

# eCall for Powered Two Wheeler (PTW)

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## **Abstract**

The decreasing numbers of fatalities in car accidents are in opposition to the stagnating figures of fatalities after motorcycle accidents. Therefore it is necessary to work continuously on solutions to turn around the current situation. One of the options is to introduce an eCall system for PTW's as well. The paper shows the necessary technical steps.

## **Introduction**

For many years a continuous discussion about the introduction of an eCall system for cars has been going on. From 2015 onwards it will become mandatory for new cars in Europe. For trucks a tracking system is quite common to get information about the location of the vehicle and its load.

The value contribution of an eCall is quite simple. It will improve the location information of an accident, it tells something about the severity and the number of people being involved and this leads to a faster and more adequate rescue action.

For motorcycles or PTWs the same benefits are generally valid. Taking into account all circumstances there are even of higher value.

Therefore patents, patent applications and papers of safety communities have shown proposals of solutions for many years. Nevertheless some important tasks are still to be done.

New technologies and affordable hardware are a door opener for a new approach to realizing an eCall for PTW.

A first after market solution is already coming into the market. EU-commissions and OEMs are discussing a series introduction of a system for 2016 or 2017.

## **Principle of an eCall system**

In comparison with other systems on a PTW an eCall system has not an isolate function. It is an infrastructure and combination of many different technologies and parties involved. These parties are moving closer to each other right now but have still some issues to solve because they come from different backgrounds.

A basic structure of an eCall system is shown in picture 1.



Picture 1: eCall example + body sensor + safety unit with BT, GSM and GPS

At first a PTW runs under stable conditions on a track. When these stability criteria are not fulfilled anymore, an accident occurs.

To determine the moving pattern of a driver and a vehicle sensors are used. These sensors have at least the capability of 6DoF (Degrees of freedom). The signals are transmitted via BlueTooth (BT) and CAN to a safety unit. The algorithm which runs inside triggers a mobile telephone message to a support center finally. The safety unit contains a GPS unit which adds the current location on top. If an optional link via BT exists, a voice communication could be built up as well. The triggering can also be done via a button as it is already common in cars.

Based on the information set which is partly stored at the support centre the rescue action is started after an assessment of the incoming data was done.

With this base information an ambulance can reach the casualties in short time.

## Comparison of eCall for Cars and PTW

The structure in picture1 is standard for passenger cars to some degree . So it is natural that most agreements can be seen as carryover for PTW. But the major differences between PTW and cars build up a rather difficult engineering task.


A summary is shown in picture 2.

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### Comparison eCall for cars and PTW

<p><u>Common</u></p> <ul style="list-style-type: none"><li>• rescue chain</li><li>• billing system</li><li>• national and international standards of communication</li><li>• forces to vehicle and driver are the same if they are combined</li><li>• power supply requirement</li><li>• infrastructure and business case</li></ul>	<p><u>Uncommon</u></p> <ul style="list-style-type: none"><li>• separation of vehicle and driver</li><li>• zero speed is safe area</li><li>• sensor types</li><li>• stability criteria</li><li>• accident detection</li><li>• location (off road)</li><li>• forces to vehicle and driver after separation</li><li>• ambient noise for voice communication</li><li>• accident recognition</li><li>• crash sensors at all sides</li><li>• population and hours of use</li></ul>
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Picture 2: Comparison eCall for cars and PTW

For cars the acceleration sensors of the airbag system are used to detect an accident. This gives reliable information about the forces which have been passed on from the car to the passenger. Vehicle and passengers are always combined during the flow of incidents. A stable power supply is a necessity to transmit the set of data to the support center. To get the important location information a GPS needed.

For PTWs the highest complication in this respect is the separation of driver and vehicle. The stability criteria require information from different sensors than those in a car. Zero speed is not safe all the time because the bike can trap the driver. To trigger an automatic eCall the accident situation has to be detected with high reliability. To determine the severity of injuries only forces affecting the driver are relevant. Because of the size of a PTW it can easily be hidden in some bushes in remote areas.

There are many special cases which have to be differentiated from normal ones to avoid a false alarm if possible.

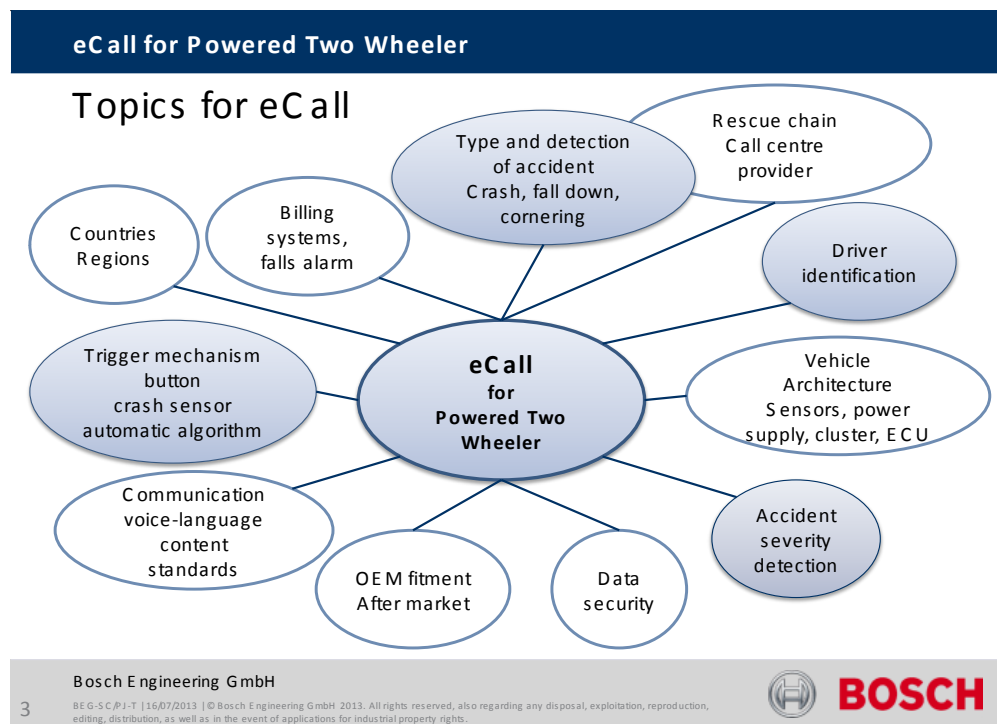
A major issue is to find out who was on the bike at the time of the accident because drivers of PTWs often swop bikes or garments. This is not the case with cars.

Another problem could be that the communication between the safety unit and the driver is impossible because he is too far away and wears the helmet. Only with a voice connection unit in the helmet there is a chance to get the same information level as with cars.

## Topics for eCall for PTW

An eCall system is a linkage of many topics. To make it work, a lot of different layers have to interact and have to be defined. There is also no current standardization which gives a frame for development and the establishment of a business case.

Each of the topics shown in picture 3 includes many issues to talk about.



Picture 3: Topics of eCall

Out of these eleven topics only four are very specific and need special solutions.

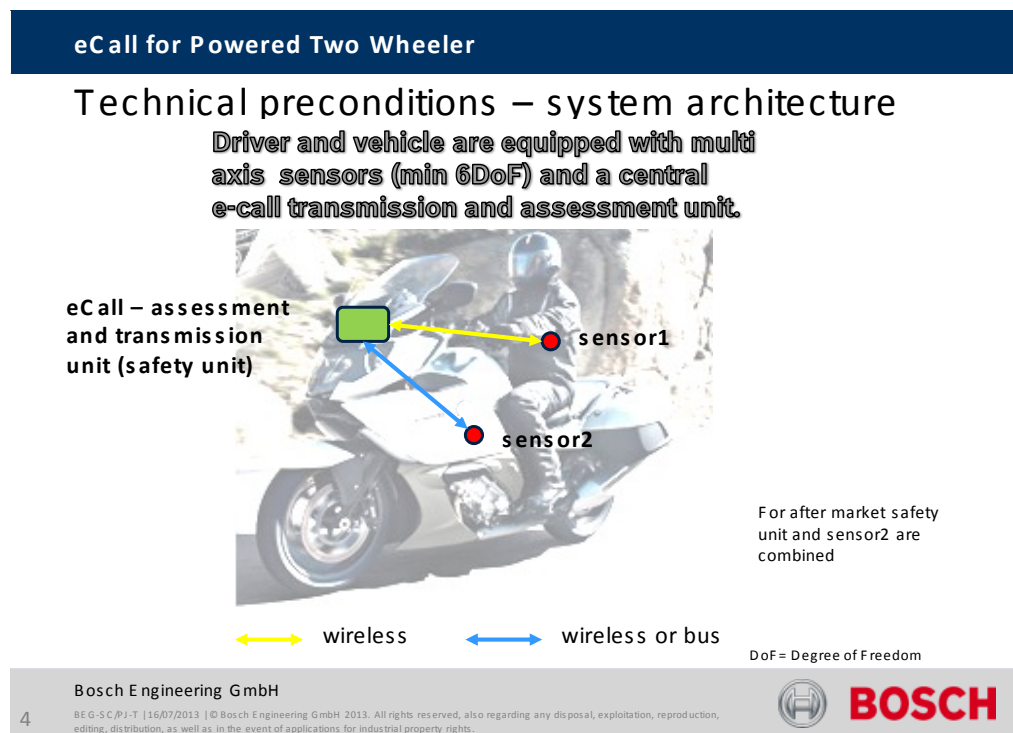
They are:

- Driver identification
- Type and detection of accident
- Accident severity detection
- Trigger mechanism

Driver identification has two aspects. One is about the individual information as for example medical treatments, special health conditions, blood group, name and address language and insurance data. This information is stored at the support centre.

Secondly, there is the combination of the driver with the bike which is the starting point of all upcoming dynamic assessments. This has to be done already at start even without a running engine. Any kind of data entry into a unit before starting seems too complicated and requires time and acceptance. So it has to be done automatically but with the avoidance of wrong interpretation.

The technical precondition is shown in picture 4.



Picture 4: Technical precondition – system architecture

The safety unit sends a polling code to sensor1. This sensor was previously registered in the unit. But this is not enough. Three cases have to be detected:

- Driver is wearing sensor1 (body sensor)
- Sensor1 is in the saddle bag
- Connection to sensor1 is interrupted

The driver wears the garment with sensor1, which means the moving pattern is phase shifted but synchronized to sensor2.

The sensor1 sits in the saddle bag which means the moving pattern is tide synchronized with sensor2.

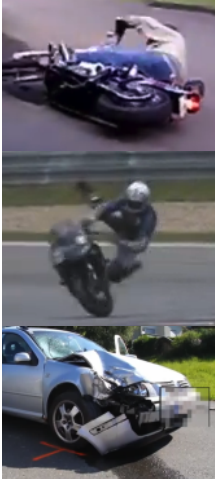
If sensor1 does not answer a polling code the transmission is interrupted and has to be indicated as malfunction on the dash board.

If sensor1 one has not received a polling code for quite a long time, it falls into a sleep mode to save battery power.

There are three different categories of accidents shown in picture 5

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### Accidents to detect




**Vehicle stands still:**  
Driver and bike suddenly fall over and driver is trapped. Injuries to hips , knees and ribs might occur. Without helmet head injuries are common. Driver is not able to activate help.

**Driving conditions:**  
At all speeds driver loses control of the vehicle dynamic behaviour, driver falls off the vehicle and is injured. If bike and driver go off the road they are not visible.

**Crash conditions:**  
Vehicle and driver crash into an obstacle. High deceleration values occur. In consequence severe injuries, also e.g. for a car driver being involved.

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Picture 5: Accidents to detect

In comparison to cars zero speed is not always a safe area for PTWs. It is a fact that after stopping or at start in some cases the driver is not able to hold the bike upright. Injuries can prevent the trapped person from releasing him-/herself. The severity of injury can make it impossible to press the alarm button manually.

A verbal description of a detection algorithm could be:

If the vehicle moves out of its upright position and the driver falls into the same direction and does not come back upright after a certain period of time, an accident has occurred. If the signals of body sensor (sensor1), assessed in the algorithm of the safety unit, detect a not plausible moving pattern, an automatic eCall is started.

The assessment of an accident during driving is much more complicated. The movement pattern has to be observed for a period of time. If all signals indicate that the driver has lost control of the dynamic behavior of the vehicle and has fallen off the vehicle, an accident situation is given.

A verbal description of a detection algorithm could be:

If the vehicle movement does not end in a stable upright position, an accident has occurred. From now on, only the body sensor is relevant for the determination whether there is a need for an automatic eCall or not.

The crash detection is based on high deceleration values coming from sensors on the vehicle. If the driver was not separated from the vehicle before, it is most likely that the same forces have to be absorbed by the body. In this case the same detection algorithms as for cars are applicable.

This leads to a general definition of an “Automatic eCall”:

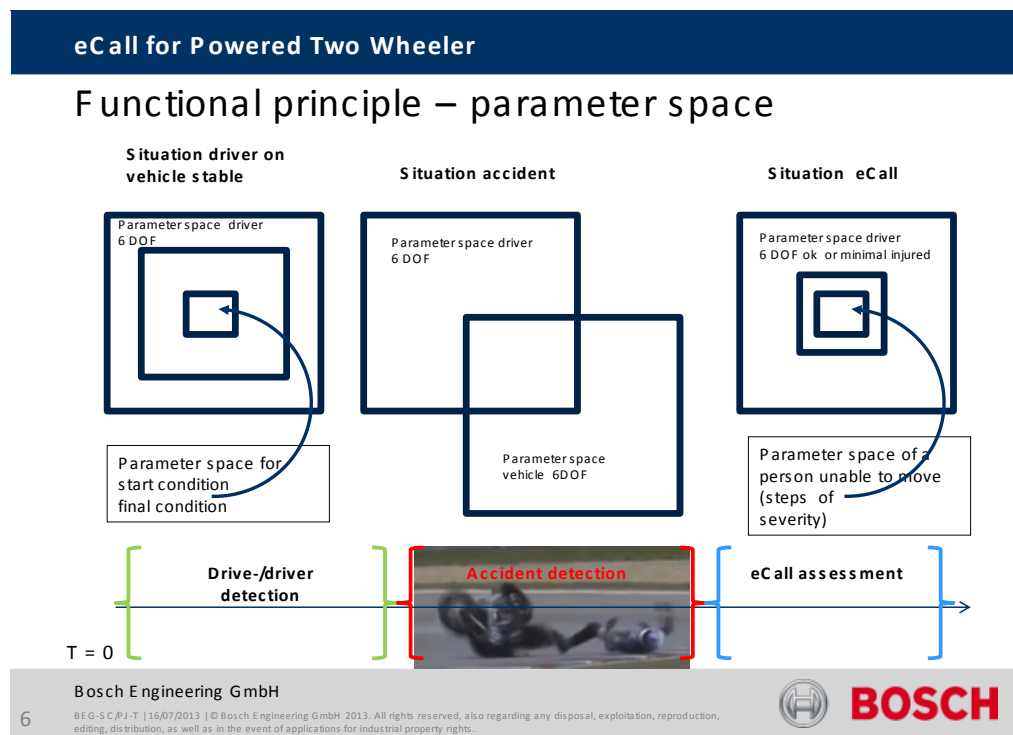
To get reliable information whether an accident of a powered two wheeler has happened or not an observation and assessment of a complete interval of incidents is necessary.

### **Description of functional principle**

To realize a solution for an automatic eCall with a detection of injury severity the monitoring of three phases is a necessity. The duration or time frame of each phase has not finally been defined so far. There is still a significant amount of research and engineering to be done before a series solution. In particular for the assessment of mobility in order to define severity of injury fundamental medical knowledge and experience is mandatory.

The functional principle is based on the assumption that the bike and the driver are equipped with sensors to detect the dynamic parameter range of the two. For the driver it would be quite helpful to have three dimensions of magnetic compass functionality in addition to three axes of acceleration and yaw. Right from the beginning the coordinates of bike sensor and body sensor are not matched.

The three phases are shown in picture 6.



Picture 6: Functional principle

The start of a two wheeler has a short phase of preliminary instability until the wheels are rotating fast enough to give a stabilizing momentum. With increasing speed all movements are in a harmonic flow and e.g. a lean angle increase goes back to a decrease after a period of time. If the direction is changed, it always goes across a zero value.

All traces generated by signals are finalized after a while in the same small zone where they were started. This means that the drive was finished with no accident.

Because driver and vehicle are a system of dynamic linkage it is possible to define that they belong together. Special filter algorithms separate those movements from implausible artifacts.

In case of an accident the parameter spaces of PTW and driver move apart more and more and get their own history trace. If the speed vector goes to zero, an accident has occurred.

But this does not mean that an eCall has to be triggered automatically because from now on only the size of the parameter space of the driver is relevant to assessing whether he/she is able to help him- or herself. If the person has lost his complete consciousness and/or mobility, a manual trigger cannot be activated if needed.

If the injuries are very severe and for example the driver has lost his consciousness, the movement pattern space is very tight. Doctors working in a rescue system at race



tracks have proved that a full stall of all movements defines an immediate need for help.

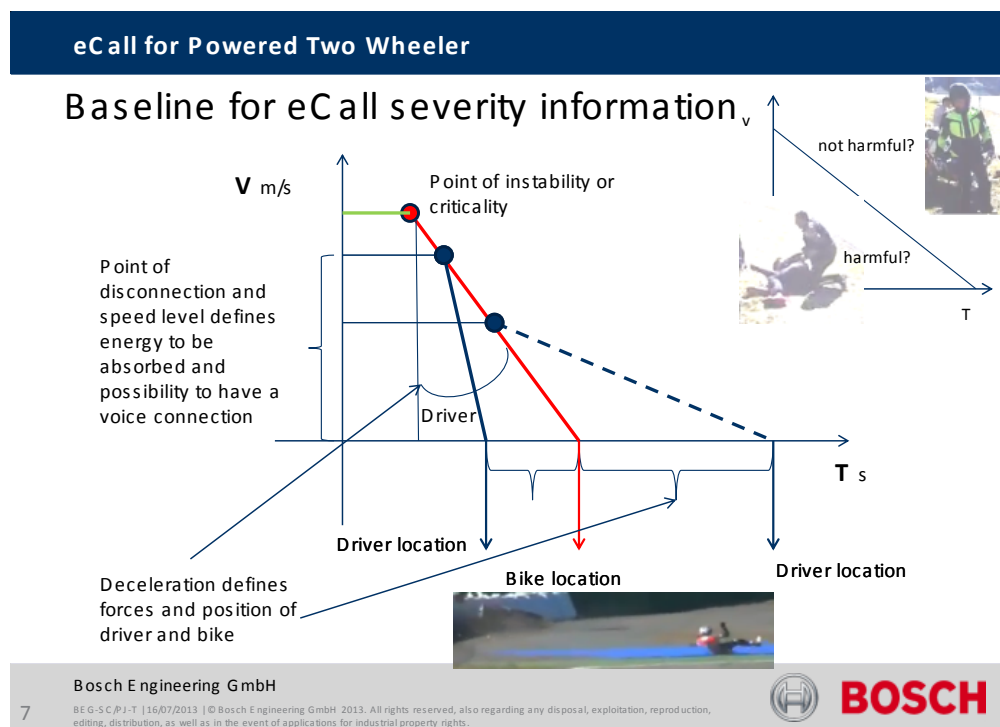
The observation of all three phases will give reliable trigger information for an automatic eCall. However, it might be possible that under certain circumstances a false alarm goes out. The emphasis should be more on the side of not required help than on missing help situations.

As it was already said for the assessment of driver reaction in an emergency situation, a trial out in reality is not possible. Most parts of the algorithms will be based on simulation and definitions from practical experience. Dummy tests for PTW do not represent the movement pattern after the accident. Data from race tracks will give a good basis for the definition of the instability criteria. Due to the wide safety spaces near the track and usually a gravel layer and air fences, forces which will act on the driver are quite different to those on public roads or in the outback.

### Base line for eCall severity information

There is a big chance to take more information out of the numbers. At the very moment an instability or critical situation is detected, intelligent algorithms are able to generate additional background for an assessment process.

In picture 7 some of the assessments are illustrated.



Picture 7: Baseline for eCall severity information

At the moment when vehicle and driver are disconnected, the current speed of the driver's body is the same as for the vehicle. This means the energy which has to be absorbed from now on can be calculated by physical rules. But on top this calculation is supported by the gradient of deceleration.

How much deceleration a human body can take without a fatal effect is quite different. There are no concrete figures available but for doctors it could be quite helpful to know the amount of absorbed energy before reaching the location.

In relation to the vehicle deceleration it is possible to measure the location of the driver. If the person was decelerated with higher gradient, he/she is located closer to the vehicle and with smoother values he/she has slid far away.

The distance between driver and vehicle is also valid information whether a voice connection as an option is possible or not. The ambient noise carpet could be measured. If it is too noisy, other ways of the decision making process in the support center can be chosen.

If an automatic eCall was triggered, a possibility to cancel this one might reduce the number of misuse cases.

### **Major work packages for eCall and conclusion**

From the technical point of view it is possible to install an eCall system with manual triggering and also voice connection with existing technology. Acceleration sensors at the helmet are used to get information about the forces which have gone to the head.

Nevertheless it seems necessary to get a very reliable method to detect an accident and to get the best possible solution for a severity assessment. This has to come via a safety unit with all features to perform a data and information transmission. The protection should not be lost at the border of a country and in very remote areas.

All rescue provisions generate costs which have to be paid by the user and the amount per person can only be reduced by a high penetration rate. In case of a false alarm all associated costs will remain in the support organization. This would increase the cost of the eCall entrance quite a bit.

A resuming statement is:

**An automatic eCall will save lives.**

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Verfahren dazu

