Connected Motorcycle Consortium

CMC Basic Specification

Application Roadmap

Based on the C-ITS concepts of the automotive industry, this roadmap paves the way for applications to be used in powered two wheelers in the future.
The focus lies on applications that positively contribute and increase the safety of motorcyclists in traffic.

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Disclaimer

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1 Background

Recognising dangers before they arise. Seeing obstacles which are not yet visible. Assess risks early and act accordingly. By connecting vehicles and infrastructure, we are taking one step further to achieve the vision of a traffic accident-free world. The communication between infrastructure and vehicles can technically be realised by cooperative systems. This is referred to as V2X communication (vehicle-to-everything) or more generally, by Cooperative Intelligent Transport Systems (C-ITS).

Since Powered Two Wheelers (PTWs) differ in design, driving dynamics and riding behaviour compared to cars, car systems cannot directly be transferred and adapted to PTWs. For the use in the PTW sector, specific PTW requirements must be taken into account. This includes elementary adaptations to the C-ITS applications (i.e. specific use cases), but also hardware and software adaptations as positioning accuracy, triggering algorithms, antenna positioning and to the human machine interface (HMI). Being aware of these challenges, well-known representatives of the motorcycle industry founded the "CMC - Connected Motorcycle Consortium" in 2016.

2 Roadmap

Based on the C-ITS concepts of the automotive industry, the "Application Roadmap" defines applications for the PTW of the future. The main focus lies on applications that can positively affect and potentially enhance the safety of riders in traffic. Based on functional descriptions of C-ITS applications, the impact on accident statistics is investigated by the Institute for Traffic Accident Research at Dresden University of Technology (VUFO)[1].

2.1 Introduction to C-ITS Roadmaps

In terms of C-ITS, numerous roadmaps exist. The reason is simple. It is not feasible to illustrate all applications, services or features of all stakeholders and show their different interests and prioritisation and focus by just one generic layout. Therefore, all major parties from the fields of road authorities, road operators or vehicle manufacturers, consortiums and projects create

[1] Christian Massong [BMW Motorrad], Marcus Petzold [VUFO GmbH] et. Al. (October 2018). CMC-Roadmap: Motorcycles on Track to Connectivity & Evaluation of the Potential of C-ITS for Motorcycles on the Basis of Real Accidents https://www.ifz.de/wordpress/wp-content/uploads/2018/10/ifz_Forschungsheft_18_Abstracts.pdf (accessed on 03.11.2020)

their individual roadmaps. For examples, please refer to the C2C Communication Consortium[2] and 5GAA[3].

2.2 Roadmap of CMC

As with most roadmaps, this roadmap purposely does not show a specific time schedule. Today, too many unknown factors have significant impact on the timeline for introducing C-ITS applications. Probably the most influential reason is that the technology to push through still needs to be defined (Cellular or Wi-Fi based or maybe even a hybrid solution). However, CMCs basic philosophy is technology neutral and is seeking for all possible solutions to be considered.

2.2.1 Prioritisation of C-ITS applications

The focus of the CMC is to enhance PTW safety. Naturally, this is the message of this roadmap. By investigating into applications and use cases in terms of C-ITS, a list of more than 30 applications was compiled. This list of applications and the corresponding documentation are essential for further steps for creating basic software and hardware specifications and defining interoperable system requirements. Furthermore, different classifications and categorisations were made. For promotion purposes it is helpful to have comprehensible categories, but for precise technical descriptions, more categories are necessary. All applications with an expected impact on safety were described in detail, leading to a list of 19 C-ITS applications. With these applications and corresponding use case descriptions it has been possible to execute an accidentology research using the German In-Depth Accident Study (GIDAS) Database. As a result, the potential impact of the evaluated applications on improving PTW safety can be compared quantitatively. With this outcome, prior made beneficial expectations of those application and use cases are substantiated. The results are shown in Figure **1** and lay the foundation for the CMC roadmap.

[2] C2C Communication Consortium. *The Car-2-Car Communication Consortium Roadmaps beyond Day-1*. Retrieved from https://www.codecs-project.eu/fileadmin/user_upload/pdfs/City_Pool_Workshop_1/CIMEC-CODECS_2016-03-3_Buburuzan.pdf (accessed on 03.11.2020)

[3] 5GAA. A Visionary Roadmap for Advanced Driving Use Cases Connectivity Technologies and Radio Spectrum Needs. Retrieved from https://5gaa.org/wp-content/uploads/2020/09/A-Visionary-Roadmap-for-Advanced-Driving-Use-Cases-Connectivity-Technologies-and-Radio-Spectrum-Needs.pdf (accessed on 03.11.2020)

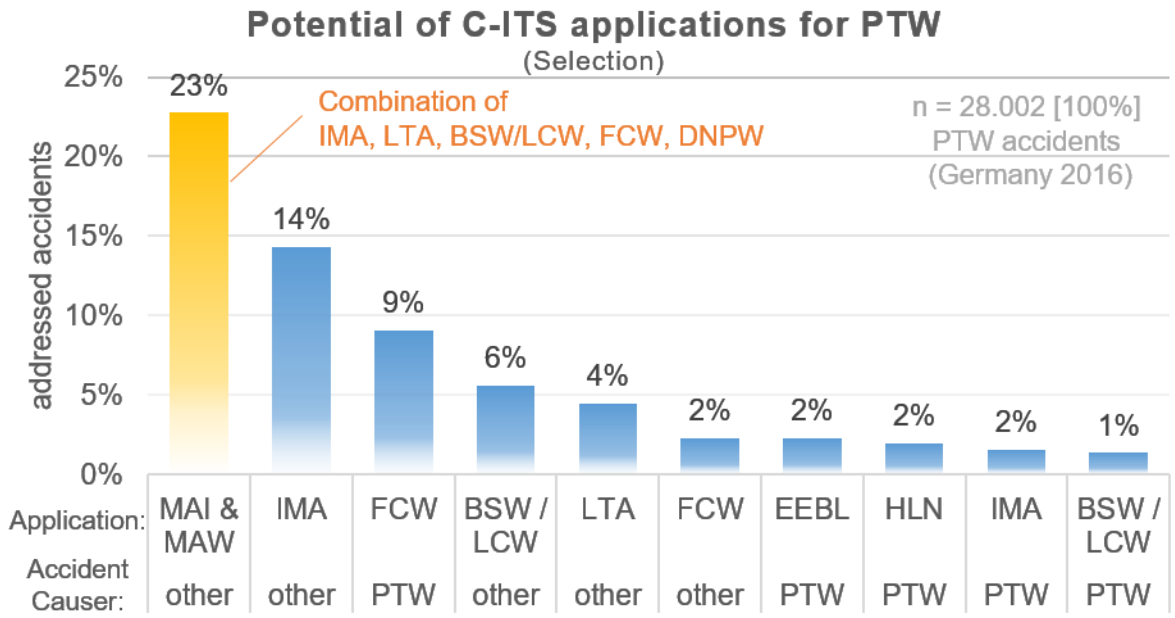

Figure 1: Calculated potential of C-ITS applications for PTW

On the horizontal axis of Figure 1 the investigated applications are shown in relevant order. The percentage specifies the share of addressed accidents per application. According to these survey results, 23% of all PTW accidents caused by the vehicle type 'other' may be addressed by the application category of MAI/MAW. (see CMC Basic Specification *"Application Specification"*.)

Unfortunately, the deployment strategy visualised by the roadmap cannot just adopt the results by focusing on those applications in just that order. The most beneficial applications are the most complex and presuppose high penetration rates. Additionally, very high localisation accuracy requirements may need to be fulfilled. Finally, yet importantly, the final effectiveness of the described applications under a real accident situation needs to be taken into account. Challenges in terms of HMI issues must be resolved to achieve better comprehension by the rider.[4] Further investigation on this topic is presented in CMC Basic Specification *"HMI Guideline"*.

[4] Sebastian Will [WIVW – Würzburg Institute for Traffic Sciences] (October 2018). Powered Two Wheeler HMI Design for Cooperative Intelligent Transport Systems (C-ITS) presented at Ifz conference, Cologne, Germany. https://www.ifz.de/wordpress/wp-content/uploads/2018/10/ifz_Forschungsheft_18_Abstracts.pdf (accessed on 03.11.2020)

2.2.2 Roadmap Diagram

The Roadmap shown in Figure 2 was elaborated using the result of an accidentology assessment in order to prioritise the deployment of C-ITS applications. This roadmap highlights the dependency of the potential safety benefit obtained through the listed C-ITS applications and the technical challenges to be taken into account for their implementation.

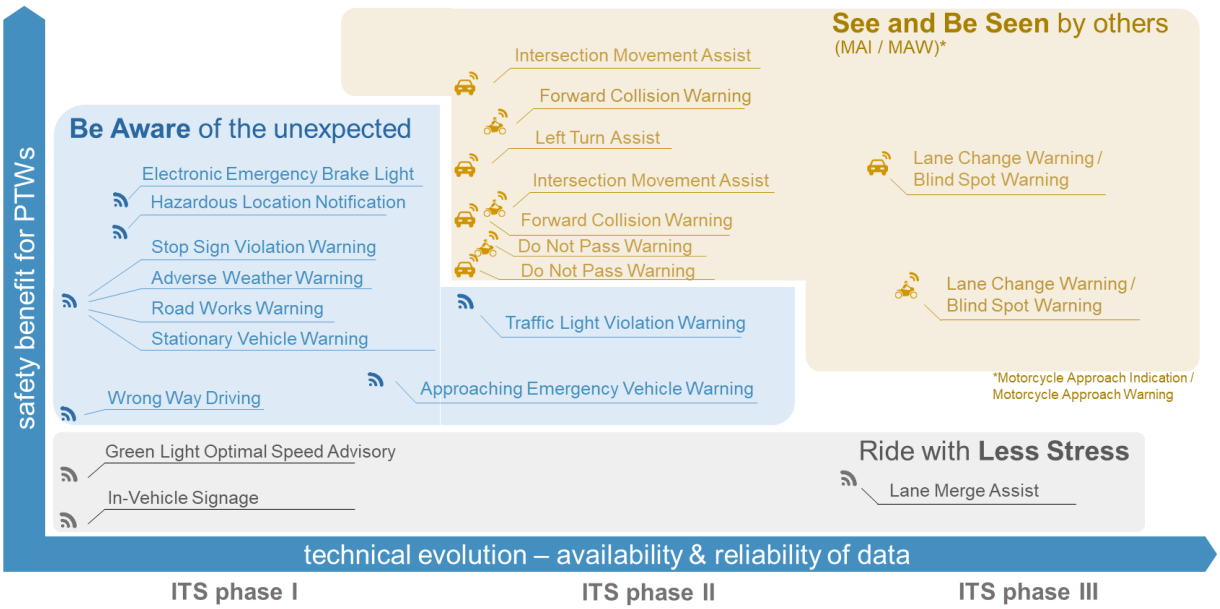

Figure 2: CMC Application Roadmap

The horizontal axis depicts the different phases in which the required technical evolution will allow the implementation of always more complex applications, while the vertical axis shows the potential benefit in rider safety obtained when a specific application is implemented.

The horizontal position of every application indicates *when* this application may be implemented, though it is an individual choice of each OEM to decide which applications to deploy at which time. The symbol next to every application illustrates if the application is addressing a PTW rider, a car driver, or stands for either. Thus for example, the Intersection Movement Assist is expected to be first introduced for cars and then for PTWs.

A common approach to cluster deployment activities in terms of C-ITS is the usage of time frames. The C2C-CC introduced the terms ‘Day 1’ and ‘Day 2’, which are equivalent to ‘Phase I’ and ‘Phase II’ in this roadmap.

2.2.3 Main categories inside this Roadmap

For this roadmap, a rough classification into three categories is being used in order to explain the key areas of action of the C-ITS applications considered.

1. **See and Be Seen** by others → *Main impact is via the other vehicle driver*
2. **Be Aware** of the unexpected → *Main impact is via the PTW rider*
3. Ride with **Less Stress** → *No direct impact on accident scenarios*

2.2.3.1 See and Be Seen by others

Accidentology studies show that the primary cause of PTW accidents is being overlooked in traffic[5] [6]. Therefore, the first and the most important category "See and Be Seen by others" embodies collision alert applications. Examples for this category are Intersection Movement Assist, Left Turn Assist and Forward Collision Warning.

2.2.3.2 Be Aware of the unexpected

Well-directed information can assist the PTW riders to adjust their riding behaviour and set their focus on potentially upcoming danger. Therefore, applications that allows you to "Be Aware of the unexpected**"** are also summarised in a category. Examples for this category are Electronic Emergency Brake Light, Hazardous Location Notification, and Approaching Emergency Vehicle Warning.

With the possibilities of its long communication range, the C-ITS system is able to provide Hazardous Warning Applications. Both backend-based (i.e. connected to a remote server) and direct communication solutions are possible, depending on the use case.

2.2.3.3 Ride with Less Stress

The category "Ride with Less Stress" represents applications that provide supporting information, such as traffic guidance data. These applications do not focus on enhancement of safety directly, but will have a positive effect, although it is hard to measure side effects to accident statistics by influencing the stress level of the riders and drivers decisively. Examples

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[5] Andrea Borin [Yamaha Motor R&D Europe], Hennes Fischer [Yamaha Motor Europe], Arne Purschwitz [BMW Motorrad], Udo Rietschel [BMW Group], Kazuyuki Maruyama [Honda R&D Co., Ltd.] and Oliver Kohlinger [Honda R&D Europe] (October 2016). ***Motorcycles in connected traffic - a contribution to safety*** presented at IfZ conference, Cologne, Germany. Retrieved from https://www.cmc-info.net/uploads/1/2/1/4/121453783/cmc-ifz-conference-2016.pdf (accessed on 03.11.2020)

[6] Sergeys F. [Honda Motor Europe Ltd. – Aalst Office] et. al. (March 2014). ***PTW Digital Conspicuity for Safety: DRIVE C2X project – Opportunities and Challenges*** presented at European Motorcyclists' Forum. Retrieved from http://www.fema-online.eu/uploads/EMF/EMF2014/III_2FilipSergeys2.pdf (accessed on 03.11.2020)

for this category are Green Light Optimal Speed Advisory, In-Vehicle Signage and Lane Merge Assist.

3 Summary

C-ITS applications offer new opportunities which can make riding significantly and sustainably safer. The Application roadmap illustrates the safety benefit of each application investigated by CMC and allocates a dependency of the safety benefit on the technical complexity.

Based on different studies and statistics about accidents involving PTWs, CMC developed a strategy for implementation of different C-ITS applications, which contribute to the safety of PTW riders. According to this strategy, the applications that help to “See and Be Seen by others” are the ones with the greater potential for improving PTW safety. At the same time, most of these applications are technically complex. Also to achieve acceptance among users, the reliability of the information shall be at a fair level so as not to be neglected by the users. Therefore, it is necessary to search for a balance between the safety benefit and the technical challenges associated with each of these applications.

Abbreviations

AWW	Adverse Weather Warning
BSW	Blind Spot Warning
C-ITS	Cooperative Intelligent Transport Systems
C2C-CC	CAR 2 CAR Communication Consortium
CMC	Connected Motorcycle Consortium
EEBL	Electronic Emergency Brake Light
FCW	Forward Collision Warning
GIDAS	German In-Depth Accident Study
IMA	Intersection Movement Assist
LCW	Lane Change Warning
LTA	Left Turn Assist
MAI	Motorcycle Approach Indication
MAW	Motorcycle Approach Warning
PTW	Powered Two Wheeler
V2X	Vehicle-to-Everything
VRU	Vulnerable Road User
VUFO	Institute for Traffic Accident Research at Dresden University of Technology