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Electric Road Systems, Intelligent Transport Systems, and Electronic Fee Collection – An Inventory of Standards

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Summary

The main objective of this study is to create an overview of, and to analyse, which standards that are directly or indirectly central for ERS in the area of intelligent transport systems (ITS) and electronic fee collection (EFC). The study employs a combination of qualitative and quantitative methods including literature studies, an interactive stakeholder workshop, and expert reviews of a tentative listing of ITS and EFC standards that are potentially applicable to ERS. The main result is a preliminary inventory of ITS and EFC standards, including 45 EFC standards, of which 33 have been marked as potentially applicable to ERS.

1 Research Questions

Electric Road Systems (ERS), are based on the idea that a vehicle can be supplied with electric energy both for propulsion and battery charging while in motion. For ERS, standardisation is still in an early phase [1][2], and there are yet no dedicated published standards neither at the Swedish, European nor the global standardisation level. Nevertheless, there is a clear need for standardisation of ERS.

As ERS technologies continue to reach higher levels of maturity, the arguments for standardisation of the field appear to be the same as for many other technically oriented areas. Standardisation facilitates industrial production and increases the opportunities for dissemination of innovations. Standards can contribute to product safety, reliability and a certain level of product quality; factors that also are of high relevance in public procurement. Standardisation would also be helpful for the interoperability, compatibility and competitiveness of ERS. This is particularly significant for the facilitation of a faster deployment of ERS as a promising future solution to replace the dominant position of fossil powered freight transport.

In order to create an overview of which standards are directly or indirectly central for ERS, and which standards that ought to be created in the future, this study makes a survey and analysis with a specific focus on standards for intelligent transport systems (ITS) and electronic fee collection (EFC) in relation to electric road systems [3]. For this purpose, the present work aims to answer the following research question:

Which standards in the area of intelligent transport systems (ITS), including electronic fee collection (EFC), can be considered to have central direct or indirect significance for the establishment and expansion of electric road systems?

2 Methodology

This study applies a combination of qualitative and quantitative methods. These include literature studies, an interactive stakeholder workshop, and expert reviews of a tentative listing of ITS and EFC standards that are potentially applicable to ERS.

The literature studies provide a foundation of qualitative and quantitative data in the area of standardisation for ERS. Specifically, the literature studies contribute to drafting a standard inventory, a quantification of standards, and an analysis to broaden and deepen available knowledge in the research area of standardisation for ERS.

The interactive stakeholder workshop among other things generates new data about the current state of knowledge, opinions of, and challenges for stakeholders regarding standardisation of ERS. Finally, the expert reviews of the listed ITS and EFC standards secure a peer-review of gathered data and aids the creation of a more refined tentative list of standards potentially applicable to ERS.

3 Results

In this study, the focus is put on *which standards in the area of intelligent transport systems (ITS), including electronic fee collection (EFC), that can be considered to have central direct or indirect significance for the establishment and expansion of electric road systems?*

The main result from attempting to answer this research question is a preliminary inventory of ITS and EFC standards, including 45 EFC standards, of which 33 have been marked as potentially applicable to ERS. This result should be viewed as a non-exhaustive initial step to a systematic and continuing identification of standards for ERS. Thus, the number of standards in our preliminary inventory may increase, decrease, or remain the same as further knowledge is gained in any subsequent studies. At the time of writing, the list of ITS standards is still under review, but the final result will be available for presentation for the 4th Electric Road Systems Conference, 2020.

When it comes to further details regarding the results, the ITS and EFC standards marked as preliminarily applicable to ERS in the reviewed inventory lists varied. A marking of a standard as “preliminarily applicable” in the inventory indicates that the standard has been deemed to have a potential central direct or indirect significance for the establishment and expansion of ERS. By this token, the substance of the standard has been judged as central for ERS. Moreover, the standard could potentially be revised to apply to ERS in the future.

One example of a relevant ITS standard marked as preliminarily applicable in our list can be found in the ISO 14813-series, namely SS-ISO 14813-1:2017 “Intelligent transport systems - Reference model architecture(s) for the ITS sector - Part 1: ITS service domains, service groups and services (ISO 14813-1:2015, IDT)” [4]. Yet another example, an EFC standard, can be found in the ISO 14906-series; “Electronic fee collection - Application interface definition for dedicated short-range communication (ISO 14906:2018)” [5].

Standard Number	Standard Title	Status
SIS-CEN ISO/TS 14907-2:2019	Electronic fee collection - Test procedures for user and fixed equipment - Part 2: Conformance test for the on-board unit application interface (ISO/TS 14907-2:2016)	Published

Figure 1: Excerpt from the reviewed inventory list of EFC standards

Scope	Limitations	Applicable to ERS
This part of ISO/TS 14907 describes tests that verify on-board unit (OBU) conformance of implementations of functions and data structures, as defined in the implementation conformance statement based on ISO 14906:2011/Amd1:2015, for electronic fee collection (EFC) applications. After the tests of isolated data items and functions (C.2 to C.4), an example is given for testing of a complete EFC transaction (C.3).	Whereas, this part of ISO/TS 14907 defines examples of test cases for DSRC and EFC functionality in Annex C, it does not intend to specify a complete test suite for a certain implementation.	Yes

Figure 2: Excerpt from the reviewed inventory list of EFC standards continued.

The results from this study's standard inventory is expected to be a useful complement to an earlier inventory of potentially applicable standards for ERS which the authors have conducted in the theme areas of "vehicle", "energy supply", and "road infrastructure" [6]. Thus, with the current study, our inventory and analysis of standards now covers yet another thematic area (ITS) in a possible system-of-systems architecture for ERS [7]. In addition, the current study is also a continuation of the authors' previous work [8] to gather valuable knowledge and views from various stakeholders in relation to standardisation of ERS.

All in all, this study provides a welcome contribution that broadens and deepens the state of knowledge in the area of standardisation for ERS. In the long term, this study may also contribute to possible follow-up in the form of standardisation work related to electric road systems. Finally, a more concrete contribution is that this study results in an update of a working document [9] that lists various standards potentially applicable to ERS. This working document with ERS standards contains macros for possible filtering of standards by theme area, standard status, etc. Finally, the snapshot view of standards in the present study, combined with the preliminary listing of standards in the working document makes a useful starting point for further studies in the field of standardisation for ERS.

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