smartCEM

Smart connected electro mobility

D2.4 (Logging tools DB definition)

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Table 0.1 Abbreviations

Abbreviation	Definition
3G	3rd generation of mobile telecommunications technology
AD	Activity Diagram
API	Application programming interface
APP	Application (software)
BEV	Battery Electric Vehicle
CAN	Controller Area Network
CIP	Competitiveness and Innovation Framework Programme
CS	Charging Station
CSV	Comma Separated Values
CYC	Charge Your Car[1]
DB	Data base
DOD	Degree of Discharge
EV	Electric Vehicle
FC	Functionality
FTP	File transfer protocol
FTS	Forensic Telecommunications Services
GPRS	General packet radio service
GPS	Global Positioning System
GTFS	General transit feed specification
GUI	Graphical user interface
HMI	Human Machine Interface
HTTP	Hypertext Transfer Protocol
ICE	Internal Combustion Engine
ICT	Information and Communication Technology
IEEE	Institute of Electrical and Electronics Engineers
ITS	Intelligent Transport Systems

[1] CYC in North East England forms the infrastructure for the operation of smartCEM's UK pilot site [1].

Abbreviation	Definition
IVR	Interactive Voice Response
KPI	Key Performance Indicators
LTE	Long term evolution
MCB	Miniature Circuit Breaker
MSDU	MAC Service Data Unit
NC	Network classes
OBU	On-Board Unit
OCPP	Open charge point protocol
O-D	Origin-Destination
OSM	Open street map
PAYG	Pay as you go
PHEV	Plug-In Hybrid Electric Vehicles
POI	Point Of Interest
PT	Public transport
RCB	Residual Current Breaker
RCD	Residual Control Device
REST	Representational state transfer
RFID	Radio Frequency Identification
RQ	Requirement
SaaS	Software as a service
SC	Speed classes
SDK	Software development kit
SH	Stakeholder
SIM	Subscriber Identity Module
SMMT	Society of Motor Manufacturers and Trader
SOA	Service-Oriented Architecture
SOAP	Simple Object Access Protocol
SOC	State Of Charge
TCP/IP	Transfer Control Protocol/Internet Protocol

Abbreviation	Definition
UC	Use Case
UCAP	Ultra capacitors
UMTS	Universal Mobile Telecommunications System
UN	User Need
UNEW	Newcastle University
VPN	Virtual Private Network
WDM	Workflow and Demand Manager
WiFi	Commercial name of the wireless communication standard IEEE 802.11b
WP	Work Package
WSDL	Web Services Description Language
XML	eXtensible Mark-up Language

Executive Summary

This document describes the local systems and processes in place at the smartCEM pilot sites for collecting, storing, and managing data that are used for the project's evaluation phase. The local databases are presented on a site-by-site basis.

An important role of this document is to highlight the crucial interrelationships between the local database architecture and the development of the central database (reported in D3.2), and the dependence of both on the identification of evaluation measures at pilots sites (in this document evaluation measures refer to the measurements acquired directly from, for example, sensors, or derived from other sources, that are used in the calculation of performance indicators. These are reported in detail in D4.3 and summarised in Annex A of this document).

Specification of data loggers at each site is presented in Annex B.

1 Introduction

1.1 Purpose and scope of D2.4

D2.4 describes the local systems and processes in place at the pilot sites (Barcelona, Gipuzkoa, Newcastle upon Tyne, and Reggio Emilia) for collecting, storing, managing and preparing data that is appropriate to provide a comparative evaluation between the smartCEM pilot sites. The local database architecture described will be in place in time for the baseline and full operational mode data acquisition processes.

Although part of WP2 Implementation, the architectures reported in this document are a key link between the evaluation phase (WP4) and the operational phase (WP3). D4.3 *smartCEM Experimental Design* has defined a set of measures based on each site's characteristics and proposed operational scenarios. It has also proposed a methodology for deriving performance indicators from these measures. D2.4 builds on D4.3 by describing the mechanics by which the local data defining the local measures is collected and made available for future analysis.

The characteristics of the central database, and the means by which local data is centrally stored and processed into a usable format for evaluation, is described in detail in D3.2 *Common Data Exchange Protocol for smartCEM*. It will include a description of the common database structure and data exchange mechanisms used in the smartCEM platform to ensure consistent data is available in a form that all can understand and use as required.

As far as possible the central database structure should be similar to the local databases. This facilitates effective and efficient data transfer and a definition of a normalized architecture between the different sites. Every week a copy of the local databases should be uploaded and stored in the central database. A possible approach could be the one defined in

Figure 1-1 below.

Once the data is transferred between databases (local to central), UNEW will analyse it in order to obtain performance indicators reflecting the table of measures specified in WP4.

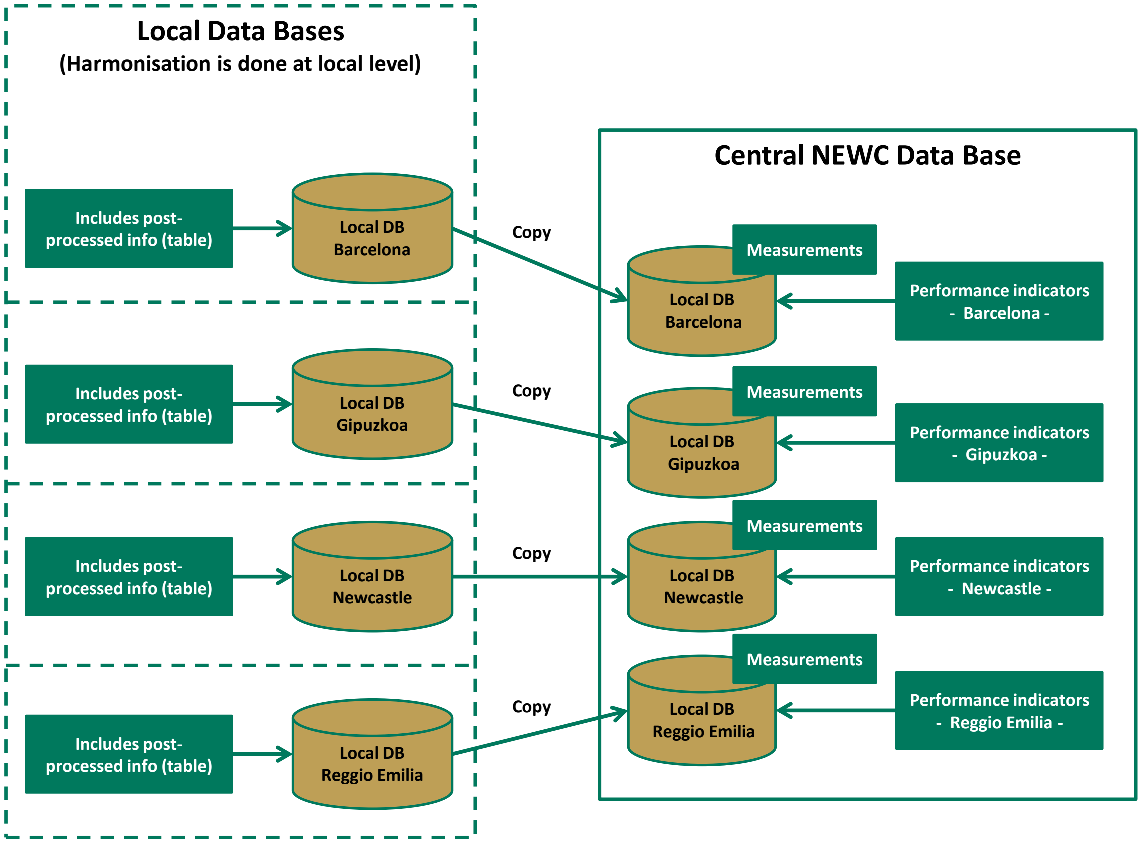


Figure 1-1 Connection between local and central databases

1.2 Structure of the document

D2.4 presents the local databases per pilot site. An explanation is given on how data is collected, stored, managed and prepared for evaluation at each site. Appendix A – Measures presents a summary of the measures at each site (described in detail in D4.3). Appendix B –Data Logger Specifications presents the specification of on board unit data loggers at each site.

2 Barcelona

2.1 Introduction

The Barcelona Pilot Site has defined a local architecture for smartCEM data acquisition processes through the baseline and operative phases of the project.

The registered data will be collected from the data inputs of the MOTIT service in Barcelona, formed by (initially) 50 electric scooters that can be booked through mobile apps.

The data stored in this local database will be sent weekly to a central database allocated in an external server at Newcastle. Data is stored in the LDB with an ID number for each user and another ID for each different booking. Associated user names are stored in Going Green[2] DB and are not available for IDIADA, hence assuring anonymity for the smartCEM project

There will be three different sources for data acquisition:

1. **Data loggers:** The first source of data will be the data loggers installed in the scooters provided by Going Green and connected to the CAN BUS of the vehicle. Apart from being an on board reservation management device, this hardware also works as a data logger. It registers figures such as GPS location, speed, completed Kms, state of charge, etc. The OBU sends this data to the Back Office of Going Green, for internal use, and to IDIADA servers in L'Albornar. The information sent is acquired in a second-per-second basis for high frequency data, and 60 seconds for low frequency data. This data is packed, compressed and sent to IDIADA DB and GoingGreen after each booking is finished and the bike is idle and waiting for a new booking
2. **Booking system:** Apart from the information coming from the vehicles, the Back Office system is also provided by car reservation information registered from the operator's booking systems. This will be the second source of information for the local database.
3. **User uptake:** The last source of data will be the drivers of the vehicles, who will contribute with personal impressions about the service provided by the operators. This qualitative data will be collected by distributing surveys among the users/drivers of the service. The methodological approach to the qualitative data collection including surveys is defined in D4.4 *smartCEM Assessment Tools*.

[2] Scooter-sharing Operator in Barcelona

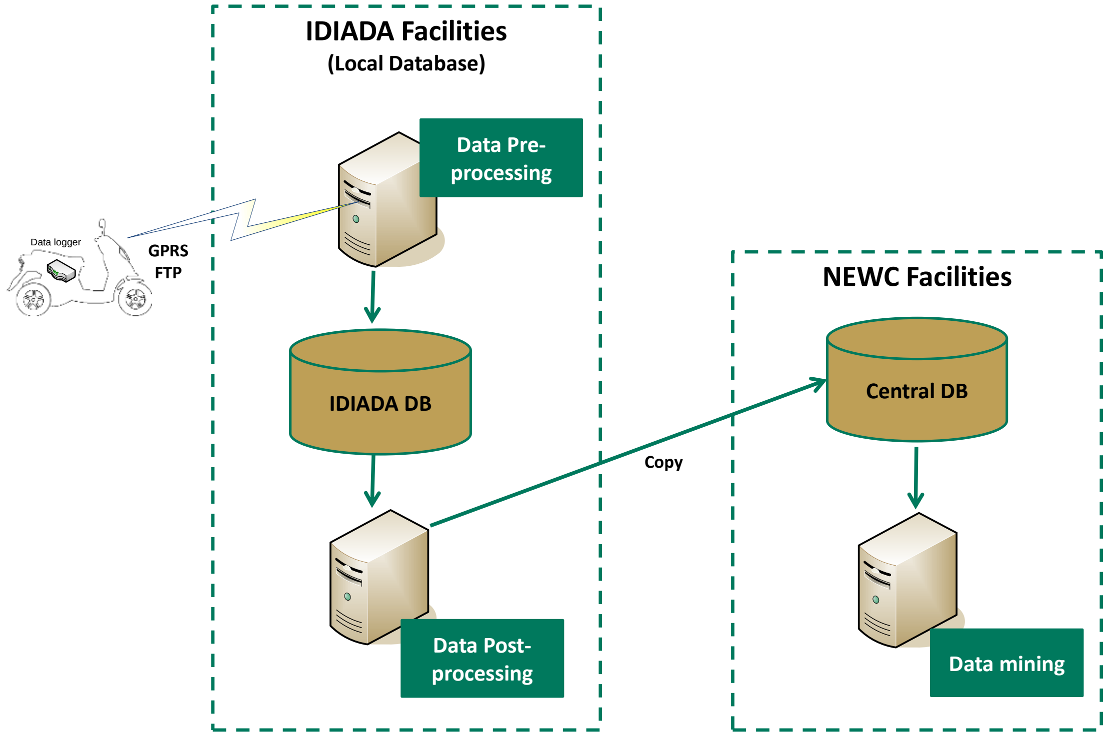


Figure 2-1 Schematic description of data collection in Barcelona

2.2 Approach

The Barcelona local database will be composed of six different tables.

Table 1: Bikes

The Bikes table will store the IDs of the bikes used in the scooter service, in order to monitor the origin of the data.

Table 2: Book_Log

This table will log all related data of the bike booking, including user ID, battery ID and different software IDs and versions.

Table 3: Event

This table will register any event given during the reservation and trip. Watchdogs will be enabled to detect different type of events held on-trip. The watchdogs will attend to the real-time data that is being collected in the fleet **Signal_HF and**

Signal_LF table, in order to identify differences or specific actions that are flagged. These events IDs and descriptions will be listed in Table Event_Types, according to the information supplied by the fleet operator.

Table 4: Event Types

This table will register the different Event IDs and its description according to the same structure that the fleet operator uses in their back office. These events will include speeds over a certain threshold and battery depleted events based in the state of charge (SoC) among other critical bike status reports.

Table 5: Signal_HF

This table will register the bike's data logged with a high frequency sampling rate (1 second).

Table 6: Signal_LF

This table will register the bike's data logged with a low frequency sampling rate (1 minute). These will be the columns for each of the defined tables:

Table 2.1: Bikes

NAME	TYPE	DESCRIPTION
BK_MODEL	**INT**	Bike model
BK_VIN	**INT**	Unique vehicle identifier
BK_ID	**INT**	Bike ID used in relations

Table 2.2: Book Log

NAME	TYPE	DESCRIPTION
BL_TIMESTAMP	**DATETIME**	Date-time of the start of trip
BL_BAT1_SERIAL	**DECIMAL(4,0)**	Battery 1 serial number (not available until September-October)
BL_BAT2_SERIAL	**DECIMAL(4,0)**	Battery 2 serial number (not available until September-October)
BL_BAT3_SERIAL	**DECIMAL(4,0)**	Battery 3 serial number (not available until September-October)

BL_BAT4_SERIAL	DECIMAL(4,0)	Battery 4 serial number (not available until September-October)
BL_SW_MOTOR	DECIMAL(3,0)	Version of motor software
BL_SW_BMS	DECIMAL(3,0)	Version of BMS software
BL_SW_ICM	DECIMAL(3,0)	Version of ICM software
BL_ID_BIKE	INT	Bike Identifier
BL_ID_USER	INT	User Identifier

Table 2.3: Event

NAME	TYPE	DESCRIPTION
EV_ID_BL	INT	Unique book identifier
EV_TYPE	INT	Unique event type identifier
EV_COMMENT	VARCHAR(255)	Event description

Table 2.4: Signal_HF

NAME	TYPE	DESCRIPTION
SHF_TIMESTAMP	DATETIME	Date-time at the sampling instant
SHF_ID_BL	INT	Unique book identifier
SHF_BUS_VOLTAGE	DECIMAL(3,0)	Bus voltage at the sampling time
SHF_BUS_CURRENT	DECIMAL(3,0)	Bus current at the sampling time
SHF_SPEED	DECIMAL(3,0)	Speed of the vehicle at the sampling time
SHF_THROTTLE	DECIMAL(3,0)	Throttle of the vehicle at the sampling time
SHF_LONGITUDE	DECIMAL(9,6)	GPS longitude for the location of the vehicle at the sampling time
SHF_LATITUDE	DECIMAL(9,6)	GPS latitude for the location of the vehicle at the sampling time
SHF_ALTITUDE	DECIMAL(6,0)	GPS altitude for the location of the vehicle at the sampling time
SHF_RPM	DECIMAL(4,0)	Engine RPM at the sampling time

Table 2.5: Signal L_F

NAME	TYPE	DESCRIPTION
SLF_TIMESTAMP	DATETIME	Date-time at the sampling instant
SLF_TOTAL_MILEAGE	DECIMAL(10,1)	Total Accumulated mileage per scooter life
SLF_STATUS	DECIMAL(4,0)	Bike status at the sampling time
SLF_AMBIENT_T	DECIMAL(3,0)	Ambient temperature at the sampling time
SLF_BAT_1_SOC	DECIMAL(4,0)	Battery 1 state of charge at the sampling time
SLF_BAT_2_SOC	DECIMAL(4,0)	Battery 2 state of charge at the sampling time
SLF_BAT_3_SOC	DECIMAL(4,0)	Battery 3 state of charge at the sampling time
SLF_BAT_4_SOC	DECIMAL(4,0)	Battery 4 state of charge at the sampling time
SLF_BAT_STATE_FAULT	DECIMAL(3,0)	Battery fault code
SLF_BIKE_FAULT	DECIMAL(3,0)	Bike fault code
SLF_INTERLOCK_POSITION	DECIMAL(3,0)	Bike interlock position
SLF_LIGHT_STATUS	DECIMAL(3,0)	The status of lights

Figure **2-2** shows the database implementation.

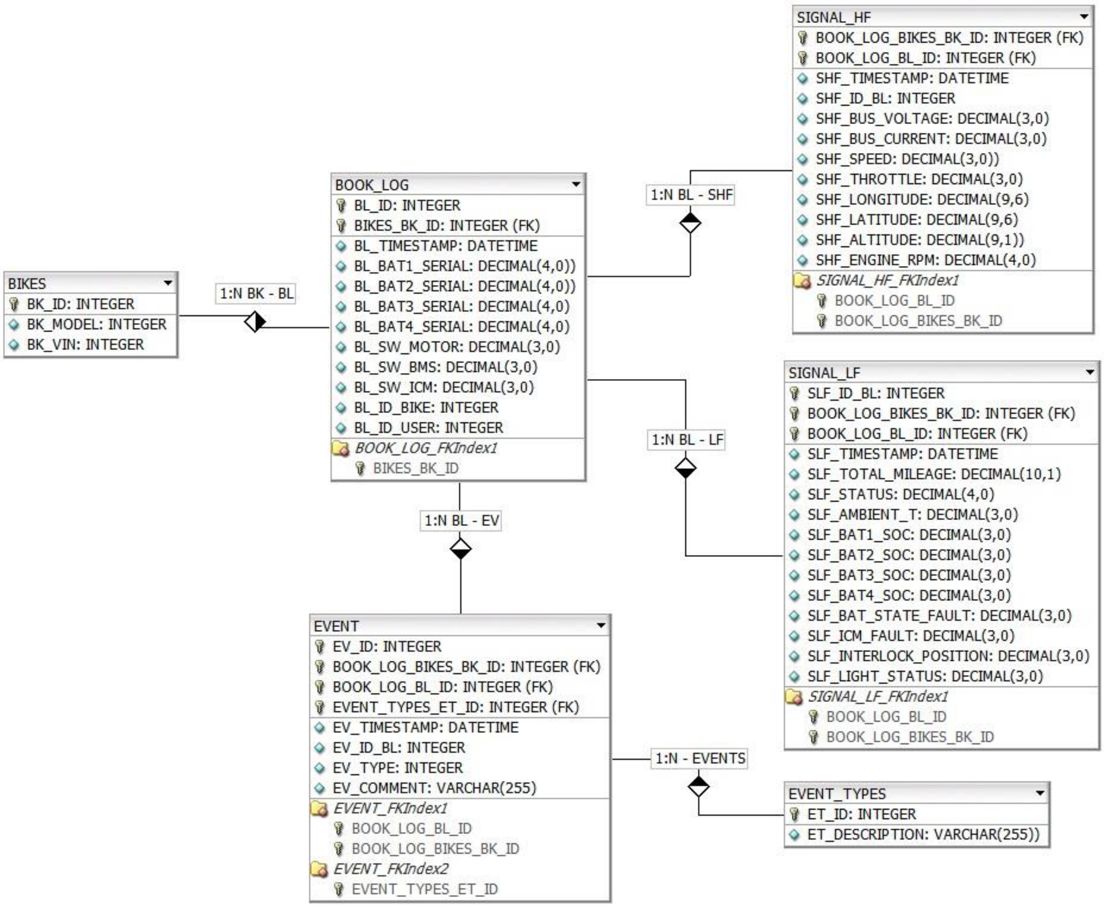


Figure 2-2 Proposed database structure

2.3 Summary

There will be different processes that will help in the data completion of the tables.

2.3.1 Event Catching

When a reservation is made and the driver picks up the vehicle, the system will start to monitor on-trip data, collecting the information in the different tables. Different algorithms will be developed, which will work as watchdogs during the monitoring process.

1. **Hard Braking Watchdog**: will detect an event, in cases when the vehicle suffers a deceleration higher than 40km/h in a time span of 5 seconds.
2. **Depleted Battery Watchdog**: will detect an event when the battery SoC is below a certain threshold.
3. **Other Watchdogs**: will be developed according to the fleet operator inputs.

Each time one of these watchdogs detects an event a new register will be generated in the **Event** table.

2.3.2 Pre Process

Data logged in the scooters will be written in a CSV file and stored in a compressed file using a lossless compressor, with certain metadata and a normalized filename which will include a MD5 checksum. This file will be sent to IDIADA database after a booking has been finished and the bike is waiting for a new user.

These zipped files will be prepared by the data logger with different strategies in order to minimize file size in order to optimize data transmission time and weight.

Files will be sent through an FTP connection to the IDIADA server. Once there they will be unzipped and pre-processed prior to being stored in order to minimize storage room and prepare the data to be post-processed and extract the WP4 measure list for the Barcelona site.

2.3.3 Post Process

Each week, when the data needs to be uploaded to the central database, a post processing task will automatically be done.

Both **Reservation** and **Events** tables will be analysed in order to obtain proper data for the **Post Process** table. The completed tasks will be calculations over the data already stored in those two tables (calculations such as average values, count of registers per day, etc.). The data obtained from the calculations will be stored in the **Post Process** table.

Every week the local database with **Reservation**, **Events, User Uptake** and **Post Process** tables will be sent to the central database.

2.3.4 Local Database Upload to Central Database

Every week a copy of the local database will be uploaded and stored in the central database.

3 Gipuzkoa

3.1 Introduction

Registered data at the Gipuzkoa site will be collected from the data inputs of the car-sharing operators. The local DB for Gipuzkoa will be similar to the database already allocated in the Back Office system of Mobera technology.

There will be three different sources for data acquisition:

1. **Data loggers:** in the carsharing, Mobera technology´s architecture an OBU (on-board unit) is installed in the cars, connected to the CAN BUS of the vehicle. Apart from being an on board reservation management device, this hardware also works as a data logger. It registers figures such as GPS location, speed, completed km, autonomy, etc. The OBU sends this data to the Back Office. In the hybrid bus, a Bus On-Board Unit exists that is used as data logger and on which the Efficient-driving [OnTrip dashboard] component runs on.
2. **Booking system:** Apart from the information coming from the vehicles, the Back Office system is also provided by car reservation information registered from the operator's booking systems. This will be the second source of information for the local database.
3. **User uptake:** The last source of data will be the drivers of the vehicles (EV cars and hybrid bus), who will contribute with personal impressions about the service provided by the operators. This qualitative data will be collected through surveys of the users/drivers. The methodological approach to the qualitative data collection including surveys is defined in D4.4 *smartCEM Assessment Tools*.

The general system of data collection for both, carsharing and hybrid is illustrated in the figure below:

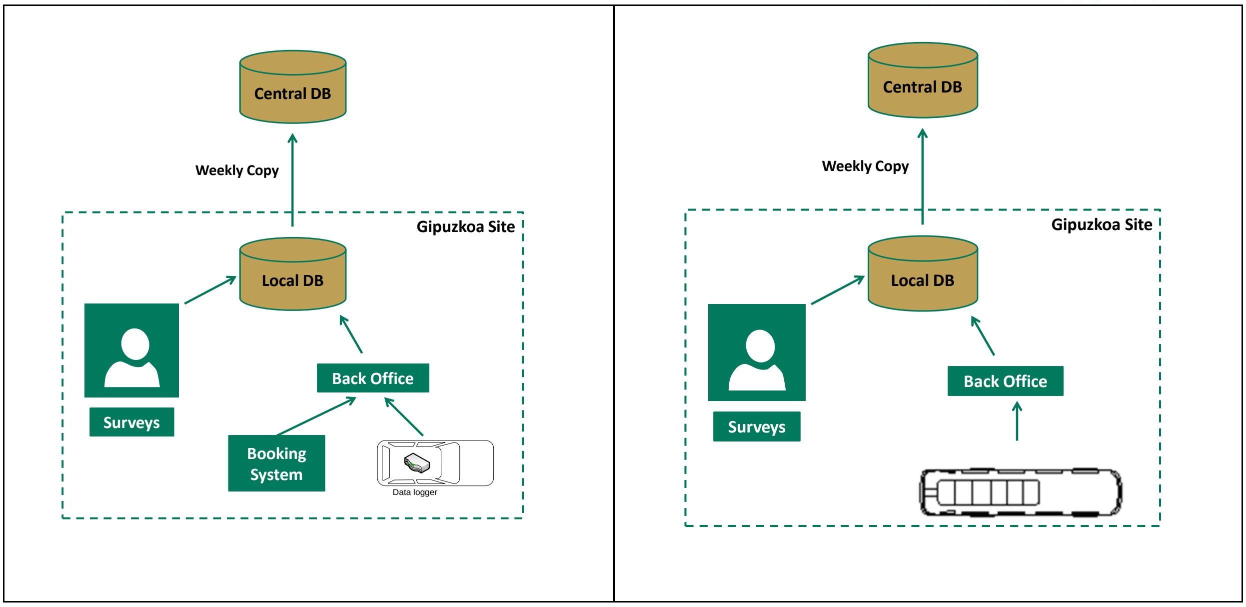


Figure 3-1 Schematic description of data collection in Gipuzkoa for carsharing (left) and hybrid bus (right)

The data stored in this local database will be sent weekly to a central database allocated in an external server.

3.2 Approach

The local database will be composed of five different tables. Figure **3-3** Proposed database structure shows the proposed database structure.

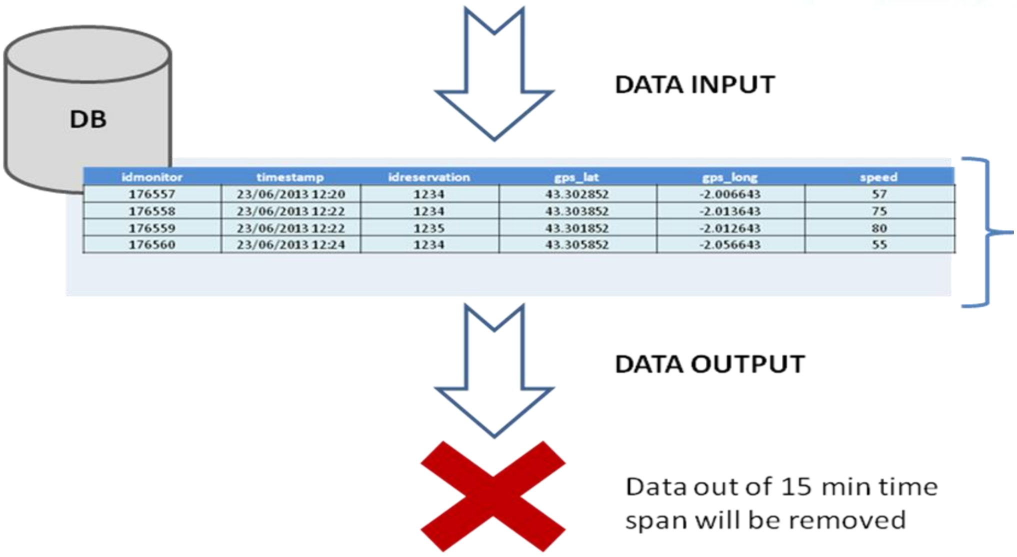
Table1: Reservations /Trips

The reservations table will be for carsharing case for will store all the data corresponding to each of the reservations registered in any of the car-sharing operator's systems.

The trips table will store all the data corresponding to each of the trips carried out in any of the bus routes participating in the project.

Table2: Monitoring

This table will monitor the car fleet's and hybrid bus real-time data, in order to control the status of the trips. It will just record data for a 15 min time span or window. Registering frequency should be established in a rate around 5 seconds/per_reg. A higher frequency will imply a higher resolution for events post processing.



idmonitor	timestamp	idreservation	gps_lat	gps_long	speed
176557	23/06/2013 12:20	1234	43.302852	-2.006643	57
176558	23/06/2013 12:22	1234	43.303852	-2.013643	75
176559	23/06/2013 12:22	1235	43.301852	-2.012643	80
176560	23/06/2013 12:24	1234	43.305852	-2.056643	55

Figure 3-2 Monitoring table

Table3: Events

This table will register any event given during the reservation trip. Watchdogs will be enabled to detect different event types held on-trip. The watchdogs will attend to the real-time data collected in the fleet **Monitoring** table, in order to identify differences or specific actions. For example, if a decrease of 40km/h is registered in a 5 sec span between registers, a Hard Braking event will be detected and stored.

Table4: Post Process

The post process table will be filled with the data obtained from the processing of the **Reservations/Trips** and **Events** table. Some algorithms will be applied to the reservations table every week in order to fill the **Post Process** table, before sending it to the central database.

Table5: User Uptake

This table will collect the inputs given by the users of the service. These inputs will be obtained from surveys and questionnaires distributed among the users.

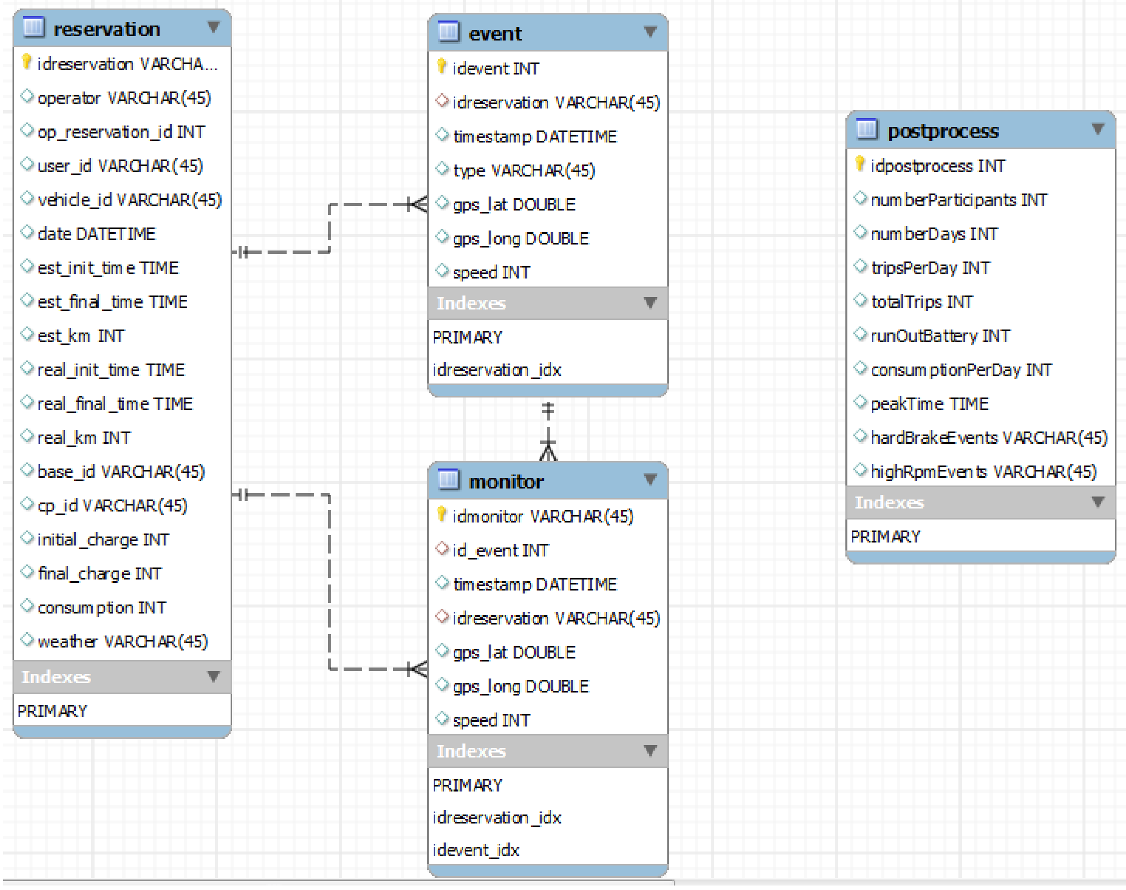


Figure 3-3 Proposed database structure

Different processes will help in the completion of the data tables. The columns for each of the defined tables are presented separated in the following two sections, one for the EV cars case and other for the hybrid bus case.

3.2.1 Tables for EV cars

The following tables are defined for the EV-cars and associated carsharing service.

Table 3.1.1: Reservations

NAME	TYPE	DESCRIPTION
RESERVATION_ID	**INT**	A unique identifier to define each reservation (unique for all operators and reservations)
OPERATOR	**VARCHAR**	Car-sharing operator of the reservation
OP_RESERVATION_ID	**INT**	A subjective unique identifier for reservations for each operator. This identifier can overlap between two reservations of two different operators,

		that is why RESERVATION_ID (unique for all the companies) has been defined as the key identifier and first column of the reservations table
USER_ID	**VARCHAR**	Unique identifier (could be the User ID registered for the user) for the user that makes the reservation
VEHICLE_ID	**VARCHAR**	Number on the plate of the car that has been reserved
RESERVATION DATE	**DATETIME**	Refers to the date-time when the user has made the booking process via web
STATUS	**VARCHAR**	Defines the status of the reservation. If it has been completed (vehicle picked up and trip done), not completed (vehicle not picked up and trip not done) or cancelled
EST_INIT_TIME	**TIME**	Estimated initial time for the reservation. Estimation done by the user when making the reservation. Detects not just the time also the date when the car is expected to be picked up
EST_FINAL_TIME	**TIME**	Estimated final time for the reservation. Estimation done by the user when making the reservation. Detects not just the time also the date when the car is expected to be returned
EST_KM	**INT**	Estimated amount of KM. Estimation done by the user when making the reservation
REAL_INIT_TIME	**TIME**	Real initial time for the reservation. Registered when the user picks up the previously reserved vehicle
REAL_FINAL_TIME	**TIME**	Real final time for the reservation. Registered when the user returns the vehicle at the end of the reservation process
REAL_KM	**INT**	Real amount of KM travelled by the user, during the reservation
BASE_ID	**VARCHAR**	Identification of the base where the user has picked up the vehicle
CP_ID	**VARCHAR**	Identification for the charging station from which the user has picked up the

		vehicle
INITIAL_CHARGE	**INT**	The battery level of the car, when the user picked up the vehicle
FINAL_CHARGE	**INT**	The battery level of the car, when the user returned the car after the reservation
CONSUMPTION	**INT**	The battery level difference between initial and final
WEATHER (Optional)	**VARCHAR**	The weather conditions (temperature, wind speed, relative humidity, etc.) for the region, when the user picked up the car
FUEL CONSUMPTION	**INT**	Fuel consumption per route

Table 3.1.2: Monitoring

NAME	TYPE	DESCRIPTION
ID	**INT**	Unique identifier for monitoring register
REGISTER_TIME	**DATETIME**	Date-time when the sample is registered
RESERVATION_ID	**INT**	The reservation id to which corresponds the sample
GPS_LAT	**DOUBLE**	GPS latitude for the location of the vehicle at the moment
GPS_LONG	**DOUBLE**	GPS longitude for the location of the vehicle at the moment
SPEED	**INT**	Speed of the vehicle at the sampling instant
NUMBER INSTRUCTIONS GIVEN	**INT**	This is the total number of instructions that the EV efficient driving service gives to the driver during a trip. Used in the hybrid bus.
NUMBER INSTRUCTIONS FOLLOWED	**INT**	This is the number of instructions given by the EV efficient driving service and that have been followed by the driver. Used in the hybrid bus.

Table 3.1.3: Events

NAME	TYPE	DESCRIPTION
ID	INT	Unique identifier for event register
REGISTER_TIME	DATETIME	Date-time when the event is registered
RESERVATION_ID	INT	The reservation id to which the event corresponds
TYPE	VARCHAR	Event type
GPS_LAT	DOUBLE	GPS latitude for the location of the vehicle at the event's moment (Define number of decimals)
GPS_LONG	DOUBLE	GPS longitude for the location of the vehicle at the event's moment (Define number of decimals)
SPEED	INT	Speed of the vehicle at the event instant
TRAFFIC (Optional)	VARCHAR	Traffic incidents to which the event could be related. In cases where traffic incidents are not registered around the GPS position this value could be defined as NULL

Table 3.1.4: Post Process

NAME	TYPE	DESCRIPTION
ID	INT	Unique identifier for post process register
NUMBER_PARTICIPANTS	INT	Number of different users that took part in the process
INITIAL_DATE	DATETIME	Initial date for the post process
FINAL_DATE	DATETIME	Final date for the post process
NUMBER_DAYS	INT	Number of days that the process took
TRIPS_PER_DAY	INT	Average number of trips made per day
TOTAL_TRIPS	INT	Total trips completed during the process
RUN_OUT_BATTERY	INT	Number of times the battery ran out
CONSUMPTION_PER_DAY	INT	Average consumption per day

PEAK_TIME	**TIME**	Time of the day when the highest average quantity of reservations is completed
HARD_BRAKING_EVENTS	**INT**	Number of hard braking events
HIGH_RPM_EVENTS	**INT**	Number of times RPM is high during idling

Table 3.1.5: User Uptake

Variables from questionnaires will be defined in D4.4 *smartCEM Assessment Tools*. The surveys are developed in collaboration with other CIP projects. Data will be stored in a set of tables as follows:

Table with the list of questions

NAME	TYPE	DESCRIPTION
QUESTION_ID	**INT**	Unique identifier for the question as identified in surveys of WP4
QUESTION_DESCRIPTION	**VARCHAR ()**	Description or full question

A table showing user response to each question

NAME	TYPE	DESCRIPTION
USER_ID	**INT**	Unique identifier for the question as identified in surveys of WP4
QUESTION_ID	**INT**	Unique identifier for the question as identified in surveys of WP4
SCALE	**INT**	1-5

The example would be:

QUESTION_ID	QUESTION_DESCRIPTION
01	**User-acceptance:** It is easy for me to remember how to perform tasks using the service

Responses are given on a scale where 1= Strongly disagree; 5 = Strongly agree

USER_ID	QUESTION_ID	SCALE
U005	**01**	4

3.2.2 Tables for the hybrid bus

The following tables are defined for the hybrid bus and associated public transport service.

Table 3.2.1: Trips

NAME	TYPE	DESCRIPTION
TRIP NUMBER_ID	INT	A unique identifier to define each trip
OPERATOR	VARCHAR	dBus
USER_ID	VARCHAR	Unique identifier for the bus driver
VEHICLE_ID	VARCHAR	ID. number of the bus
REAL_INIT_TIME	TIME	Real initial date and time of the trip at the beginning of the bus line.
REAL_FINAL_TIME	TIME	Real final date and time of the trip at the end of the bus line.
BUS_ROUTE_ID	VARCHAR	Number identifying the bus line to make difference among the ones considered in the tests
DIRECTION	VARCHAR	Two directions per bus route exist. This parameter indicates the direction in which the trip has been carried out
REAL_KM	INT	Real amount of KM travelled by the bus during the trip
FUEL CONSUMPTION	INT	Fuel consumption per trip

Table 3.2.2: Monitoring

NAME	TYPE	DESCRIPTION
ID	INT	Unique identifier for monitoring register
REGISTER_TIME	DATETIME	Date-time when the sample is registered
TRIP NUMBER_ID	INT	The trip id to which corresponds the monitored sample. Links the sample with a trip
DISTANCE	DOUBLE	Distance travelled at the sampling instant
SPEED	INT	Speed of the vehicle at the sampling instant

NUMBER INSTRUCTIONS GIVEN	INT	Total number of eff. driving instructions given by the system to the driver
NUMBER INSTRUCTIONS FOLLOWED	INT	Number of eff. driving instructions given by the system and followed by the driver

Table 3.2.3: Events

NAME	TYPE	DESCRIPTION
ID	INT	Unique identifier for event register
REGISTER_TIME	DATETIME	Date-time when the event is registered
TRIP_ID	INT	The trip id to which the event corresponds
TYPE	VARCHAR	Event type: hard braking, excess RPM when idling
GPS_LAT	DOUBLE	GPS latitude for the location of the vehicle at the event's moment (Define number of decimals)
GPS_LONG	DOUBLE	GPS longitude for the location of the vehicle at the event's moment (Define number of decimals)
SPEED	INT	Speed of the vehicle at the event instant

Table 3.2.4: Post Process

NAME	TYPE	DESCRIPTION
ID	INT	Unique identifier for post process register
NUMBER_PARTICIPANTS	INT	Number of different drivers that took part in the process
INITIAL_DATE	DATETIME	Initial date for the test period (different for baseline and for operational)
FINAL_DATE	DATETIME	Final date for the test period (different for baseline and for operational)
NUMBER_DAYS	INT	Number of days that the test period took
TRIPS_PER_DAY	INT	Average number of trips made per day

TOTAL_TRIPS	**INT**	Total trips completed during the process
CONSUMPTION_PER_DAY	**INT**	Average fuel consumption per day
HARD_BRAKING_EVENTS	**INT**	Total number of hard braking events
HIGH_RPM_EVENTS	**INT**	Total number of times RPM is high during idling
HARD_ACCELERATING_EVENTS	**INT**	Total number of hard accelerating events
TOT_INSTRUCTIONS FOLLOWED	**INT**	Total number of instructions followed during the considered period
TOT_INSTRUCTIONS_GIVEN	**INT**	Total number of instructions given during the considered period

Table 3.2.5: User Uptake

See what applies to Table 3.1.5 in section 3.2.1.

3.3 Summary

3.3.1 Event Catching

When a reservation is made and the driver picks up the car, the system will start to monitor on-trip data, collecting the information in the **Monitoring** table. This table will store data for 15min time lapses, and should have a registering frequency of 5 sec/reg.

Three different algorithms will be developed, which will work as watchdogs during the monitoring process.

1. **Hard Braking Watchdog**: will detect an event, in cases when the vehicle experiences a deceleration higher than (for example) 40km/h in a time span of 5 seconds.
2. **High Acceleration Watchdog:** will detect an event, in cases when the vehicle experiences acceleration higher than (e.g.) 50km/h in a time span of 5 seconds, after an idle status.
3. **High RPM Watchdog:** will detect an event, in cases when the vehicle experiences a high engine RPM (only for hybrid bus)
4. **Stop Watchdog:** will detect an event in cases in which the car doesn't change GPS position for a time span of 10 sec. (only for EV-cars)

Each time one of these watchdogs detects an event a new register will be generated in the **Event** table.

3.3.2 Post Process

Each week, when the data needs to be uploaded to the central database, a post processing task will be carried out. Both **Reservation/Trips** and **Events** tables will be analysed in order to obtain proper data for the **Post Process** table. The completed tasks will be calculations over the data already stored in those two tables (calculations such as average values, count of registers per day, etc.). The data obtained from the calculations will be stored in the **Post Process** table.

3.3.3 Local Database Upload to Central Database

In the case of the EV-vehicles, every week the local database with **Reservation**, **Events, User Uptake** and **Post Process** tables will be sent to the central database. **Monitoring** table data does not need to be uploaded, as it is just a control table with data not required for evaluation purposes.

In the case of the hybrid vehicle the information will be sent to central database twice: one for baseline and one for operational.

4 Newcastle

4.1 Introduction

The data from the Newcastle site will be collected from the data inputs of the two participating vehicle operators. The local DB for the system will be a locally built PostgreSQL server which has been previously used in the FootLITE and SwitchEV projects to similar effect.

The following different sources will be available for data acquisition:

1. **Data Loggers:** There are two different real time data loggers recording the vehicle data, due to existing historical technical capabilities. The data provided by the two logger types is on a second-by-second basis using an on-board logging system that is connected to the vehicle's CAN BUS. The two systems provide broadly similar data such as GPS, speed, power consumption etc. For the most important data types (GPS, power etc.) the data is functionally identical. Both OBUs send this data back to the local Newcastle database.
2. **CYC Data:** The main data supplied from CYC will be charge point location data. Data related to vehicles operating in the trial and their use of charge points will also be available.
3. **User Uptake:** The last source of data will be qualitative data provided by the drivers of the vehicles, who will contribute with personal impressions about the service provided through specially designed before-and-after surveys. The methodological approach to the qualitative data collection including surveys is defined in D4.4 *smartCEM Assessment Tools*.

The general data flow is shown below.

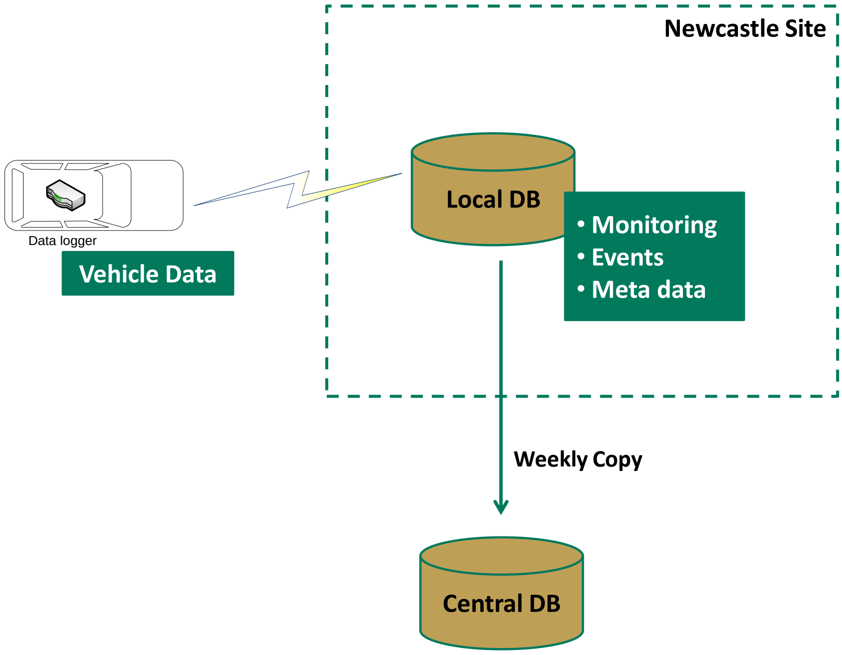


Figure 4-1 Schematic description of data collection in Newcastle

4.2 Approach

Three different tables in the local database will be populated with vehicle data.

Table 1: Monitoring

This is the main data store and will record all data from the vehicles and archive it in a spatially accessible format which can be acquired at any future point if other research questions arise. In general the data will be secure and anonymous to meet both security and ethical constraints. The measurement frequency of the data is approximately 1Hz (with some variation for data dropout) with a database update frequency after every completed trip.

Table 2: Events

In this table the aggregated results from the detailed second-by-second data in Table 1 will be stored in the form of single events. Typically a single event will be a *drive* event, a *charge* event or a *park* event. The data is constructed from automated analysis of the second-by-second data and will allow for flexible analysis of the data through the ability to alter analysis methods and techniques after the data is collected.

Table 3: Logger/Vehicle Table

This table tracks the GPS position of loggers and which vehicle each logger is installed in.

Table 4: Summary Table

This table is currently unformed and may simply be a query on the more complete “Events” table, rather than an independent table in its own right. Past experience has shown that the creation of a summary table is exceptionally quick and can thus be done on a case-by-case basis, if needed, although it is likely that a master summary table will be maintained, for each upload to the central database.

Table5: User Uptake

This table will collect the inputs given by the users of the service. These inputs will be obtained from surveys and questionnaires distributed among the users.

These will be the columns for each of the defined tables.

Table 4.1: Monitoring

NAME	TYPE	DESCRIPTION
ID	**INT**	Unique identifier for event register
USERID	**INT**	Individual id for each user
CHARGE_ID	**INT**	The id corresponding to each charge point
CHARGE_TRANS	**INT**	Charging transactions id
TIMESTAMP	**DATETIME**	Date-time of trip
LOGGERID	**VARCHAR**	The id corresponding to the data logger
GPS_LAT	**DOUBLE**	GPS latitude for the location of the vehicle
GPS_LONG	**DOUBLE**	GPS longitude for the location of the vehicle
GPS_ALT	**DOUBLE**	GPS Altitude, may be supplemented with additional info if inaccuracy
SPEED	**INT**	Instant speed either measured from the vehicle or derived from GPS position

SOC	**DOUBLE**	Current State of Charge (SOC) for the vehicle
Inst_Energy	**DOUBLE**	Energy consumption of the battery for each second
TEMP	**DOUBLE**	Ambient temperature as measured by the vehicle
BOOLEAN_#	**BOOLEAN**	Miscellaneous Boolean values for the different toggled states of the vehicle. For example, Headlights ON/OFF. Air Con ON/OFF, ignition ON/OFF. Varies for different vehicles

Table 4.2: Events

NAME	TYPE	DESCRIPTION
ID	**INT**	Unique identifier for event register
USERID	**INT**	Individual id for each user
CHARGE_ID	**INT**	The id corresponding to the charge point
CHARGE_TRANS	**INT**	Charging transactions id
TIMESTAMP	**DATETIME**	Date-time when the event is registered
LOGGERID	**VARCHAR**	The reservation id to which the event corresponds
TYPE	**VARCHAR**	Event type (Charge or Drive, possibly Park)
GPS_LAT_START	**DOUBLE**	GPS latitude for the location of the vehicle at the event's moment (start of journey)
GPS_LONG_START	**DOUBLE**	GPS longitude for the location of the vehicle at the event's moment (start of journey)
GPS_LAT_END	**DOUBLE**	GPS latitude for the location of the vehicle at the event's moment (end of journey)

GPS_LONG_END	**DOUBLE**	GPS longitude for the location of the vehicle at the event's moment (end of journey)
SPEED	**INT**	Speed of the vehicle over the event, if applicable
EVENTDURATION	**DATETIME (delta)**	Duration of the event
EVENTDISTANCE	**DOUBLE**	Event distance, if applicable
ENERGY	**DOUBLE**	Total Energy either consumed or used in the charge/drive event
REGEN	**DOUBLE**	Total energy regenerated
TEMPERATURE	**DOUBLE**	Ambient Temperature of the event
HARD_BRAKE	**INT**	Number of hard braking events
HARD_ACCEL	**INT**	Number of hard acceleration events

Table 4.3: Logger/Vehicle table

NAME	TYPE	DESCRIPTION
LOGGERID	**VARCHAR**	Unique identifier for logger
USERID	**INT**	Individual id for each user
VEHICLEID	**VARCHAR**	Unique identifier for the vehicle the logger is on
DATE_INSTALLED	**DATETIME**	Date the logger was installed

DATE_REMOVED	**DATETIME**	Date the logger was removed, if applicable

Table 4.5: User Uptake

Variables from questionnaires will be defined in D4.4 *smartCEM Assessment Tools*. The surveys are developed in collaboration with other CIP projects. Data will be stored in a set of tables as follows:

Table with the list of questions

NAME	TYPE	DESCRIPTION
QUESTION_ID	**INT**	Unique identifier for the question as identified in surveys of WP4
QUESTION_DESCRIPTION	**VARCHAR ()**	Description or full question

A table showing user response to each question

NAME	TYPE	DESCRIPTION
USER_ID	**INT**	Unique identifier for the question as identified in surveys of WP4
QUESTION_ID	**INT**	Unique identifier for the question as identified in surveys of WP4
SCALE	**INT**	1-5

The example would be:

QUESTION_ID	QUESTION_DESCRIPTION
01	**User-acceptance:** It is easy for me to remember how to perform tasks using the service

Responses are given on a scale where 1= Strongly disagree; 5 = Strongly agree

USER_ID	QUESTION_ID	SCALE
U005	**01**	4

4.3 Summary

4.3.1 Data Collection

The data collection will initially be identical to that undertaken for FootLITE and SwitchEV. The loggers will log all recorded data from the CAN-BUS which will be systematically uploaded through GPRS to a local database. This data will be stored "as-is" with no data checking or repairing at this point. The second table in the data, the "Event Table" will then be constructed from the second-by-second data on a regular basis. The error checking and correction will occur at this point with errors in data being either removed, replaced with more consistent data and interpolated over as is deemed necessary. All analysis will be conducted locally on the system, with additional FTP access used as required.

4.3.2 Data Summarising

Currently there are no firm plans for a single summary data table. However, as it will be generated from the event table it may not be necessary to create this as a stand-alone table, rather have the table exist as a series of queries on the event table. This will allow for a greater flexibility in reporting the data as the queries can be changed on a faster basis than a single concrete table.

4.3.3 Event Catching

The system will not be actively catching interesting events from the vehicles, partially due to the nature of the logging mechanisms used but mainly because a proper analysis of events is needed to put the interesting events into context before they are uploaded to a database devoid of context.

4.3.4 Local Database Upload to Central Database

The data upload will occur automatically from Table 2 (Events) and Table 4 (if the summary table exists). If Table 4 is only a virtual table produced form a local query on Table 2 then it will be this that is uploaded into the central database. Due to the size of the table, the monitored data will only be stored locally. In addition the metadata concerning the logger position will only be stored locally.

5 Reggio Emilia

5.1 Introduction

The registered data will be collected from the OBUs mounted onto the 10 vehicles that will be used within the project and the car sharing services of the Municipality of Reggio Emilia.

All data recorded from the vehicles will be archived it in LDB. In general the data will be secure and anonymous to meet both security and ethical constraints. Each user and vehicle will be assigned an ID not accessible to ICOOR/UNIMORE personnel, thus assuring anonymity for the smartCEM project.

The data stored in this local database will be sent daily to a central database allocated in the Newcastle external server. Update will be performed through FTP sending incremental data through ***.csv*** file to Central Database.

There will be three different sources for data acquisition:

1. **Data Acquisition System:** The first source of data will be the Data Acquisition System. Two OBUs (On-Board Unit) are installed in the cars in order to have a DAS connected to the vehicle network. This hardware communicates with a 7’’ Android tablet through Bluetooth and with Local Database through GPRS, sending data to the webserver. It registers figures such as, GPS location, speed, completed km, State of Charge.
2. **Key management system:** Apart from the information coming from the vehicles, the Back Office data are also provided by the car sharing management system of the municipality. It is a particular cabinet for vehicle key management and it will be integrated with smartCEM architecture and services providing data of vehicle usage.
3. **User uptake:** The last source of data will be the drivers of the vehicles, who will contribute with personal impressions about the service provided by the operators. This qualitative data will be collected by distributing surveys among the users/drivers of the service. The methodological approach to the qualitative data collection including surveys is defined in D4.4 *smartCEM Assessment Tools*.

The general system of data collection is illustrated below:

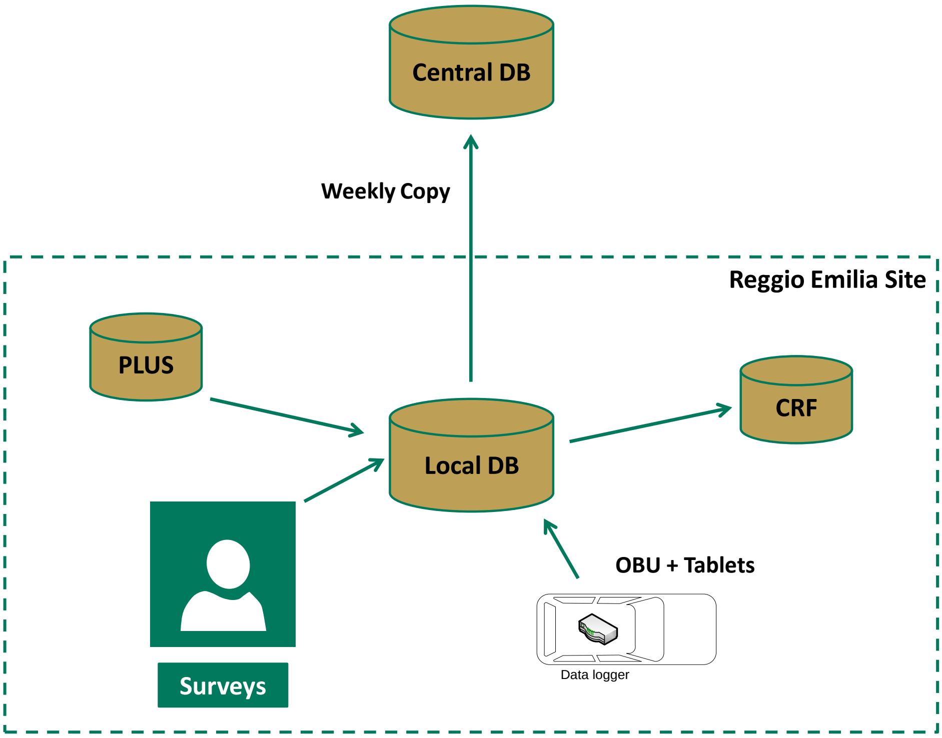


Figure 5-1 Schematic description of data collection in Reggio Emilia

5.2 Approach

The local DB is currently being designed. The tables for this new database will keep the information that is needed in order to complete the table of measures specified for WP4. The local database will be composed of four different tables.

Table1: Vehicle

This table will report details of vehicles involved in project. It will be fixed as much as possible, but also data about covered distance, status and SoC will be reported.

Table2: Users

This table will report details of users involved in project. It will be fixed as much as possible, but also data about covered distance and status will be reported.

Table3: Charging Spot Area

This table will report data about Charging Spot Areas and Point of Charge. Their status will be present.

Table4: Monitoring

This table will monitor the car fleet's real-time data, in order to control the status of the reservations. Registering frequency should be established at a rate of 2seconds/per_reg (0,5 Hz). Data coming from DAS will be reported in this table.

Table5: Trips

This table will present post-processed data about performed trips reporting data such as vehicle, driver and covered distance.

Table6: Events

This table will register any event given during trip. Watchdogs will be enabled to detect different type of events held on-trip (e.g. battery run-out events).

Table7: Post Process

The post process table will be filled with the data obtained from the processing of the **Events** table.

Table8: User uptake

This table will collect the inputs given by the users of the service. These inputs will be obtained from surveys and questionnaires distributed among the users.

These will be the columns for each of the defined tables:

Table 5.1: Vehicle

NAME	TYPE	DESCRIPTION
VEHICLE_ID	**INT**	Unique identifier for vehicle
PLATE	**VARCHAR**	Vehicle plate number
VEHICLE_STATUS	**INT**	Status of vehicle concerning project

STARTING_DISTANCE	**INT**	Km covered at project starting (from odometer)
CURRENT_DISTANCE	**INT**	Current km covered (from odometer)
COVERED_DISTANCE	**INT**	Km covered during project
VEHICLE_SOC	**INT**	Current vehicle State of Charge
RUN_OUT_BATTERY	**INT**	Number of times the battery ran out
TOTAL_CONSUMPTION	**INT**	Total consumption during project

Table 5.2: Users

NAME	TYPE	DESCRIPTION
USERS_ID	**INT**	Unique identifier for user
GENDER	**VARCHAR**	User gender
YEAR_BIRTH	**INT**	Year of birth of users
USER_STATUS	**INT**	Status of user concerning project
COVERED_DISTANCE	**INT**	Km covered during project
TOTAL_CONSUMPTION	**INT**	Total consumption during project

Table 5.3: Charging Spot Area

NAME	TYPE	DESCRIPTION
CSA_ID	INT	Unique identifier for Charging Spot Area
CSA_STATUS	VARCHAR	Status of Charging Spot Area
DESCRIPTION	VARCHAR	Charging Spot Area description
ADDRESS	VARCHAR	Address of Charging Spot Area
CITY	VARCHAR	City of Charging Spot Area
CSA_LAT	DOUBLE	GPS Latitude of Charging Spot Area
CSA_LONG	DOUBLE	GPS Longitude of Charging Spot Area
PDR	INT	Number of Charging Point for each Charging Spot Area

Table 5.4: Monitoring

NAME	TYPE	DESCRIPTION
MONITORING_ID	INT	Unique identifier for monitoring register
TIMESTAMP	DATETIME	Date-time when the sample is registered
VEHICLE_ID	INT	Vehicle running

KEY_STATUS	**INT**	Status of vehicle in logging (e.g. Key ON event, Key on and running, Key OFF event, Key OFF continuous, charging)
USER_ID	**INT**	User driving
GPS_LAT	**DOUBLE**	GPS latitude for the location of the vehicle at the moment (Define type of GPS coordinate to be logged)
GPS_LONG	**DOUBLE**	GPS longitude for the location of the vehicle at the moment (Define type of GPS coordinate to be logged)
ALTITUDE	**INTEGER**	Altitude of the vehicle
SPEED	**INT**	Speed of the vehicle at the sampling instant
HEADING	**VARCHAR**	Direction
INCREMENTAL_DISTANCE	**INT**	Incremental distance from Key ON Event to Key OFF event
INCREMENTAL_TIME	**INT**	Incremental Travel Time from Key ON Event to Key OFF event
CURRENT	**DECIMAL**	Electricity (A)
TENSION	**DECIMAL**	Potential Difference (V)
STATE OF CHARGE	**DECIMAL**	Charge of the battery

Table 5.5: Trips

NAME	TYPE	DESCRIPTION
TRIP_ID	**INT**	Unique identifier for Trip
VEHICLE_ID	**INT**	Vehicle used in trip

USER_ID	**INT**	User driving in trip
STARTING_TIME	**DATETIME**	Starting time of trip
END_TIME	**DATETIME**	End time of trip
TRIP_DURATION	**TIME**	Duration of trip (s)
ENERGY CONSUMPTION	**DECIMAL**	Energy consumed
STARTING_SOC	**INT**	Starting State of Charge
END_SOC	**INT**	Ending State of Charge
STARTING_LAT	**DOUBLE**	GPS Latitude of Trip Starting
STARTING_LONG	**DOUBLE**	GPS Longitude of Trip Starting
STARTING_CSA	**INT**	Starting Charging Spot Area ID
ENDING_LAT	**DOUBLE**	GPS Latitude of Trip Ending
ENDING_LONG	**DOUBLE**	GPS Longitude of Trip Ending

ENDING_CSA	**INT**	ENDING Charging Spot Area ID
TRAVELLED_DISTANCE	**DECIMAL**	Travelled distance
SMARTCEM_SERVICES_ON	**INT**	Active smartCEM services (0=none, 1=Navigation, 2=Efficient Driving, 3=Both).

Table 5.6: Events

NAME	TYPE	DESCRIPTION
ID	**INT**	Unique identifier for event register
TIMESTAMP	**DATETIME**	Date-time when the event is registered
TYPE	**VARCHAR**	Event type
GPS_LAT	**DOUBLE**	GPS latitude for the location of the vehicle at the event's moment
GPS_LONG	**DOUBLE**	GPS longitude for the location of the vehicle at the event's moment
SPEED	**INT**	Speed of the vehicle at the event instant
TRAFFIC (Optional)	**VARCHAR**	Traffic incidents to which the event could be related. In cases where traffic incidents are not registered around the GPS position this value could be defined as NULL
EVENT STARTING TIME	**DATETIME**	Starting time of the charging session

EVENT END TIME	**DATETIME**	Ending time of the charging session

Table 5.7: Post Process

NAME	TYPE	DESCRIPTION
ID	**INT**	Unique identifier for post process register
NUMBER_PARTICIPANTS	**INT**	Number of different users that took part in the process
NUMBER_DAYS	**INT**	Number of days that the process took
TRIPS_PER_DAY	**INT**	Average number of trips made per day
TOTAL_TRIPS	**INT**	Total trips completed during the process
RUN_OUT_BATTERY	**INT**	Number of times the battery ran out
CONSUMPTION_PER_DAY	**INT**	Average consumption per day

Table 5.8: User Uptake

Variables from questionnaires will be defined in D4.4 *smartCEM Assessment Tools*. The surveys are developed in collaboration with other CIP projects. Data will be stored in a set of tables as follows:

Table with the list of questions

NAME	TYPE	DESCRIPTION
QUESTION_ID	**INT**	Unique identifier for the question as identified in surveys of WP4
QUESTION_DESCRIPTION	**VARCHAR ()**	Description or full question

A table showing user response to each question

NAME	TYPE	DESCRIPTION
USER_ID	**INT**	Unique identifier for the question as identified in surveys of WP4
QUESTION_ID	**INT**	Unique identifier for the question as identified in surveys of WP4
SCALE	**INT**	1-5

The example would be:

QUESTION_ID	QUESTION_DESCRIPTION
01	**User-acceptance:** It is easy for me to remember how to perform tasks using the service

Responses are given on a scale where 1= Strongly disagree; 5 = Strongly agree

USER_ID	QUESTION_ID	SCALE
U005	**01**	4

5.3 Summary

5.3.1 Data Quality Check

Data will be checked for integrity and completeness before being processed.

5.3.2 Post Process

Each week, when the data needs to be uploaded to the central database, a post processing task will be done. The **Events** table will be analysed in order to obtain proper data for the **Post Process** table. The completed tasks will be calculations of the data already stored in those two tables (calculations such as average values, count of registers per day, etc.). The data obtained from the calculations will be stored in the **Post Process** table.

5.3.3 Local Database Upload to Central Database

Every day the local database with **Events, User Uptake** and **Post Process** tables will be sent to the central database. **Monitoring** table data does not need to be uploaded, as it is just a control table with data not required for evaluation purposes.

6 Conclusion

This document has described the local systems and processes in place at the smartCEM pilot sites for collecting, storing, and managing data that is the minimum appropriate for the project's evaluation phase. The local databases have been presented on a site-by-site basis.

Each site will collect data to a number of tables. Broadly (with some slight variations) these are Monitoring, Events, Post Process and User Uptake. The User Uptake tables store qualitative data collected from driver response questionnaires and are not presented in detail in this document. These will be populated based on the methodological approach and designed surveys to be presented in D4.4.

Data from the Monitoring tables will not be uploaded to the central database as this is a control table with large amounts of data not required for evaluation purposes.

Table 6.1 presents the Events data that will be transferred from each pilot site local database to the central database on a weekly schedule. **This table will not be replicated in the database, but is for information only.** It shows which data is common across the sites and which is specific to individual sites. Note that the name of some events may vary between sites (for precise names please refer to the tables shown in the site-by-site chapters).

Table 6.1: Consolidated table of events for all pilot sites showing events data to be transferred from local databases to the central database

NAME	TYPE	DESCRIPTION	PILOT SITE			
			BAR	GIP	NEW	REG
RESERVATION_ID	**INT**	A unique identifier to define each reservation (unique for all operators and reservations)	1	1	1	1
ID	**INT**	Unique identifier for the event register	1	1	1	1
REGISTER_TIME	**DATETIME**	Date-time when the event is registered	1	1	1	1
TYPE	**VARCHAR**	Event type (charge, drive or park)	1	1	1	1
GPS_LAT	**DOUBLE**	GPS latitude for the location of the vehicle at the event's moment	1	1	1	1
GPS_LONG	**DOUBLE**	GPS longitude for the location of the vehicle at the event's moment	1	1	1	1
SPEED	**INT**	Speed of the vehicle over the event	0	1	1	1
SHF_SPEED	**DECIMAL**	Speed of the vehicle at sampling time	1	0	0	0
TRAFFIC	**VARCHAR**	Traffic incidents to which the event could be related	0	1	0	1
START TIME CHARGING EVENT	**DATETIME**	Starting time of the charging session	0	0	0	1
END TIME CHARGING	**DATETIME**	Ending time of the charging session	0	0	0	1

NAME	TYPE	DESCRIPTION	PILOT SITE			
			BAR	GIP	NEW	REG
EVENT						
EVENT DURATION	**DATETIME**	Duration of the event	0	0	1	0
EVENT DISTANCE	**DOUBLE**	Event distance if applicable	0	0	1	0
ENERGY	**DOUBLE**	Total energy consumed or used in the charge/ drive event	0	0	1	0
REGEN	**DOUBLE**	Total energy regenerated	0	0	1	0
TEMPERATURE	**DOUBLE**	Temperature of the event	0	0	1	0
HARD_BRAKE	**INT**	Number of hard braking events	0	0	1	0
HARD_ACCEL	**INT**	Number of hard acceleration events	0	0	1	0

This document should be read in conjunction with D3.2 *Common Data Exchange Protocol for smartCEM* in which a final version of the above table will be produced.

References

[1] smartCEM, D2.1 Reference Architecture, 2012

[2] smartCEM, D2.2 Platform Architecture, 2012

[3] smartCEM, D2.3 Guidelines and requirements for the integration of local systems into the smartCEM architecture, 2012

[4] smartCEM, D3.2 Common data exchange protocol for smartCEM, due October 2013

[5] smartCEM, D4.3 smartCEM experimental design, 2013

[6] smartCEM, D4.4 smartCEM Assessment Tools, 2013smartCEM, Description of Work, 2012

[7] Switch EV http://vehicletrial.switchev.co.uk/the-project/what-is-switch-ev.aspx (checked 1st August 2013)

[8] Footlite http://www.foot-lite.net/ (checked 1st August 2013)

List of Figures

List of Tables

Appendix A - Measures

The table below is an abbreviated version of the full measures table for each pilot site, presented in full in D4.3.

FIELD	CODE	NAME	DESCRIPTION	PILOT SITE				UNIT	ACQUIRED OR REQUIRED	DATA TYPE
				BAR	GIP	NEW	REG			
DEMOGRAPHICS	ME_001	NumP	Number of participants	1	1	1	1	Participant	Required	Integer NEW: character
MOBILITY	ME_101	Td	time of day	1	1	1	1	hh:mm:ss	Required	Date time NEW: POSIXlt
MOBILITY	ME_102	da	Date	1	1	1	1	yy:mm:dd	Required	Date NEW: POSIXlt
MOBILITY	ME_103	Stt	Starting time of trip	1	1	1	1	hh:mm:ss	Required	Date time
MOBILITY	ME_104	Ett	End time of trip	1	1	1	1	hh:mm:ss	Required	Date time
MOBILITY	ME_105	du	Duration of trip	1	1	1	1	min	Required	Date time
MOBILITY	ME_106	NumD	Number of days.	1	1	1	0	Number	Required	Integer
MOBILITY	ME_107	dt	travelled distance	1	1	1	1	km (kilometers)	Required	Integer
MOBILITY	ME_108	kmd	Kilometers travelled per day	1	0	1	0	km/ day (kilometers per day)	Required	
MOBILITY	ME_111	NumIT	Number of incentivized trips per day.	1	0	0	0	Number	Required	Integer
MOBILITY	ME_112	NumTT	Number of complied trips per day	1	1	1	1	Number	Required	Integer
MOBILITY	ME_118	NumT	Number of trips	1	1	1	0	Number	Required	Integer

MOBILITY	ME_119	GPS	Lat,Long,altitude	1	1	1	1	Degrees	Acquired	Float (double)
ENGINE	ME_204	Fc	Fuel consumption per route	0	1	0	0	l(liters)	Required	Float
VEHICLE	ME_251	VIS	Vehicle instant speed	1	1	1	1	Km//h per time unit	Required	Float
VEHICLE	ME_252		Vehicle ID	1	1	1	0	Code	Required	string / varchar
BATTERY	ME_301	SOC initial	State of charge of the battery initial.	1	1	1	0	kWh (kilowatts x hour)	Required	Float
BATTERY	ME_302	SOC final	State of charge of the battery final.	1	1	1	0	kWh (kilowatts x hour)	Required	Float
BATTERY	ME_303	NROB	Number of run-out of battery events	1	1	1	1	Number	Required	Integer
BATTERY	ME_305		State of charge	1	1	1	1	%	Acquired	
BATTERY	ME_306	Current	Current of battery	1	0	1	1	Amps	Acquired	
BATTERY	ME_307	Voltage	Voltage of battery	1	0	1	1	Volts	Acquired	
ENERGY	ME_401	E	Energy consumption	0	0	1	1	kWh (kilowatts x hour)	Required	Integer
ENERGY	ME_402	Re	Regenerated energy	0	1	1	0	kWh (kilowatts x hour)	Required	Float
ENERGY	ME_403	Ec	Energy consumption per day	1	0	1	1	kWh	Required	Integer
ENERGY	ME_405	Emx	Energy mix	1	1	1	0	kWh	Required	Float
ENERGY	ME_407	Ekm	Energy consumption		0	1	0	kW/km	Acquired	Integer
CHARGING	ME_501	Ece	End time charging event	0	0	1	1	hh:mm:ss	Required	Date

CHARGING	ME_502	Sce	Starting time charging event	0	1	1	1	hh:mm:ss	Required	Date time
CHARGING	ME_505	cpID	Charging post ID	0	1	1	1	post per day	Required	Integer (varChar)
CHARGING	ME_506	ctID	Charging transaction ID	0	1	1	1	Number	Required	Integer
CHARGING	ME_507	Pt	Peak- Time	0	1	1	1	hh:mm:ss	Required	Date time
CHARGING	ME_508		Number of charge events	0	0	1	0		Acquired	
USER UPTAKE	ME_601	NumSc	Number of score	1	1	1	1	score	Required	Integer
USER UPTAKE	ME_602	AnS	Range anxiety score	1	1	1	1	score	Required	Integer
USER UPTAKE	ME_603	GAccS	General acceptance scores for electric vehicles	1	1	1	1	score	Required	Integer
USER UPTAKE	ME_604	Gwp	General willingness to pay items	1	1	0	1	score	Required	Integer
USER UPTAKE	ME_606	AccSs	User acceptance score of smartCEM services	0	0	1	1	score	Required	Integer
USER UPTAKE	ME_607	ConSc	Confidence questionnaire items	0	0	1	0	score	Required	Integer
USER UPTAKE	ME_609	Uss	Usefulness scale scores	0	0	1	0	score	Required	
USER UPTAKE	ME_610	Sss	Satisfaction scale scores	0	0	1	0	score	Required	
USER UPTAKE	ME_611	AccSIT	User acceptance scores for incentived trips.	1	1	1	0	score	Required	Integer
USER UPTAKE	ME_613	Swp	Willingness-to-pay scores	1	1	0	1	score	Required	Integer
DRIVER BEHAVIOUR	ME_701	NumIF	Number of instructions followed by EV driver	0	1	0	0	instruction	Required	Integer
DRIVER BEHAVIOUR	ME_702	NumIG	Number of instructions given by EV driver	0	1	0	0	instruction	Required	Integer
DRIVER BEHAVIOUR	ME_712	InsAccel	Instant acceleration (EVs)	1	0	0	0	m/s2	Required	Float
DRIVER BEHAVIOUR	ME_716		Number of hard braking events	0	1	0	0	Number	Required	Integer

DRIVER BEHAVIOUR	ME_717		High RPM when idling	0	1	0	0	seconds	Required	Float
SITUATIONAL VARIABLES	ME-901		Weather (rain, snow)		1			On / off OR Event		VarChar
SITUATIONAL VARIABLES	ME-902		Traffic flow		0			veh/h		Integer
SITUATIONAL VARIABLES	ME-903		Road capacity		0			veh/h		Integer
SITUATIONAL VARIABLES	ME-904		Traffic events		1			Event		VarChar
SITUATIONAL VARIABLES	ME-905		Light condition		0			On/off		Boolean
SITUATIONAL VARIABLES	ME-906		Transport card use		0			Yes / NO		Boolean

Appendix B -Data Logger Specifications

Barcelona

Technical specifications of the data loggers used in Barcelona are listed below.

Element	Value/ Characteristics
Memory	32 Mb RAM
Processor type	ARM9
Communication	GSM/GPRS
Interfaces with the vehicle	CAN, DIO's
Battery Management System	NA
OS	Android
Interface with other devices	USB, RS 232
SD-card size/internal memory	NA

Gipuzkoa

The following table presents the main OBU/data logger utilised by the Gipuzkoa pilot site in projects.

Element	**Value/Characteristics**
Processor	32 bits RISC ARM9 220MIPS
RAM memory	64 MB
Internal Storage	128 MB
Mobile communications	Dual-Band UMTS: 900 / 2100 Mhz Dual-Band GSM: 900 / 1800 Mhz
GPS	Sensitivity up to -160 dBm in tracking Sensitivity up to -147 dBm in startup
Communication with vehicle	CAN BUS and 3 digital inputs
OS	Linux kernel 2.6.26
Temperature range	-20 to 70ºC
Interfaces	USB Host USB Device mini A-B

Newcastle upon Tyne

The data loggers to be used in the Newcastle pilot site are supplied by RDM Telematics.

GENERAL SPECIFICATIONS

- Power Supply:
  - —Nominal Voltage Range: 6 to 36 Vdc.
- Interfaces:
  - —Power Supply.
  - —4 Digital Inputs, 3 Digital Outputs, 1 Power Output
  - —Power ON/OFF input signal.
  - —Audio IN/OUT.
  - —RS-232 Serial Port.
  - —Secondary UART.
  - —GSM and GPS antenna connectors.
  - —1 Odometer (1) input.

(1) Multiplexed with one of the digital inputs.

- Approvals
  - —CE Marking.
  - —e-marking.
- Power Consumption-Typical Average @ 12V

Zero Power Mode	4 uA
Low power mode	2 mA
Sleep(2)	6 mA
Run(3)	180 mA

(2) GSM camping and CPU I sleep.
(3) GPS Running and GSM transmitting at maximum power.

- External LEDs for information and internal Movement Sensor.
- RTC and GPS with dedicated battery, 1 month autonomy at 25°C.
- Temperature Ranges:

Operating (Fully GSM compliant)	-30°C to +75°C
Operatig with GSM OFF	-40°C to +85°C
Storage	-40°C to +85°C
With internal battery back-up accessory. (4)	-20°C to +60°C

(4) Allowing battery discharge.

FIRMWARE SPECIFICATIONS

- 32 bits RISC ARM7 core up to 60 MIPS (Dhrystone 2.1) at 70 Mhz.
- Linux OS (Kernel v.2.4.18).
- TCP/IP Stack
- Memory:
  - —8 Mbyte FLASH
  - —16 Mbyte RAM
- Application Programming Interface for:
  - —Owa21A control.
  - —Power management.
  - —GSM/GPRS.
  - —Internet connection.
  - —Controlling all the interfaces: I/Os.
  - —GPS.
  - —Movement Sensor
- Multiplexed communication supported with GSM/GPRS modem allowing GSM events and SMS during GPRS connection.

GSM/GPRS SPECIFICATIONS

- GSM850 + EGSM900 + DCS1800 + PCS1900.
- Power Output Class 4 (2W) for GSM850/EGSM900.
- Power Output Class 1 (1W) for DCS1800/PCS1900.
- GPRS Class B, Class 10 (4+2).
- Audio and CSD Data calls.
- SMS (MT/MO).

GPS SPECIFICATIONS

- Receiver: L1 frequency, 16 Channel.
- Update Rate: >/= 4 Hz.
- Accuracy: 2.5 m CEP (Circular Error Probability).
- Signal Acquisition:
  - — Cold Start: 34 sec.
  - — Warm Start: 33 sec.
  - — Hot Start: < 3.5 sec.
  - — Aided Start: 5 sec.
- Signal Reacquisition: < 1 sec.
- Power supply for active antenna.: +3 Volt @ 30mA current

MECHANICAL SPECIFICATIONS

- Dimension (mm): 106 (W) x 27 (H) x 55 (L).
- Weight < 170gr (plain device with no accessories).
- Material: Aluminum anodized.
- Connectors:
  - — GSM: FAKRA D Plug.
  - — GPS: FAKRA C Plug
  - — AMP Micro Mate-N lock 14 pins.
  - — RS-232 DB-9 (Female).
  - — Molex Mini-fit 6 pins.
  - — Tamper-proof SIM card holder.

UNIVERSAL DEVELOPMENT KIT

A development kit is available, including:
— GSM/GPRS, GPS and Bluetooth antennas.
— Developer's board.
— Power supply cables.
— Cables for interfaces.
— CD with: Cross compiler, API's library, manuals, and application notes.
— Wall-plug to supply the owa21X and Development Board.

RELATED PRODUCTS AND ACCESSORIES

— Internal Battery back-up accessory 1000mAh.
— owa21A-BASIC.
— owa21I-Telemetry and all owa2X products.

Reggio Emilia

Technical specifications of the data loggers used in Reggio Emilia are listed below.

Element	**Value/ Characteristics**
Processor	Freescale Kinetis k60 (cortex-m4)
Communication	GPS/GPRS/BT
Interfaces with the vehicle	CAN, OBD-II
User Interface (touch screen, ...)	N/A
Internal Storage	N/A