

F^o-BRIC

Feasibility analysis and development of on-road charging solutions for future electric vehicles



International Electric Vehicle Conference Workshop



Wireless Charging: Related Standards and needs



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ANNOUNCEMENT

Wireless Charging: Related Standards and needs

December 18, 2014, (11:00 a.m. -1:30 p.m.) || Florence, Italy

The goal of this workshop is to bring together leading experts from industry, policy makers, automotive manufacturers and relevant standardization bodies to discuss the latest developments in the field of inductive charging for electric vehicles focusing on standardization issues. The workshop aims not only to review the current status of any relevant standardisation effort but to highlight the steps needed for any related action and possibly assist in prioritizing them by reaching a consensus at the end of the workshop among participants.

The workshop is organised by FABRIC, a 7th framework funded Integrated Project, which aims to perform a feasibility analysis and implementation of on-road charging solutions for future electric vehicles (<http://www.fabric-project.eu/>).

EXPECTED PARTICIPANTS

- Automotive Companies
- European and International Authorities
- ICT and Infrastructure Companies
- Researchers
- Standardization experts
- Energy providers
- Charging solution providers
- Road Operators
- Grid Operators
- Distribution System Operators



CHAIR/MODERATOR:

Angelos Amditis

Research Director,
Institute of Communication & Computer Systems
(ICCS), FABRIC IP Coordinator

Joachim Taiber

Research Professor,
Clemson University,
Chair of IEEE WPT Committee, USA

SPEAKERS



**Angelos
Amditis**

Research Director,
Institute of Communication &
Computer Systems (ICCS),
Greece



**Joachim
Taiber**

Research Professor,
Clemson University, USA
Chair of IEEE WPT Committee



Grzegorz Ombach

Vice President of Engineering,
global research & development
Wireless Electric Vehicle
Charging (WEVC) technology,
Qualcomm, USA



Konrad Woronowicz

Fellow Expert,
Bombardier Transportation,
Canada



Jeff Muhs

Director,
Business Development, AIMM,
WiTricity Corporation, USA



Jae Seung Lee

Research Manager,
Toyota Research Institute of
North American, USA



Keith Wilson

Project Manager,
Technical Programs, Global
Ground Vehicle Standards,
SAE INTERNATIONAL, USA



Gian Maurizio Rodella

Director,
Commissione Tecnica di
Unificazione nell'Autoveicolo-
CUNA, Italy



**Michael
Scholz**

Senior consultant,
Electric mobility department,
P3 automotive GmbH, Germany



Peter Van den Bossche

Lecturer, Vrije Universiteit
Brussel, Belgium

THE FOCUS

Inductive charging is steadily gaining ground in the field of Electric Vehicles. Nowadays inductive charging systems are moving from research labs into the market and are becoming commercial products. Inductive charging is considered the ultimate solution which will pave the way for the actual and broad electromobility implementation. However, regardless of the large technological advances and research investments, technology penetration is not the only bottleneck. Interoperability among systems is a must in order to actually enjoy the benefits of inductive charging systems. Interoperability is currently pursued either through standardisation or ad-hoc cooperation between manufacturers aiming to pursue "de facto" standards. Standardisation is currently equally, if not more, important with pure technical aspects and is a topic that involves the entire supply chain from OEMs and Tier 1 suppliers to road operators, DSO and grid operators.

The workshop will open with introductory speeches from the two Workshop co-chairs; then a general overview of the related technology will follow with emphasis on current standardisation needs while key experts will provide a general overview of wireless charging Standardizations activities. An after-workshop roundtable dialogue will be stimulated, in which all participants will expose their opinion and debate. Discussions of the workshop can focus on Standardization activities needed for the following topics indicatively:

- Coil alignment (dynamic)
- Package and distances (geometry)
- Power levels
- Allowable frequencies
- Communication protocols
- Health impact
- Environmental impact
- Cost impact of system design decisions

WORKSHOP AGENDA

Title - Topic	Presenter	Duration
"Wireless charging: Related Standards and needs" – Workshop introductory presentation	Angelos Amditis , Institute of Communication & Computer Systems (ICCS)	10'
"Building a testbed for EV wireless charging solutions – experiences and thoughts for standardization aspects"	Joachim Taiber , Clemson University	10'
OEM prospective (developed technology and future needs)		
"Wireless Power Transfer Ecosystem" - Toyota actual and future plan for integration of WPT (both static and dynamic)	Jae Seung Lee , Toyota Research Institute of North America	10'
Supplier perspective (offer of technology)		
"Magnetic solutions towards interoperability for stationary, semi-dynamic and dynamic charging"	Grzegorz Ombach , Qualcomm	10'
"Standardization Questions" - Bombardier developed technologies & challenges)	Konrad Woronowicz , Bombardier	10'
"An Overview of WiTricity Corporation's Involvement in International Standards Development"	Jeff Muhs , WiTricity	10'
Standardization bodies perspective (feasibility and standards)		
"CUNA: Commissione Tecnica di Unificazione nell' Autoveicolo" - CUNA activities and overview of the standards concerned to electric vehicles. Connection to international standardization institutes	Gian Maurizio Rodella , CUNA	10'
"IEC International Standardization Work on Wireless Power Transfer for Electric Vehicles"	Peter Van den Bossche , Secretary of IEC TC69	10'
"ISO19363 – Standardization of the vehicle part of inductive charging systems"	Michael Scholz , Project Leader of the ISO JPT 19363	10'
"An overview of work in progress to develop SAE J2954 Wireless Charging Standard"	Keith Wilson , SAE INTERNATIONAL	10'
Dialogue session		

PRESENTATIONS

1. Title of presentation: *“Wireless charging: Related Standards and needs”*

Content:

- Paving the way to standardized wireless charging
- Workshop objectives
- Workshop presentations
- Workshop agenda @ dialogue session issues for discussion
- Proposal for common definition of charging modes.

2. Title of presentation: *“Building a testbed for EV wireless charging solutions – experiences and thoughts for standardization aspects”*

Content:

The Southeast of the US has become a major cluster in Automotive and a collaboration between CU-ICAR (Clemson University for Automotive Research) has pioneered in collaboration with SC-TAC (South Carolina Technology & Aviation Center) and the Oakridge National Lab (ORNL) the development of a testbed that supports the wireless charging of electrified vehicles. In this presentation first experiences in the development of such a testbed are provided and suggestions are being made with respect to standardization aspects of wireless charging – in particular in context with in-motion wireless charging and road electrification.

3. Title of presentation: *“Wireless Power Transfer Ecosystem”*

Content:

The wireless power transfer technology has demonstrated its potential by various projects from all around world. It is time to move one more step up of commercialization. The importance is to involve multitudes of stakeholders in the beginning of in-motion wireless power transfer project to be successful in wide social adoption.

4. Title of presentation: *“Magnetic solutions towards interoperability for stationary, semi-dynamic and dynamic charging”*

Content:

The goal for wireless electric vehicle charging is to provide a universal charging solution for different vehicles classes and different use cases like stationary, semi-dynamic and dynamic charging. In order to guarantee such interoperable solution proper foundation has to be setup like: common operating frequency, universal magnetic coil design, optimum size and position of vehicle coil, various power levels, communication etc... Short presentation is going to focus on potential magnetic design which can support such long term vision.

5. Title of presentation: *“Standardization Questions”*

Content:

The purpose is to incite the discussion on whether we are ready to standardize the WPT right now or do we have to wait and involve parties from a broader circle before we issue the first draft.

6. Title of presentation: *“An Overview of WiTricity Corporation’s Involvement in International Standards Development”*

Content:

WiTricity Corporation's perspectives on international standards, interoperability, and safety compliance with an emphasis on resonator coil types, z- height tolerances, and operating frequencies, and associated impacts on safety compliance.

7. Title of presentation: *“CUNA: Commissione Tecnica di Unificazione nell' Autoveicolo”***Content:**

- Short presentation of CUNA;
- Connection with international standardization institutions;
- Overview of the standards concerned to electric vehicles Connection to international standardization institutes;
- FABRIC needs and suggestions.

8. Title of presentation: *“IEC International Standardization Work on Wireless Power Transfer for Electric Vehicles”***Content:**

Reporting on current projects for WPT standardization, taking into account the actors involved and what is going on on the standardization shop floor, highlighting ongoing and future projects as well as the interaction with other committees.

9. Title of presentation: *“ISO19363 – Standardization of the vehicle part of inductive charging systems”***Content:**

The ISO/IEC standardization of inductive charging systems is done by a joint project team between IEC61980 and ISO19363. The team is ambitiously working towards the goal of defining the requirements for interoperable and safe charging systems, however, the technical complexity of inductive power transfer is quite challenging. Different vehicles create different surrounding conditions and thus influence the optimal design of the charging systems, which could not be defined, yet.

10. Title of presentation: *“An overview of work in progress to develop SAE J2954 Wireless Charging Standard”***Content:**

An overview of an industry/government collaborative effort for the development of SAE J2954 which will establish minimum performance, interoperability and safety criteria for magnetic resonance wireless charging of electric and plug-in vehicles. The document scope includes residential, parking lot and roadway charging locations and Wireless Power Transfer (WPT) charging levels 1, 2 & 3.

STATE OF STANDARDIZATION IN ELECTROMOBILITY

A joint project ISO/IEC has recently started for the development of a specific standard dedicated to Interoperability and Safety in the wireless magnetic interaction vehicle - infrastructure, with the contribution of ISO TC22/SC21 and IEC TC 69 and participation of SAE.

Two meetings have been held:

- in Berlin on February 7th 2014 (Kick off Meeting)
- in Tokyo on March 13th and 14th 2014

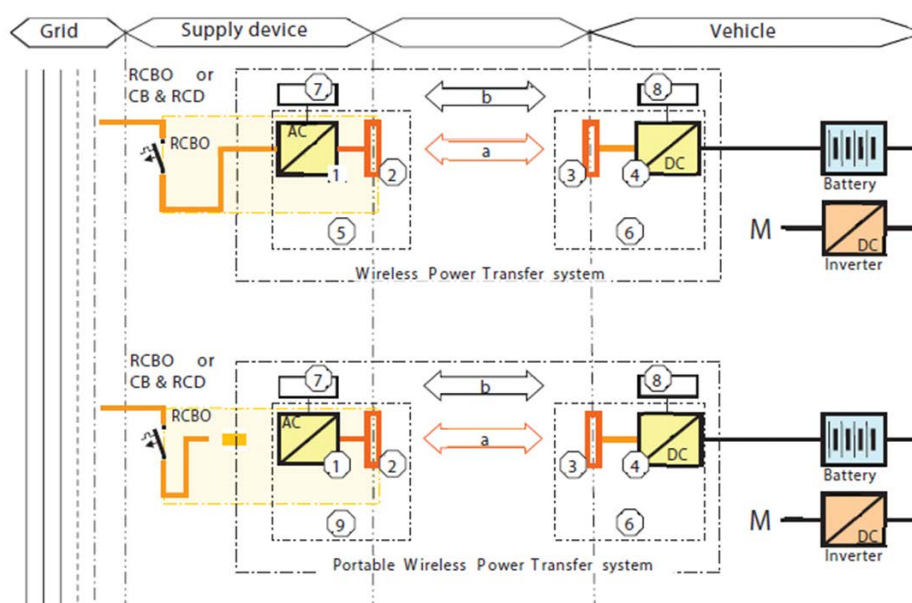
The Standard under development is ISO 19363 “Magnetic field Wireless Power Transfer - Interoperability and Safety requirements”.

The Standard is considered to be complemented by the Standard IEC 61980, under development and harmonized with other standards dealing with the WPT.

Standards harmonization concerning wireless systems, electric vehicles and grid infrastructure can play a fundamental role as guidance for the technology development by providing prescriptions and procedures related to system safety, assuring a common basis for the development of interoperable systems and providing coordination between the energy supply networks, the Information communication infrastructure, the vehicle and the end user.

Standards should not interfere with technology development, should not be related to specific design but should assure functional response of the system addressing safety and interoperability, providing the appropriate boundary conditions.

The general scheme of WPT between primary and secondary elements (infrastructure and vehicle) considered in the Standards is shown below:



The future transportation scenario based on WPT entails enhanced power transfer modes:

- Static. This is the currently used mode for plug-in charging where the vehicle is immobile during charging and driver/passengers are not required to be in the vehicle during charging.
- Stationary. This mode is only possible using WPT since it envisions recharging the vehicle during short stops, which is ideal for urban mobility scenarios.
- Dynamic. This mode envisions en-route EV recharging while on the move.

In this future scenario WPT will heavily rely to ICT and information communication and processing should be coordinated by a central mobility management entity.

Current standardization activities on wireless charging (ISO, IEC, SAE, UL) include the following standards:

- **ISO 19363** (scheduled for 10-2016) electrically propelled road vehicles – Magnetic field Power Transfer – Interoperability and Safety requirements. The key points under consideration are:
 - Interoperability:
 - Operating air gap classes
 - Offset classes
 - System frequency
 - Transfer Power Classes
 - Location and positioning of secondary device
 - Command & control communication
 - Safety requirements:
 - Protection against electrical shock (in accordance with ISO 6469-3)
 - Protection against electromagnetic effect
 - Protection against temperature effects by electromagnetic fields
 - Operational safety in accordance with ISO 6469-2)
- **IEC 61980** Electric vehicle wireless power transfer (WPT) systems
 - Part 1: General requirements. Status: FDIS circulation January 2015
 - Part 2: Specific requirements for communication EV and infrastructure. Status: Now circulating as CD, first publication as TS mid 2015
 - Part 3: Specific requirements for the magnetic field power transfer systems. Status: Now circulating as CD, first publication as TS mid 2015
- **ISO/IEC 15118** (scheduled for 10-2016) Road vehicle to grid communication interface
 - Part 6: General information and use-case definition for wireless communication
 - Part 7: Network and application protocol requirements for wireless communication
 - Part 8: Physical layer and data link layer requirements for wireless communication
- **SAE J2954** Wireless Charging of Electric and Plug-in Hybrid Vehicles (Guideline scheduled for 06/2014)
- **SAE J2836/6 J2847/6 J2931/6** Communication for inductive charging (Guideline scheduled for 06/2014)
- **SAE J1773** Electric Vehicle Inductively Coupled Charging (published as recommended practice)
- **UL 2750** Wireless EV charging

Standardization Committee interactions are:

- Vehicle issues (ISO TC22 SC37): ISO 19363
 - Optional communication issues (ISO TC22 SC31): ISO 15118 series
 - EMC/EMF issues: (Wireless Power Transfer Task-Force CISPR B/WG1/ TF WPT)
-

Standardisation targets should mainly be focused on:

- Interoperability, at the general mobility system level, should concern the Wireless Power Transfer capability between vehicle and infrastructure with dynamic mode and with static wireless infrastructure facilities.
- Harmonize vehicle layout in order to improve every aspect related to safety and rescue activities in case of accident.

Conclusions:

1. ISO and IEC in connection with SAE are working jointly for the development in harmonized way on standards for Magnetic field Wireless Power Transfer.
2. The standards under development intend to offer guidelines for the studies of systems on WPT vehicle and infrastructure addressing the safety and interoperability for future applications.
3. Issues coming from the technical developments of the studies, research and developments are welcome to be addressed in the relevant standards development.

DIALOGUE SESSION

The dialogue session took place after the presentation session. One of the important discussion points was related to the many standardization activities around the world and how they can be harmonized and perhaps merged into a global standard. However standardization bodies should be cautious not to hinder innovation which is very important for new technologies such as wireless EV charging. Companies should be given room to invent and the standards could spring out from the best solutions and practices.

In the same context, there should be distinction between static and dynamic charging modes because there are already commercially available static charging systems. So standardization could proceed faster for such mature systems. On the other hand room for development should be allowed for dynamic and stationary wireless charging systems prior to standardization. A good example is Tesla Motors which developed a proprietary charging system that is currently the state of the art in static plugin EV charging and then opened it by making all of its patents publically available.

Another point was that standards need to be dynamic and adapt to new technological developments. As an example, the standard for conductive EV charging is currently in its 5th iteration.

One point on which the participants agreed was that there should be a body or committee that will consider which areas should not be standardized in order to protect competition. The decisions should be disseminated to the engineering world (both research and industry) so that no resources are wasted.

EV charging entails many technologies ranging from energy to telecommunications sector. It is a very difficult task to standardize everything and in addition many technologies have already been standardized for other applications. It was pointed out that fundamental technologies should not be re-standardized because they are standardized already but other areas focusing towards interoperability should be investigated for standardization.

ANNEX 1: SPEAKERS BIO



Dr. Angelos Amditis
Research Director, ICCS,
Greece

Dr. Angelos Amditis is Research Director in the Institute of Communication and Computer Systems (ICCS), and member of its Board of Directors. He is the founder and the Head of the I-SENSE Group. He is the President and one of the founding members of ITS Hellas, and member of the ERTICO Supervisory Board. He is the president of the EuroVR Association. He is the writer of several peer reviewed journal articles, book chapters and many conference papers. He has participated in more than sixty projects in the last 10 years and he is currently the coordinator of the following projects: FABRIC, INTE-TRANSIT, RECONASS, and ROBO-SPECT. He has been working with ITS including Automation and Electromobility the last 20 years.



Joachim Taiber
Research Professor,
Clemson University, USA
Chair of IEEE WPT
Committee

Dr. Joachim G. Taiber joined Clemson University in 2010 as a research professor member of the faculty of Automotive Engineering located at the Clemson University International Center for Automotive Research (CU-ICAR) in Greenville, South Carolina, USA. Since 2011 he is also institute director. The research focus of his institute is Sustainable Mobility and Connected Vehicle Technology where he studies in particular the interaction between vehicle and infrastructure systems. He is leading a joint economic development initiative between CU-ICAR and SC-TAC (South Carolina Technology Aviation Center) with the purpose to redevelop a significant part of an airport/business park property into a unique test bed for public and private stakeholders to develop and validate innovative vehicle-infrastructure solutions. Prior to his engagement at Clemson University, Dr. Taiber was leading the Information Technology Research Office of the BMW Group Information Technology Research Center (ITRC), the first facility created at the CU-ICAR campus. He joined BMW in Germany in 1997 as an in-house consultant for business process re-engineering in product development with a focus on functional integration and vehicle systems integration. Since 1999 he worked in different leadership positions in the BMW Group Enterprise IT organization in the areas of IT strategy, IT program management, IT innovation management and IT benchmarking. In 2005 he came to the US to implement collaborative IT innovation projects for the BMW Group in the ITRC which included topics in the domain of the “networked vehicle”. Dr. Taiber started his career as assistant to the CTO of a Swiss start-up company in the area of CAD/CAM/PDM systems where he was responsible for product strategy and university research collaboration. He holds a Master Degree in Mechanical Engineering and a PhD Degree in Technical Sciences from the Swiss Federal Institute of Technology in Zurich (ETHZ). He has been instrumental to develop the IEEE Transportation Electrification Initiative and chairs a new IEEE pre-standardization working group in dynamic wireless charging.



Grzegorz Ombach
Vice President of
Engineering, global
research & development

Dr. Ombach joined Qualcomm in April 2012 from Brose Fahrzeugteile, where he managed the design of automotive electric drive systems as Director of Advanced Development Drives. Prior to Brose Fahrzeugteile, Dr. Ombach was Principal Expert for Electromagnetic Simulation and Motor Design at Siemens VDO Automotive AG. Dr. Ombach's responsibilities included management of a panel of experts in charge of electric drive systems for automotive at the company. Dr. Ombach holds a MSc. in Electrical Engineering from the Technical University of Lodz, Poland, and a Ph.D. in Electrical Engineering from the Silesian University of Technology, Poland. Dr.

Wireless Electric Vehicle Charging (WEVC) technology, Qualcomm, USA

Ombach has authored and coauthored over 70 papers and holds more than 25 patents (awarded and pending) on automotive electrical systems.



Konrad Woronowicz

Fellow Expert,
Bombardier
Transportation, Canada

Konrad Woronowicz (M'13) received the B. Sc. and M. Sc. Degree from the Technical University of Szczecin, Poland and a Ph. D. degree from the West Pomeranian University of Technology, Szczecin, Poland. Since 1995 he has been with Bombardier Transportation working on various transportation systems and R&D projects and played a key role in the development of LIM-based mass transit systems for New York, Beijing, Vancouver and Kuala Lumpur among others. He is in a position of Fellow Expert and his current interests include electromagnetic design for wireless power transfer for electric traction and automotive applications, high performance linear motors, special permanent magnet motors and energy storage.



Jeff Muhs

Director, Business
Development, AIMM,
WiTricity Corporation,
USA

Jeff Muhs directs automotive business development and I.P. licensing activities for WiTricity Corporation. Prior to joining WiTricity, Jeff was Vice President of the Utah State University Research Foundation and Director of the Energy Dynamics Laboratory. Mr. Muhs also spent two decades at the U.S. Department of Energy's Oak Ridge National Laboratory where he was named ORNL Engineer of the Year in 1997. Jeff holds a B.S. in Electro-Optical Sciences and has authored over 30 publications and 14 patents.



Jae Seung Lee

Research Manager,
Toyota Research Institute
of North American, USA

Jae Seung Lee is leading electronics research in Toyota Research Institute of North American as a research manager. Jae established and expands power electronics and advanced sensor research of Toyota in USA. His current research focuses are high power density power module, vehicle application for wide bandgap devices, high power vehicle charging technology, wireless power transfer for vehicle charging, efficient energy management, advanced radar sensor for autonomous driving etc. He recently completed ARPA-E awarded 3 year project on SiC high power battery charger for PHEVs with an order of magnitude improved power density. He also researches on in-motion wireless charging technology for EVs and PHEVs energy transfer. In 2012, his team awarded DOE VTP program on this project. He holds M.S. and Ph.D. degrees in Electrical and Computer Engineering from University of California Davis.



Keith Wilson

Project Manager,
Technical Programs,
Global Ground Vehicle
Standards, SAE
INTERNATIONAL, USA

Keith is a Project Manager for Technical Programs at SAE International. Keith coordinates projects and standards activities related to advanced vehicle technologies. He is involved in developing innovative business strategies surrounding various vehicle technologies such as advanced vehicle safety systems, connected vehicle technology, electro-mobility (including hydrogen fuel cell vehicles and lithium ion battery systems), chassis systems and materials/processes. Keith's role at SAE International also includes responsibility for new industry business initiatives including obtaining funding support for verification of new industry standards and the management of government and industry cooperative research programs. Prior to joining SAE International, Keith has served in automotive engineering and technical leadership positions, including Engineering Group Manager, General Motors Automotive Safety Center. Keith managed

	<p>engineering/technical groups responsible for supporting product litigation activities and product defect investigations. In addition, Keith served as Manager, Vehicle Crash Test Operations, for GM Safety and Restraints Center. Keith earned a Master of Science in Business Administration from Central Michigan University, a Bachelor Degree in Business Management from Cleary University and a Degree in Applied Science from Oakland College.</p>
 <p>Gian Maurizio Rodella Director, Commissione Tecnica di Unificazione nell'Autoveicolo-CUNA, Italy</p>	<p>Dr. Engineer RODELLA Gian Maurizio is Director of CUNA (Commissione Italiana dell'Automobile). He is a member of the Steering Committee of ISO TC/22.</p> <p>His specific experience in Automotive field come from '80 years, like responsible of Engine and vehicle Development in international team (Europe, USA and China and India). His experience is focused on Diesel Engines and Commercial Vehicles.</p> <p>He is consultant to the Italian Ministry of Infrastructure and Transport for innovative vehicles and new fuels.</p>
 <p>Michael Scholz Senior consultant, Electric mobility department, P3 automotive GmbH, Germany</p>	<p>Dipl. Wirt.-Ing. Michael Scholz operates as Senior Consultant within the P3 Group since 2010. He has consulted various customers within the electric mobility sector and thus accompanied the development of charging infrastructure from the beginning. First he was involved in the field of conductive charging and since 2012 in the standardization of inductive charging. Michael Scholz graduated from University of Applied Sciences Kempten as Industrial Engineer (Dipl. Wirt.-Ing.) and specialized in automotive engineering.</p>
 <p>Peter Van den Bossche Lecturer, Vrije Universiteit Brussel, Belgium</p>	<p>Peter Van den Bossche promoted in Engineering Sciences from the Vrije Universiteit Brussel on a thesis "The Electric vehicle, raising the standards". He is currently lecturer at the Erasmushogeschool Brussel and the Vrije Universiteit Brussel. Since more than 15 years he is active in several international standardization committees, currently acting as Secretary of IEC TC69. He has been closely involved in electric vehicle research and demonstration programmes in collaboration with the Vrije Universiteit Brussel and the international associations AVERE and CITELEC, and is now coordinating research projects on battery modeling, always observing the link to standardization development in the field.</p>

ANNEX 2: WORKSHOP PHOTOS



Figure 1. Opening presentation by Dr. Angelos Amditis, ICCS, WTP Workshop Co-chair



Figure 2. Opening speech by Dr. Joachim Taiber, Clemson University, WTP Workshop Co-chair



Figure 3. Dr. Grzegorz Ombach's speech, Qualcomm



Figure 4. Dr. Konrad Woronowicz's speech, Bombardier Transportation



Figure 5. Presentation by Jeff Muhs, WiTricity Corporation



Figure 6. Presentation by Dr. Jae Seung Lee, Toyota Research Institute of North American



Figure 7. Dr. Keith Wilson's speech, SAE INTERNATIONAL



Figure 8. Gian Maurizio Rodella's speech, CUNA

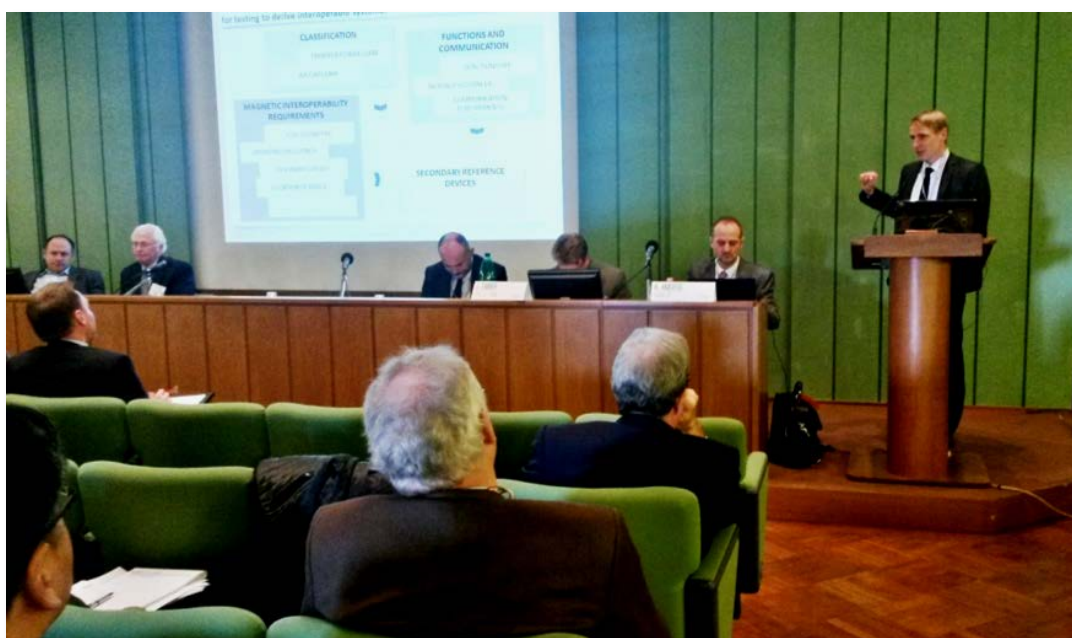


Figure 9. Presentation by Dr. Michael Scholz, P3 automotive GmbH



Figure 10. Dr. Peter Van den Bossche's speech, Vrije Universiteit Brussel



Figure 10. Dialogue session