BORDEAUX 2015

22nd ITS World Congress
Bordeaux, France
5 to 9 October
2015

ICT Requirements for On-Road Electric Vehicle Charging

Presenter and co-author:
Andrew Winder
ERTICO

Main authors:
Oussama Smiai, Francesco Bellotti
University of Genoa

TOWARDS INTELLIGENT MOBILITY
Better use of space

Organised by
ERTICO ITS Europe

Co-organised by
ITS America
Asia-Pacific ITS

Hosted by
TOPOS Cluster Aquitain Applications Satellitaires

On behalf of
Région Aquitaine
Gironde Le Département gironde.fr
Bordeaux Métropole
Bordeaux

Supported by
ITS France Systèmes de Transport Intelligents
Ministère de l'Écologie, du Développement durable et de l'Énergie
Cerema
IFSTTAR

BORDEAUX 2015

22nd ITS World Congress
Bordeaux, France
5 to 9 October
2015

Contents

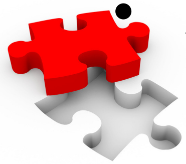
- Electro-mobility and the FABRIC project
- EV charging modes
- Charging architecture
- ICT requirements and gap analysis
- Conclusions and next steps

TOWARDS INTELLIGENT MOBILITY
Better use of space

Electro-mobility & the FABRIC project

- Electro-mobility:
  - Potentially a key contributor to decarbonising road transport
  - But “range anxiety” is still a barrier for longer distance users

- Barriers:
  - Locations and availability of charge points
  - Plug standards or requirements (accounts) for using them
  - Charging time



- A solution:
  - On-route charging (conductive or wireless power transfer)
  - The FABRIC project is investigating this

FABRIC

- “Feasibility analysis and development of on-road charging solutions for future electric vehicles”
- 23 partners, 4 years (2014-2018)
- Funded by European Commission, DG-Research & Innovation

Electric vehicle charging modes

Static charging

- Typically over 5 minutes duration, at an off-road location
- Vehicle motor switched off, driver presence not necessary except to verify start of charging

Stationary charging

- Typically under 5 minutes duration, on road (or roadside)
- Driver is present and vehicle motor may be on or off

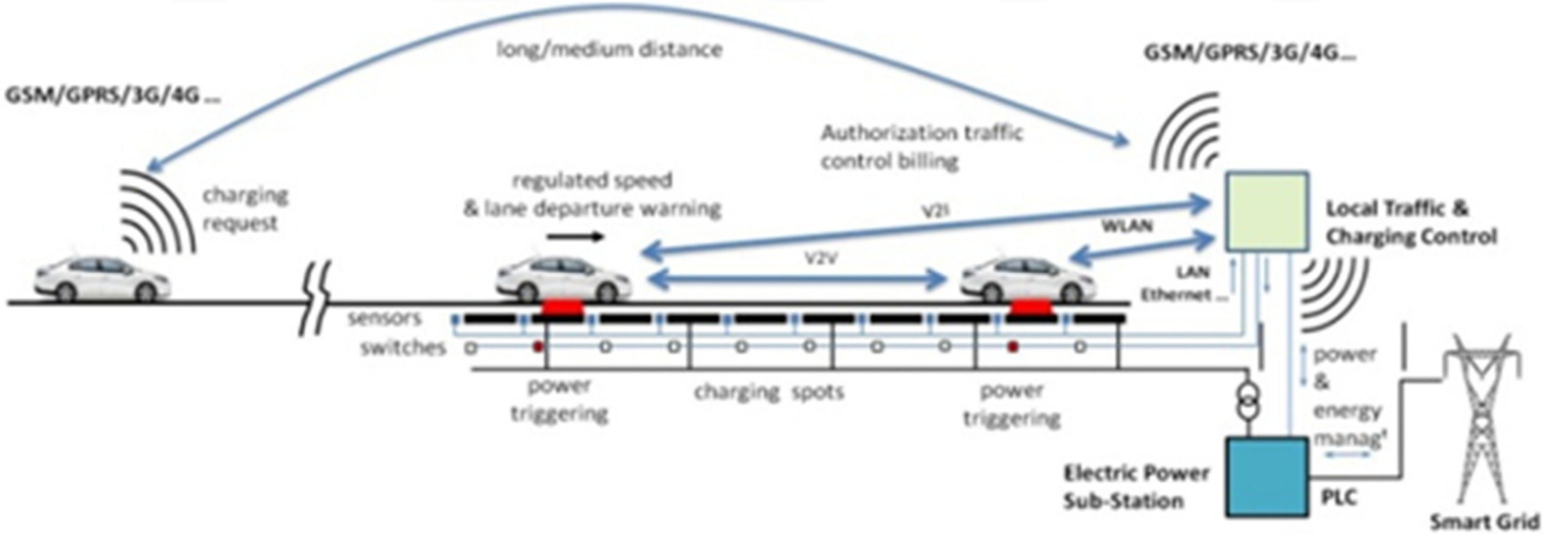
Dynamic charging

- Charging time depends on vehicle speed and dimensions of the charging infrastructure: perhaps several seconds, almost certainly under 1 minute
- Vehicle is being driven either in a shared traffic lane or a dedicated lane
- With wireless charging, several pads will be needed in order to provide sufficient charge to a moving vehicle

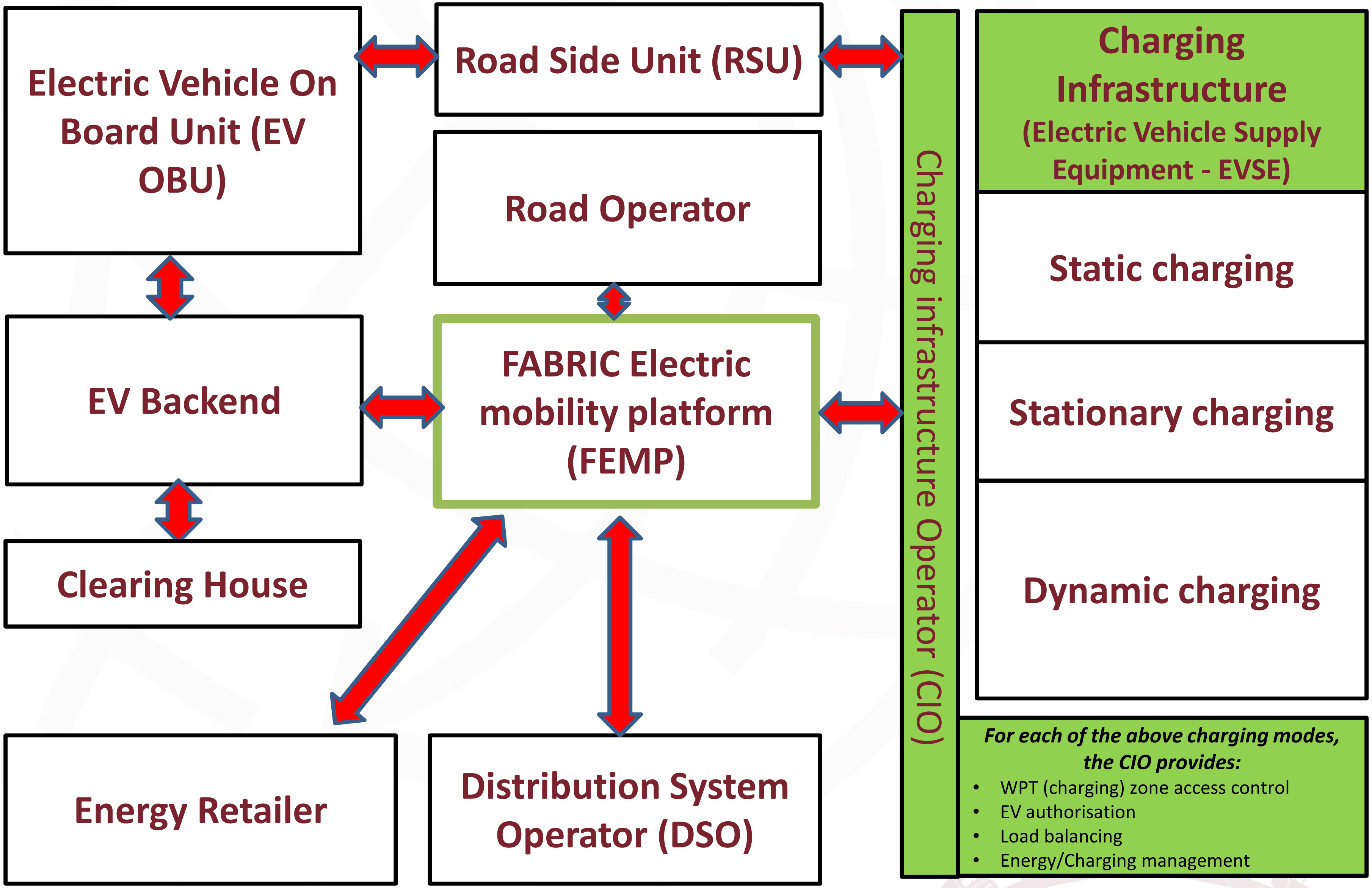
Wireless Power Transfer (WPT)

- Uses charging pads in or on the road surface
- Stationary charging trials with pads already operational, e.g. for buses

- Dynamic WPT is the next level and focus of FABRIC



Charging architecture



ICT requirements

FABRIC listed 31 functionalities grouped into 6 categories:

1. **User accounts, booking and billing** (5 functionalities)
2. **Dynamic routing for Electric Vehicles** (10 functionalities)
3. **Vehicle identification, charging lane access control and management/enforcement** (3 functionalities)
4. **ICT control of Wireless Power Transfer** (2 functionalities)
5. **Driving assistance while charging** (1 functionality)
6. **Distribution Supply Operator (DSO) and grid management** (10 functionalities)

- Done for a projected future system concept in the year 2030+
- Priority of functions:
  - 23 High (essential)
  - 5 Medium (important, but not essential for an early prototype)
  - 3 Low (nice to have)

ICT requirements – 1

User accounts, booking and billing

- Driver needs to create an account to use the charging infrastructure, which uses a list of users to identify eligibility

- Account should allow driver to use charging stations of different operators and in different countries
- A booking system would enable charging station operator to meet demand
- Need to take into account the difference between the transmitted energy and the energy that is actually received by the electric vehicle

Gap analysis – 1

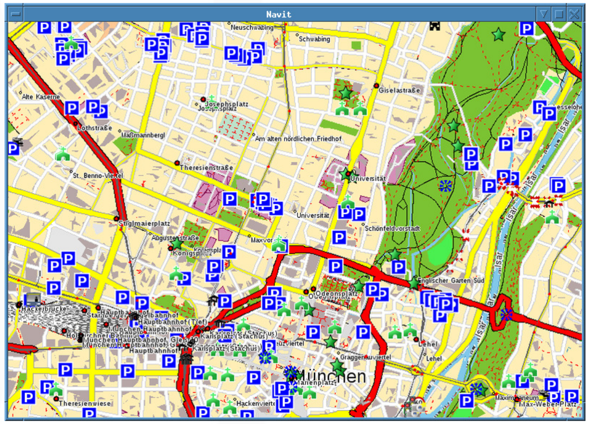
User accounts, booking and billing

- Need for booking for the stationary & dynamic charging should be investigated. If booking is necessary there should be a mechanism to take into account delays in reaching the charging infrastructure

- Billing process will need to be different for two reasons:
- The EV is on the move and there is no physical contact of the user with the EVSE (to use a credit card for example)
- The billing process should take into account the difference between the transmitted energy and the energy that is actually received by the EV (wireless charging losses can be more than 20%)

ICT requirements – 2

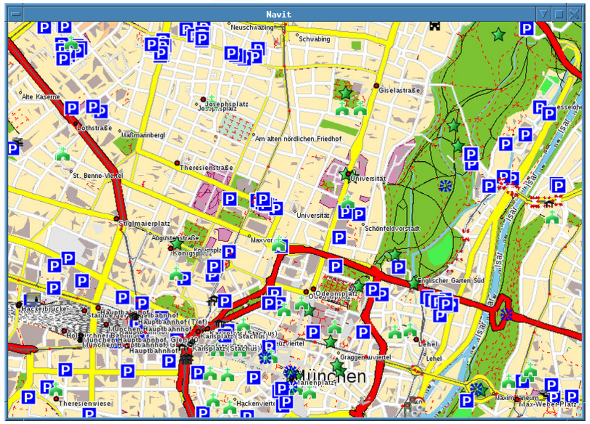
Dynamic routing for EVs



- Itinerary choice
- Charging infrastructure location and availability:
  - When a charging lane is used by a high number of EVs, the delivered power will stress the grid and possibly put the electric charging lane temporarily out of service
- Low charge warning and routing to closest charging infrastructure
- Charging location choice
- Trip timing
- Saving preferences

Gap analysis – 2
Dynamic routing for EVs

- State-of-the-art for EV navigation systems from 5 vehicle manufacturers:
  - Display places that can be reached within the battery range
  - Warn the driver if not possible to reach destination without charging
  - Display characteristics of charging stations (operator, mode, voltage, etc.)



- Existing navigation systems meet the essential requirements:
  - Itinerary choice, locating infrastructure, route calculation
- Future requirement:
  - Provide availability and pricing information in real time.

ICT requirements – 3

EV identification, lane access control and management / enforcement

- Speed of identification & authorisation for dynamic charging should be much faster than for static charging. Depending on speed, it should take only a few milliseconds per charging pad
- Need a mechanism to take into account delays in reaching the charging infrastructure for booked vehicles

- Access to lane could be controlled (traffic signals or barriers), possibly with camera enforcement, or free access (all vehicles):
  - Physical configuration may depend on charging lane location (urban, motorway, etc) and traffic speeds.
  - A mechanism for emergency closure may be needed.

Gap analysis – 3

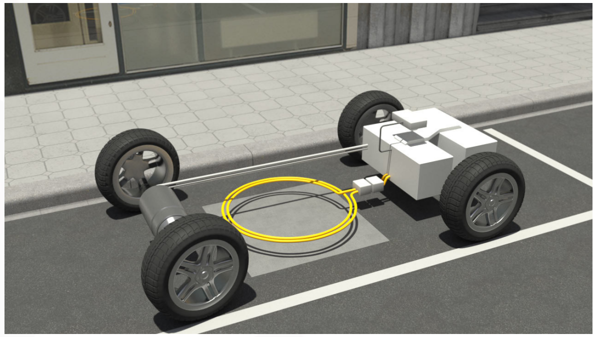
EV identification, lane access control and management / enforcement

- Current detection technologies are:
  - Automatic Number-Plate Recognition (ANPR) – based on artificial vision (OCR)
  - Dedicated Short Range Communications (DSRC) - Vehicle-to-Infrastructure (V2I) wireless communications

- The relative merits of these technologies will be assessed in a future stage of the FABRIC project.
- In-lane guidance can be provided by Lane Control Signals or VMS:
  - Technology is mature but common symbols and signing strategies needed to ensure comprehension by drivers

ICT requirements – 4

ICT control of Wireless Power Transfer

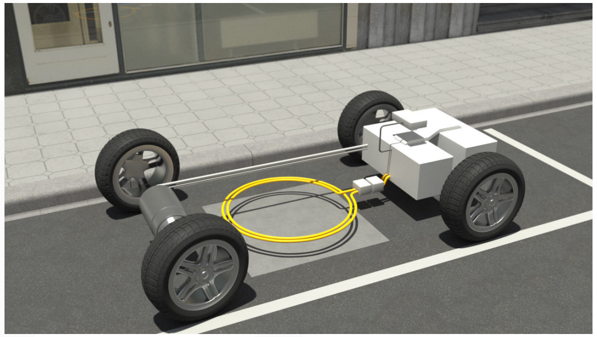


- Smart metering:
  - May be energy transferred from the road (in which case off-vehicle metering would be required)
  - or energy received by the vehicle (on-board metering) – then needs to take account of energy loss.

- Emergency cut-off function:
  - When energy transfer drops below a certain level of efficiency (due to driving behaviour or technical factors)

Gap analysis – 4

ICT control of Wireless Power Transfer



- Challenge for accurate metering:
  - The higher the speeds and traffic densities, the more difficult it is to meter energy use accurately
  - Affects customer billing

ICT requirements – 5
Driving assistance whilst charging

- Provision of information on approaching and activating charging, including pricing
  - On-board unit: needs to minimise driver distraction
- Trajectory and speed advice:
  - FABRIC not looking at automated driving, but this could be a future scenario

Gap analysis – 5

Driving assistance whilst charging

- Several Advanced Driver Assistance Systems (ADAS) and automated vehicle control applications have the potential to fulfil the requirements:
  - "Open" systems that advise or warn the driver
  - "Closed" systems that restrict the driver's actions e.g. limiting speed.
- Adaptive Cruise Control (ACC)
- Intelligent Speed Adaption (ISA)
- Lane Departure Warning (LDW)

… all developed as safety applications but also potentially valuable applications for a dynamic on-road charging system.

ICT requirements – 6

Distribution Supply Operator (DSO) and grid management

- To maintain distribution system balance, direct control strategies and intelligent distributed algorithms are needed.
- Direct load control: centralised modules that collect aggregate charging information from EVs and assign optimised energy schedules.
- Optimisation strategies can be formulated, e.g. based on energy supply availability: smart pricing schemes that enable demand shifting

Gap analysis – 6

Distribution Supply Operator (DSO) and grid management

- Charging service must be strictly provided in-time while a given vehicle is on the charging lane
- Need a decision regarding the actual metering deployment (on- or off-board)
- Standardisation needs:
  - Wireless systems
  - Electric vehicles
  - Grid infrastructure
  - Coil alignment
  - Power levels and frequencies
  - Communication protocols
  - Etc.

Conclusions and next steps

- Dynamic charging needs ICT solutions
- Requirements and use cases identified in FABRIC project:
  - See “Downloads” section of www.fabric-project.eu
- The state-of-the-art of ICT solutions meets some of the requirements of dynamic charging
- Main gaps are in ICT for the wireless power transfer, EV identification, billing and booking.
- ICT systems being developed will be tested in two test sites: Versailles (France) and Turin (Italy) next year.
- ICT solution interoperability is a key requirement for European roll-out of dynamic electric charging: both technical compatibility and institutional interoperability.

BORDEAUX 2015

22nd ITS World Congress

Bordeaux, France

5 to 9 October

2015

Thank-you

Andrew Winder

a.winder@mail.ertico.com

FABRIC

www.fabric-project.eu

TOWARDS INTELLIGENT MOBILITY

Better use of space

Organised by

Co-organised by

Hosted by

On behalf of

Supported by