Concepts, Capacities and Methods for Testing EV systems and their interOperability within the Smartgrids

Rapports

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Final Report Summary - COTEVOS (Concepts, Capacities and Methods for Testing EV systems and their interOperability within the Smartgrids)

Executive Summary:
COTEVOS' team has worked to establish the optimal laboratory infrastructure and capabilities able to assess the interoperability between electric vehicle (EV) systems and the smart grid.

The interoperability between different electromobility devices is key for lower prices and extended services availability for final users. In addition, the smart grid integration of EVs is highly dependent on the interoperability of electromobility solutions with electric network management procedures. The benefits of an increased interoperability are expected to push the deployment of EVs in Europe.

The EU-funded project COTEVOS (Concepts, capacities and methods for testing EV systems and their interoperability within the smart grids) addresses the issue of interoperability. As one of its main objectives, COTEVOS developed plans and schemes for the assessment, validation and certification of the interoperability of electromobility systems. The interoperability assessment infrastructure has been developed from the standpoint of business: testing services, while supporting EV deployment and smart grid progress, should be designed to be profitable.

Along the project, partners have defined methods and procedures to test, analyse and simulate the impact of EV integration in the power grid. Testing will help assess and solve potential issues regarding the suitability of existing protocols and standards. In addition, technology interoperability across providers and countries is crucial in the establishment of efficient interactions among stakeholders, so that they can plan their market approach in the best way and contribute consistently to the regulatory framework. Real testing environments, along with the corresponding testing principles and procedures, allow technology providers to demonstrate that their new products do really fulfil the expected features and help them improve their designs at different stages of the development process.

Project reports, most of them available at COTEVOS website, present in detail the path and findings of the developed work, including:
• the analysis of the state of the art and the identification of needs;
• the situation, needs and gaps according to the standardization bodies and the relevant industry stakeholders;
• the design of a common laboratory reference architecture and the different COTEVOS' infrastructures;
• the testing procedures and the multiple interoperability tests carried out by the partners;
• the vision of the exploitation of interoperability assessment services according to EU priorities and market expectations; etc.

COTEVOS implemented a remarkable network activity with stakeholders. Around 400 contacts (mainly OEMs, DSOs, Electro Mobility Service Providers, Charging Station Operators, Laboratories and R&D stakeholders) have been regularly informed and invited to participate in the Workshops, the Industry Summit and the Interoperability PlugtestTM in ISPRA, where the JRC has been again a relevant support.

The interaction and exchange of information with the main actors has been the basis to place COTEVOS in the focus of EV integration in the smart grid in the international ground.

COTEVOS was conceived as an electromobility project with 11 partners from 9 member states and 3 third parties, one of them from the USA.

Project Context and Objectives:
COTEVOS' main objectives have been followed according to the Work Packages' structure below.

The principal objective of WP1 was to analyze the actual and foreseen future situations and requirements in the scope of EV systems and their interaction with the electrical power grid. The conditions for the EV deployment, considering potential business models, were analyzed and the envisaged interoperability needs were defined.

Some challenges, which contribute to the optimization of energy use within smart grids, were identified and the needs for new testing procedures were indicated. The achievements were the following:
• Analysis of actual and foreseen future potential in EV mobility.
• Study and definition of the reference networks and models to be used for the testing.
• Specification of needs for interoperability between EVs and electrical power system.
• Roadmap for the new services and facilities to be implemented within COTEVOS.

The objective of WP2 “Integration and alignment of testing methods with standards (and standardization needs)” was to incorporate COTEVOS into the relevant ongoing and realized agreements dealing with the integration of EVs within the electricity infrastructure, mainly with standardization issues as highlighted by all described Coordination Groups. The following specific objectives were fulfilled:
• Analysis and alignment of new tests and conformance test procedures with existing standards, regulations, standardization activities and standardization needs at European level, concerning the interaction between EVs and grid infrastructure. Collaboration with standardization working groups has been relevant.
• Design of a complete COTEVOS Standardisation Table, with references to the related e-mobility standards and groups. This has been the basis for the further definition of the test procedures and the selection of the IOP tests that were performed within WP4.
- COTEVOS agrees that, at this moment, the current set of standardisation groups should be able to cover the needs that are currently present, and also those to be expected in the near future, without any need for new groups. So this should be a joint effort of TC 69/TC 57, OCA and eMI3.
• Definition of priorities for new tests and conformance testing methods with broad consensus at European level (both inside and outside COTEVOS).
• Proposal of the COTEVOS reference architecture, defined in WP3, as a tool for the methodology for standards and interoperability, together with other methods as described in M/490 SGAM (Smart Grid Architecture Model) or in the “Common methodology to make developments in accordance with EV/ infrastructure standards”.
• Recommendations on standardization, such as the need for deepening in the current international cooperation, especially with TC 57/69, OCA and eMi3.

The figure below summarizes the results of the standardisation analysis and the comparison with the international standardisation scenario. The different continents have different standards, but they can be mapped on each other, since the main structure, areas, and topics are similar. This led to the recommendation to extend international (US) cooperation from the current NREL - JRC cooperation to also TC 57/TC 69, OCA, eMI3 and selected COTEVOS partners in a kind of “Open Joint Working Group”.

The objective of WP3 was to analyze, define and develop the reference architecture to assess that EV/EVSE systems can interoperate and be used by the smart grid actors, as defined in M/468

(Standardization for road vehicles and associated infrastructure) and M/490. This architecture provides a broad tool for the assessment of interoperability tests as well as an instrument to exchange and generate use-cases and test-cases. The following objectives were achieved:
• Identification of the protocols used by (smart) grid actors.
• Evaluation of the current level of interoperability for charging interfaces.
• Definition of smart grid environments as charging infrastructure.
• Correlation of input/output parameters for test setups (together with WP 4 and 5).
• Definition of data transfer infrastructure (data transfer protocols).
• Development of the software interfaces.

The reference architecture was duly validated, as an indicator for assessing the implementability of the reference architecture, as a very theoretic tool, through an exemplary validation utilizing one of COTEVOS' laboratory infrastructures.

The objective of WP4 was to create and propose cost effective interoperability test procedures based on ideas, suggestions and findings from the standardization groups, ICTs and the state of the art in general. These test procedures have been designed to be commonly accepted and agreed among EVs, EV infrastructure manufacturers and power utilities, in a way that they can be used to assess the interoperability of the different systems to be implemented. The following objectives have been fulfilled:
• Design of procedures for doing cost efficient interoperability testing smart charging of EV's, in order to facilitate load management in the smart grid, including as well back end systems to a basic set of functions. The procedures cover interoperability testing based on standards and interoperability testing based on informational objects and functions when standards are not available
• Testing of different products and devices according to those procedures. To cover the whole scene of e-mobility, a COTEVOS methodology for developing test cases was envisioned and developed. The methodology ensures that future input from e-mobility stakeholders can be processed and used for future test cases.
• Implementation of interoperability round robin test according to a selection of test cases. According to that approach, when the round robin tests results are the same, customers could test their products for interoperability in any of the participating laboratories with the highest ::::
• Identification of the potential approach towards a unified interoperability testing facility distributed across Europe.
• Analysis of the preliminary conditions to test wireless charging.
• Reporting of test results, with suggestions for future improvement of standardized test procedures.
Several ways for validating the test cases are described. With the developed methodology, the set of test cases can be expanded to any level within the available test facilities.

WP5 aimed at the creation of the appropriate capacities for testing within the COTEVOS partnership. A more ambitious result is to generalize the outcomes of the project to be applied in the EU and also at the international level, in order to facilitate the adequate EV deployment and its integration into the management of the electricity network.

The following objectives have been achieved:
• Setting up a unified infrastructure for conformance and interoperability testing. The different laboratories

have implemented the most relevant parts of the common reference architecture that was developed within WP3.
• Setting up a unified infrastructure for integrated functional testing of EV and EVSE, power network and communication interfaces.
• Specification of the convenient way for assessing interoperability and conformance testing through COTEVOS' implementations looking at a common approach. Each individual facility being different to the others, one major achievement has been to maintain a common approach to interoperability testing.
• Development of a unified strategic vision and approach. From a first analysis carried out in the first period, in the framework of T1.5 and considering the capabilities that have been implemented by the individual laboratories, the visions and plans for a future exploitation of an offer for IOP assessment has been developed, and the outcomes are described in this report.

The following figure show COTEVOS' common approach based upon the physical layer of the COTEVOS reference architecture developed within WP3.

The figure below depicts how the different partners laboratories have implemented respective parts of the architecture, stating the current testing capabilities of the COTEVOS consortium utilizing a depiction of the 3rd layer of the COTEVOS common reference architecture.

The main objective of WP6 has been to create and support an international network to guarantee that COTEVOS' development of interoperability specifications and facilities was realized in the best way according to the ongoing efforts for EV deployment and properly integrated in the smart grid environment, looking forward to facilitating that the newly developed knowledge will be exploited on a broad international scale among industry, key users, local or national authorities, decision-makers, standardization bodies and other relevant stakeholders in Europe and the U.S. In this way the achievements have been:
• Promotion of COTEVOS' results and newly developed testing services among project partners to different target groups using the dissemination potential of the project partners and to gain feedback on the project results and activities.
• Creation of a strong project image and establish the right dissemination tools (e.g. COTEVOS' website).
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• Raising of awareness and lesson learned about future EV business and product developments as well as influence decision-makers in EV business fields.
• Interaction with the networking structure developed in the first period, with around 400 contacts and some dozens of key contacts. This network has been extensively used, informing and encouraging COTEVOS' contacts to participate in the Workshops, Industry Summit and PlugTest Festival.
• Dissemination of the project outcomes for the right target audiences.

Project Results:
This section has been duly covered with the publication of COTEVOS' White Book "Business Opportunities and Interoperability Assessment for EV Integration", available in paper, as well as PDF format, in COTEVOS website:

www.cotevos.eu

At that web location all the public material developed during the project, such as videos, deliverables, reports, etc., is also available.
Next the relevant activities over COTEVOS' life and its achievements are summarized.

Potential Impact:
This exploitation plan has been worked and agreed by COTEVOS' partners in order to face the best approach to the market of services for the assessment of interoperability of products for EV integration in the electricity grid. It is now under the valuable evaluation of the SSERR (Support Service for the Exploitation of Research Results) provided by the EC, what suggests a potential improvement in the close future.

The way towards interoperability assessment: the need and the opportunity
EV market is growing and IOP should be a must, in order to allow profitable business models to arise and EV market to deploy.
The EU wide harmonisation challenge in the field of smart grids has driven COTEVOS project efforts towards the setting up of a unified laboratory infrastructure for e-mobility interoperability testing.

Capabilities that are needed for interoperability assessment
The first step in the way to this objective was to agree on a common framework for all project tasks, which was finally based on the work of the Smart Grid Coordination Group. The analysis of the state of the art permitted COTEVOS partners to have a broad view on the existing alternatives in the e-mobility field, from regulatory aspects to ICT protocols. This global picture helped those partners expecting to offer testing services in the future to draft their current strategy.
Participant laboratories assessed the interfaces between components, identified in the state of the art analysis phase. In general, their opinion about standardization relevance and market interest was linked to their expectations on testing services provision, as detailed in D1.3. The interest of partners often exceeded their short-term strategy, since it is conditioned by their business approach. This happened, for example, in regard to interfaces belonging to domains other than e-mobility, like home automation, AMI and ITS, or to too specific services, like the fleet management-EV link.
The uncertainty surrounding future e-mobility scenarios and the broad options spectrum make necessary for laboratories to adopt flexible architectures able to adapt to a great variety of use cases linked to different market and business models. This is why the consortium designed a common laboratory reference architecture, in order to fit every partner's approach into one unified scheme. This architecture is flexible enough to cover the several use and test cases that may well coexist in the future in the e-mobility field in Europe. It permits to combine simulated, emulated and real systems and to define different devices under test.
Since many components of the e-mobility environment are based on ICTs and software applications in backend and frontend systems, it is technically feasible and realistic to exchange data between remote devices located in different laboratories to test interoperability. This approach was tried, for instance, by TECNALIA and TNO, where a scenario with more actors and interfaces was tested according to a complementary scheme. In this way, considering that not all partners are expected to develop the complete architecture containing all components (devices, applications, persons and organisations) involved in end-to-end communications, complex interoperability assessment services can be offered. Although a challenge, this represents a relevant progress towards the concept for a unified laboratory

approach for e-mobility assessment in Europe and it would also contribute to cost effectiveness of test procedures. Nevertheless, several barriers should be tackled in the way to achieve this goal, the main one being the potential economic benefit and business models for the different participating entities and, in the end, for the unified laboratory.
Looking at the future, besides emulations and simulations for individual actors, and implementations of communication protocols for specific interfaces, the toolchain for automated interoperability testing is expected to require further development. It should allow for supervision and control of all the involved components, from EV and EVSE to back-office software and possibly the grid control system, and should be flexible as to regards the communication protocols involved in the tests. Functional requirements of the tests should be verified in a protocol-agnostic manner, as far as possible. An abstract test modelling language such as TTCN-3 is very well suited for this purpose, and its use should be further encouraged. Interoperability-critical settings should be identified in a fully-standards based EV infrastructure, in order to ensure practical relevance of the selected test cases. Cooperation and sharing of results among laboratories is advisable, and this could offer the possibility to extend the scope of the services provided.

Starting facing the market
After setting up the IOP assessment infrastructures during COTEVOS' life, the laboratories have carried out many tests to improve the facilities, the procedures and the capabilities. Some of the partners, in line with the test procedures designed and reported in D4.3 have started to offer testing services that have been added to their portfolio.
The services offered by testing facilities will be defined according to business model based strategies. IEC61851-1 for the EV-EVSE interface is the protocol around which most testing facilities have been developed. All test procedures in the different laboratories should lead to the same results.
As mentioned before, the relevance of Interoperability assessment services are expected to increase as the smart grid becomes more complex. And COTEVOS' partners are conveniently positioned to answer to the potential needs. DERlab will coordinate the activities around the services for IOP assessment, and address the queries for testing to the corresponding laboratories.
The extent of actual interoperability tests that can be performed at multiple laboratories is still limited at present. Building up a unified lab infrastructure is expensive and time-consuming, and there are still uncertainties about the relevant use cases and business models, and the role that some of the involved communication standards will play in practice. However, some consolidation seems to be taking place now, with charging stations supporting OCPP being commercially available, and cars that implement the ISO15118 standard.
The COTEVOS consortium has closely followed these developments, and the implementations of the unified laboratory infrastructure by several partners have achieved an advanced state, regarding in particular the EV - EVSE and EVSE - back-end communications. Nevertheless, some further work is required at least on the ISO15118 and OCPP implementations and test systems. Several partners have created EV and EVSE emulators able to execute conformance tests for the IEC61851 and ISO15118 standards that will be further developed to allow fully automated test runs, to extend the scope of the executable tests, and to integrate them into the interoperability testing toolchain.
The integration around the DSO- related protocols is less advanced, with IEC61850 being the favoured one, in particular parts 90-8 and 7-420. Several COTEVOS partners are working on interconnecting their EV and smart grid labs, but fully standards-based solutions are still to be developed. The OSCP protocol has also been assessed and could be easily implemented as an alternative means for a communication

channel between grid operator and back-end system of the CSO, allowing exchanging only simple aggregated data, at the benefit of greatly reducing the complexity with respect to IEC61850-based integration of the charging stations into the grid control system. It remains to be seen which approach will be more relevant in practice. A further harmonisation of the COTEVOS reference architecture with the Smart Grid Architecture Model (SGAM) could benefit the discussions between experts from both domains.
Capabilities for testing a roaming proprietary platform has been developed and verified by COTEVOS. OCHP has also been addressed and the testing platform could be easily developed, though it has not been done since its potential market need seems to be unlikely.
How to present the unified test service portfolio to the market is another question that needs to be worked out. As explained before, DERlab association will play a key role in the marketing activities. A possible way to enhance the visibility of the services offered could be the introduction of an interoperability certificate for EV infrastructure components. The participants should further evaluate the potential interest and market relevance of such a certificate.

Potential market for interoperability assessment
The IOP assessment market is expected to be small in the short term. At present, after 3 years of intensive networking activities, this market could be defined as insignificant. A high interest is always present and growing around this subject, but usually only when research projects or funded activities are behind. The main business is just around certification tests, mainly for IEC61851 and, in a much more reduced amount, for OCPP.
Some figures are expected to be available within some months, if the market really starts to wake up and the activities that COTEVOS' laboratories, individually, have started to carry out, start to get positive outcomes.
The position of a consistent offer of IOP assessment services by a reliable network of laboratories, focused in DERlab Association, is expected to be the best way for the industry and the laboratories themselves to face and push this potential new market. In this framework, DERlab will behave as a catalyser for the potential business embryos that are expected to arise. For instance, its active participation in the Smart Grid International Research Facility Network (SIRFN) is a guarantee of bidirectional flow of information between DERlab associated laboratories and other key stakeholders in order to be punctually aware of the need of an offer around IOP assessment services.

Mid and long term actions
During the last 30 months COTEVOS has developed the approach for a unified interoperability centre, considering the individual strategies and policies of the different laboratories.
From now on, business models for exploitation of individual laboratory deployment and project results will be developed. As the market starts to react to the interoperability assessment offer, successful business models with acceptable risk profiles (market, technical, managerial and financial) will be appraised and managed.
The following figure shows the main structure and activities to be carried out in order to drive and assess the market.

DERlab Association will be the core to drive and bring together the efforts for exploitation of interoperability testing services. During the last years DERlab has dealt with the assessment and conformance in the field of Distributed Energy Resources (DER), as an international active player to disseminate the capacities, to

look for gaps, and to bring business opportunities to their Associated Members. In this sense, EV integration into the smart grid has also become a strategic area for DERlab. It is expected that DERlab, also supported by COTEVOS' outcomes, be recognised worldwide as a node for EV interoperability assessment.
In the previous figure three different kinds of laboratories are shown:
• COTEVOS partners being DERlab Members (all but TNO)
• Laboratories that have collaborated with COTEVOS
• Other laboratories that will benefit from this new market, many of which are already part of COTEVOS' network.
DERlab will gather and strategically summarize the views and progress of the associated laboratories. It will disseminate the interoperability assessment approach of the unified laboratory, according to its networking activities.
The laboratories have already started different activities to face this new market, in line with their own strategies. As a general basis, the interoperability assessment offer, considering each's capabilities, is being presented to the customers. This is the main and best driver to ensure that any potential business opportunity will be answered punctually.
As mentioned before, no relevant market is available at present, and any estimation looking at the mid and long term would be even more bizarre that those for EV penetration. However a rough estimation of the following variables will be aimed:
• Quantitative assessment of the different testing services to be offered, in the framework of feasible and promising models:
o revenue and profit generation
o investment required to reach the market.
In some cases, e.g. TECNALIA, specific tools for assessing the IOP market, interviewing potential new customers and other stakeholders, mainly prescribers, have been already launched and are on-going.
It is expected that much of the interoperability assessment will be developed focussed on testing conformance to adequate standards. That way the laboratories willing to offer IOP assessment services should be accredited for those standards, as conformance testing would be the first formal step for the global IOP service.
In the framework of the next DERlab General Assembly meeting, beginning 2017, an open workshop about EV integration Interoperability Assessment will be organised.

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Documents connexes

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