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PIARC Special Project

Smart Road Classification

CALL FOR PROPOSALS

Deadline for submission of proposals: 25 January, 2021

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1 PURPOSE AND STRATEGIC SIGNIFICANCE

1.1 Introduction

PIARC (the World Road Association) has established a Special Projects mechanism to enable it to respond to emerging issues and priorities identified by its members outside the usual four-year Technical Committee cycle. This paper is a Call for Proposals to conduct the "Smart Roads Classification" (SRC) Special Project.

1.2 Preliminary definition of Smart Roads in the context of this project

Smart Roads and their interaction with connected and autonomous vehicles (CAVs) have an important meaning in this study, and a common understanding of the terms must be ensured.

Smart Road: A Smart Road can monitor, measure, analyze, communicate and act, based on information captured from road sensors and other external sources, to achieve an improved performance with regards to safety, efficiency, traffic management, risk and disaster management, comfort and environmental impact among other aspects.
Smart Road communication with CAVs: Smart Roads should be capable of interacting with CAVs through information exchange and to offer CAVs some minimum standard infrastructures in which CAVs can rely to perform efficiently.

If needed, the selected consultant will be able to adjust these definitions during the project in consultation with the Project Oversight Team (POT).

1.3 Purpose of the project

This Special Project intends to define a methodology for the classification of the infrastructure based on its physical characteristics, as well as on the reception capacity of the automation and connectivity of the vehicles. This new approach should serve as the basis for future PIARC work on the subject, which would subsequently develop and specify all the details and thresholds for a definitive road classification system.

Context
Road classification is a basic tool for planning and managing road networks, with high influence on road geometry and traffic capacity. This classification has traditionally been centered on the balance between mobility and accessibility, but new approaches have added more factors, such as economic-administrative functionality, environment, and users [1, 2].

These new approaches, despite being recent, do not consider a newer factor: the proliferation of semi-autonomous and connected vehicles. Not long ago, Advanced Driver Assistance Systems (ADAS) were introduced as independent systems to help humans in the driving task. Some of them have evolved into very sophisticated devices, able to take control of the longitudinal and lateral vehicle negotiation (e.g., Active Cruise Control, ACC, and Lane Centering Assist, LCA). Their remarkable role on the driving task pushed the Society of Automotive Engineers (SAE) to establish a six-level automation classification based on how the driving roles are shared between driver and vehicle [3].

In the near future, these systems are expected to actively contribute to the reduction of road crashes, by partially substituting humans in the driving task. The automotive industry is rapidly enhancing the capabilities of these systems and increasing their incorporation in new vehicle

models when available. Many governments around the world are also working on new laws to require new and/or existing vehicles to incorporate these systems. Regulation 2019/2144 of the European Parliament and of the Council establishes that in 2022, all new marketed vehicles in the EU must be equipped with level 2+ systems [4]. In the United States, 38 Governments entities combine efforts with research and other agencies to ensure a consistent approach towards vehicle automation [5]. China is working on finishing a set of standards for autonomous vehicles, including technology, legislation, supervision, and network safety by 2025 [6].

Existing CAV systems are up to levels 2 –3 at most– which implies that these systems cannot adapt to all road and traffic situations. When a limiting condition appears, the system transfers control to the driver (i.e. it disengages), in a different manner across technologies. These disengagements are an important safety concern due to the driver's unawareness. This concern increases with the time between transfers of control, so paradoxically, a system that presents less disengagements may be more unsafe. On the other hand, the driver may be willing to disconnect the system if disengagements become too frequent. This frequency depends on the system technologies, the takeover abilities of the drivers, the road infrastructure and the environment. Generally speaking, more complex road environments (presence of vulnerable road users, frequent intersections or driveways, sharper alignments) are prone to more disengagements.

User confidence is necessary to foster a fast and secure generalization of autonomous vehicles. A driver or a connected automated vehicle (CAV) should not decide subjectively whether to connect the driving automation system or not, but based on objective information about how it would perform throughout a road segment. This information must be based on road infrastructure and the driving automation system capabilities.

In addition to driving automation, many efforts have been undertaken in vehicle-infrastructure connectivity in the recent years. New devices, applications and information exchange protocols for vehicles and infrastructure are being developed. This will presumably improve traffic performance (e.g. by means of cooperative driving) and road safety. In fact, the European Union is progressing in the development of Roadside Units (RSUs) [7] and has taken on the commitment to deploy 5G technology at all urban zones and along main highways and railways by 2025 [8]. By the same year, China expects to have deployed 5G-V2X technology in some cities and expressways [6]. Various telecommunication methods must be considered.

Description of the need

The increasing presence of connected and autonomous vehicles makes it very convenient to have **a road classification system that, in addition to the factors mentioned above, includes information about how ready the road feature is to support autonomous and/or connected vehicles**. This information, from none to full readiness to autonomous driving, should be provided indicating different degrees of support. Connectivity capabilities should also be considered.

When it exists, the classification level of a road should be displayed physically and digitally. Drivers must be informed by means of physical road signs – such as existing vertical ones – and the digital classification will also provide detailed information to driving automation systems (e.g. road geometry). This information could be used by driving automation systems to

determine their driving performances (i.e.: actuated speed) and potential disengagement zones in advance.

This classification system should be compatible with existing driving automation systems, as well as very resilient to their technological development, to ensure fast adaptation to future changes, which can be abrupt. Additionally, it should be a universal classification (i.e., being adaptable to roads worldwide), and with consensus, ensuring a fast implementation. This also requires compatibility with different shares of non-autonomous vehicles and other road users.

When the time comes, it may be appropriate to have an Advisory Board on roadway design and connected and autonomous vehicles in order to foster the information exchange and the universalization of the classification system. This is not expected to be a core part of this project.

Challenges

Smart Roads Classification has to face several challenges:

- High level of uncertainty
- Diversity of approaches (Europe, USA, Australia, China, LMICs)
- Controversial positions
    - Connected vs Autonomous
    - ITS & 5G & AI
    - Road Administrations-Automotive Industry- Silicon Valley
- Transition and coexistence of systems

Expected impact

A road classification that is relevant for connected and autonomous vehicles will have an immediate impact on high-end infrastructures, due to the existing driving automation systems that are expected to be already compatible. By defining clear AV-safe road segments, which would be loaded as a new layer to driving navigators, drivers would be able to plan their trips using this information as a new source.

The definition of the thresholds between the different classification levels, will be a valuable input to the automotive industry which would have clear targets to orientate their immediate research efforts. Moreover, this would also contribute to establish clear Operational Design Domains (ODDs), essential for a fast deployment of level 4 semi-autonomous vehicles.

The impact will be even higher in the future, especially when the penetration rate of connected and autonomous vehicles represents a remarkable amount of the total. An adequate classification of itineraries and communication capabilities would allow a substantial enhancement of traffic performance and safety worldwide.

Smart Roads Classification could increase the relevance of roads as regards Safety, Mobility, Environment. It could contribute to proper investments and maintenance. It could also confirm the role of road operators and road administrations in managing the use of the infrastructure.

An integral road classification system would also allow an efficient planning of public investments on physical infrastructure, by enhancing operativity of driving automation, and

on digital infrastructure by increasing the benefits of connectivity between highways and their users (V2X).

1.4 Key points of the project

- It is important to reiterate that the responsibility of driving rests fully with the driver. This project does not mean that road authorities intend to shoulder any commitment.
- The project should give road operators and administrations tools, a methodology, that will then help them decide a classification.
- The project should focus on the current status and at the same time be forward-looking. The classification method should be flexible and future-proof.
- Examples on how to apply the methodology are welcome.
- The project should explore ways to demonstrate that SRC can be included and operated safely i.e. guidance regarding the associated safety case that will be required to be demonstrated
- The classification should be compatible with all road users who will coexist on the roads: human drivers, with CAVS, etc.
- The importance of communicating the « level » of the road towards road users is part of the project.
- The project should not duplicate what already exists. This is why it begins with a state-of-the-art exercise. Also, see annex.

1.5 Out of the scope

The project should not focus on:

- Defining the standards for the communication and information exchange between vehicles and infrastructures
- Defining an advisory board

2 METHODOLOGY AND APPROACH

2.1 Overview and compilation of the state of the art, including the identification and analysis of case studies, implemented projects and scientific approaches

1. First, the study should provide a short general overview of what Smart Roads are around the globe and their interaction with CAVs, as well as a short general overview of principles of current road classifications. This will provide a clear view of the State of the Art, as well as the importance of having a SRC. A definition of Smart Road should also be proposed, as it will be relevant for further discussion in this study. The definition listed above is a proposal and it can be modified in consultation with the POT. Other relevant definitions must be compiled to facilitate the common understanding and consensus on the project outputs.

2. Overview and compilation of the literature review for implemented projects, policies and scientific publications dealing with:

- Road classification systems.
- Technical and operational constraints between autonomous vehicles and road infrastructure.
- Digital infrastructure, ITS and connectivity systems.
- Human factors consideration and integration in automation process and efficiency
- Responsibilities of the different Actors (automotive industry, road managers, drivers)

3. Potentials and challenges that can be derived from the state of the art with regard to added value of having a SRC should be described.

4. Identification and description of stakeholders around the world in terms of their involvement, incentives and ambition in Smart Roads, such as road administrations, transport regulators, mobility services providers, vehicles manufacturers, road users, etc.

5. Possible business models, challenges and risks for National Road Administrations (NRAs) as regards possible infrastructure classifications. The purpose of this task is to describe the different scenarios and business models that are under discussion among the actors and in the identified case studies.

6. To propose to PIARC a methodology to address a road classification system. This classification system must include road segments and junctions, physical and digital classification criteria. The proposal will include recommendations towards its development, generalization and extension, and management, with relevant parties and a first draft of the classification if possible.

7. It is essential that the study addresses the needs of PIARC members both in High Income Countries (HIC) and Low Middle Income Countries (LMIC) as it should enable them to identify the potential of establishing SRC.

2.2 Business model from Road Administration perspective

The report shall enable the potential for NRAs to develop SRC.

The report shall identify the best practices and make recommendations that would help road operators and road authorities contribute to SRC.

The report shall also present the conditions that are necessary, such as skill development, organizational change, etc. from a road administration perspective.

2.3 Approach

Proposals in response to this Call must use the template “Answer to the Call for Proposals for the Smart Roads Classification PIARC Special Project”.

The answer shall include a description of the approach that will be taken to collect and compile the information to be requested to the stakeholders.

The proposal shall answer the following questions about the tenderer’s approach:

1. How will the study collect international information regarding SRC and its future trends?
2. How will the study collect world-wide state-of-the-art sources, applications and business cases that deal with SRC?
3. How will the study identify challenges and opportunities of SRC?
4. How will the study be structured in order to ensure a clear presentation and to show the potential of SRC?
5. How the classification of the different roads and their segments and junctions must be carried out, as well as which factors in terms of infrastructure, communications, ITS, environment, safety will be considered.
6. Which key performance indicators are proposed to establish an objective and effetcive smart road classification?
7. How stakeholders around the world regarding the topic will be identified?
8. How the study will analyze a business model from NRA perspective?
9. How will the study take LMICs' reality into account in order to provide specific recommendations to them regarding SRC?
10. What project milestones and associated deliverables are proposed? What will be the approach for monitoring the progress and to include the inputs from the Project Oversight Team (POT)? It is recommended to organize monthly videoconference, and to share with the POT regularly intermediate deliverables asking for feedback.
11. How the management of the project will be organized including quality assurance and quality control without taking significant resources from the project.

2.4 Options

The proposal can be structured as a core proposal plus additional options.

The bid would then include a core proposal within the proposed budget, and then some options which must be described in detail as well as priced.
If the bid is selected, PIARC would place the order for the core proposal as well as any option at PIARC's discretion.

In any case, the core proposal has to answer all the expectations which are presented in this call for proposals document.

2.5 Key areas

Please describe the key areas for consideration in the framework:

1. What will be the project's methodology of collecting information from different areas of road administration, transport regulators and operators, other public administrations, academia and relevant industry (i.e. planning, financing, asset management, design, construction, operations, and maintenance) from international road sector including successful and unsuccessful case studies?
2. LMIC represent an important share of PIARC membership and it is crucial that their needs, opportunities and challenges are addressed within PIARC activities. How will case studies from LMIC be gathered and how their needs will be taken into account? How some of the findings of the project will be identified as particularly suitable for LMIC?

3. As this classification will have a global impact, it is important to define clearly the key performance indicators that will enable the evaluation of the level of the smartness of a road.

3 FINAL DELIVERABLES

The final deliverables will comprise:

3.1 A report

This report will present:

A. The state of the art regarding:

- Road classification systems.
- Limitations between autonomous vehicle and road infrastructure.
- Digital infrastructure, ITS and connectivity systems.

B. An analysis of how ready existing road networks distributed worldwide are to support connected and autonomous driving, including the limitations in their efficient performance.

C. Proposal of a methodology for PIARC and PIARC members to address a classification system.

This classification system would include road segments and junctions, physical and digital classification criteria. The proposal will include recommendations towards its development, generalization, extension, and management, with relevant parties and maybe (if possible) a first draft of the classification.

The general structure of the report should be as follows (adjustments with the agreement of the POT are acceptable):

Executive Summary
1. Introduction: project background, objectives and scope.
2. Methodology and approach.
3. Description of roads classifications and their principles.
4. Definition of Smart Roads and their interaction with CAVs (including case studies and current research).
5. Readiness of road networks to support connected and autonomous driving.
5. Description of potentials and challenges in this field.
7. Methodology for Smart Road Classification. Key performance Indicators.
8. Optional (if possible). Trial Smart Road Classification.
9. Business models for road administrations.
10. Conclusions of the study.
11. Recommendations, for road administrations, LMIC and PIARC.
12. References
13. Appendices

Taking into consideration LMICs in the study: each chapter of the report should make reference to LMICs when relevant. A chapter inside the report's conclusions with possible **specific recommendations for LMICs** must also be considered.

The specific recommendations for road administrations and regulators are a key element of the report. They should be relevant for high decision makers and operators.

The specific recommendations for PIARC could include recommendations to liaise with specific industries, take part in existing conferences and/or create a new technical committee / task force on the subject.

3.2 Dissemination material

This will be used to present the results of the Special Project at PIARC Council meeting in October 2021 in Dakar, Senegal (final date will be defined in the first semester 2021).

The selected tenderer will also be invited to join the meeting physically or via videoconference; the proposed option should be specified in the proposal.

3.3 Voluntary contribution at the next PIARC Congress

This will be a session devoted to Special Projects at the **World Winter Service and Road Resilience Congress**, due to be held in Calgary, 8-11 February 2022. Selected tenderer will be invited to join the Session (participation is optional) and to provide inputs to the Session program. This contribution will be requested after finalizing the project and is out of the project budget; this point is provided as information.

3.4 Intellectual Property, Formats

The final products will be submitted by the selected consultant in electronic form in English, using PIARC's template for Technical Report and PIARC template for PowerPoint presentations.

The report and final products will be owned by PIARC and it will acknowledge the contribution of the external consultant.

PIARC will ensure translation into French and Spanish. In addition, they will be available free of charge in PIARC's Virtual Library to ensure a large world outreach for the report.

4 KEY DATES

The proposal shall include work plan to fit the project milestones.

The schedule must identify dates or timeframes for accomplishing major milestones in the project. The work schedule will include monthly videoconference meetings and dates or timeframe for an interim product or products to allow enough time for review and feedback from POT prior to the final deliverable.

The schedule must be completed, and the final report should be delivered by September 17th, 2021, so PIARC can proceed to translation and dissemination of the document in advance to the attention of the participants in the PIARC Council meeting.

The project milestones to be included in the offer are:

- 1st half of February: Kick-off videoconference meeting.
- Intermediate milestones to be proposed by the tenderer.
- 17thof September 2021: Finalization of the report in English.
- 1st of October 2021: Finalization of Council presentation.
- October 2021, Presentation at PIARC Council meeting.
- 8-11th February 2022, Voluntary presentation at the World Winter Service and Road Resilience Congress.

5 PROPOSED BUDGET

The tenderer must provide a general budget for the project. The funding requested from PIARC should not exceed 40.000 Euros all taxes included. The budget should include a general itemization of the costs of the major work elements of the project and the proposed schedule of invoicing.

Invoices will be processed only for completed and approved items, with 10% of each invoice payment to be held back until final deliverables have been accepted by the Project Oversight Team and approved by PIARC.

In line with EU regulations, the payment will take place 60 days after the acceptation of the invoice by the POT.

Since a timely delivery of the outputs is at the essence of the Special Projects mechanism, late penalties can be applied if the external consultant fails to deliver the outputs according to the proposed milestones. In line with French regulations, if the delay is the contractor's responsibility, the penalties will be 1% of the budget per week of delay, with a grace period of 15 days, and up to a maximum of 5% of the budget.

6 PROPOSED EXPERTS AND INTERNATIONAL NETWORK

The proposal should also include a description of the relevant expertise that qualifies the contractor to undertake the project. Specifically:

- Please describe any past or current work projects that relate to the subject of this proposal.

- Please also identify the composition of the Working Group that will be working on this project, describing the different figures (e.g. responsible, project manager, experts, quality manager, scientific board), their roles and estimated contribution to the project, and providing information on their backgrounds, experience and expertise.

- Please provide information about any other international network, other than PIARC, from which tenderer could receive inputs.

7 PROJECT OVERSIGHT AND PROPOSALS EVALUATION

The project will be overseen by a project evaluation and steering committee called "Project Oversight Team" (POT) which will select the preferred tenderer and assist in the development of the project.

These experts are drawn from PIARC membership and will include representatives from Technical Committees TC 1.1 Performance of Transport Administrations, TC 2.4 Road Network Operations/ITS, TC 3.1 Road Safety, TC 3.3 Asset management, TF B.2 Automated Vehicles, TC 4.4 Tunnels, TF 4.1 Road Design Standards and the PIARC Strategic Planning Commission, as well as some experts nominated by member countries and PIARC General Secretariat staff.

7.1 Evaluation of proposals

The POT will assess proposals and select the preferred tenderer on the basis of its assessment of:

a) Technical approach and methodology (up to 35 points): how well tenderer address the project objectives and deliverables and how effective and resilient is the proposed approach and methodology including collecting case studies internationally and addressing the needs of different PIARC member countries, such as LMIC;
b) Proposed project management process and work plan including intermediate milestones (up to 15 points).
c) Value for money presented by the tenderer (up to 20 points): including the time offered by different contributors of the tenderer's team.
d) Experience of the proposed team on the holistic vision of the road sector (up to 10 points)
e) Experience of the proposed team on the Smart Roads sector (up to 10 points)
f) International experience and network of the proposed team (up to 10 points)

7.2 Project oversight

The POT will oversee the progress of the Project, including participating in periodic calls, reviewing interim and final products. The POT will also provide any relevant information from the PIARC work to the selected tenderer (e.g., information obtained from surveys) for use in the project. In addition to review and oversight by the POT, input may also be sought from other members of Technical Committees and the PIARC Executive Committee and Strategic Planning Commission.

8 PROPOSAL SUBMISSION

Proposals should include the elements identified in this Call for Proposals.
Answers should use the Word template "Answer to the Call for Proposals for the Road Related Data and how to use it PIARC Special Project".

Proposals should be submitted electronically in English to PIARC's General Secretariat at: info@piarc.org

no later than January 25, 2021

For any questions, please send an e-mail to info@piarc.org

REFERENCES

[1] Sistematización de las vías de una red viaria. Comité Técnico de Carreteras Interurbanas y Transporte Integrado Interurbano de la Asociación Técnica de Carreteras. Revista Rutas, nº 147, 2011.
[2] An Expanded Functional Classification System for Highways and Streets. National Cooperative Highway Research Program 15-52, 2018.
[3] J3016: Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles. Society of Automotive Engineers, 2019.
[4] Regulation 2019/2144 of the European Parliament and of the Council of 27 November 2019 on type-approval requirements for motor vehicles and their trailers, and systems, components and separate technical units intended for such vehicles, as regards their general safety and the protection of vehicle occupants and vulnerable road users. European Parliament and Council, 2019.
[5] Ensuring American Leadership in Automated Vehicle Technologies (Automated Vehicles 4.0). National Science & Technology Council and the United States Department of Transportation. 2020.
[6] Strategy on Developing Smart Vehicles. https://www.ndrc.gov.cn/xxgk/zcfb/tz/202002/t20200224_1221077.html. 2020
[7] An Overview of USDOT Connected Vehicle Roadside Unit Research Activities. U.S. Department of Transportation, 2017.
[8] 5G for Europe: An Action Plan. Communication from the Commision to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions. 2016.

Important references:

- Existing PIARC Reports
- Especially TF B.2 Automated Vehicles – Challenges and Opportunities for Road Operators and Authorities

Other possible references:

- INFRAMIX Project
  - EU H2020 project; Finished since May 2020
  - Deliverable D.5.4. presents a classification of the highways to be used by CAVs
  - https://www.inframix.eu/
- SLAIN Project
  - EU CEF project; Finished since December 2020
  - Deliverable 7.2: “Other initiatives to meet the needs of automated cars”
  - https://eurorap.org/press-release-results-from-the-cef-slain-project-presents-the-road-infrastructure-requirements-for-connected-and-autonomous-vehicles-cav/