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Intelligent transport systems — Definition of data elements and data frames between roadside modules and signal controllers for cooperative signal control

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Foreword

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This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Signal controllers and traffic control centres optimize signal timings based on real-time traffic information for each approach. For example, signal controllers may extend the green time for an approach with a long queue.

The aim of this document is to define data elements and data frames that are useful for optimising local and coordinated signal operations.

ISO 22951 (PRESTO) specifies the message sets for signal system pre-emption and priority for transit vehicles including communications between roadside modules and signal controllers. This document complements PRESTO by defining message sets for traffic information that is useful for optimizing normal signal operations. Thus, signal controllers and traffic management centres can generate signal timings referring to the messages of PRESTO and this document.

The red arrows in Figure 1 illustrate message flows that are within scope of this document.

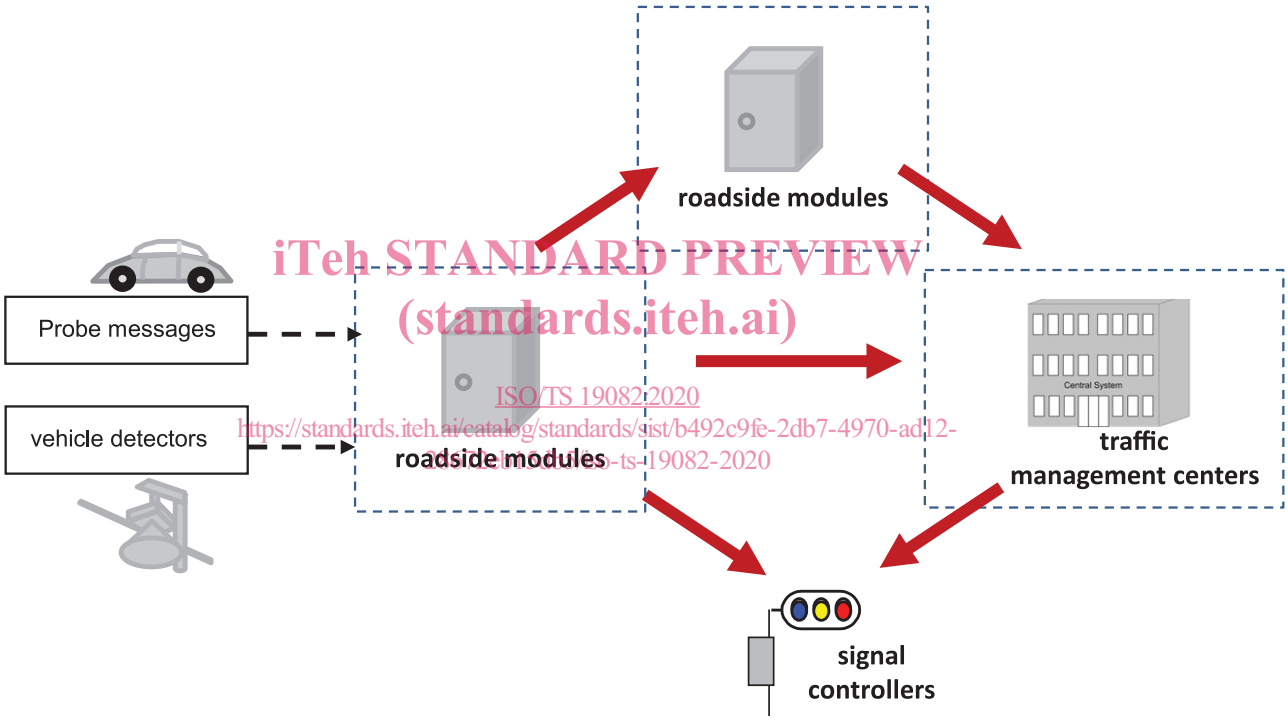

Figure 1 — Physical scope of this document

Intelligent transport systems — Definition of data elements and data frames between roadside modules and signal controllers for cooperative signal control

1 Scope

This document specifies data elements and data frames for messages

a) exchanged between roadside modules and:

   1) signal controllers,

   2) traffic management centres, and/or

   3) other roadside modules.

b) exchanged between traffic management centres and signal controllers.

NOTE Roadside modules can generate data based on inputs from vehicle detectors and/or probe data transmitted by vehicles. This document does not address how the roadside module generates the data; it only addresses communication after receiving and processing raw data from one or more sources.

EXAMPLE A roadside module can calculate vehicle volume, average speed, and queue length by utilizing data from vehicle detectors and probe information.

The data structure follows the framework specified in ISO 14817-1, and the data elements and data frames are described by description, name, object identifier, definition, and data type following ISO 14817-1. The specifications of this document complement those from ISO/TS 19091 and other standards.

The roadside modules can be constructed in any manner using any architecture including the ITS station as described in ISO 21217, or other hardware and software constructs.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14817-1, *Intelligent transport systems — ITS central data dictionaries — Part 1: Requirements for ITS data definitions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14817-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
adaptive signal control
signal control concept where vehicular traffic in a network is detected at one or more points upstream and/or downstream and algorithmically combined with other information to predictively optimize traffic signal operations

3.2
conflicting turn
turn manoeuvre that conflicts with another manoeuvre at an intersection

3.3
cooperative signal control
signal control utilizing not only vehicle detector data but also V2I communication data

3.4
dilemma zone
area upstream of a traffic signal in which different drivers are likely to make different decisions on whether they should continue through or stop at the signal as they see the signal indication change from green to yellow

Note 1 to entry: There are two types of dilemma zones. Type I occurs when yellow and red clearance times are too short for a driver to either stop or clear the intersection before the beginning of a conflicting phase. Type II, also known as an "Option Zone", or "Indecision Zone". This occurs as the result of different drivers making different decision on whether to go or stop, upon the change from a green to yellow indication.

3.5
flow rate
equivalent hourly rate at which vehicles, bicycles, or persons pass a point on a lane, roadway, or other trafficway, computed as the number of vehicles, bicycles, or persons passing the point, divided by the time interval (usually less than 1 h) in which they pass

Note 1 to entry: It is expressed as vehicles, bicycles, or persons per hour.

3.6
phase
signal controller timing unit associated with the control of one or more movements

3.7
probe data
vehicle sensor information, formatted as probe data elements and/or probe messages, that is processed, formatted, and transmitted to a roadside module to create a good understanding of the driving environment

3.8
queue
line of vehicles, bicycles, or persons waiting to be served by the system in which the flow rate from the front of the queue determines the average speed within the queue

Note 1 to entry: Slowly moving vehicles or people joining the rear of the queue are usually considered part of the queue. The internal queue dynamics can involve starts and stops. A faster-moving line of vehicles is often referred to as a moving queue or a platoon.

3.9
roadside module
group of components, or applications, installed at the roadside that can be controlled and/or monitored by a remote entity

3.10
signal controller
roadside module that manages the right-of-way at an intersection, typically by displaying green, yellow, and red indications to the intersection's various approach lanes

4 Symbols and abbreviated terms

PRESTO Data Dictionary and Message Sets for Pre-emption and Prioritization Signal System for Emergency and Public Transport Vehicles

5 Conformance

In order to claim conformance with this document, the structure of data elements and the data frames between roadside modules and signal controllers shall follow the data types described in Clause 7.

6 Use cases

6.1 General

This Clause describes several usage examples where data defined within this document can be used.

6.2 Macroscopic signal control systems

Many adaptive signal control systems perform macroscopic control functions on a central computer, which determines the signal parameters such as cycle length, split and offset based on congestion information. These systems aim to reduce delays and stops by improving the timing efficiency of green indications at critical intersections and maximizing traffic capacity.

Conventionally, volumes and occupancy from vehicle detectors have been used for the input of these systems; the introduction of connected vehicles now allow probe data to be used for this purpose (Figure 2). Probe data can be received over short range communication technologies and processed by roadside modules; the processed data can then be transferred to traffic control centres. Probe data can also be collected via wide area communication. In this case, the central computers process the collected raw probe data and calculate signal parameters by combining processed probe data transferred from roadside modules (but care must be taken not to duplicate data in this process).

The central computer calculates optimal signal parameters and transmits them to signal controllers every a few minutes. Sometimes micro control functions described in 6.2 is combined with macro control functions by signal controllers.

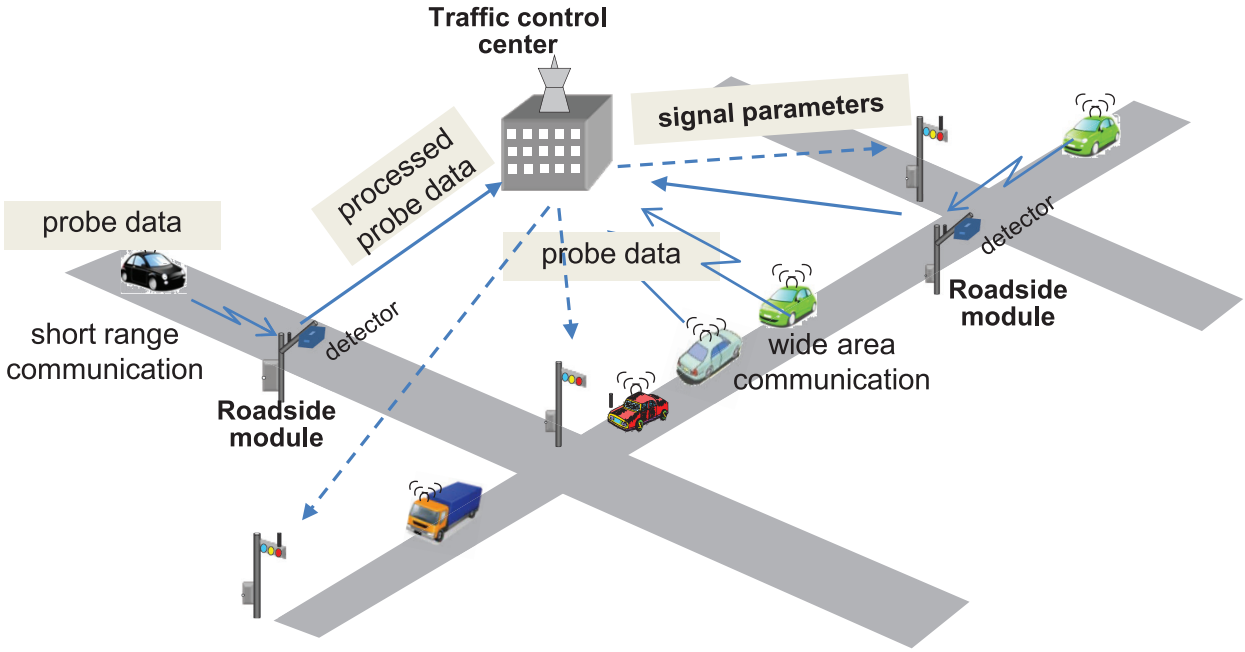

Figure 2 — Macroscopic signal control system

An example flow of macroscopic signal control systems is shown below:

a) Roadside modules with detectors gather raw data of the presence and position of vehicles.

b) Vehicles equipped with in-vehicle units transfer probe data to roadside modules.

c) The roadside modules calculate some characteristic data of intersections, e.g. flow rate, average speed, divergence rate, and vehicle type ratio by utilizing data from vehicle detectors and probe data.

d) The roadside modules transfer the calculated data to the traffic management centre.

e) The traffic management centre calculates the optimum parameters for intersections, e.g. splits, cycles, and offsets and transfers them to the signal controllers.

Another example of macroscopic signal control systems is shown below:

a) The vehicle detectors gather raw data of the presence of vehicles and the positions of vehicles.

b) Vehicles which equip in-vehicle units transfer probe data to roadside modules.

c) The roadside modules assemble data of each vehicle, e.g. position, speed, stop position. The roadside modules can generate snapshots of vehicle positions.

d) The roadside modules transfer the assembled data to the traffic management centre.

e) The traffic management centre calculates some characteristic data of each intersection, e.g. flow rate, average speed, divergence rate and vehicle type ratio, utilizing data from roadside modules, then calculates the optimum parameters for intersections, e.g. splits, cycles, and offsets and transfers them to the signal controllers.

6.3 Micro signal control systems

Roadside modules are usually installed near an intersection in local control systems. Probe data is collected via short range wireless communication (referred to as "localized communications" in ITS, see e.g. ISO 21215, ISO 29281-1). Traffic signals with actuated conflicting turns are an example of this kind of system. This system optimizes the left-turn phase time according to the presence and numbers of queued vehicles. Figure 3 shows one of the examples (a left hand turn for roads that drive on the right).

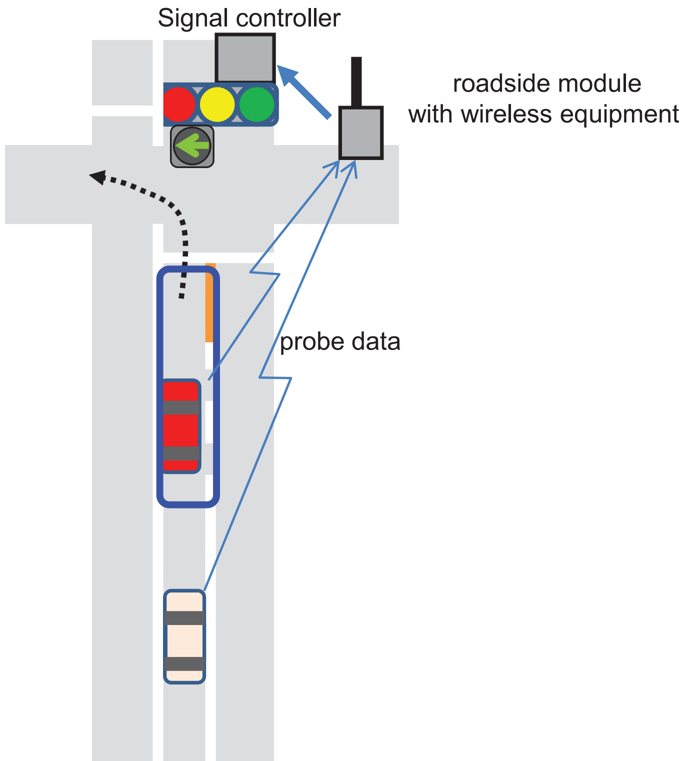

Figure 3 — Actuated conflicting turns

An example flow of left-turn control systems is shown below:

a) The vehicle detectors gather raw data of the presence of vehicles and the position of vehicles.

b) Vehicles which equip in-vehicle units transfer probe data to roadside modules.

c) The roadside modules assemble data of vehicle presence and each vehicle's position and speed.

d) The roadside modules calculate the queue length of vehicles, and the time gap between vehicles.

e) The roadside modules transfer the processed data to the signal controller.

f) The signal controller decides the phase timing with the processed data. For example, the signal controller extends the green phase if vehicles are present in a specified area.

Another example of micro signal control systems is the dilemma zone control system. The dilemma zone control system minimizes the number of vehicles in the dilemma zone by adjusting the start time of the yellow and red signal phase either earlier or later, based on observed vehicle locations and speeds. Figure 4 shows the examples.