

Determination of Powertrain Performance of Hybrid Electric Vehicles

Presented by: Germany, Korea

EVE-14 meeting

April 20, 2015

Outline

1. Status after EVE-13, Geneva, Jan 2015
2. Activities and current state-of-play
3. Planned activities until EVE-15, Geneva, June 2015

Status after EVE-13

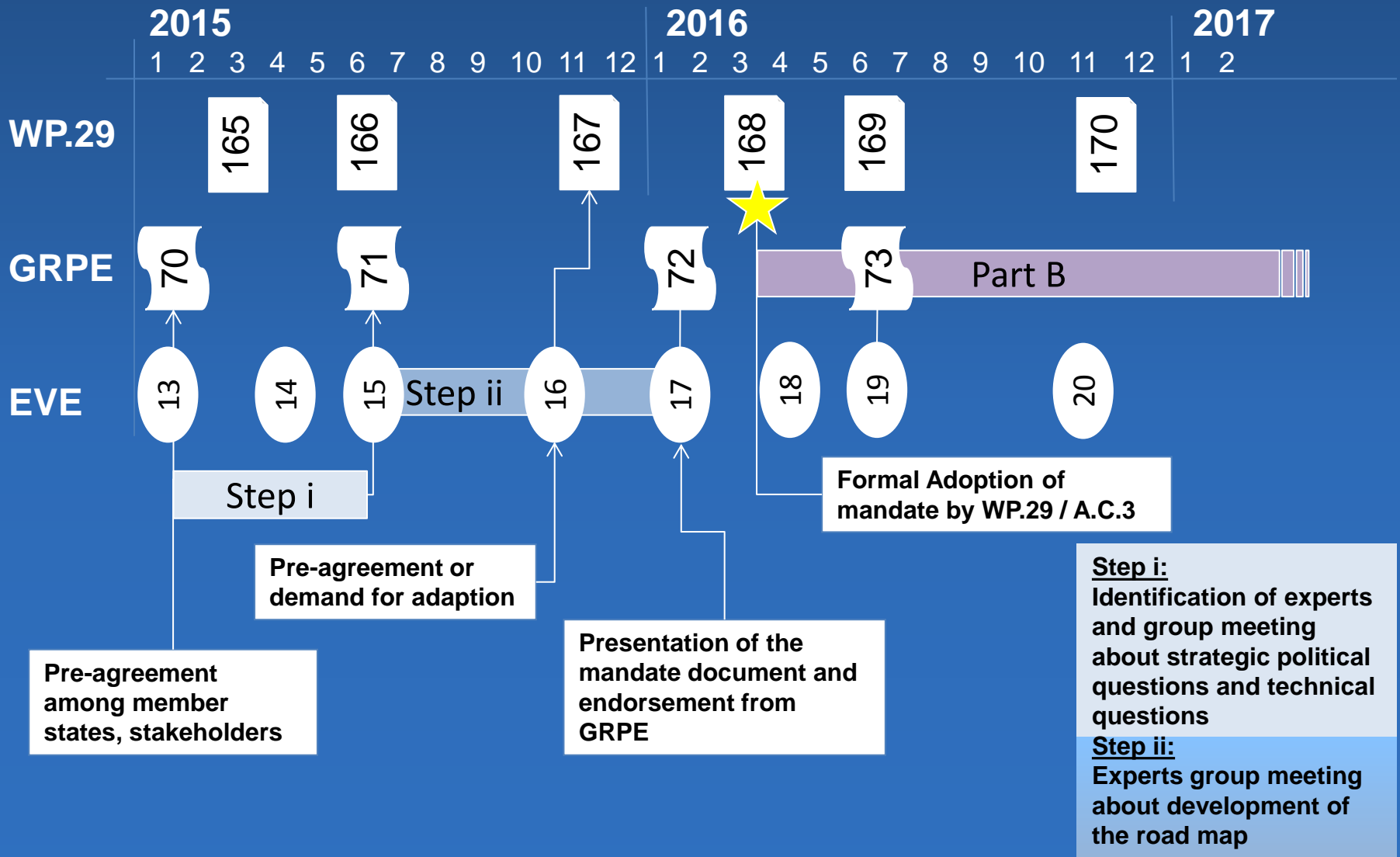
There was agreement to focus on:

- ✓ Electrified Vehicles (PEV, NOVC-HEV and OVC-HEV, FC(H)V)

of types

- ✓ Passenger Cars and Light Commercial Vehicles (M1, N1)

Draft Timeline Part A (updated version)



Status after EVE-13

Step i:

Fundamental discussion and decisions on:

- **strategic political questions:**
need for technical information on best/worst case or representative case?
- **technical questions:**
to be answered in detail including information, which resources will be needed therefor

Step ii:

Development of the Road Map:

- **What? Where? When?**
- Development of the Road Map by delegates from the Contracting Parties and stakeholders

Status after EVE-13

Kick-off for Step i:

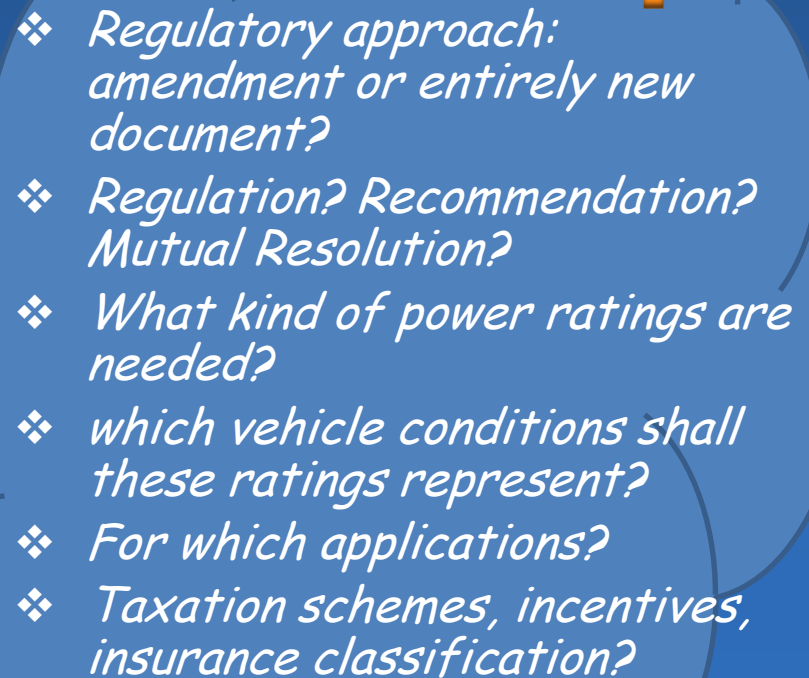
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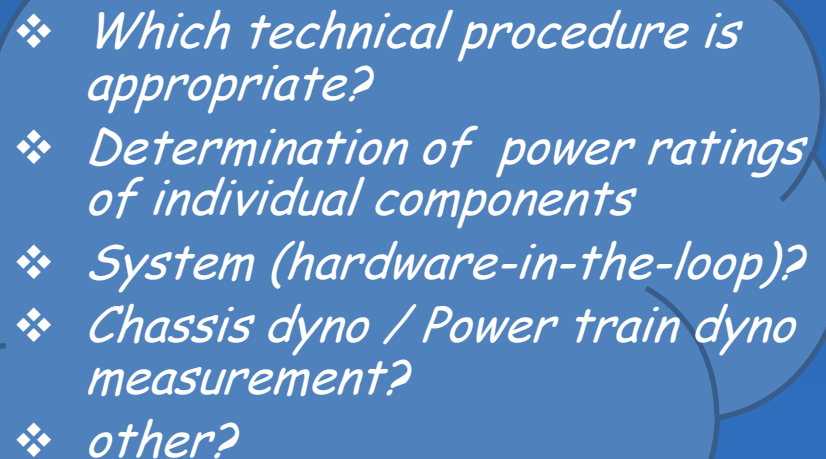
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- ❖ *Regulatory approach: amendment or entirely new document?*
 - ❖ *Regulation? Recommendation? Mutual Resolution?*
 - ❖ *What kind of power ratings are needed?*
 - ❖ *which vehicle conditions shall these ratings represent?*
 - ❖ *For which applications?*
 - ❖ *Taxation schemes, incentives, insurance classification?*

Status after EVE-13

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Fundamental discussion and decisions on:

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- 
- ❖ *Which technical procedure is appropriate?*
 - ❖ *Determination of power ratings of individual components*
 - ❖ *System (hardware-in-the-loop)?*
 - ❖ *Chassis dyno / Power train dyno measurement?*
 - ❖ *other?*

Activities and current state-of-play

**EVE-13 Meeting,
Jan. 12./ 13., 2015:**

- ✓ Presentation of concept, **tentative work plan** and a list of open questions (EVE-13-05e)
 - ✓ First meeting of interested stakeholders and decision for drafting a **questionnaire**. Addressee: all interested parties, chairs of the relevant SAE / JARI groups
-

**WLTP-SG-EV,
Mar. 03./ 04., 2015:**

- ✓ Information about the current status of questionnaire
 - ✓ Exchange of views
-

**Outline / Drafting of
Questionnaire**

- aims at gathering information from all kinds of interested parties
- Draft document, see EVE-14-~~XX~~e



Identifier
not yet
fixed

Planned activities until EVE-15

Agreement on Questionnaire and distribution:

- already 'pre-agreed' among task-leader group
 - presentation and discussion of the paper during the **today's** 14th EVE IWG meeting of April 20th, 2015
-

Next steps:

- Finalization and distribution:
 end of April/ early May
 - Feed-back, analysis / evaluation:
 early /mid of June
-

Questionnaire

Basic structure:

1. 2-pager cover letter, introducing IWG and topic, giving motivation and general information
2. Heading with keyword and essential question
3. Explanatory part
4. Detailed questions
5. Tick-box answers
6. Space for free text answers and general comments

QUESTIONNAIRE TO SUPPORT THE DEVELOPMENT OF ELECTRIFIED VEHICLE'S SYSTEM POWER DETERMINATION

Introduction:

The Electric Vehicle and Environment (EVE) Informal Working Group is mandated by the WP.29 and has been formed to examine environmental issues related to all types of road vehicles (motorcycles, passenger cars, light, medium and heavy-duty vehicles) with electrical propulsion, including battery electric vehicles (BEV), hybrid electric vehicles (HEV) and plug-in hybrids (PHEV). The group recently presented its "EV Regulatory Reference Guide"¹ for environmentally-related EV requirements. In addition to the identified regulatory gaps listed in Chapter 5 of the Guide, the group decided to take care for a regulatory requirement that comes from a lack of information of the system power of electrified vehicles. It is an issue that the WLTP-IWG recently has found necessary to be addressed, however could not be tackled by the group with respect to its mandate and resources.

We kindly ask you for your input to the attached Questionnaire. It is critical to the delivery of this activity. We are counting on your support to complete this questionnaire by **May 31, 2015. Send your completed questionnaire electronically** to the EVE "Determining power of EVs" Leading Team, either

hans.holdik@bmvi.bund.de

(Hans Holdik, Federal Ministry of Transport and Digital Infrastructure, GERMANY)

or

dsechoi@ts2020.kr

(Dongseok Choi, Korea Automobile Testing and Research Institute, TS, KOREA)

A summary of the information gathered will be presented at the EVE-15 session to be held September XX-YY, 2015 in Ottawa, Canada.

Should you have any questions, or concerns, please do not hesitate to contact the EVE "Determining power of EVs" Leading Team.

Thank you for your contribution to this work.

The EVE "Determining power of EVs" Leading Team

Background:

Currently the UNECE provides a regulation under the 58' Agreement that can be used for approval of internal combustion engines (ICE) and electric drive trains in M and N category vehicles². It focusses on the determination of engine power values, however, the technical description part of the regulation merely provides for the individual determination of the power of either an ICE or an electric motor. The role of the propulsion battery is not considered by the regulation. A determination or recommendation for a calculation of the 'motive power' of the vehicle expressed as combined power or system power is missing. Furthermore in many cases (if not even in the majority) it is the REESS (propulsion battery) and not the electric motor that reveals to be the limiting element and therefore determines the power of an electrified power train. Consequently in many cases of state-of-the-art power train concepts of electrified vehicles, the concept of an individual determination of the engine's or electric

¹ Reference Guide for environmentally-related EV requirements already established or being considered by Contracting Parties (ECE/TRA/WP.29/2014/81).

² Regulation No. 85 of the Economic Commission for Europe of the United Nations (UNECE) – Uniform provisions concerning the approval of internal combustion engines or electric drive trains intended for the propulsion of motor vehicles of categories M and N with regard to the measurement of net power and the maximum 30 minutes power of electric drive trains"

motor's power is insufficient or even leads to misinterpretation of results. This holds for cases, where distinct information about the combined power of the system is eligible or needed.

System power specifications may be used in different fields. Among others, it may serve as customer technical information (e.g. maximum declared power), may be used by the legislator (as basis for taxation schemes) or by insurance providers (as a classifier for tariff determination). Further on, a strong demand for an improved power determination prescription currently comes from the WLTP-IWG¹ subgroup "electrified vehicles" that needs a system power specification for the classifications of electrified vehicles into distinct power-to-mass ratio classes, for the application of the so-called downscaling method that enables adaption of the test cycle for low powered vehicles and for the application of the WLTP gear-shift-calculation model.

The outlined situation may become even worse, since in future more and more sophisticated hybrid vehicle concepts for instance with distributed power sources are likely to gain market maturity (e.g. electrified vehicles with rim motor concepts). Being aware of this and according to its mandate, the IWG on EVE² meanwhile has identified action demand and therefor established a subgroup (SG) "Determining power of EVs" It's mission is to clarify, how an improved technical prescription for the determination of the system power of sophisticated powertrains like applied in pure and hybrid electric vehicles, could be realised under the ceiling of the UNECE. Scope of the work covers light duty vehicles (M1 and N1) and shall result in a recommendation or regulation for determination of the performance criteria "power" and "torque".

The group agreed upon organising the work in two parts. The first part shall be spent for gathering all necessary information, in an open and transparent way, for instance about,

- stakeholders to be invited to participate in the process so that they can share their potential interest and expertise,
- which system power information is of potential interest for the individual stakeholders and for which individual purposes,
- identification of other working groups that are currently involved in similar work and potential synergies that could be used.

Results from the study shall be used thereafter to compile an appropriate project work plan that should allow for all so far identified issues. Depending on the character of the points to be handled, there will be decision making processes necessary for political questions or research work for the clarification of technical questions.

The purpose of the following questionnaire is to gather information from possible stakeholders about their demands and attitudes in this subject.

Instructions: For each item presented below, please provide answers to the questions. We realize there may be overlap in requirements for multiple attributes; if this is the case, include information in each attribute even if repetitive.

¹ Worldwide harmonized light vehicles test procedure <https://www2.unece.org/wiki/pages/viewpage.action?pageId=2523179>

² EVE-IWG has been established in 2012 under the Working Party on Pollution and Energy (GRPE) and is reporting to GRPE and the WP.29. The Terms of Reference of the EVE IWG can be found at: <https://www2.unece.org/wiki/display/trans/EVE+2nd+Session>

1st part of Q. related to political questions:

- Amendment / additional module to R85
- New Regulation / Recommendation / Mutual Resolution

Question 1: Regulatory Approach

What would be your preferred option regarding the regulatory approach under the WP.29 / GRPE?

Background information: Harmonisation of technical prescriptions of Contracting Parties with respect to wheeled vehicles, equipment and parts is the declared objective of both the 1958 and 1998 Agreements. Before the actual project could start one issue comes with the regulatory approach that should be followed under the WP.29 / GRPE. Basically WP.29 provides for two options that could be chosen for an appropriate application of a mandate. EV system power determination could be developed, either

1. as a **Regulation**, or
2. as a **Recommendation / Mutual Resolution**.

Regulations could be annexed either to the 1958 Agreement as part of the type approval methodology or to the 1998 Agreement, as part of the GTR repository. While one could deem the amendment (extension) of a topic- related regulation a direct and straightforward way to accomplish the outlined objective, it must be stated that UN Regulations, as being part of the type approval methodology, are less suited for an extended international harmonisation level. On the other hand, an international fully harmonised approach would need a development of an entirely new GTR, which could be eventually very time-consuming.

Should it turn out that an agreement on a regulatory level could not be achieved, WP.29 provides for a second category of formal instruments that work like mutual adopted rules or recommendations. These recommendations or mutual resolutions, however, are not mandatory to the contracting parties.

ANSWER (tick only one box and/or give some explanation):

The prescription for determination of a system power of M1, N1 vehicles should be developed,

- by an amendment /additional module of the **UN ECE No. 85** under the 58' Agreement.
- by a **new GTR** or new module to an existing GTR under the 98' Agreement.
- by a **new Recommendation / Mutual Resolution** (or an additional **module** to one of these) annexed to the 98' and/ or 58' Agreement.
- by other means, and that is: <Please indicate and add some background explanation >

Space for general comments:

Please give your comments / recommendations

Continuation **political** qs:

- Appropriate power ratings
- Contracting parties individual requirements
- Vehicle configuration / condition

Question 2: Motive Power and appropriate measuring values -

Do you have requirements (voluntary, regulatory, etc.) in regards to appropriate power ratings that a new regulation / recommendation should / include?

The term 'requirements' is broad and can refer to any practise, regulation, legislation, code, and/or standard. Please keep in mind that the outlined undertaken "system power determination" focuses on electrified M1, N1 vehicles only (HEVs, PHEV, BEVs passenger cars and light commercial vehicles). If appropriate, specify individual requirements by vehicle type. Describe the requirements, stating its objective and goal. Indicate if the requirement is already established/ active or under development on a regional level. If the requirement is under development, what is the expected timeline for its adoption? Finally, if a definition of the particular power attribute is included in the requirement, please provide this information.

Background information

The current UN Regulation No 85 (UN-R85) provides for combustion engines a measuring value of the Net Power (NP) and for electric motors of a drive train the 30 min Maximum Continuous Net Power (MCNP). In case of multiple propulsion systems like with hybrid vehicles R85 does not account for the amount of power each path is actually providing in a particular driving phase. Generally speaking, the arithmetic sum of power of the individual motive sources does not reflect the correct actual power of the vehicle. In addition, the traction battery is the limiting power element in the majority of cases.

This could affect the proper classification of BEVs and vehicles with hybrid powertrains regarding for instance taxation schemes or insurance tariffs and makes it difficult for e.g. customers, to compare the motive power of two vehicles with different power train concepts.

ANSWER (tick only more than one box, where appropriate. Feel free to give an alternative proposal or a general comment):

- No, I haven't any further requirements that would go beyond the current status of UN-R85.
- Yes, in fact the Net Power ratings from current UN-R85 are sufficient but the power limit ascribed to the traction battery should be properly considered and determined. The regulation should then accordingly be adapted.
- Yes, a prescription for determination of a "combined system power" of M1, N1 HEV, PEHV, BEV vehicles should be entirely new developed and I have the following requirements for power rating information:
 - Information / power ratings about the complete power train should be given and should include following ratings (tick more than one box, if appropriate)
 - Maximum Net Power and Torque (Peak Power) / best case configuration and pre-condition
 - Average Net Power and Torque / representative case configuration and pre-condition
 - Minimum Net Power and Torque/ worst case configuration and pre-condition
 - Other, and that is: <Please give your proposal
<Description>
<Objective and goal>
<Established / active or under development>
<If under development, timeline for adoption>
<power attribute definition found in the requirement>
< any SAE, ISO, UL, national, international, voluntary, industry etc. standards referenced in the requirements? If yes, list the standards referenced>

Space for general comments:

<Is there any other relevant related information you would like to include? - Please give further comments /suggestions / recommendations, if you wish>

2nd part of Q. related to technical questions:

- Appropriate power ratings
- Individual requirements
- New Regulation / Recommendation / Mutual Resolution

Question 3: Which technical procedure is appropriate?

Requirements: Do you have requirements (voluntary, regulatory, etc.) in regards to the test procedure?

The term 'requirements' is broad and can refer to any practise, regulation, legislation, code, and/or standard. Please keep in mind that the outlined undertaken "system power determination" focuses on electrified M1, N1 vehicles only (HEVs, PHEV, BEVs passenger cars and light commercial vehicles). If appropriate, specify individual requirements by vehicle type. Describe the requirements, stating its objective and goal. Indicate if the requirement is already established/ active or under development on a regional level. If the requirement is under development, what is the expected timeline for its adoption?

Background information

Currently the UN-R85 provides for the determination of power ratings regarding internal combustion engines or electric motors obtained on a test bench at the end of the crankshaft (the so-called Net Power). Once the particular demand for power ratings of the total system is defined, an appropriate technical approach must be determined. It is foreseeable that three levels of technical procedures are able to be applied. The accuracy of results depends on the level of additional expenses of preparative and measurement work. However, it must be considered that practicability and a well-balanced cost- benefit relation of the technical procedure is given.

ANSWER (Tick only one box. Feel free to give an alternative proposal or a general comment):

- Determine net power and torque of each individual component (engine or electric motor) and estimate / calculate the system power and torque by means of a computational model / mathematical procedure.
- Determine the system power and torque directly by using a test bench configuration/ hardware-in-the-loop set-up.
- Determine the power and torque at the wheels of an entirely assembled vehicle applying a kind of chassis dyno or powertrain dyno measurement.
- Other, and that is: <Please give your proposal
<Description>
<Objective and goal>
<Established / active or under development>
<If under development, timeline for adoption>
<power attribute definition found in the requirement>
< any SAE, ISO, UL, national, international, voluntary, industry etc. standards referenced in the requirements? If yes, list the standards referenced>

Space for general comments:

<Is there any other relevant related information you would like to include? - Please give further comments /suggestions / recommendations, if you wish>

Feedback highly appreciated

- Additional ideas / issues
- Recommendation regarding the distribution list/ addressees
- Basic endorsement



Planning:

- Further 1 ½ - 2 weeks for written feedback from EVE-IWG
- Final version and distribution
- Preliminary analysis of responses ahead of the June EVE-IWG meeting

**Thank
you !**