INTERNATIONAL STANDARD FOR ELECTRIC ROAD SYSTEM

Junichi Hirose

Abstract— This paper describes the international standard activities for the electric road system for the sustainable mobility and transportation for smart city and communities. The international standard is being created by ISO/TC268/SC2/WG2. The electric road system is particularly needed for long-haul freight transport battery powered electric vehicles. The framework, concept of operations (How roadside feeding electric road system can be configured and integrated in a sustainable mobility and transportation), and system components are explained.

Keywords— International standard, sustainable mobility, electric road system, ISO4078, reusable energy, fee management, ISO/TC268SC2.

1 INTRODUCTION

Transportation carbon neutral can be achieved by deploying non-ICE (internal combustion engine) heavy vehicles such as BEV (battery electric vehicle).

To realize sustainable long-haul freight transportation by such vehicles needs electric road system which has a dynamic charging capability even while vehicles are on the move.

Dynamic charging system needs to be designed as whole eco-system from upstream to downstream. Defining appropriate service role model architecture for such dynamic charging eco-system services in sustainable mobility and transportation is indispensable as international standards. Electric road system service classification can be described as shown in table 1 below. This paper is applied to dynamic/contact/from roadside type. The comparison of advantage and disadvantage of ERS comparison between various kinds of ERS is shown in table 2 below.

Note: This table shows evaluation results performed by certain party not in neutral position. Therefore, this content shall be considered as reference only.

2 ELECTRIC ROAD SYSTEM INFRASTRUCTURE COMPONENTS

The following system components are required for electric road system as shown in figure1.

2.1 Reusable Energy Source

Power source for electric road system should be considered carefully. It is important that if it comes from grid network, it should be from reusable source and if it comes from standalone source, it should be from same kind of resources. Instability of reusable energy should be compensated by combining with power storage facilities.

2.2 Electric Network Storage Infrastructure

Taking into the account of power demand serge effect on power grid network, it is better to avoid charging demand peak occasion for charging during driving and power storage facilities are required to the electric road system.

2.3 Electric Road Infrastructure

This paper is for contact and roadside feeding type electric road system. The vehicle side facility is out of scope of this standardization work.

The electric road system defined as the system in this standard is for the system feeding from roadside not from road surface or overhead.

2.4 Vehicle Facility Interacting with Road Infrastructure

The vehicle side facility interfacing with road infrastructure is out of scope of this standardization work but interactions with road infrastructure is defined in this standard.

2.5 Digital Infrastructure Supporting Electric Road System for Electric Power Management

The electric road system should be supported by digital infrastructure.

2.6 Power Feeding Facility

The power feeding system installed along side of roadway is key component of this roadside feeding electric road system. It needs to be effectively interfacing with vehicle side feeding system facilities.

Safety measures to avoid human hazard from electric road systems should be built in. Details will be defined in part 2 and 3 of this standard

• *Junichi Hirose, Highway industry development organization, Tokyo, Japan, junichi.hirose@hido.or.jp*

TABLE 1.
Electric Road system service classifications

Charging state
static
dynamic

Contact type
contact
contactless

Contactless types
Inductive coupling
Radio wave coupling

Feeding type
From roadside
Catenary
Road surface/embedded

Charging time continuation
Occasional
Continuous

Electric current
AC
DC

Electric voltage
High
Low

TABLE 2.
Comparison of advantage and disadvantage of ERS

3 High score 2 Medium score 1 Low score

Type		Wireless			Conductive		
		Overhead	In-road	Side	Overhead	In-road	Side
Basic Specification	Supply power	1	1	1	3	3	3
	Vehicle speed	1	2	2	1	2	3
	Body type	1	3	2	1	3	3
Safety	Electromagnetic noise	1	1	1	3	3	3
	Foreign matter from road	3	1	2	3	1	2
	Motorcycle	1	1	1	3	1	3
Convenience	Positioning	1	1	1	2	1	3
	Emergency lane change	1	3	2	1	1	3
	Road maintenance	3	1	3	3	1	3
Cost		1	1	1	2	1	3

3 Concepts and Operation

This clause describes the characteristics of a proposed electric road system from the viewpoint of an individual who will use that system. Its objective is to communicate the quantitative and qualitative system characteristics to all stakeholders.
This paper describes the roles and responsibilities of the classes and actors involved in the provision of electric road system service applications. This paper recognizes that there will be variations between regional authorities.

A concept of operations (CONOPS) evolves from a concept and is a description of how a set of capabilities may be employed to achieve desired objectives.

4 Operational Physical Layer Role Model

The model of overall operational physical layer role and functional model of electric road system service is derived from the one shown in figure 2.

4.1 Actors

Following actors are defined in this paper.

a) The electric road system service control center
b) The electric road system service user with nomadic device
c) The electric road system facility provider
d) The electric road system service facility
e) The electric road system service recorder
f) The electric road system service facility owner
g) The electric road inspection/certification authority
h) The first responders (police/fire fighters)
i) The electric road system service supporting infrastructure facilities (physical and digital)
j) The regulator (municipal's)
k) The regional road authority
l) The scms (security credential management system)
m) The traffic management center

5 Overlap analysis of work between ISO/TCs and IEC

For understanding the scopes between ISO/TC22, ISO/TC204, ISO/TC268SC2 and IEC/TC69, figure1below shows

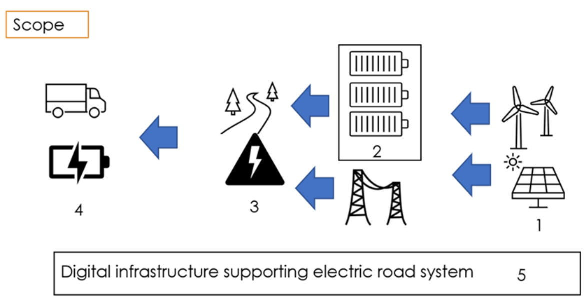

Fig 1. Electric Road system components

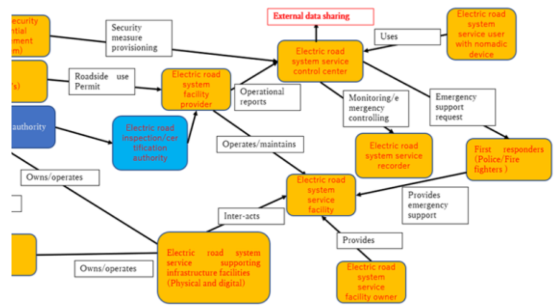

Fig 2. Operational physical layer role and functional model

no overlap between TCs and rather, close harmonization is the key point to be required.

6 Intermittent Charging While Driving

The roadside feeding ERS which has large charging amount capability, deployment of intermittent charging operation is possible. ERS service provider should install feeding facility only sections of the roadside along the roadway. Continuous Charging While Driving

The roadside feeding ERS which has small charging amount capability, deployment of continuous charging operation is recommended. ERS service provider should install feeding facility all parts of roadside.

7 Charging Feed Line Segmentation

The infrastructure side charging feed line can be segmented so that safe operation by segmentation and providing measures for avoiding non charging right user from the ERS are possible. When non charging right user vehicle approaches, power shutdown operation on only that segment is possible.

8 Services and Concept of Operations

The following services and operational concepts shall be considered.

a) Power feed from ERS to/from vehicle
b) Data aggregation from vehicle and ERS
c) Security management of charging right and payment history of user
d) ERS fee collections from user
e) Exporting data to external services outside of ERS
f) Data communication link between ERS and vehicles
g) Power generation/storage/consumption/regeneration (vehicle) management
h) Weather watch for efficient carbon free power generation
i) Battery temperature management
j) Carbon reduction management of ERS
k) Operational rules
l) Minimize maintenance
m) Emergency recovery after incident
n) Hazard material control over ERS

9 Physical Objects

The following physical objects shall be considered for deployment.

a) Feed line installation details
b) Safety measures (for example, prevent electric shock to VRU)

10 Digital Objects

The following digital objects shall be considered for deployment.

a) Data platform for ERS
b) Data sharing between ERS systems which shall be harmonized with ISO/TC204 standards
c) ◎Data format of ERS which shall be harmonized with ISO/TC204 standards
d) Interface protocols which shall be harmonized with IEC TC69 standards

11 Communications

The communication system is an essential part of ERS, and detailed interface shall be harmonized with IEC/TC69 standards and detailed those required standards shall be available for the preparation of deployment of ERS.

a) Wireless communication between ERS and vehicle for authorization protocol before feeding action
b) Data acquisition from vehicle for service validation
c) Service information provisioning/notification to vehicles

12 Operational Use Cases and Scenarios

The operational use cases and scenarios shall be considered for the system design of ERS.

13 Electric Road Charging Fee Management

Basic concept should be defined based upon the idea that

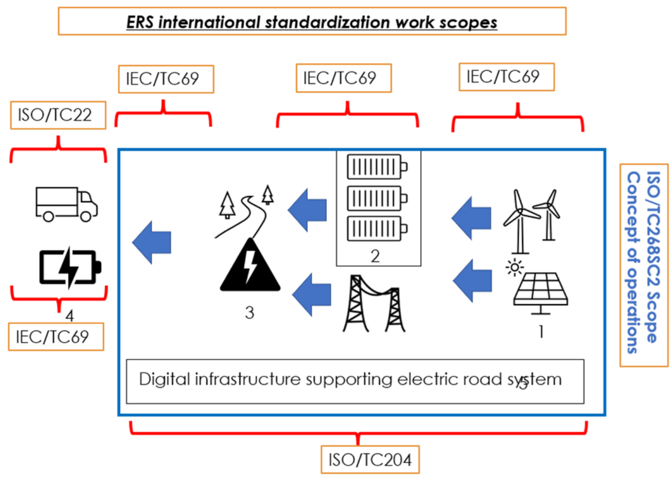

Fig 3. Gap and overlap analysis of work

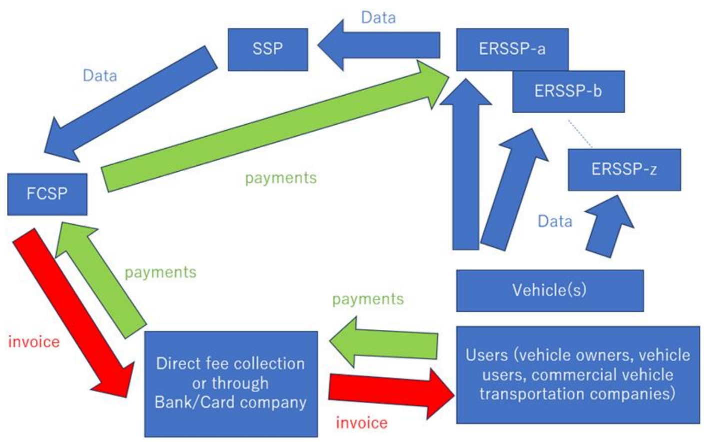

Fig 4. ERS fee collection role model

ERS fee collection is a newly created business model apart from current toll road electric fee collection services.

ISO/TC204 may develop its own standards using current EFC standards.

Key points for power supply to electric vehicles while driving is as follows.

a) Electricity usage data collection should be done at both sides, vehicle, and infrastructure
b) Validation of charging amount to/from vehicles should be done at ERSSP by using on board measured data and infrastructure measured data to avoid undesired data modification at user on board unit
c) Billing electricity usage to vehicle users based on validated vehicle data by FCSP
d) International standardization harmonization of electric road framework, operation concept, other requirements should be considered by multiple ISO or IEC TCs and WGs

13.1 Concept of ERS fee collection service

Figure 4 shows the concept of ERS fee collection service. The following observation shall be observed.

a) Vehicle uses multiple ERS's during move through ERSSP (ERS service provider) –a, -b----z
b) Single or multiple SSP, Security SP (service provider) manage(s) fee collection for ERS
c) Fee collection data should be processed before handing over to Fee collection SP and acts as security service provision to protect privacy, intellectual rights
d) FCSP, Fee collection SP manages invoice to user/commercial vehicle transportation companies and collects fee for ERS services
e) Closed ERS services in mines and ports does not need fee collection system
f) One single entity (such as road operator) can function as ERSSP, SSP and FCSP by using existing toll collection system

14 Conclusion

International standardization work at ISO/TC268SC2 is still in the initial stage and more work and time are required.

Creating the complete set of standards by IEC/TC69, ISO/TC22SC31, ISO/TC22SC37, ISO/TC204 and

ISO/TC268SC2WG2 should be harmonized, and liaison relationships shall be agreed by all parties.

There are several types of electric road systems developed or being developed and continuous updating of the set of the standards are especially important activity.

REFERENCES

[1] ISO/TR 4445:2021 Intelligent transport systems — Mobility integration — Role model of ITS service application in smart cities

[2] ISO 4078-1 Sustainable mobility and transportation–Roadside feeding electric road system –Part 1 – Service role architecture

[3] ISO 4078-2 Sustainable mobility and transportation–Roadside feeding electric road system –Part 2 – Service and operational concept