Radio interference risks to electronic road charging

Executive summary

Distance-based road charging plays an integral part in the EU's transport policy and the achievement of environmental and climate goals. More than 80.000 kilometres of motorways in Europe are toll motorways and road charging generates more than EUR 26 bln for the maintenance and safety of Europe's transport networks and implementing Europe's 'polluter pays principle' and policies to internalise the external costs of road transport.

CEN DSRC and the 5.8 GHz radio spectrum band play a key role implementing EU transport policy. CEN DSRC is one of the road charging technologies recognised in EU law. Electronic road charging systems use CEN DSRC for their enforcement, no matter if the localisation also uses CEN DSRC or GNSS location technology.

Harmful radio interference on the 5.8 GHz frequency band may disrupt the collection of tolls necessary to maintain Europe's high levels of road safety and environmental goals.

The following three requests for spectrum use are critical for the interference-free operation of distance-based road charging systems and their enforcement:

1.) There is a potential 'in-band' interference risk through the possible use of Wi-Fi as a short range device in the 5.8 GHz frequency band
2.) There is a potential 'in-band' interference risk through the possible use of Wi-Fi with a higher transmission strength in the 5.8 GHz frequency band
3.) There is a potential 'out-of-band' interference risk from LTE-V2X in the 5.9 GHz frequency band
4.) There is a potential 'out-of-band' interference risk from beam forming antennae on the 6 GHz frequency band

Running these services on these bands may cause harmful interference to the operation of electronic road charging systems. They would also be difficult to prevent, since they could be legal in some EU Member States. In the case RLAN/Wi-Fi this may lead to 'legal jamming'.

European radio regulators, organised in the 'CEPT', examine possible interference risks to CEN DSRC. CEPT reports outline under which conditions the interference-free operation of radio services is possible.

Active key stakeholders

CEPT (European Conference of Postal and Telecommunications Administrations): The CEPT is the organization of the European radio regulators. It is older than the EU Institutions and also

encompasses countries outside of the EU. The CEPT elaborates recommendations on how radio spectrum in Europe can be used efficiently and free of harmful interference. These recommendations then find recognition in European and national spectrum regulation. Inside of the CEPT the Electronic Communications Committee, abbreviated ECC, is the most senior decision-making body on radio spectrum. The ECC itself has numerous working groups that are subordinated to it and to which industry experts may contribute.

ASECAP (Association of European Toll Road Operators): ASECAP, as a trade association, takes an advocacy role at EU level. In addition that it plays an active role implementing radio spectrum policy: it administers the 'Protected Zone Database' (PZDB), a reference database that contains the positions of toll gantries for road charging. This database prevents radio interference, as other radio services are aware of the positions of the toll gantries and have to mitigate radio interference in their vicinity. ITS devices use the PZDB and it is also suitable for so-called 'wireless industrial applications' or Wi-Fi. The PZDB is essential for protecting CEN DSRC. Note: it can only protect fixed installations. The PZDB does not protect enforcement devices, since they are mobile and their location should not be known[1]. ASECAP experts participate in ECC working groups to advise on how to mitigate the risk of radio interference for electronic road charging systems.

ETSI (European Telecommunications Standards Institute): ETSI is one of the three European standardisation institutes and responsible for drafting specifications for most radio services. In the field of mobile telephony ETSI cooperates with standardisation body 3GPP and adopts 3GPP standards into European harmonized standards.

Regulatory aspects of electronic road charging

CEN DSRC is a standardised short-range communication technology. It is based on European Norms (EN): namely EN 1253, EN 12795, EN 12834, EN 13372 and EN 300674. CEN DSRC broadcasts on the 5795-5815 MHz frequency band. This frequency band is colloquially referred to as the 5.8 GHz band in the context of transport. CEN DSRC is a very secure and robust radio technology. From a regulatory point of view CEN DSRC devices are classified as 'short-range devices'. They are specified in Implementing Decision 2019/1345 on 'harmonised technical conditions in the area of radio spectrum use for short-range devices' as 'TTT' – 'Transport and Traffic Telematic devices'. TTT cover road tolling applications, smart tachograph and weights and dimensions applications[2].

CEN DSRC is one of the road charging technologies recognised in the EU's 'Interoperability Directive' 2019/520. The Eurovignette Directive 1999/62/EC enshrines the 'user pays' and the

[1] ETSI TR 102 792 , Intelligent Transport Systems (ITS); Mitigation techniques to avoid interference between European CEN Dedicated Short Range Communication (CEN DSRC) equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range' describes mitigation mechanisms for CEN DSRC road charging, as well as the smart tachograph to protect them from ITS-G5 related interference risks. The 'Protected Zone database' (PZDB) is one way of mitigating the risk for fixed road charging installations and a beacon system for the smart tachograph and mobile control equipment.

[2] Commission Implementing Regulation (EU) 2019/1345 'amending Decision 2006/771/EC updating harmonised technical conditions in the area of radio spectrum use for short-range devices', see Band 62

polluter pays' principles into EU law and that road operators may charge for 'infrastructure maintenance' and the 'internalisation of external costs'.

Road charging in EU transport policy

Road charging plays a key role for Europe's single market and the non-discriminatory application of road tolls, environmental policy and climate are key drivers of European transport policy and accordingly road charging.

The EU's 'Smart and Sustainable Mobility Strategy' COM (2020) 789 sees the internalisation of external costs as key policy to drive Europe towards 30 million zero emission vehicles by 2030. Likewise the European Commission's proposal for the revision of the above-mentioned Eurovignette Directive 1999/62/EC and the according staff working document establish a clear link between road charging and the decarbonisation of transport through vehicle renewal and further internalising the external cost.

Technical aspects & risks

Interest in the 5.8 GHz frequency band has increased over the past few years. Radio services that share radio spectrum with CEN DSRC implement various mitigation methods to protect CEN DSRC from harmful interference.

The prevention of radio interference tales place at the approval stage, before the deployment of a service. This counts particularly for transport, since equipment is mobile, culprits are next to impossible to trace after causing interference and enforcement through the recall of equipment, as is feasible with fixed equipment, cannot be done in the field of transport.

Potential risks to CEN DSRC on the 5.8 GHz frequency band:

- *RLAN as a short range device*

The interference risk is high. Note that the term Wi-Fi is commonly used for RLAN devices. A high density of RLAN devices in the CEN DSRC radio spectrum 5795-5815 MHz could crowd the radio spectrum and so cause interference to CEN DSRC. As stated above: it would be next to impossible to identify interferers. Even if RLAN devices are intended for indoor-use, there is no way preventing their use in vehicles. The use of RLAN devices may even be permitted in individual EU Member States. The CEPT already examined the use of RLAN on the 5.8 GHz frequency band[3]. The CEPT recommends that the RLAN has to implement mitigation measures to protect CEN DSRC from harmful interference. Currently it is possible to operate RLAN on the 5.8 GHz frequency band, if the output strength is kept below of 25 mW and if EU Member States grant their permission:

[3] ECC Report 244, 'Compatibility studies related to RLANs in the 5725-5925 MHz band'

- Norway permits RLAN use on the 5.8 GHz frequency band, except on the 20 MHz that CEN DSRC uses (5795-5815 MHz). Interference may occur through 'out-of-band' emissions from neighbouring frequency bands.
- Czech Republic granted permission for RLAN use on the 5.8 GHz frequency band in 2021. To protect road charging from harmful interference a database similar to the PZDB has to be used. It protects only fixed installations, or gantries not registered in the PZDB, for example new gantries or enforcement equipment.

- *Higher transmission strength RLAN*

In its 'ECC Report 330' the CEPT analyses the possible use of RLAN at higher transmission power than already permitted on the 5.8 GHz frequency band under a regime based on national permissions[4]. An EU-wide permission is out of question, since many radio regulators are convinced that it is not feasible to protect road charging and the smart tachograph, if RLAN would be permitted on the 5.8 GHz frequency band. The report in itself poses no risk. A risk may arise swiftly, should too many states individually grant permission to operate RLAN on the 5.8 GHz frequency band. There is also the risk that this report would be interpreted as a recommendation for granting national permission to operate RLAN on the 5.8 GHz frequency band, without considering the interference risk for CEN DSRC (e.g.: because there is no electronic road charging system present, or the radio regulator lacks expertise about the properties of electronic road charging or for the lack of human resources).

This issue would be best addressed at national level raising awareness of radio regulators of the risk of harmful interference to electronic road charging systems.

- *LTE-V2X*

The interference risk from LTE-V2X would be high, since LTE-V2X is envisioned to be installed in every vehicle by its manufacturers. LTE-V2X is foreseen to broadcast on the EU-wide ITS frequency band 5875-5935 MHz[5]. The CEPT has requested changes to the LTE-V2X standard for it to meet the requirements for band use[6].

LTE-V2X is a technology that is foreseen to enable the direct communication between vehicles (V2V) and between vehicles and the road infrastructure (V2I). It is originally standardised by standardisation body 3GPP. Currently the detection of CEN DSRC and mitigation is not yet fully specified, the use of the PZDB to protect fixed CEN DSRC installations is foreseen, the smart tachograph is not considered. The ECC has analysed the impact of vehicle-to-vehicle

[4] ECC Report 330 'To enable WAS/RLAN use on a national basis in the band 5725-5850 MHz but also ensure the protection of RTTT/Smart Tachograph and radars (including Fast Frequency Hopping) taking into account free circulation of WAS/RLAN'
[5] Commission Implementing Decision 2020/1426 'on the harmonised use of radio spectrum in the 5 875-5 935 MHz frequency band for safety-related applications of intelligent transport systems (ITS)'
[6] ECC Liaison statement to ETSI requesting changes to the LTE-V2X standard: https://www.cept.org/Documents/wg-fm/66803/fm-21-155annex17_ls-to-etsi-on-road-its-technologies-coexistence

communication based on ITS-G5[7] and has shown a low interference risk[8]. This interference risk would be higher with LTE-V2X because of several reasons; retransmissions (HARQ)[9], simultaneous transmissions[10] and more transmitted messages for segmented payloads[11]. This situation requires urgent clarification.

There is no ECC study on the impact of LTE-V2X on the smart tachograph. A compatibility study similar to the ECC Report 291 would be useful in this context.

- *Cellular beam forming technologies on 6.4-7 GHz*

The interference risk here is spatially limited and difficult to predict. Mobile network operators would like to use the 6.4-7 GHz frequency band for future 5G cellular networks, idea here would be to use dynamic beam forming to follow mobile devices. First calculations here assume a transmission strength of 72 dBm, or 16 kW EIRP[12], in the direction of the radio beam. This transmission strength would be significantly higher than that in use by current beam forming antennae. The ECC has just started examining this idea, which would be due for discussion at the World Radio Conference 2023. This use of 5G on the 6.4-7 GHz frequency band merits deeper analysis and road charging ought to be adequately considered at the World Radio Conference.

*The **DSRC Interest Group** promotes the benefits of CEN DSRC technology to reach socio-economic and environmental goals in Europe. The DSRC Interest Group is registered in the EU transparency register (Transparency Register Number: 551694339025-26).*

CEN DSRC plays a key role implementing EU transport policy and generating socio-economic benefit. It is a key to implementing the 'user pays' and 'polluter pays' principles in road transport and hence is key to protecting the environment and maintaining Europe's road network. It plays a key role keeping our roads safe, since CEN DSRC helps protecting motorists from overloaded trucks or fatigued truck drivers. Through the tolls it helps to collect and enforce, CEN DSRC internalizes external transport cost and helps keeps Europe's roads infrastructure safe. Enforcing rules on Weights & Dimensions of trucks or the drive and rest times of truckers CEN DSRC also helps maintaining working conditions and fair competition in Europe's road haulage sector.

[7] ITS-G5 is currently used for V2V and V2I communication and would be used for automated driving or 'platooning'. It is a standardised technology that allows instant, direct and ad-hoc V2V and V2I communication and broadcasts short-range. ITS-G5 and LTE-V2X fulfil the same purpose, both are ad-hoc short-range communication technologies. ITS-G5 is mature and already deployed by several European motorway operators and serialised in Volkswagen's Golf and ID series. At policy level ITS-G5 and LTE-V2X would be considered as C-ITS (cooperative ITS). ITS-G5 also plays a role in enforcing vehicle weight in Europe: Commission Implementing Regulation (EU) 2019/1213 'laying down detailed provisions ensuring uniform conditions for the implementation of interoperability and compatibility of on-board weighing equipment pursuant to Council Directive 96/53/EC', Annex II 4.1 mandates ITS-G5 for the exchange of weight data between the tractor and the trailer of a truck.

[8] ECC Report 291, 'Compatibility studies between smart tachograph, weight & dimension applications and systems operating in the band 5795-5815 MHz and in the adjacent bands'

[9] ETSI TS 103 723, Intelligent Transport Systems (ITS); Profile for LTE-V2X Direct Communication

[10] ECC Report 290, 'Studies to examine the applicability of ECC Reports 101 and 228 for various ITS technologies under EC Mandate (RSCOM 17-26Rev.3)'

[11] ECC Report 290, 'Studies to examine the applicability of ECC Reports 101 and 228 for various ITS technologies under EC Mandate (RSCOM 17-26Rev.3)' same as reference 13

[12] Figures are calculated based upon ECC PT1(21)229_Annex 2 and ITU 'Electromagnetic field compliance assessments for 5G wireless networks'

CEN DSRC is in wide use across the EU. Electronic road charging approximately 80.000 kilometres of roads relies on CEN DSRC for localization or enforcement. There are millions of pieces of CEN DSRC equipment in circulation, be that on-board units or digital tachographs.