risks due to the size, complexity and number of actors involved. The mitigation here is risk management methodologies and tools, and ensuring that the detailed design takes account of mitigation strategies (for example built-in redundancy of critical components).
- Finally the built system may be subject to many operational risks in the form of security attacks, failure of operational processes, human error and many more. The mitigation here is through the use of methodologies and tools as described above.

© 2010 IBM Corporation

ETI EV Work Package 2.4

SP2/IBM/28 ETI EV Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks

Appendix A – Conceptual Design Detail

Details are to be found in the embedded document:-

Microsoft Word Document

© 2010 IBM Corporation

ETI EV Work Package 2.4

SP2/IBM/28 ETI EV Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks

Appendix B – Budgetary Estimates for the Simple Evolutionary Phase

© 2010 IBM Corporation

Appendix B - Budgetary Estimates for the Simple Evolutionary Phase

- SP2/IBM/16 defines the requirements (in terms of use cases) for this phase. The scope which defines the investment required in this phase is captured in the following table:-

Actor	Component	Component Type	Assessment Headline
Electric Vehicle OEM	None in this phase	None in this phase	None in this phase
Charge Point OEM	SCADA Manager	COTS Configuration	Simple Component
Charge Point OEM	Comms' Controller	COTS Configuration	Simple Component
Charging Location Operator	Customer Services Manager	COTS configuration – Customer Relationship Management System	Medium complexity component
Charging Location Operator	Charge Point Status Manager	Bespoke build on hardware/software platform provided by another (larger) package	Simple component
Charging Location Operator	Charge Point SCADA Manager	COTS configuration – Supervisory Control and Data Acquisition	Simple component
Charging Location Operator	Charge Point Asset Manager	COTS configuration – Asset Management System	Simple component
Charging Location Operator	Payment Manager	COTS configuration – Payment application	Simple component
Intelligent Infrastructure Operator	None in this phase		

- Budgetary estimates for total market investment for this phase is:-

Actor	Investment and Commentary
Electric Vehicle OEM	£0
Charge Point OEM	£50k - £100k per OEM. Assuming 10 OEMs, investment in the range £0.5m - £1m
Charging Location Operator	£1m - £2m. Assuming 6 CLOs, investment in the range £6m - £12m
Intelligent Infrastructure Operator	£0
Total Market Investment Range – Simple Phase	**<£15m**

© 2010 IBM Corporation

ETI EV Work Package 2.4

SP2/IBM/28 ETI EV Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks

Appendix C – Budgetary Estimates for the Semi-Intelligent Evolutionary Phase

© 2010 IBM Corporation

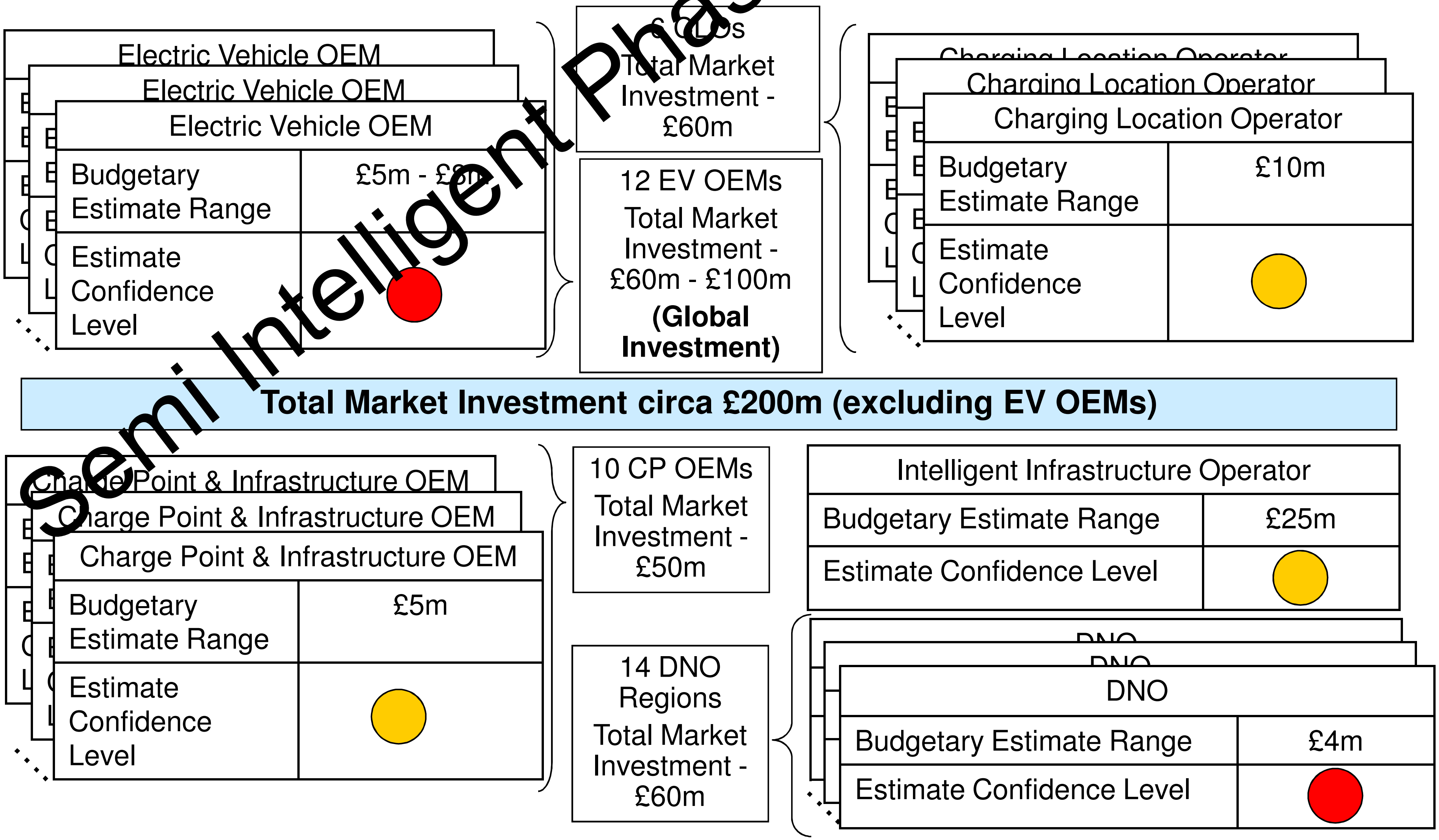
Appendix C – Budgetary Estimates for the Semi-Intelligent Evolutionary Phase

- SP2/IBM/16 captures the requirements (in terms of use cases) for this evolutionary phase.
- Differences to the Smart Phase which affect budgetary estimates are:-
  - When compared to the requirements of the Smart Phase (total 36 Use Cases) , the requirements of the Semi Intelligent Phase are reduced by omission of the following 4 Use Cases:-
    - Charging Location Management/Charging Activity Management/Domestic Charging/Smart Charging – Centrally Controlled
    - Charging Location Management/Charging Activity Management/Non-Domestic Charging/Smart Charging – Centrally Controlled
    - Charging Location Management/Charging Activity Management/Vehicle to Grid
    - Pricing & Billing Management/Pricing and Tariff Management (Dynamic)
  - The Semi-Intelligent Phase has therefore been specified to cover all the elements of requirements in the Smart Phase with the exception of those that depend on Smart Grid or Smart Meter technology deployments. It is acknowledged that some functionality may not be developed to the full – meaning that budgetary estimates are at the lower end, or even below, those for comparable Smart developments
  - Semi-Intelligent and Smart Phases will also, by definition, differ in non-functional requirements – fewer EVs, EV owners, Charge Points, Charging Transactions etc.
- It is assumed that investments made by market actors will be made on the basis of strategic (long term) forecasts – we can envisage no scenario where an actor would make investments in certain systems for the Semi-intelligent Phase and then make further re-investments in radically different technologies for the Smart phase (other than to meet increasing non-functional requirements and add some additional functionality).
- Conclusions:-
  - Therefore budgetary estimates for this phase will be similar to those made for the Smart Phase – very likely to be at the lower end of the range / possibly lower to reflect the reduced non-functional requirements see next slide.
  - Market actors need to make investments for the Smart Phase at the start of the semi-intelligent phase

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Intelligent Infrastructure Realization – Budgetary Estimates for Realization in the Semi Intelligent Phase - Summary

Semi Intelligent Phase



Electric Vehicle OEM	
Budgetary Estimate Range	£5m - £8m
Estimate Confidence Level	🔴

12 EV OEMs
Total Market Investment - £60m - £100m
(Global Investment)

6 CLOs
Total Market Investment - £60m

Charging Location Operator	
Budgetary Estimate Range	£10m
Estimate Confidence Level	🟡

Total Market Investment circa £200m (excluding EV OEMs)

Charge Point & Infrastructure OEM	
Budgetary Estimate Range	£5m
Estimate Confidence Level	🟡

10 CP OEMs
Total Market Investment - £50m

Intelligent Infrastructure Operator	
Budgetary Estimate Range	£25m
Estimate Confidence Level	🟡

14 DNO Regions
Total Market Investment - £60m

DNO	
Budgetary Estimate Range	£4m
Estimate Confidence Level	🔴

🟢	High Confidence possible estimation error <50%
🟡	Medium Confidence – possible estimation error 50% <> 100%
🔴	Low Confidence – possible estimation error >100%

© 2010 IBM Corporation

ETI EV Work Package 2.4

SP2/IBM/28 ETI EV Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks

Appendix D – Requirements Recap - High Level Use Cases

The Use Cases contained in the Appendix are reproduced (in condensed form) from SP2/IBM/14 – Intelligent Architecture Requirements Report – and act as a baseline set of requirements for the Intelligent Infrastructure Conceptual Design described above.

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap - Customer Management/Account & Contact Management (see SP2/IBM/14 for details)

Vehicle User

Account Management

- request account
- create account
- find account
- view account
- amend account details
- close account

Vehicle Owner

Account Management

- request account
- create account
- find account
- view account
- amend account details
- close account

Charging Location Operator

Account Management

- create account
- find account
- view account
- amend account details
- merge account
- suspend account
- close account

Electricity Retailer (relates to wholesale customer account)

Account Management

- create account
- find account
- view account
- amend account details
- merge account
- suspend account
- close account

EV Electricity Retailer

Account Management

- create account
- find account
- view account
- amend account details
- merge account
- suspend account
- close account

Intelligent Infrastructure Admin

Account Management

- create account
- find account
- view account
- amend account details
- merge account
- suspend account
- close account

Vehicle User

Contact Management

- request information
- make complaint
- provide feedback

Vehicle Owner

Contact Management

- request information
- make complaint
- provide feedback

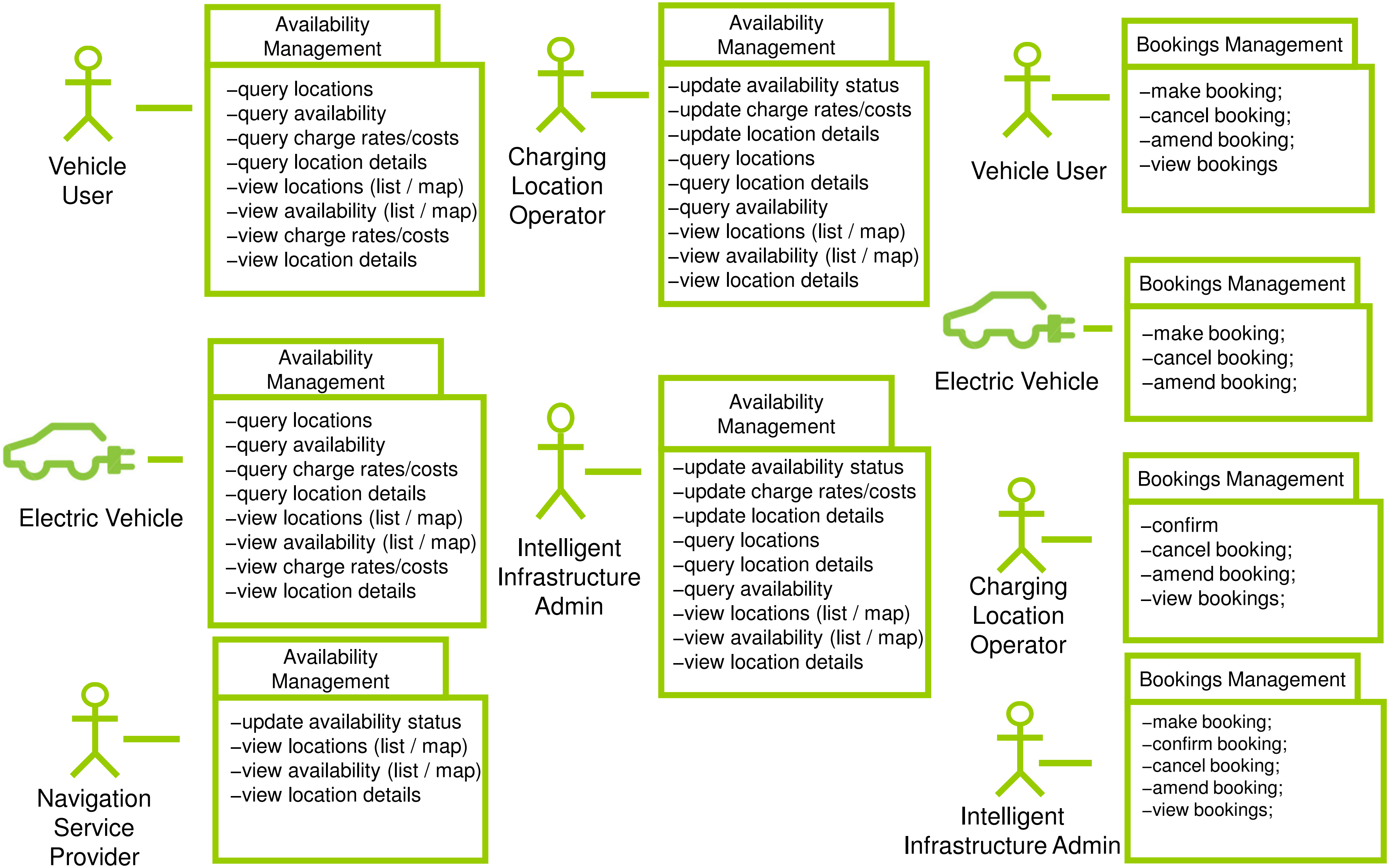
Intelligent Infrastructure Admin

Contact Management

- generate outbound contact
- receive inbound contact
- manage documents
- fulfil information request
- manage complaint
- provide feedback
- manage contact history

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap - Charging Loc’n Management/Availability & Bookings Management (see SP2/IBM/14 for details)



Vehicle User

Availability Management

- –query locations
- –query availability
- –query charge rates/costs
- –query location details
- –view locations (list / map)
- –view availability (list / map)
- –view charge rates/costs
- –view location details

Charging Location Operator

Availability Management

- –update availability status
- –update charge rates/costs
- –update location details
- –query locations
- –query location details
- –query availability
- –view locations (list / map)
- –view availability (list / map)
- –view location details

Vehicle User

Bookings Management

- –make booking;
- –cancel booking;
- –amend booking;
- –view bookings

Electric Vehicle

Availability Management

- –query locations
- –query availability
- –query charge rates/costs
- –query location details
- –view locations (list / map)
- –view availability (list / map)
- –view charge rates/costs
- –view location details

Intelligent Infrastructure Admin

Availability Management

- –update availability status
- –update charge rates/costs
- –update location details
- –query locations
- –query location details
- –query availability
- –view locations (list / map)
- –view availability (list / map)
- –view location details

Electric Vehicle

Bookings Management

- –make booking;
- –cancel booking;
- –amend booking;

Charging Location Operator

Bookings Management

- –confirm
- –cancel booking;
- –amend booking;
- –view bookings;

Navigation Service Provider

Availability Management

- –update availability status
- –view locations (list / map)
- –view availability (list / map)
- –view location details

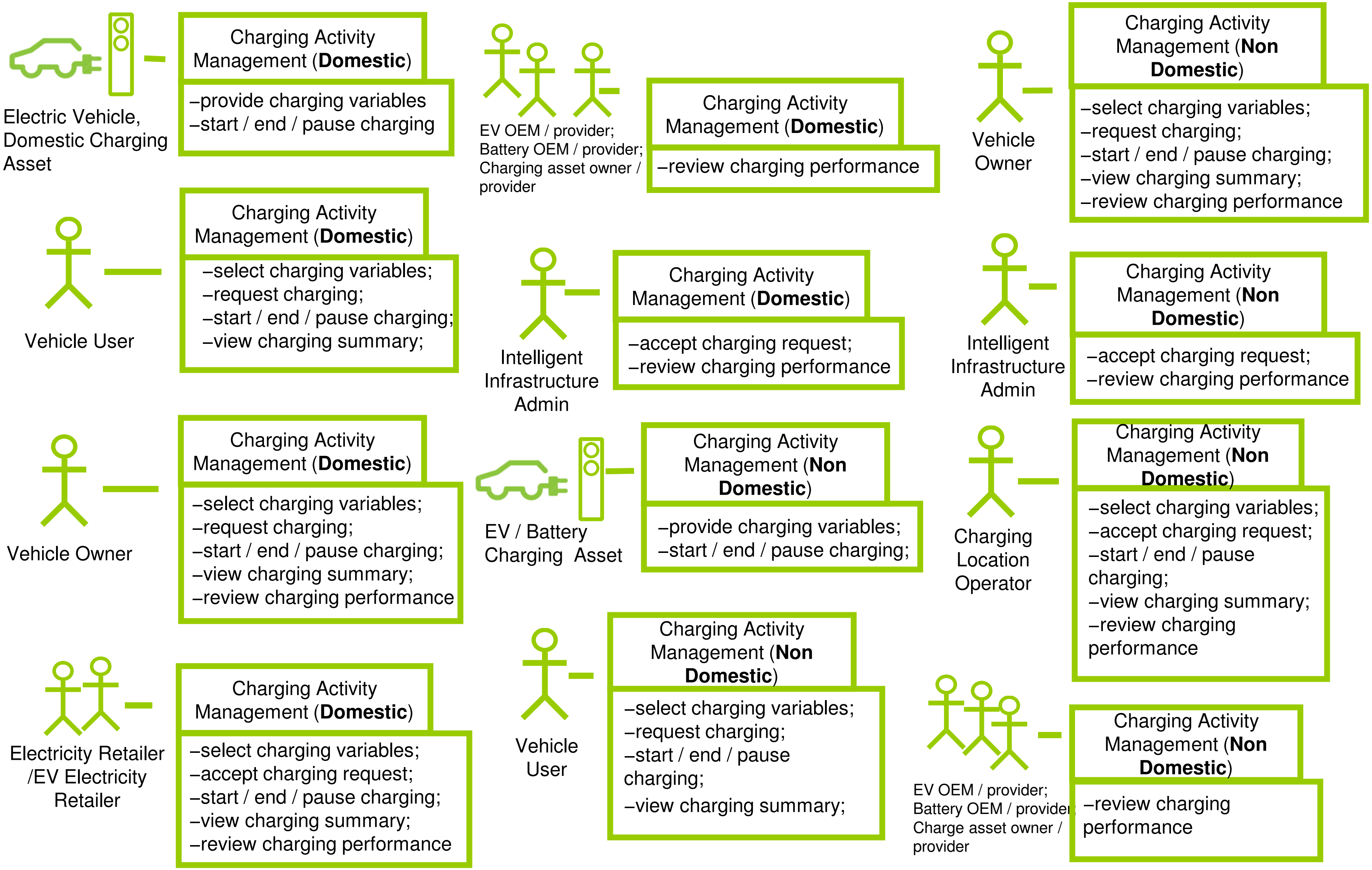
Intelligent Infrastructure Admin

Bookings Management

- –make booking;
- –confirm booking;
- –cancel booking;
- –amend booking;
- –view bookings;

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap - Charging Location Management/Charging Activity Management (see SP2/IBM/14 for details)



Electric Vehicle, Domestic Charging Asset

Charging Activity Management (**Domestic**)
- provide charging variables
- start / end / pause charging

Vehicle User

Charging Activity Management (**Domestic**)
- select charging variables;
- request charging;
- start / end / pause charging;
- view charging summary;

Vehicle Owner

Charging Activity Management (**Domestic**)
- select charging variables;
- request charging;
- start / end / pause charging;
- view charging summary;
- review charging performance

Electricity Retailer /EV Electricity Retailer

Charging Activity Management (**Domestic**)
- select charging variables;
- accept charging request;
- start / end / pause charging;
- view charging summary;
- review charging performance

EV OEM / provider; Battery OEM / provider; Charging asset owner / provider

Charging Activity Management (**Domestic**)
- review charging performance

Intelligent Infrastructure Admin

Charging Activity Management (**Domestic**)
- accept charging request;
- review charging performance

EV / Battery Charging Asset

Charging Activity Management (**Non Domestic**)
- provide charging variables;
- start / end / pause charging;

Vehicle User

Charging Activity Management (**Non Domestic**)
- select charging variables;
- request charging;
- start / end / pause charging;
- view charging summary;

Vehicle Owner

Charging Activity Management (**Non Domestic**)
- select charging variables;
- request charging;
- start / end / pause charging;
- view charging summary;
- review charging performance

Intelligent Infrastructure Admin

Charging Activity Management (**Non Domestic**)
- accept charging request;
- review charging performance

Charging Location Operator

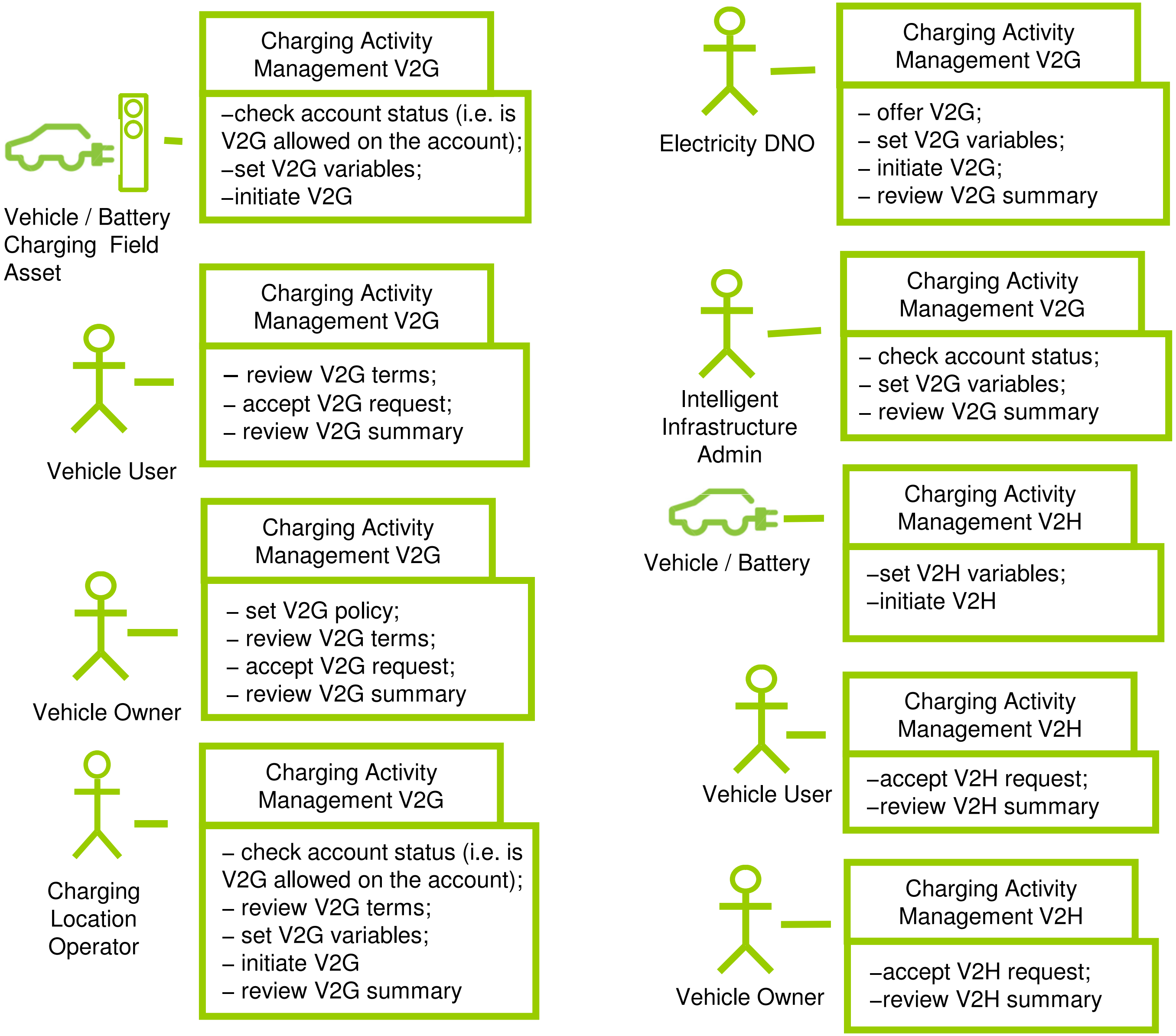
Charging Activity Management (**Non Domestic**)
- select charging variables;
- accept charging request;
- start / end / pause charging;
- view charging summary;
- review charging performance

EV OEM / provider; Battery OEM / provider; Charge asset owner / provider

Charging Activity Management (**Non Domestic**)
- review charging performance

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap - Charging Location Management/Charging Activity Management/V2G & V2H (see SP2/IBM/14 for details)



Vehicle / Battery Charging Field Asset

Charging Activity Management V2G

- check account status (i.e. is V2G allowed on the account);
- set V2G variables;
- initiate V2G

Vehicle User

Charging Activity Management V2G

- review V2G terms;
- accept V2G request;
- review V2G summary

Vehicle Owner

Charging Activity Management V2G

- set V2G policy;
- review V2G terms;
- accept V2G request;
- review V2G summary

Charging Location Operator

Charging Activity Management V2G

- check account status (i.e. is V2G allowed on the account);
- review V2G terms;
- set V2G variables;
- initiate V2G
- review V2G summary

Electricity DNO

Charging Activity Management V2G

- offer V2G;
- set V2G variables;
- initiate V2G;
- review V2G summary

Intelligent Infrastructure Admin

Charging Activity Management V2G

- check account status;
- set V2G variables;
- review V2G summary

Vehicle / Battery

Charging Activity Management V2H

- set V2H variables;
- initiate V2H

Vehicle User

Charging Activity Management V2H

- accept V2H request;
- review V2H summary

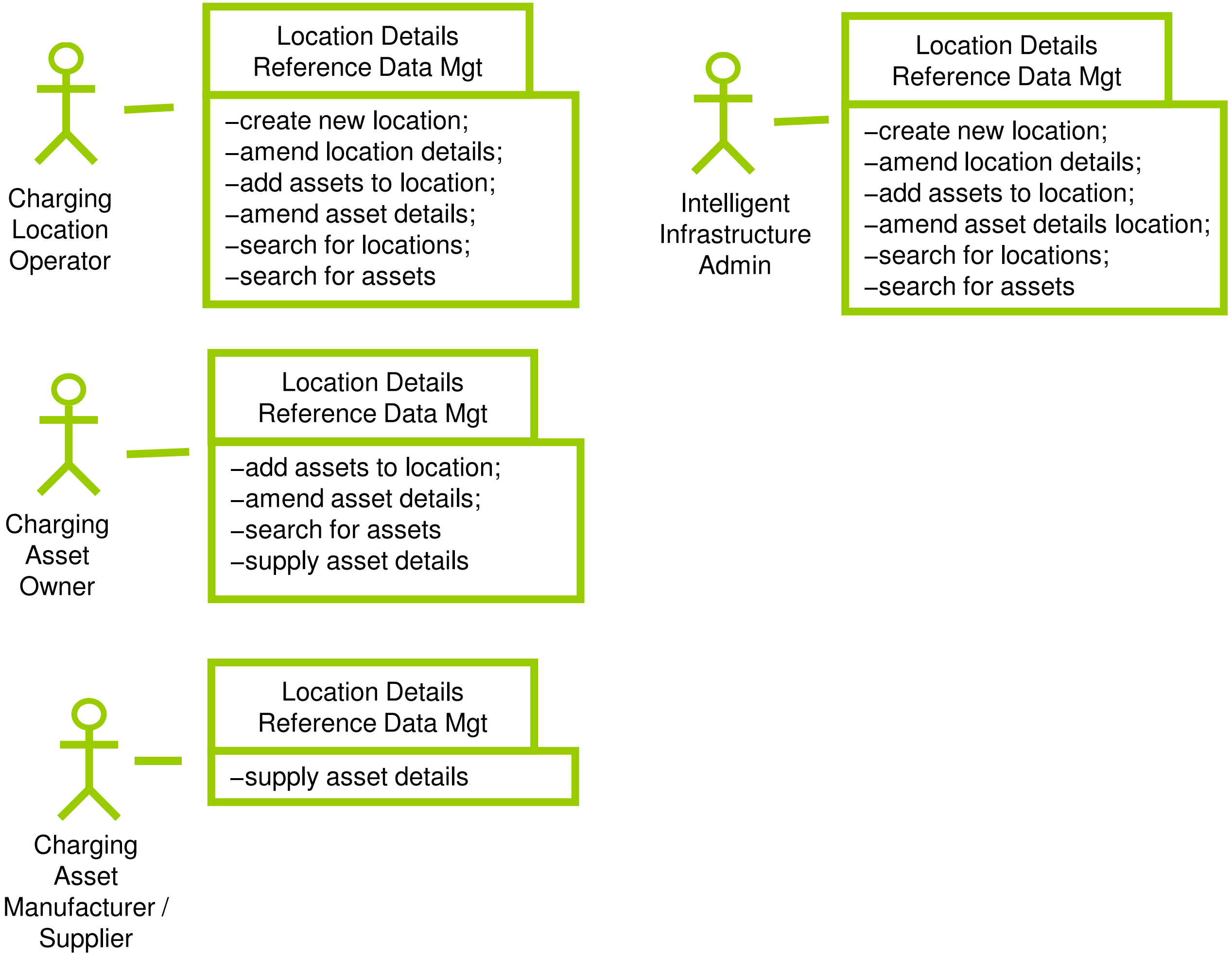
Vehicle Owner

Charging Activity Management V2H

- accept V2H request;
- review V2H summary

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap - Charging Location Management/Charging Activity Management/Location Details (see SP2/IBM/14 for details)



Charging Location Operator

Location Details Reference Data Mgt

- –create new location;
- –amend location details;
- –add assets to location;
- –amend asset details;
- –search for locations;
- –search for assets

Intelligent Infrastructure Admin

Location Details Reference Data Mgt

- –create new location;
- –amend location details;
- –add assets to location;
- –amend asset details location;
- –search for locations;
- –search for assets

Charging Asset Owner

Location Details Reference Data Mgt

- –add assets to location;
- –amend asset details;
- –search for assets
- –supply asset details

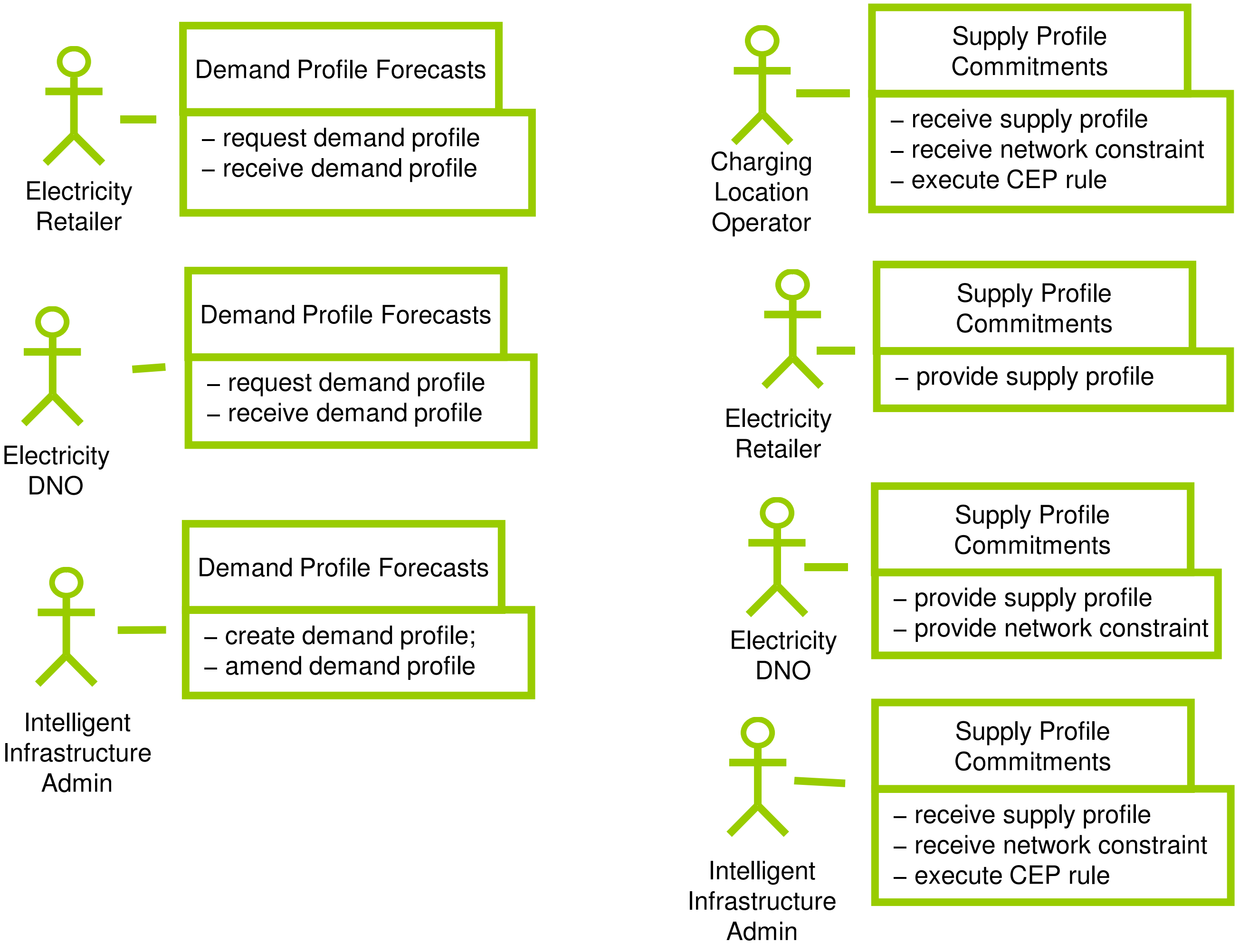
Charging Asset Manufacturer / Supplier

Location Details Reference Data Mgt

- –supply asset details

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap – Demand/Supply Management (see SP2/IBM/14 for details)



Electricity Retailer

Demand Profile Forecasts

- request demand profile
- receive demand profile

Electricity DNO

Demand Profile Forecasts

- request demand profile
- receive demand profile

Intelligent Infrastructure Admin

Demand Profile Forecasts

- create demand profile;
- amend demand profile

Charging Location Operator

Supply Profile Commitments

- receive supply profile
- receive network constraint
- execute CEP rule

Electricity Retailer

Supply Profile Commitments

- provide supply profile

Electricity DNO

Supply Profile Commitments

- provide supply profile
- provide network constraint

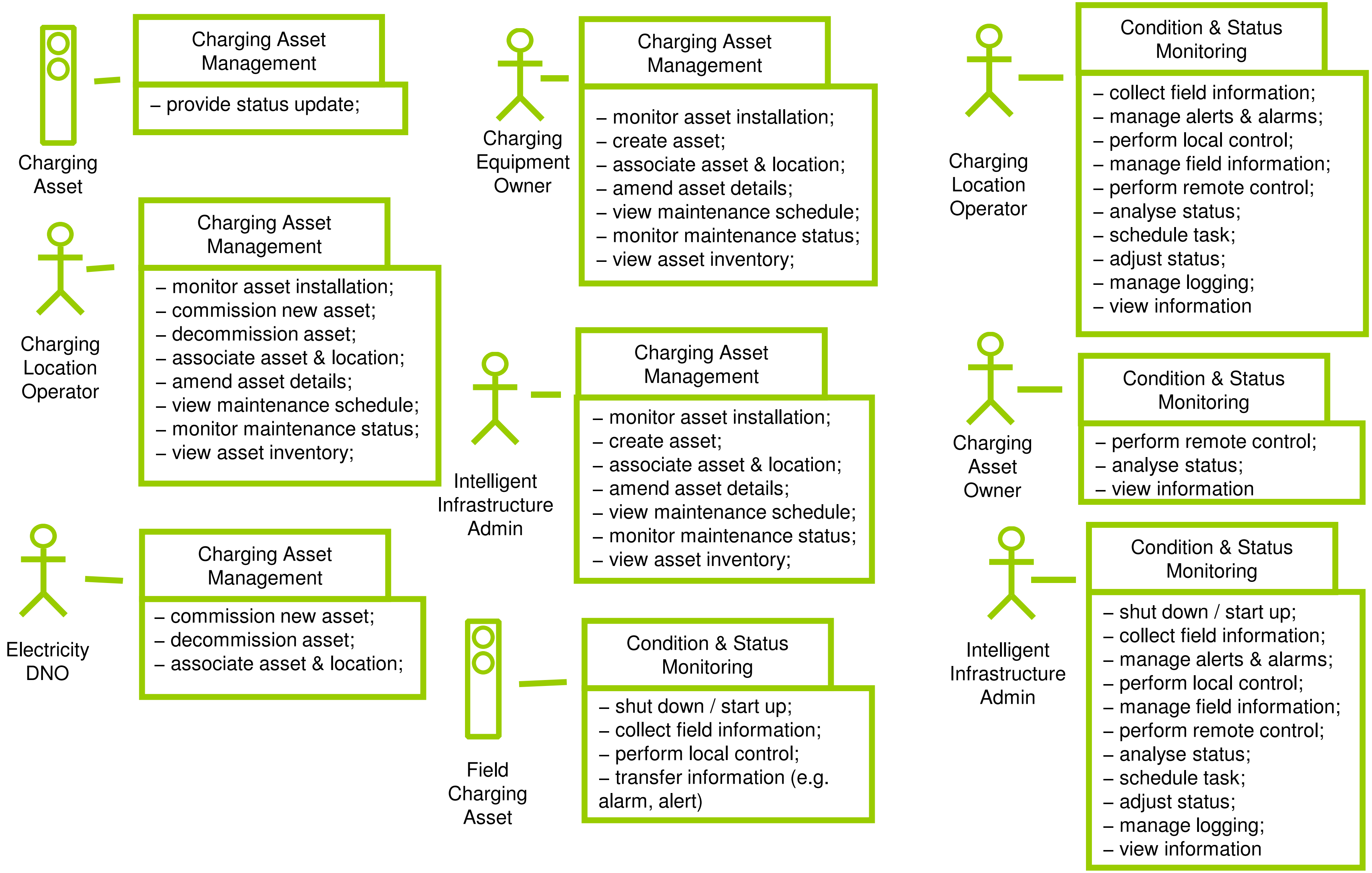
Intelligent Infrastructure Admin

Supply Profile Commitments

- receive supply profile
- receive network constraint
- execute CEP rule

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap – Charging Infrastructure Management & Safety (see SP2/IBM/14 for details)



Charging Asset

Charging Asset Management

– provide status update;

Charging Location Operator

Charging Asset Management

– monitor asset installation;
– commission new asset;
– decommission asset;
– associate asset & location;
– amend asset details;
– view maintenance schedule;
– monitor maintenance status;
– view asset inventory;

Electricity DNO

Charging Asset Management

– commission new asset;
– decommission asset;
– associate asset & location;

Charging Equipment Owner

Charging Asset Management

– monitor asset installation;
– create asset;
– associate asset & location;
– amend asset details;
– view maintenance schedule;
– monitor maintenance status;
– view asset inventory;

Intelligent Infrastructure Admin

Charging Asset Management

– monitor asset installation;
– create asset;
– associate asset & location;
– amend asset details;
– view maintenance schedule;
– monitor maintenance status;
– view asset inventory;

Field Charging Asset

Condition & Status Monitoring

– shut down / start up;
– collect field information;
– perform local control;
– transfer information (e.g. alarm, alert)

Charging Location Operator

Condition & Status Monitoring

– collect field information;
– manage alerts & alarms;
– perform local control;
– manage field information;
– perform remote control;
– analyse status;
– schedule task;
– adjust status;
– manage logging;
– view information

Charging Asset Owner

Condition & Status Monitoring

– perform remote control;
– analyse status;
– view information

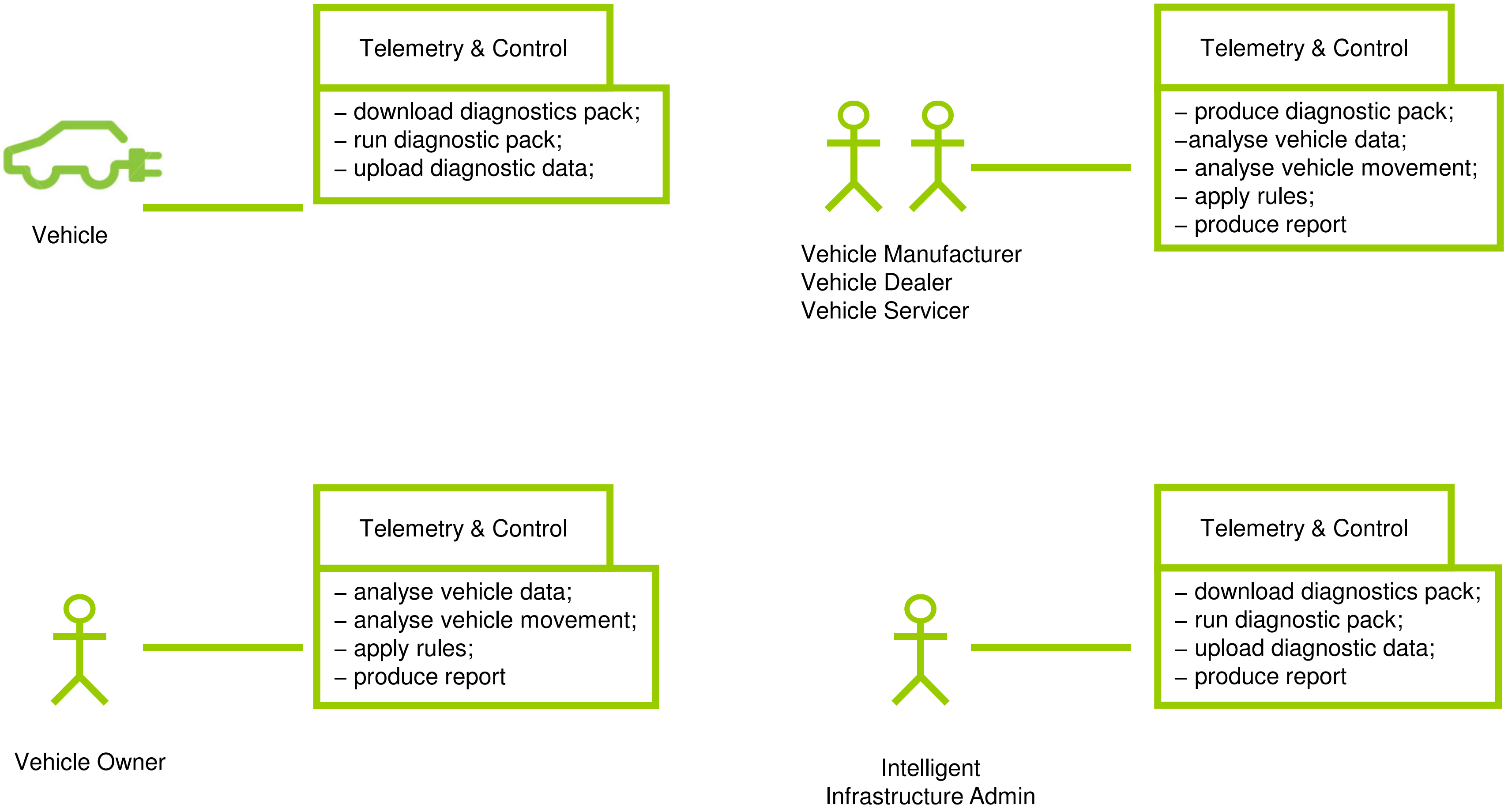
Intelligent Infrastructure Admin

Condition & Status Monitoring

– shut down / start up;
– collect field information;
– manage alerts & alarms;
– perform local control;
– manage field information;
– perform remote control;
– analyse status;
– schedule task;
– adjust status;
– manage logging;
– view information

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap – Charging Infrastructure Management & Safety (Telemetry & Control) (see SP2/IBM/14 for details)



Vehicle

Telemetry & Control

– download diagnostics pack;
– run diagnostic pack;
– upload diagnostic data;

Vehicle Manufacturer
Vehicle Dealer
Vehicle Servicer

Telemetry & Control

– produce diagnostic pack;
–analyse vehicle data;
– analyse vehicle movement;
– apply rules;
– produce report

Vehicle Owner

Telemetry & Control

– analyse vehicle data;
– analyse vehicle movement;
– apply rules;
– produce report

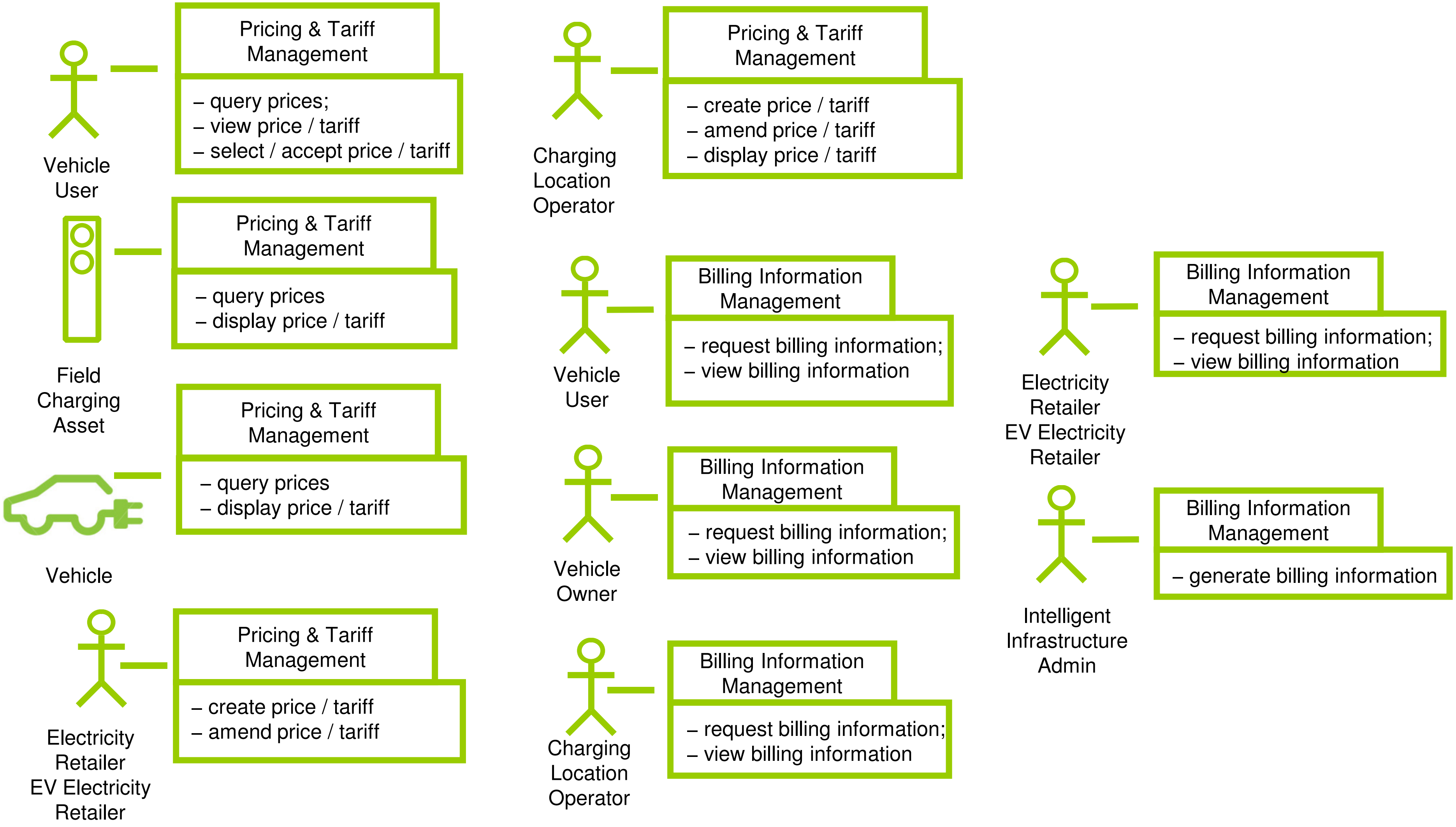
Intelligent
Infrastructure Admin

Telemetry & Control

– download diagnostics pack;
– run diagnostic pack;
– upload diagnostic data;
– produce report

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap – Pricing & Billing (see SP2/IBM/14 for details)



Vehicle User

Pricing & Tariff Management

- query prices;
- view price / tariff
- select / accept price / tariff

Field Charging Asset

Pricing & Tariff Management

- query prices
- display price / tariff

Vehicle

Pricing & Tariff Management

- query prices
- display price / tariff

Electricity Retailer EV Electricity Retailer

Pricing & Tariff Management

- create price / tariff
- amend price / tariff

Charging Location Operator

Pricing & Tariff Management

- create price / tariff
- amend price / tariff
- display price / tariff

Vehicle User

Billing Information Management

- request billing information;
- view billing information

Vehicle Owner

Billing Information Management

- request billing information;
- view billing information

Charging Location Operator

Billing Information Management

- request billing information;
- view billing information

Electricity Retailer EV Electricity Retailer

Billing Information Management

- request billing information;
- view billing information

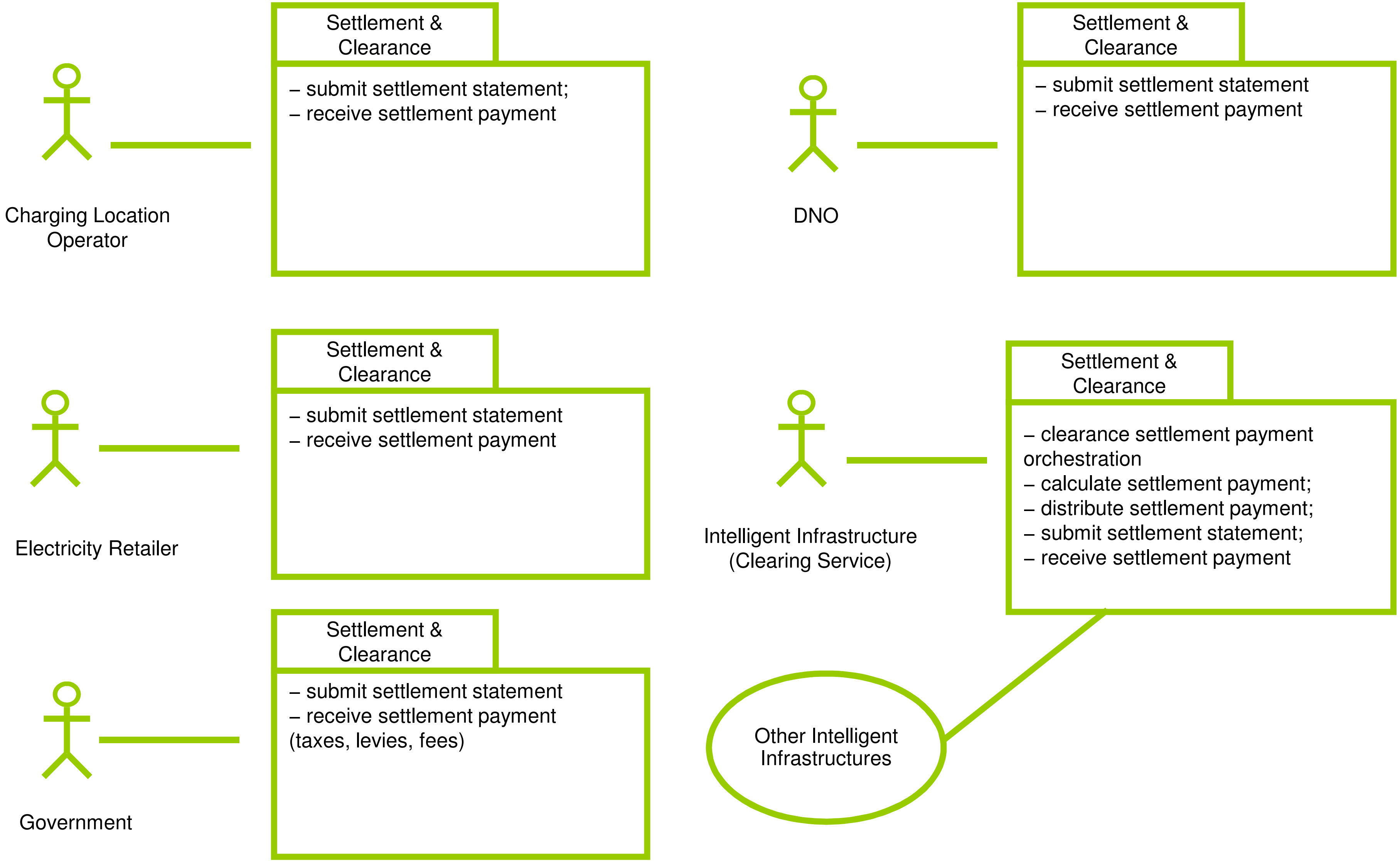
Intelligent Infrastructure Admin

Billing Information Management

- generate billing information

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap – Settlement & Clearance Services (see SP2/IBM/14 for details)



Charging Location Operator

Settlement & Clearance

– submit settlement statement;
– receive settlement payment

DNO

Settlement & Clearance

– submit settlement statement
– receive settlement payment

Electricity Retailer

Settlement & Clearance

– submit settlement statement
– receive settlement payment

Intelligent Infrastructure (Clearing Service)

Settlement & Clearance

– clearance settlement payment orchestration
– calculate settlement payment;
– distribute settlement payment;
– submit settlement statement;
– receive settlement payment

Government

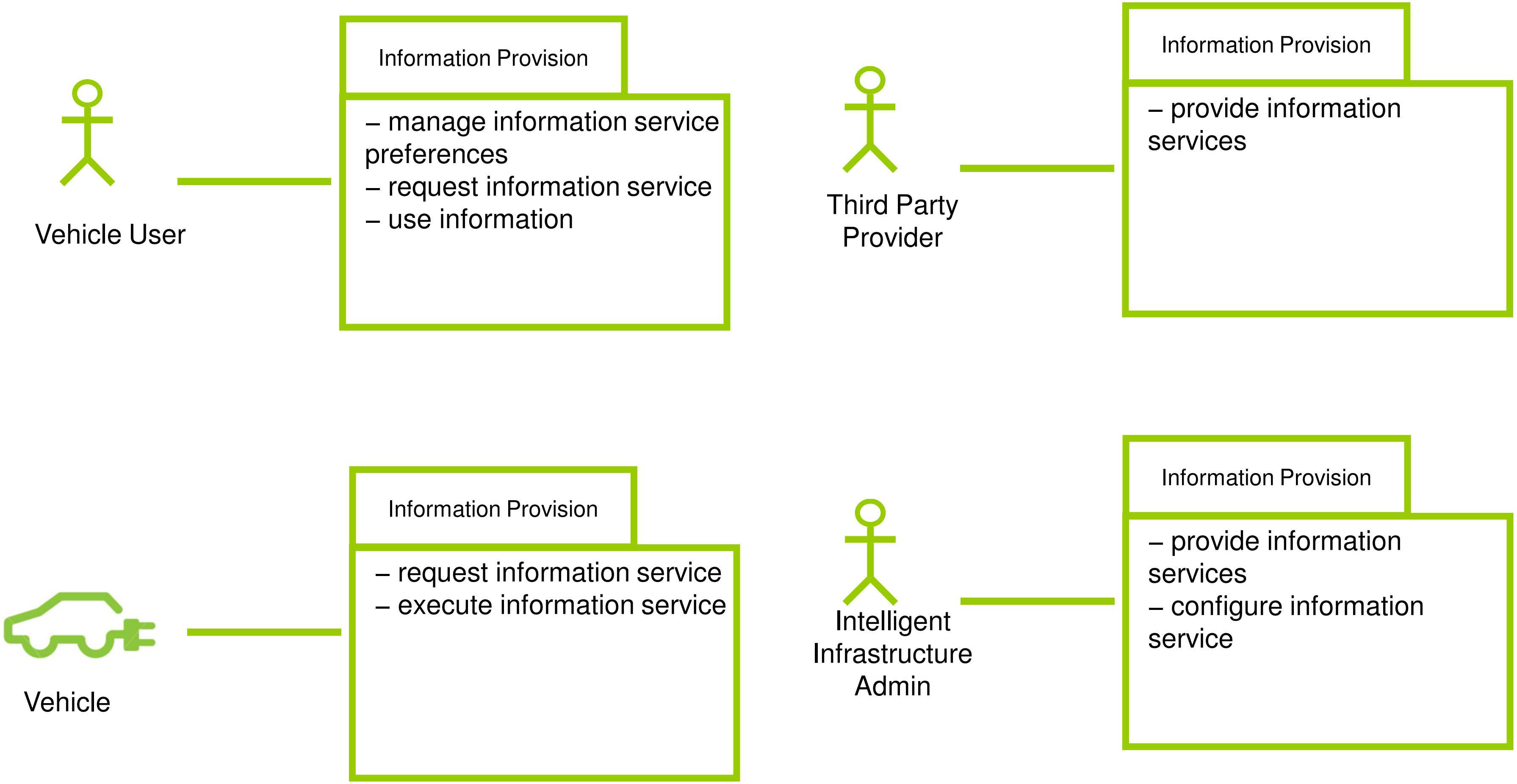
Settlement & Clearance

– submit settlement statement
– receive settlement payment
(taxes, levies, fees)

Other Intelligent Infrastructures

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap – Information Provision (see SP2/IBM/14 for details)



Vehicle User

Information Provision

- – manage information service preferences
- – request information service
- – use information

Third Party Provider

Information Provision

- – provide information services

Vehicle

Information Provision

- – request information service
- – execute information service

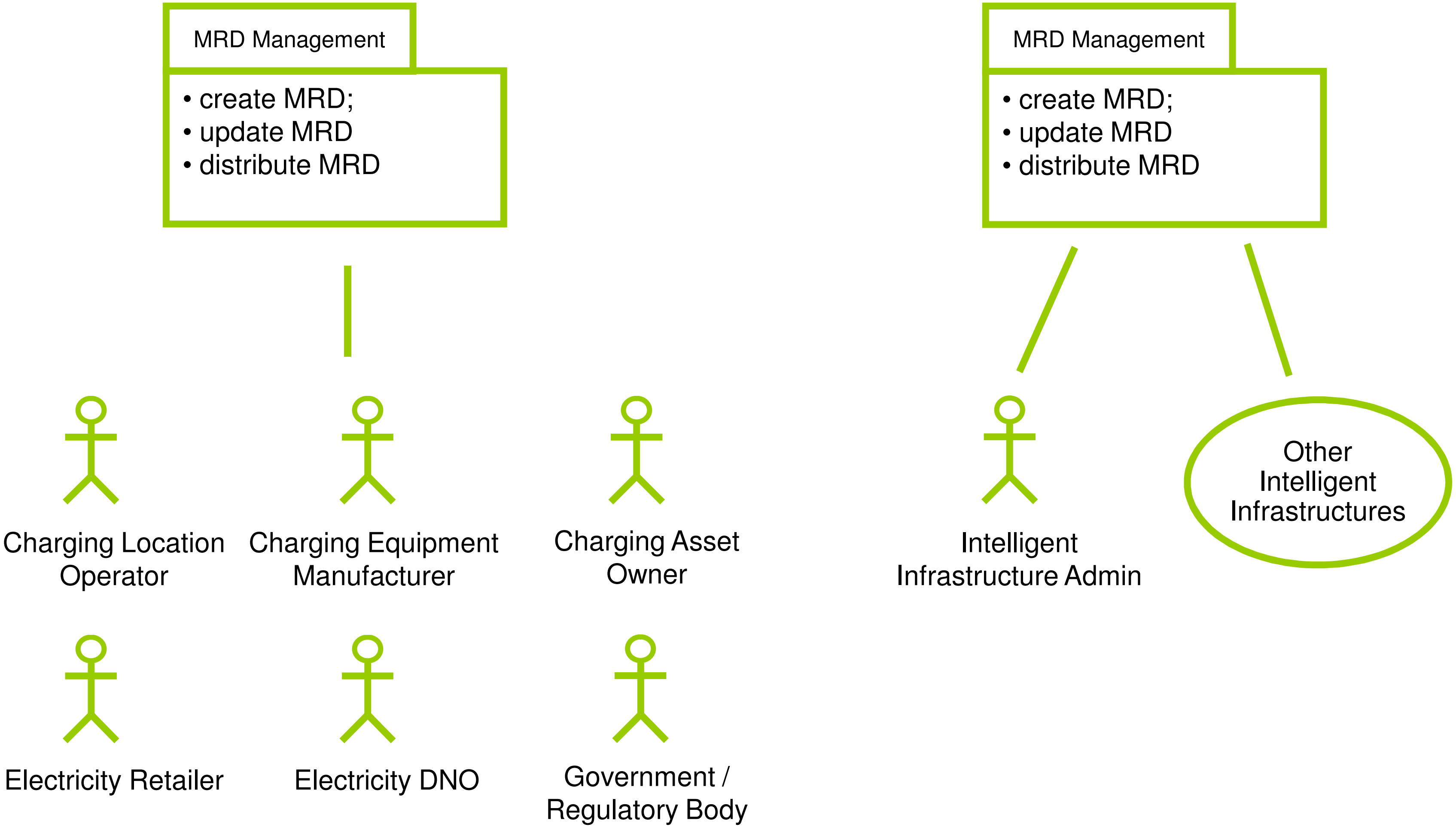
Intelligent Infrastructure Admin

Information Provision

- – provide information services
- – configure information service

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap – Master Reference Data Management (see SP2/IBM/14 for details)



MRD Management

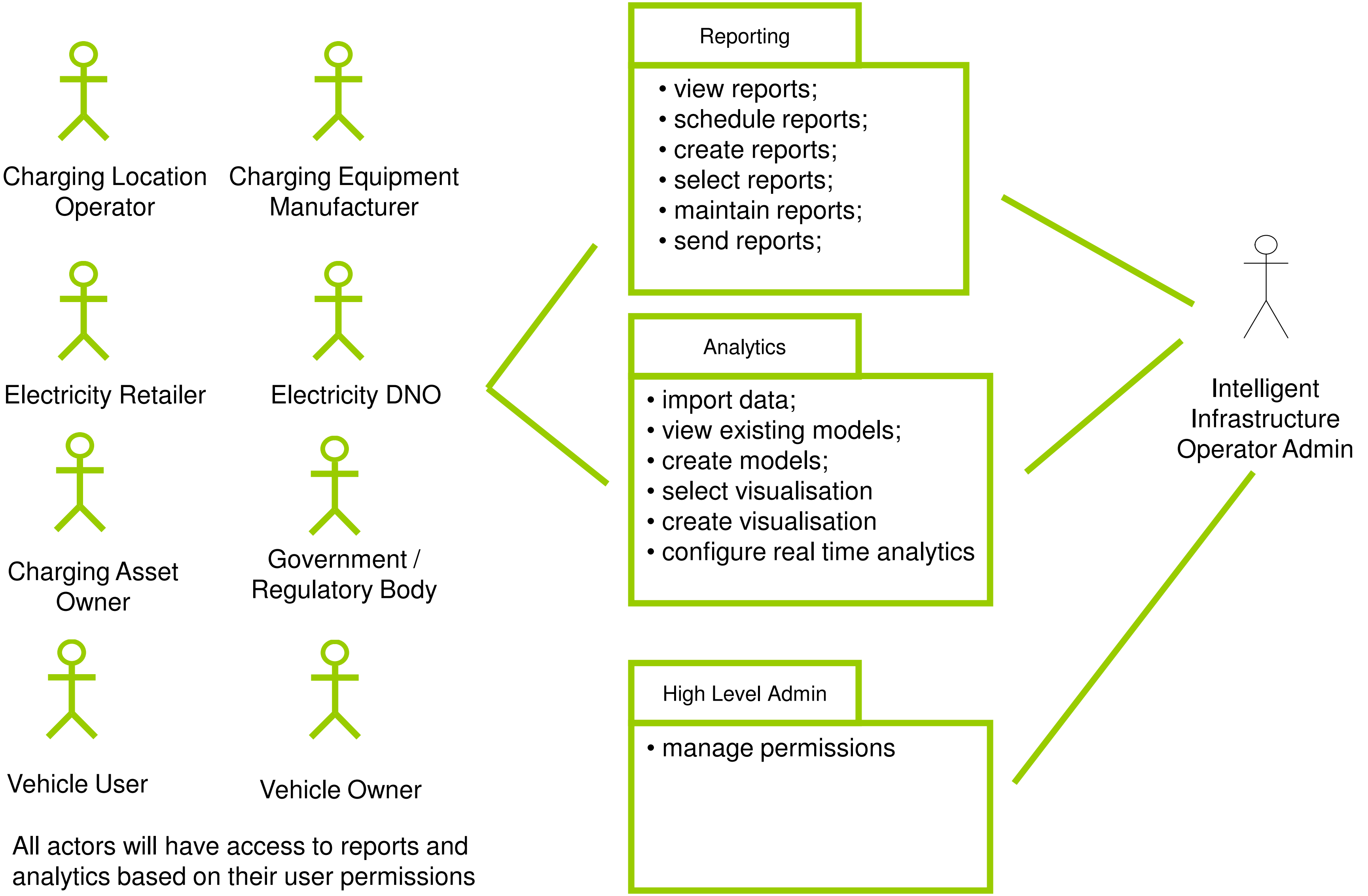
- create MRD;
- update MRD
- distribute MRD

MRD Management

- create MRD;
- update MRD
- distribute MRD

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap – Business Analytics and Reporting (see SP2/IBM/14 for details)



Charging Location Operator

Charging Equipment Manufacturer

Electricity Retailer

Electricity DNO

Charging Asset Owner

Government / Regulatory Body

Vehicle User

Vehicle Owner

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

Reporting

- view reports;
- schedule reports;
- create reports;
- select reports;
- maintain reports;
- send reports;

Analytics

- import data;
- view existing models;
- create models;
- select visualisation
- create visualisation
- configure real time analytics

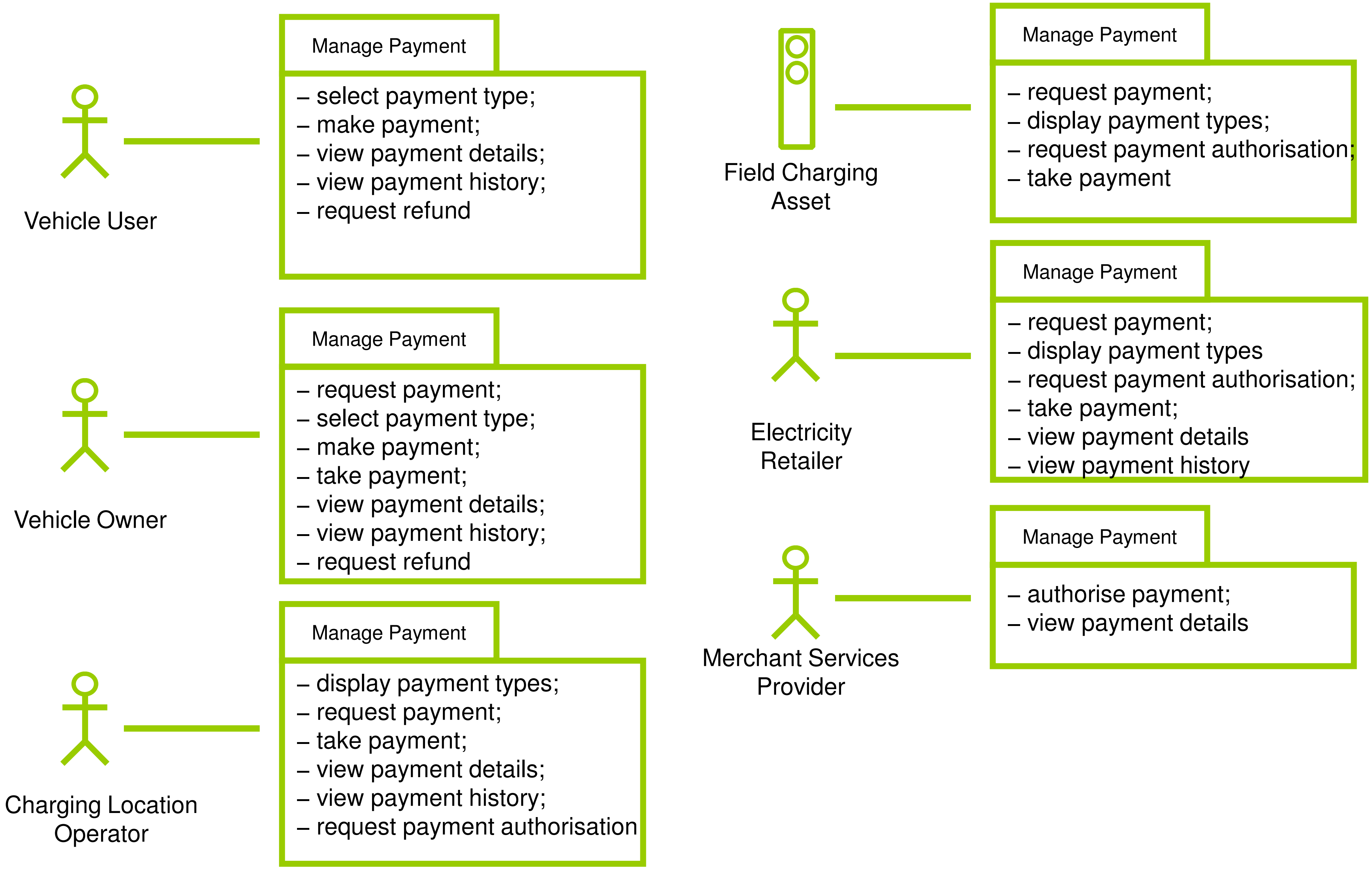
High Level Admin

- manage permissions

Intelligent Infrastructure Operator Admin

© 2010 IBM Corporation

EV Intelligent Infrastructure Delivery – Requirements Recap – Billing & Payment Management Payments (see SP2/IBM/14 for details)



Vehicle User

Manage Payment

- – select payment type;
- – make payment;
- – view payment details;
- – view payment history;
- – request refund

Vehicle Owner

Manage Payment

- – request payment;
- – select payment type;
- – make payment;
- – take payment;
- – view payment details;
- – view payment history;
- – request refund

Charging Location Operator

Manage Payment

- – display payment types;
- – request payment;
- – take payment;
- – view payment details;
- – view payment history;
- – request payment authorisation

Field Charging Asset

Manage Payment

- – request payment;
- – display payment types;
- – request payment authorisation;
- – take payment

Electricity Retailer

Manage Payment

- – request payment;
- – display payment types
- – request payment authorisation;
- – take payment;
- – view payment details
- – view payment history

Merchant Services Provider

Manage Payment

- – authorise payment;
- – view payment details

© 2010 IBM Corporation

ETI EV Work Package 2.4

SP2/IBM/28 ETI EV Intelligent Infrastructure Delivery – Phases, Options, Costs and Risks

End of Document

© 2010 IBM Corporation