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Annex 1 to the Report of the Ethics Committee of the Ministry of Transport – Recommendations

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IDENTIFICATION

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Introduction

While the idea of connected and autonomous vehicles (CAVs) has a relatively long history, it is only in recent years that it has come to the forefront of scientific and technological research and development. The advent of CAVs is usually associated with expected improvements in transport safety and overall transport efficiency, e.g., transport speed, accessibility, or environmental friendliness. However, CAVs go beyond the narrow technical and safety issues framework regarding their importance and potential impacts. They raise some technical, moral, and social issues. Therefore, several countries worldwide and specifically within the EU have established committees at various levels and platforms to address these issues and issue advisory or binding opinions systematically. With the establishment of the Ethics Committee for the Assessment of Issues Related to the Operation of Automated and Autonomous Vehicles in the Conditions of the Czech Republic at the Ministry of Transport (MoT) in March 2020, the Czech Republic, as one of the countries with a mature automotive industry, has become one of the countries that are systematically addressing ethical issues of autonomous mobility, including at the level of state administration. The primary mission of the Ethics Committee is to work as an advisory body on CAV implementation issues to the Ministry of Transport.

The present document draws on the ethical reflection of CAV in European and non-European countries but situates its recommendations in the context of the Czech environment. The recommendations, therefore, respect foreign knowledge and observations but are not a mere adaptation of them. They are their own, partly original contribution to the international discourse. The individual recommendations are specified for the Czech Republic and enriched with new general principles and aspects that we consider crucial for the ethics of CAV. If the analyses presented here prove successful and the recommendations can be successfully implemented at the national level, other countries, especially the EU, can offer feedback for possible improvement.

Among the principles and emphases that have been somewhat neglected so far, which are the basis of our recommendations and which we are trying to respect consistently, we would like to highlight here:

(1) the vision of big mobility,

(2) the feasibility factor, and

(3) the crucial importance of an integral connection of the ethical (in the narrower sense of the word), legal and technical dimensions of the CAV issue.

The vision of big mobility

The vision of big mobility implies pursuing a holistic and interdisciplinary approach to developing human and societal life quality. This concept also includes the moral intuitions of the population, the existing legal framework, cultural influences, data protection, the environment, and spatial planning. The vision allows for a long-term rational approach that avoids unilateral prioritisation of new technologies, emphasising short- or medium-term benefits. Fundamental societal changes can thus be preceded by a discussion of what we expect from transport in the light of the many different interests typical of (not only Czech) pluralistic societies. The basic premise of the recommendations

is that we cannot compromise our core values for the sake of short-term and one-sided benefits of individuals or corporations (which, moreover, often go beyond the people and countries concerned). The most important thing is to think through and follow through on the benefits for people, cities, society, and nature. The aim of the recommendations presented in the vision of big mobility is not to promote CAV in our context unilaterally and at any cost but to implement them in the context of all aspects of human existence. The aim of the recommendations is thus to contribute to a gradual, safe, fair, and responsible transition from conventional vehicles to CAVs, with the cooperation and support of all stakeholders, in the context of developing a good life for individuals and society and in harmony with the environment.

Realistic treatment

A principal added value of the present recommendations is their practical and realistic treatment, which considers the actual context of our environment and the feasibility of the recommendations. While similar documents from abroad often start from the level of thought experiments and philosophical statements of 'how it would be in an ideal world' and often end there, this document presents a set of fundamentally realistic recommendations. The realism of the recommendations was underpinned by the unique interdisciplinary composition of the committee, which has not only philosophical but also legal and technical competencies. Thanks to the unique combination of expertise of the members of the committee and the intensive cooperation between its various working groups, the legal and technical constraints and thus the practical non-/implementability of multiple solutions, which is only marginally addressed in similar documents, are considered. All these aspects were also consulted with the competent staff of the Ministry of Transport to maximise the document's usability in the shortest possible time.

A holistic perspective

The third key aspect of the document has already been mentioned above: the integral integration of different disciplines, expertise, and points of view. Although the recommendations are divided into three areas for clarity, they are all interlinked and were developed through an exchange of views among all the members of the Committee. All relevant aspects of big mobility were considered: human individuals and their well-being in society, societal requirements for the operation of CAVs, government, scientific institutions, applied research, and the technical, legislative, and practical aspects of autonomous transport.

The individual recommendations are classified into one of three groups: ethical, legal, and technical. The ethical dimension is present, explicitly or implicitly, in each recommendation, so we address it in more detail in the introductory section and present the basic ethical principles that should guide the development, production, and operation of CAVs. Overall, the document contains six ethical, six

legal, and nine technical recommendations. In the interests of readability, the list of references used is given at the end of the text, and we have kept the use of additional notes to an absolute minimum.

Finally, we would like to thank the Ministry of Transport of the Czech Republic, particularly JUDr. Václav Kobera and PhDr. Tereza Čížková, as well as all the members of the Committee and colleagues who read the text at various stages and helped us to improve it.

The vision of big mobility and the objectives of the ethical recommendations

The recommendations aim to contribute to a gradual, safe, fair, and responsible transition from conventional vehicles to CAVs (connected and autonomous vehicles), with the cooperation and support of stakeholders, in the context of the well-being of individuals and society.

An important starting point for ethical and related legal and technical-informational reflection on the development, production, and deployment of CAVs is the idea of "big mobility," which represents a holistic view of mobility from both the individual and societal perspectives, always taking into account all aspects of its implementation. The new vision of mobility implies the pursuit of a holistic and interdisciplinary view of the good life of people and society, i.e., not only concerning transport and public health (safety) but also to people's ethical expectations, the existing legal framework, data protection, the environment, spatial planning, local practices, etc. Rather than rushing into new technologies, even though their short or medium-term benefits may be unquestionable, significant disruptive changes should be preceded by discussing what we expect from them. It is equally essential that the conclusions of such discussions are then implemented as widely as possible. We cannot afford to compromise our core values for short-term and unilateral gain (which, moreover, often goes beyond the people and countries concerned). Let us not be afraid of setting strong norms from the outset; this is not about fast-tracking CAV at any cost. It is essential to think through and follow through on their benefits for people, cities, landscapes, nature, society, health, and other areas of our interest. Let us ask, for example, about the benefits of CAVs in Czech cities. We can conclude, after careful reflection, that the development of a smart city is more important from these perspectives than promoting the fastest possible implementation of CAVs (emphasis on accessibility of services and amenities versus unnecessary transport). Therefore, the aim of these recommendations is not to promote CAV in the Czech context unilaterally and at any cost but rather to consider it in the context of other aspects of human existence, especially moral values based on human dignity and rights. In this context, it is interesting to follow the results of comparative studies of values across European countries, which have long been carried out by a group of researchers around Prof. Hofstede from the Netherlands (www.hofstede-insights.com). They show some interesting facts about the Czech environment. Security and clear rules are more important to the Czech citizen than the joy of innovation and a possible feeling of insecurity. Therefore, creating clear standards, a well-understood hierarchy of procedures, and their clarity (even if they do not work perfectly) will help establish trust and support the implementation of CAV. Czechs are much more pragmatic than normative. They see life as so complex that it is impossible to understand it completely, so they do not try to understand everything. The pragmatic nature of the Czech context is that people try to live a good life rather than to know the truth about everything that happens. Combined with our tendency towards pessimism and cynicism, the repeated reference to the fact that autonomous vehicles will increase the opportunities to enjoy life more and create a better work-life balance would probably not be understood, unlike in other countries. Much more appropriate here is the appeal to increased safety and, above all, the supposed increase in work efficiency. Certain egocentrism means that the majority of the country's population will not

be how the introduction of CAVs will help the community or the planet, but what it will specifically bring to them and their loved ones. As a somewhat hierarchical society, we assume that some will access the benefits of CAV before others. Therefore, this should not matter so much when introducing pilot programmes in the Czech Republic, as unequal distribution is assumed at the outset.

Given these specificities of the Czech environment, the recommendations in this document are divided into three areas: ethical recommendations, legal recommendations, and, finally, technical recommendations. All three areas are united by an emphasis on the safety of autonomous traffic as the primary ethical value most likely to resonate with the Czech population.

Given the above, the technological transition to autonomous transport should be:

1. gradual: Czech society, including the labour market and urban and landscape planning, needs time to adapt to the fundamental changes that CAVs will bring. Transparency is an essential value behind the whole process, which, together with the phasing of CAV implementation, will make it possible to anticipate the different phases and prepare accordingly.

2. Safe: not only should health and property be protected as much as possible, but also be aware of other potential risks associated with CAV, including socio-psychological phenomena, where people often react more intensely and less predictably to unusual and novel stimuli than to normal ones.

3. Responsible: at each stage of the gradual transition to CAV in the Czech Republic, the areas for which the different actors are responsible must be defined in advance. This transition must be continuously analysed and take into account the latest knowledge and findings.

4. cooperative: given the extreme complexity and risks involved in CAVs, it is necessary to analyse not only the usual market-based, competitive aspects of technological change but also to emphasise the synergy of all the parties involved in the pursuit of the main ethical objectives of autonomous transport, first and foremost safety.

5. The good: CAVs need to contribute to the full comprehensive development of individual and societal life (to their well-being). Therefore, its implementation should not be an end in itself and should not be promoted outside this value context. It is also essential that CAV is approached to improve people's lives where it is not easy to do so in other ways. However, their usefulness to one group must not be bought at the expense of discrimination against other population groups.

Benefits and risks of CAV

Both the history and philosophy of technology point to the fact that there are benefits and risks associated with each technology; therefore, each technology must be considered individually and in a broader perspective. Where possible, efforts should be made to maximise the benefits of technology and minimise the risks. There is no denying that, in addition to the benefits, some risks will arise from the introduction of CAVs, but many proponents of the technology hardly mention these. This makes it all the more important to address them in this document. In the context of CAVs, these include the following phenomena.

Possible benefits of CAVs

1. Public health: reduction in the number of traffic accidents; reduction in the stress of driving for both the crew and other road users by making road behaviour more predictable and reducing the number of dangerous situations (chases, drivers under the influence of alcohol or drugs, etc.); reduction in the risk of transmitting infectious diseases by allowing individual transport even for those who would otherwise be dependent on carpooling.
2. Environment: secondary reduction of harmful emissions from transport through more efficient use of cars and their integration into transport and urban infrastructure; greater efficiency in the use of energy sources.
3. Improved accessibility: improved transport accessibility; time savings in transport; increased travel comfort; more targeted urban planning with the introduction of mobility-on-demand services, without the need to park near the destination; connection to smart cities technologies.

Possible risks associated with CAVs

1. Increase in energy intensity and environmental burden. Dependence on producing many times more data than existing vehicles; significantly higher energy requirements; dependence on rare metals, especially for battery-powered vehicles; environmentally demanding vehicle recycling and disposal.
2. Personal data and algorithms: invasion of privacy by tracking actors; the threat of inability to avoid misuse of personal data for financial gain (e.g., targeted advertising); possibility of alteration or substitution of personal data for various reasons (e.g., to benefit a particular group) or purely due to technological error or inadequacy; further increase in complexity of transport systems and incomprehensibility of decision-making processes; implicit ambiguity of preferences of control algorithms (due to application of artificial intelligence) and the threat of external interference in the operation of vehicles.
3. Reinforcement of societal inequalities: algorithmically determined routing through preferred neighbourhoods; purposeful avoidance of specific locations; congestion on some roads; economic (and potentially political) attempts to exploit CAV routing and operation for parochial interests.
4. Lack of accountability: unfair and misdistributed responsibility for the development, production, and use of CAVs; inadequately determined liability for damage caused by CAV operations.
5. Economic change: loss of jobs; dependence on information technology in previously unaffected areas; unfair redistribution of economic gains and losses; unforeseen negative change in the lifestyles of individuals and society as a whole.

6. Transport paralysis: possible traffic congestion, especially in historical cities (including the Czech Republic); potential energy and computer networks attacks, leading to transport paralysis.

However, the risks can be minimised, and many can be seen as opportunities: to better secure personal and digital privacy; to ensure the general availability of vehicles, both through fair distribution and fair allocation of time in sharing systems; to educate the public widely about the benefits and risks of CAVs; to set criteria for attributing responsibility and to encourage the creation and cultivation of a culture of accountability; to create new jobs to replace professions that have disappeared. It is essential to start from the premise that the benefits and risks associated with CAV are largely predictable and can be influenced in different ways. Technological progress alone is insufficient to maximise its positive potential; benefits need to be maximised and foreseeable risks minimised during development, deployment, and regulation. While unforeseen situations may always arise, sequencing the steps taken should reduce the likelihood of their occurrence and avoid negative consequences.

CAV developers and manufacturers, private companies, and the relevant Czech administrative authorities and legislators should systematically and integrally incorporate the considerations mentioned above into the development and implementation of CAVs. This is not only in the actual standard-setting process, in which private entities can intervene, e.g., through lobbying, but also in other preventive aspects. The current situation, where technical standards, legal and approval regulations are often developed with the direct assistance of private stakeholders interested in their wording, needs to change. The Ministry of Transport, or the relevant independent research centres, should continuously monitor the development and implementation of CAVs in terms of actual and foreseeable ethical impacts and create tools for their optimisation.

General ethical principles

Several fundamental ethical theories are encountered in the current literature. In these recommendations, we will rely on the so-called principlism, which is accepted as a good starting point for many analyses in the field of applied ethics and plays a vital role in new European Commission documents on the topic of CAVs, such as the Ethics of Connected and Automated Vehicles of 2020.

Principlism is not based on general normative theories but domain-specific ethical principles (hence the name 'principlism' or 'principialism'). This approach has initially been born out of dissatisfaction with the state of medical ethics. Still, it has found its application in other fields, such as the ethics of modern technology. The list of principles may vary from case to case, as they aim to provide normative anchoring for the different spheres of application of the technology in question. Domain-specific ethical principles are general, and the forms of their specific application must always be carefully determined. It is also essential to recognise that applying the principles to a specific case

may lead to conflicting conclusions. A balancing methodology should be developed to determine which principles have greater normative force in a given situation.

We consider the following to be the basic principles of the domain-specific area of CAV ethics:

1. the principle of non-maleficence. This principle prohibits intentional infliction of harm, especially, but not exclusively, harm to health and life.

2. The principle of beneficence. This principle imposes a positive duty to benefit, i.e., to bring benefit, to benefit all.

3. The principle of dignity. According to this principle, every person is endowed with inherent dignity. An ethical principle also finds a vast anchorage in the primary international human rights conventions and other human rights documents.

4. The principle of autonomy. This principle imposes an obligation to respect human autonomy and the conditions for its exercise, such as various forms of privacy.

5. The principle of justice. The standard and fair sharing of the expected positive and negative aspects of CAV.

6. The principle of inclusiveness. This principle imposes a positive obligation to include all groups, especially the disadvantaged, in all considerations, processes, and distribution of benefits.

7. The principle of accountability. This principle imposes a positive obligation to accept prospective and retrospective role-specific responsibilities associated with a particular role in society, e.g., autonomous systems developer, as well as individual responsibility.

Ethical recommendations - Preamble

The ethical recommendations are based on generally applicable ethical principles and standards, which result from long-standing research in the field of ethics and related disciplines. The ethical part of the recommendations is based on the above principles and shows how to apply these principles to the concrete problems of autonomous mobility concerning humanity and society. Like any ethical recommendation, the following must deal with the question of its validity. Usually, ethical recommendations, even in the field of applied ethics, are seen as universal. Our approach differs slightly from the generally accepted practice. Ethical recommendations also seek to deal with local norms that modify the applicability of some universal norms. For the modifications to be systematically traceable, they must be based on a single source of values. Fortunately, research on value preferences and their comparison across Europe has been carried out for a long time, and we can draw on the pan-European research from the Netherlands mentioned in the introductory section on the vision of high mobility. The result is generally valid recommendations that take into account the culturally conditioned values of the Czech population.

Please also note that, unlike legal and technical recommendations, ethical recommendations can lead to potential conflicts with each other when trying to implement them. The reason is that the status of ethics is different from that of positive law or technical standards. The generality of ethical recommendations may give the appearance of conflict when applied to specific cases, as different recommendations may lead to different commitments, but this does not invalidate them. The proper way to resolve similar conflicts is to undertake further ethical analysis to determine which recommendations prevail over others in a given situation. Each similar conflict must be resolved in the context of the case, as all recommendations carry equal weight, and it is impossible to give any random priority. Therefore, the use of the recommendations in practice requires careful, practical consideration and cannot be reduced to a mechanical application.

Legal recommendations - Preamble

Ethics and law are interrelated systems, and the goal of legal systems is to reflect at least a minimum of ethics. However, in the case of introducing new technologies into practice and the setting of their legal regulation, the representation of moral values should be higher. Because only if the legal regulation is built on a sufficiently robust ethical foundation will it be more readily accepted by the public. At the same time, it must be stressed that ethics also plays a significant role in contemporary human rights discourse, and it is clear that the introduction of new technologies will be evaluated through the lens of human rights doctrine. Natural rights - such as the right to life or the right to privacy - are such a significant value that any new legislation on the use of CAVs must be primarily analysed in terms of compatibility/non-compliance with human rights (and the related ethical discourse).

Given the above, the lekal doctrines are based on three basic principles, which are to ensure the legitimacy of any legal regulation of the use of CAVs. These principles are:

1. The deployment of CAVs and their society-wide use is only acceptable if it is clear and can be effectively ensured that CAV systems will cause less overall harm (especially to life and health) than maintaining the current human-driven driving.

2. Human life and health are always worth more than material damage.

3. When using CAVs, it is necessary to ensure that a person's privacy is sufficiently safeguarded.

In general terms, the recommendations are based on the basic principles and values of a democratic state, which place human life and health in the first place, i.e. as an asset worthy of the highest protection in terms of law and ethics. These values cannot be questioned in any way and have the necessary priority over any potential economic gains. Similarly, the fundamental values of a democratic state include the protection of privacy, which can only be restricted under certain conditions, and interference with this right must always be minimised and proportionate.

The right to privacy is to be understood in a broader context as a whole set of different rights that include our presentation to other members of society (how we want to be perceived by others), control over what data and information about us and our lives are available to others and how it can be obtained, stored, processed and disseminated.

There are four dimensions of privacy:

1. **Physical privacy.** It defines the contours

   of "physical" freedom, which sets boundaries that prevent interference in our physical environment, including surveillance of our lives by others.

2. **Mental privacy.** It defines the contours

   of "mental" freedom from the psychological influence; it limits the possibility of access to and manipulation of the circuits of our mind.

3. **Privacy in decision making.** It determines the limits of our freedom to make our own decisions without influences that would limit or influence our decisions.

4. **Information Privacy**. It defines the area of our freedom in which no one can obtain, process, store or disseminate information about us.

Taking into account the above principles and rationale, four main areas for the development of legal recommendations have been identified:

- The development of legal standards in transport regulations and their effective review, i.e. examining their adequacy in the light of new technological systems and their possible revision. The main objective is to protect human life and health, i.e. to improve traffic safety.

- Protection of privacy and personal data (mitigation of possible harm resulting from the processing and possible misuse of data).

- The issue of setting up an adequate system of legal responsibility with respect to respecting corrective justice and minimising the harms and risks in society, including setting up a fair system of compensation for victims.

- Protection from discrimination and protection of vulnerable parties in transport.

Road traffic

Road traffic legislation needs to be monitored and continuously reviewed to enable testing and operation of CAVs in the Czech environment and to ensure that the legislation is consistent with the ethical principles governing the use of CAVs.

The Czech Act No 361/2000 Sb., on-road traffic and on changes to some laws (Road Traffic Act), in its current form, requires the driver to "devote his full attention to driving the vehicle and to monitoring the traffic situation on the road". For the operation of at least partially autonomous vehicles of automation levels, 3 to 5, i.e. conditional, high and full automation according to SAE International, which does not require the full attention or even the driver's presence, a revision of this act will be necessary. At the same time, the qualification requirements for driving licences should also be reviewed in this context and consideration given to the possible legal regulation of test runs for such vehicles. The new legislation will need to sufficiently reflect the different requirements imposed on drivers at different levels of autonomisation.

Possible legislation should be addressed at the national level, considering European legislation and possible inspiration from foreign legislation. Future regulation must take into account, among other things, the ethical aspects of the issue, for example, the responsibility of road users in conjunction with other potentially responsible parties (e.g. vehicle manufacturers and others) or the information obligations associated with this traffic.

Privacy and data protection

Any interference with the privacy shall be minimized and the right to protection of personal data shall be ensured. Personal data might be used only with the consent of concerned individuals. All data shall be used transparently, and it shall be specified which data shall be stored and for how long.

Operation of CAV involves collection and processing large volumes of data, including various combinations of static and dynamic CAV data, data on CAV users and the environment. To ensure moral and legal rights to privacy in the operation of CAV it is necessary to introduce new data management policies, further research, and new industrial processes. In context of autonomous transport (and modern technologies in general) the protection of personal data is very important. This protection must be based on the Charter of Fundamental Rights and Freedoms of the Czech Republic, but also from European Convention on Human Rights, The Charter of Fundamental Rights of the European Union, and the General Data Protection Regulation ("GDPR").

Privacy must be based on the following principles:

1. Privacy and data protection must be proactive and by design. Respect for privacy and personal data must be present at all stages of development, production, operation and use of CAV. Lawmakers and relevant government agencies must ensure that laws require a proactive approach to protect privacy and personal data and do not respond only ex post to the cases of data breaches or interference with the privacy. Manufacturers, operators, and users of CAV shall accept responsibility for security of personal data throughout the whole retention period. Manufacturers shall provide secure data encryption methods, data access and deletion of data without the threat of data breach. Responsibility for the security of personal data shall be assigned to specific

individuals who shall have a duty to ensure security and transparency of all processes of acquisition, storage, processing, and transfer of data. In case there are no legal exceptions set by law, informed consent shall be provided by all data subjects at all stages of personal data processing. CAV manufacturers have a duty to ensure that personal data is accurate, complete, and up-to-date, and could thus serve the purposes for which they are obtained. All CAV users have the right to be informed about the purposes for which their data are processed, about their scope, method of processing and time frame, for which they can be stored. CAV manufacturers must also ensure that all CAV users have access to their personal data, and there shall be effective mechanisms by which the CAV users might request correction of their data. Regulation in this area shall be based on the above mentioned GDPR, however, it might be appropriate to also introduce a specific regulation that would be similar to for example, regulation of mobile operators.

2. Interference with the right to privacy and personal data shall be minimized and justified. Processing personal data should be in accordance with the GDPR, Article 5 and, shall be proportionate, relevant and limited to the extent necessary with regards to the purpose for which the data are processed. In case personal data processing is not necessary for the operation of the CAV (e.g., for purposes of advertising or profiling), it is also necessary to get informed consent from the CAV users. Everyone has the right to deny the provision of informed consent in this case and this fact shall not affect functionality and services provided by CAV in any way. Everyone must be explicitly informed of their right to refuse to provide their consent and that this refusal does not affect the functionality of the CAV in any way. General transfer of personal data to administrative authorities is inadmissible for the protection of the individual's right to privacy, a possible exception might be transfer for the purposes of criminal proceedings in accordance with the conditions specified by applicable law.

3. Lawmakers are encouraged to make an amendment to the criminal laws to specify the conditions under which the provision of personal data obtained during the operation of the CAV shall be permissible. This provision of data might be based on the already existing Criminal Procedure Code; however, it would be appropriate to specify the conditions under which CAV operators are obliged to provide the necessary cooperation to the police authority performing surveillance, i.e., similarly as the Criminal Procedure Code currently specifies the obligations for the cooperation of telecommunications operators.

4. Lawmakers shall also include specific restrictions in the laws establishing that the manufacturers and operators of the CAV can only store personal data for the period which is necessary for the technical and safety analyses, and it shall be specified, that this period might not exceed a certain time framework, for example 6 months.

Mandatory insurance

Following the EU legislation, a mandatory insurance system for CAVs should be assessed and developed to provide an adequate legislative framework for a mandatory insurance system covering injuries caused by autonomous operations. Cooperation with the private sector, e.g. through the Czech Association of Insurance Companies, is appropriate. It is essential to monitor and respect the

relevant European legislation in autonomous transport and the planned liability regulation in the field of artificial intelligence in general.

Artificial intelligence and CAV Technology – Preamble

Autonomous vehicles (AVs) move on roads, using sensors to monitor their surroundings and drive with little or no driver intervention. At present, virtually three directions of development of autonomous vehicles and autonomous systems can be identified:

Fully autonomous vehicles for mobility and logistics (so-called automation level 5 - see below).

Fully autonomous systems capable of operating in clearly defined environments (so-called automation level 4).

Autonomous cooperative systems providing an additional level of vehicle safety (so-called integrated or integral safety systems) - these are not assistance systems as in the above cases, but complementary to them.

The classification of autonomous systems, or vehicles, is specified in the automotive industry's widely accepted SAE J3016 standard. The standard does not specify a hierarchy of systems, but only their capabilities:

L0 No automation

The driver carries out all driving operations.

L1 Driver assistance

The driver is assisted by the autonomous system in either the longitudinal (ACC, AEBS, etc.) or lateral direction (LKA, LCA, etc.) and must continuously monitor the behaviour of the vehicle and take over the steering immediately if necessary.

L2 Partial automation

The driver is provided with both longitudinal and lateral assistance (e.g. queue assistance), while the driver must continuously monitor the behaviour of the vehicle and take over the steering immediately if necessary.

L3 Conditional automation The autonomous system is capable of full control of the vehicle in defined situations and on specified infra-structure (e.g. motorway traffic), whereby the driver must be able to take control at any time when alerted.

L4 High automation

The autonomous system is capable of total control of the vehicle in defined situations and on specified infrastructure (e.g., motorway traffic), without the driver having to take over at the time of the problem.

L5 Full automation

The autonomous system can fully control the vehicle in all situations on all relevant infrastructure, without the driver or controls being physically present in the vehicle.

Automation level 1 system (Adaptive Cruise Control ACC, Lane Keep Assist LKA) are now commonly found in regular road traffic and mandatory for M2, M3 and N2, N3 vehicles in the EU from 2013. The introduction of automated emergency braking for newly homologated M1 and N1 vehicles is expected from 2022.

Today, many vehicles and automation level 4 manufacturers are introducing fully automatic park/unpark systems without a driver in the car. Soon, legislation permitting, we can expect the implementation of valet parking, i.e. fully automatic parking in a specially arranged car park or parking house.

This parking can replace current automatic parking systems, so-called stackers, or rotating parking towers.

Autonomous transport is being promoted for several reasons - one is the lack of professional staff, which is cited as the main argument for introducing automation in logistics and mass transportation. Others are passenger comfort and safety. Comfort is primarily about spending the time that people lose in transport more efficiently. This can often be achieved by organisational change, i.e. by offering a more suitable type of transport. The safety aspect is rather complicated to implement - it is evident that in some cases, especially in deterministic transport situations, the reliability of the driver-vehicle unit can be improved (e.g. in long-distance traffic or when driving in a traffic jam, etc.). If we focus on the causes of accidents, then the common denominator is a misjudgement of the traffic situation - either by the driver or the autonomous vehicle. In the case of autonomous vehicles, the primary reason is the indeterminacy of the environment in which such a vehicle is moving. Implicitly, this involves two causes. Either the vehicle does not receive enough information on which to make decisions, or it receives enough information, but its evaluation is incorrect.

In this situation, there are two ways to proceed. The first one is not to expose the CAV to complex situations that require more information than the vehicle can obtain with its sensors. This will create a deterministic environment for the operation of autonomous vehicles. To this end, vehicle operation will be restricted to specific geographical areas and known routes, their speed will be

limited, or even the time of day selected (e.g., only during the day), thus reducing the occurrence of complex traffic situations. An example of this is the transport of students on a university campus, where only autonomous buses run between departments at selected times during the day. Other vehicles have access to the campus outside these times. Other examples include the transport of employees in extensive manufacturing facilities, passengers at the airport to their flights, shopping centre customers from public transport terminals to the shopping centre, etc. The second option is to work on improving the sensing and evaluation capabilities of the vehicle. This is exactly what is currently happening with all CAV manufacturers.

A good idea of how CAVs can reduce the number of accidents caused by drivers is provided, for example, by research carried out by the Insurance Institute for Highway Safety IIHS in the USA. The research results are captured in the following table, which also describes the mechanisms of CAVs that can eliminate most of the errors made by drivers.

Error origin: PERCEPTION

Driver's inattention, limited visibility, inability to recognise unsafety in time.

64 %

The CAV's elimination mechanism: enhancing the sensing capabilities of the vehicle with additional types of sensors and information supplied by an external intelligent support infrastructure.

Origin of the error:

ANTICIPATING TRAFFIC SITUATIONS

Underestimating the distance in traffic, misjudging the speed, or not understanding the intention of another vehicle.

17 %

CAV's elimination mechanism: improved traffic situation recognition thanks to additional information.

Origin of the error:

PLANNING AND DECISION-MAKING

Driving too fast or slow for the situation, aggressive driving, leaving a small distance between vehicles.

44 %

The CAV's elimination mechanism: a combination of enhanced vehicle information activity and automatic traffic regulation enforcement.

Error origin: PROVISION

The incorrect evasive maneuver, excessive caution, and other driving errors. 27%

CAV's elimination mechanism: automatic compliance with traffic and safety regulations that

steer the vehicle in given conditions mediated by the vehicle's enhanced information capability.

Error origin: DRIVER LIMITATION

Limitations due to alcohol, drugs, medication, health problems, fatigue, falling asleep. 10 %

Due to their design, CAVs are immune to these limitations.

The frequency of driving errors in the table does not add up to 100% because some errors fall into more than one category.

It is clear from the table that the elimination of driver error through automated driving can, in some cases, make a significant contribution to road safety. It is also clear that, in all cases, the way to improve road safety is to maximise the amount of information on which the vehicle makes decisions. This is information supplied both by the vehicle's sensors and from outside, from the so-called intelligent support infrastructure (ISI).

The vehicle's onboard sensor systems also include so-called V2V ("vehicle-to-vehicle") communication systems, through which the vehicle communicates with other vehicles in its environment. It thus receives information about the position and intention of other vehicles and at the same time informs them of its intentions. This allows vehicles to agree on a mutually safe solution to the traffic situation. In addition, the vehicle ideally receives further information from the intelligent supporting infrastructure employing V2I ("vehicle-to-infrastructure) communication. This infrastructure is embedded in the surroundings of traffic routes, and its purpose is to inform vehicles about essential features of the surroundings from a traffic perspective. This is done utilising so-called intelligent roadside units, which provide wireless communication between the vehicle and its static surroundings. Examples include information about the entrance to parking lots or garages and their available capacity, communication with parking meters, pedestrian crossings, traffic lights and similar types of street furniture. V2X ("vehicle-to-everything") communication can also include GNSS signals around tall buildings, highly detailed (HD) maps of the surrounding area, information from mobile units carried by pedestrians, cyclists (mobile phones) or information about non-autonomous vehicles from special microprocessors that will be equipped with these vehicles.

The additional information from ISI covers a broader area than that covered by the onboard CAV sensors. For example, this can be online information about the road conditions in front of the vehicle, including weather and accidents and/or obstacles, including traffic congestion. Such list

includes but is not limited to the presence of people, excavations that cannot be recorded on static maps, non-typical vehicles in the vicinity (garbage trucks, ambulances, oversized loads), vehicles "around the corner", which cannot be registered by CAV units, pedestrians about to enter into the road, etc. Some of this information may be redundant with the information from the onboard units, but the fusion of these is a welcome boost to human confidence in the perception of the car. The fusion of all available information results in a more accurate view of the world around the vehicle, thus enabling better decision-making. The vehicle makes decisions not only based on more information but also based on information unavailable to the human senses. However, it cannot be forgotten that electronic and wireless communication also comes with an energy burden that needs to be optimised. One of the benefits of autonomous vehicles can be lower energy consumption and fewer emissions. However, if the fleet of all vehicles in the world were replaced by an ideal number of shared autonomous cars, which will share only half of their data with other infrastructure, the CO2 production would by ca. 4x of the CO2 output of the entire transport sector in Europe. In this area, the development of autonomous systems thus needs to consider very carefully what information will be shared, when and in what form, while at the same time promoting technologies that process emissions in a way that does not further damage the ecosystem. CAV manufacturers favour improving the cognitive capabilities of CAVs, as this is entirely within their control. Building ISI is complex, long-term, costly, requires standardisation, and falls under the responsibility of other investors. However, it is clear from the brief initial overview that no significant progress in CAV safety can be made without the cooperation of onboard units with intelligent support infrastructure.

The purpose of the technical part of the Ethical Recommendations is to identify critical technical areas and requirements for CAVs that are particularly relevant to meeting the ethical objectives of putting these vehicles into service. Autonomous transport should be safe; it should protect life, health and property; it should increase the accessibility of automobile transport for those excluded from it for various reasons and enhance their autonomy and independence; it should be inclusive, equitable, distribute benefits and risks fairly, etc.

From an ethical point of view, several essential values can be realised in autonomous transport, ranging from safety (protection of life, health, and property), respect for human dignity, inclusiveness, non-discrimination to environmental protection and respect for the obligations towards future generations. However, these values can only be fulfilled by interdisciplinary and holistic autonomous transport, which relies on a comprehensive approach to coordinating research, development, and production. Too particularistic an approach – while discrimination and the primary ethical requirement- minimise the benefits associated with CAV while simultaneously minimising the potential negative impacts of this modern technology. The current debate in the philosophy of technology shows that human rights and essential values are not just an instrumental part of the development, production and use of modern technologies. This value dimension is an intrinsic element of technology and must be understood as an integral part. Modern technologies cannot be seen as value-neutral; they should serve good ends and align with the non-negotiable

principles of respect for human dignity, equality and rights. Even the seemingly "mere" technical recommendations in this section are based on today's consensus on the importance of values in all phases of the creation and use of technology and are grounded in concrete values and human rights. All recommendations in this section should be read in the light of fundamental human rights, the essential values of human individuals and society as a whole, respect for human dignity and equality, demands for fairness, rejection of the potential to contribute positively to the safety of CAV operations, the protection of life, health and property, respect for human equality and fairness, inclusiveness and non-discrimination.

Review of the current situation

Review the current state of the transport research and development chain to ensure effective coordination and cooperation between vehicle manufacturers, road infrastructure suppliers and managers, technology and communication service providers, universities and research institutions to ensure that the ethical aspects of road transport are taken into account.

1. Comment on the first technical recommendation

Support for applied research in the field of automotive transport and related systems must be conceived to strengthen the Czech Republic as a competitive state in these areas. It would be appropriate to build on the Czech Republic's globally significant history in transport development.

The topic of autonomous transport and new mobility systems further increases the interdisciplinarity in the field of transport science, and such broadly conceived projects are often challenging to evaluate by the current mechanisms of research project assessment, where one or more opponents may not be able to evaluate an interdisciplinary project in its entirety objectively, thus discriminating the necessary conceptually focused projects and topics.

A small country as the Czech Republic cannot support a large number of top-notch teams. It is, therefore, necessary for research support to encourage primarily cooperative approaches from all interested groups.

We need to broaden the possibilities of carrying out groundbreaking research that can benefit society and not limit ourselves to supporting only the technical frontier. In order to support the development of such a broadly interdisciplinary field as transport, and specifically autonomous transport and advanced mobility and logistics systems, balanced projects with a long-term concept for transport should be supported, not forgetting topics of fundamental importance, such as human interaction with large-scale autonomous technological units (HTI – Human – Technology - Interaction).

2. Conformity of standards

There is a need to ensure consistency between the standards for the design of ground traffic infrastructure and actual implementation.

Comment on the second technical recommendation

In order to increase the reliability and ensure the safe operation of automation level 4 or 5 systems, it will be necessary to complement not only the pure road infrastructure with additional elements,

which may also be related to changes in the rules of the road. These elements represent many complex tools to enhance road safety and meet other essential ethical requirements for CAVs. In this sense, it is advisable to proceed in incremental steps so that the characteristics of the

infrastructure precede the capabilities of autonomous systems in vehicles. These include, for example, consistent compliance with the marking of road work sites, visibility of road signs, coverage by a highly reliable and relevant wireless network, completeness and practically daily up-to-date mapping, etc. This is probably the highest financial cost on the part of the state. It is necessary to review the application of traffic rules in the implemented infrastructure - at present, they are often not followed during the implementation of the infrastructure due to increased road capacity and reliance on the driver's skills. This recommendation may also significantly impact advertising regulation, the abundance of which in the vicinity of roads complicates the technical possibilities of identifying traffic signs.

3 Creation of methodology

Methodologies for measuring safety and CAV in road traffic need to be developed.

Comment on the third technical recommendation

The methodology should allow a comparison between the safety of CAVs and human-driven vehicles. Therefore, it is necessary to collect data not only from accidents involving CAVs but from all CAV can be expected that data collected only in the Czech Republic will not be based on a sufficient sample of CAV.

The results may show that CAV accidents are more frequent in any particular environment. This can be addressed by improving CAV algorithms, which is a task for all manufacturers and operators. A possible approach may also be to optimise the infrastructure or, on the other hand, to regulate the CAV operation in the respective environment.

The forthcoming revision of the General Safety Regulations will prescribe a "black box" event data recorder (EDR) in cars in the EU from July 2022 for new models and all new cars from July 2024. The data from the EDR can be used to objectively determine the course of an accident and pre-accident events from the perspective of the vehicle's sensors (not just the CAV). The methodology for measuring CAV safety should use EDR data as much as possible. It is necessary to equip the Police of the Czech Republic, which investigates traffic accidents, with the means for reading data and subsequent analysis of EDR data.

4. Ensuring compliance with contemporary legislation

Vehicles with autonomous features need to be maintained in compliance with current legislation, even during their life cycle; otherwise, the function or the entire vehicle may be banned.

It is necessary to ensure a minimum lifetime requirement for autonomous vehicle systems to prevent discrimination of older systems than current regulations require. On the part of the Vehicle Licensing Authority with autonomous driving features should therefore be necessary a declaration by the manufacturer to provide updates for a certain minimum period of operation, for example, in the form of authorised service centres carrying out these

updates or sufficiently secure updates in over-the-air (OTA). The creation of a registry may be recommended of vehicles to which the manufacturer would have to report successful

update of individual vehicles to facilitate checking whether a car in service implements the required updates. In addition, it would be advisable to protect consumers, to information campaign (or create a similar consumer assessment as provided by EuroNCAP in the context of passive and active safety) so that potential owners to choose their cars based on the capabilities of manufacturer's ability to carry out these updates in a timely manner, thus avoiding temporary or complete disabling of the vehicle. Thus, requiring a guarantee from the manufacturer or, for example, a particular form of availability insurance from the distributor. The vehicle itself should sufficiently inform the owner of the need to update, the date of the earliest implementation, and the status of current violations of operation of the vehicle in the event of a failure to update. The first step in this area is now in place, but not compulsorily applied, UNECE Regulation No. 156 on software updates and the system for managing their updates. Unfortunately, the idea of the regulation is more about requirements for software updates if the manufacturer to do so. Nowhere is it yet required, which is the aim of this recommendation, which is mandatory software updates for CAVs to keep them up-to-date with technical progress even during operation.

5. Effect on drivers abilities

A vehicle with autonomous features must not adversely affect a person's ability to drive or generally navigate through the transport system and the ability to interact with other entities in this socio-technological system.

Commentary on the fifth technical recommendation

The transition from manually driven vehicles to fully autonomous vehicles is gradually introducing various driver assistance systems, the so-called ADAS - Advanced Driver Assistance Systems. These have a degree of autonomy that both changes driver behaviour and reduces their abilities, e.g. in estimating driving speed or distance. As the use of these systems becomes more widespread, there will be situations where the driver will not be able to drive the vehicle safely in the event of a limitation of the system's function (e.g. due to bad weather). Unlike in aviation, where pilots can be mandated to fly a minimum number of hours per year as PIC (Pilot-In-Command), the same cannot quickly be done in road transport. Piloting aircraft is a matter for a few individuals, and relatively strict rules have been set since the early days of aviation and are relatively automatically accepted. By contrast, driving a car or a motorcycle is considered almost an exercise of the constitutional right of freedom of movement. Although the necessity of adherence to this principle is evident from the perspective of human-machine interaction and the related manifestations of de-evolution, it is challenging to apply in classical democratic principles of state management. In this context, the most challenging task is, therefore, to determine the appropriate socio-economic mechanisms that ensure choice while at the same time providing the required level of road safety. In its form of application, the recommendation is very closely related to the seventh recommendation (trust

between the driver and autonomous systems). Optionally, different levels of driving licences could be considered, similar to what is now the case with, for example, automatic transmission.

6. Trust between driver and CAV

Trust between the driver and autonomous systems must be built bi-directionally and individually for each driver.

Commentary on the sixth technical recommendation

The driver must be a permanent part of the control cycle. If he/she is only an operator not involved in normal driving operations and only has to intervene when the system cannot function, the likelihood of incorrect intervention by the driver increases. Both the driver and the vehicle systems need to know with some degree of probability how one or the other will behave in driving the vehicle shortly, much as this principle is implicit in interpersonal communication. Thus, this principle should be required of systems that run independently of the driver, e.g., highway autopilot - the driver can only be out of the loop when the system's ability to handle all situations is precisely 100 per cent, and the driver's take-back of control, as well as the handover of control to the autonomous system, must be done in a way that ensures mutual trust. Last but not least, each driver has different abilities, a different approach to controlling complex systems, including the vehicle. Therefore, the in-vehicle system must adapt its behaviour and response to the driver's input. It, therefore, needs to know the behavioural patterns of the individual driver, to which it adapts the safety systems - for example, the automatic braking system will intervene later for a more experienced driver than for a novice driver, which can also teach the novice driver to make good guesses.

7. Rules for CAV testing

Rules need to be defined for testing CAVs on public roads and to take into account local specificities in international regulations, which should also ensure unambiguous identification of CAVs.

Commentary on the seventh technical recommendation

The implementation of testing of autonomous vehicles in the industry, with the possibility of transporting passengers while ensuring sufficient safety, will positively impact companies that carry out research and development in the field of CAVs. These companies will then be motivated to implement the tests in the Czech Republic. This will bring quality know-how to the country's industry and investment in higher value-added sectors. At the same time, increased operational safety is a primary ethical requirement and a frequently mentioned benefit of autonomous transport. All the necessary technical measures must therefore be taken to ensure this. From an ethical point of view, it is also essential to encourage the creation of a bond of trust between users and this sophisticated technology. This will facilitate a smoother introduction into practice and avoid moral panics.

In order to ensure the safety of vehicles in normal traffic, it is also necessary for the Czech Republic to take an active position in the negotiations of the working groups and for the specifics of traffic on Czech roads to be reflected in the regulatory basis for the approval of vehicles for use in terms

of safety. In addition, it is appropriate to ensure that both manufacturers and state authorities correctly inform the public about the functionalities of the vehicles and the benefits and risks of CAV operation. This can be achieved, for example, by appropriate categorisation of autonomous functions and the obligation for manufacturers to label vehicles as such. A certain parallel can be found in the labelling of tyres (and home electronics) with 'energy' labels. In addition, vehicle advertisements could be required to describe the auto- nomic functions of the advertised car clearly. It is then up to the public authorities to inform the public what the advertisement labels mean for citizens.

8. Interactions with other drivers

There is a need to ensure consistency between standards for ground traffic infrastructures, CAV behaviour and interaction with drivers of non-autonomous vehicles.

Commentary on the eighth technical recommendation

With a clear external distinction between autonomous driving and manual driving, the settings of autonomous systems could be abused, i.e. limiting the driving of such a vehicle. In principle, it cannot be said that this is against the current rules, and autonomous systems should be resistant or prepared for such situations. However, for example, the current implementation of the queue assist system is designed with safety in mind so that the vehicle's spacing allows another vehicle to be seamlessly added. In contrast, the spacing is further adjusted according to the current vehicle in the queue, thus making room for the following vehicle. It is thus possible that such an autonomous car will be practically unable to reach its destination. Therefore, for example, the zipper rule should be more general. However, there will be more such rules.

9. Handbook for consumers

We recommend developing a short overview guide for the Czech consumer to provide a quick overview of vehicle autonomy. This

the manual should be a vehicle classification scale according to which manufacturers will

Furthermore, distributors clearly label their products for the Czech consumer.

Commentary on the ninth technical recommendation

For the Czech consumer, it would be helpful to compile a document summarising basic information about autonomous vehicles, their parts, and activities. The document should build on labelling of the Seventh Recommendation and should be structured in such a way that vendors and distributors can adequately refer to the individual parts and the Czech consumer has an overview of what a

particular vehicle will or will not contain, what functions to expect from it and who will be responsible for what.

The document should contain basic facts about autonomous vehicles (e.g. independence from the type of fuel - the autonomous vehicle does not have to mean an electric car) and the expected advantages and disadvantages (the possibility of making driving more straightforward, but also the implications of future legislation - for example, the possibility of mandating driver testing for long-term use of CAVs or banning certain functions (or even operation) if the vehicle does not behave correctly).

The document should emphasise one of the existing scales (or a new scale) for determining vehicle autonomy, which vehicle manufacturers and sellers will use in the Czech Republic.

The document should also contain classifications of types of detection and decision algorithms (for example, a distinction between a predefined state automaton, where the conclusion is always a decision according to prescribed rules, or an adaptive neural network, which can cover many more situations, but its decision is not precisely preset).