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Intelligent transport systems — The use of simulation models for evaluation of traffic management systems — Input parameters and reporting template for simulation of traffic signal control systems

Systèmes intelligents de transport — Utilisation de modèles de simulation pour l'évaluation des systèmes de management du trafic routier — Paramètres d'entrée et modèle de rapport pour la simulation des systèmes de contrôle des signaux du trafic routier

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information.

The committee responsible for this document is ISO/TC 204, *Intelligent transport systems*.

Introduction

Many kinds of signal control systems are used in the world. Some systems are based on simple time-of-day control while some systems are operated in real time, adaptively controlled in accordance with changing traffic conditions.

When adopting a new signal control system in the field, simulations are often used to evaluate its effect. However, although traffic conditions vary considerably in each country and area, simulations can be operated only with some limited conditions. Some control systems and algorithm achieve good performance only in specific conditions, and sometimes simulations are operated assuming virtual road networks for studying a new algorithm.

By disclosing simulation conditions, it becomes possible to learn whether the signal control systems are applicable to many conditions or good in particular conditions, and whether the conditions are practical or the simulation is for theoretic quality assessment. Thus, this Technical Report aims to provide guidelines for disclosing simulation conditions and results in order to evaluate and compare various signal control systems.

For a fair evaluation of signal control systems from simulation results, this Technical Report describes minimum necessary items of conditions of simulation that shall be disclosed. The items of simulation results cannot be regulated because various kinds of results are created depending on simulators, so this Technical Report shows some examples of simulation results.

Intelligent transport systems — The use of simulation models for evaluation of traffic management systems — Input parameters and reporting template for simulation of traffic signal control systems

1 Scope

This Technical Report provides guidelines for disclosing simulation conditions and results when evaluating the performance of signal control methods, focusing on algorithm that establishes signal timings based on traffic conditions. The following are the main aims of the evaluation of signal control systems:

a) to evaluate the quality of the algorithm in various traffic conditions;

b) to evaluate the validity of the algorithm for specific applications (types of intersection);

c) to establish a fair comparison of the algorithm versus other existing algorithms or other types of control systems;

d) to evaluate the results of the implementation of a signal control system objectively.

When claiming and/or comparing the performance of signal control systems from simulation results, it is necessary to clarify simulation conditions and results so that third parties can objectively judge its fairness and reasonability.

This Technical Report describes minimum necessary items of conditions that shall be disclosed to ensure fair evaluation and does not describe maximum possible items.

2 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

2.1
additional lane
added lane which is branched from another *lane* (2.6)

2.2
clearance time
time between signal phases during which an intersection is not used by any traffic

Note 1 to entry: It is expressed in seconds.

2.3
cycle
complete sequence of signal indications

2.4
cycle length
time required for a complete sequence of signal indications

2.5
detection area
area where a vehicle detector can count and/or determine the presence of a vehicle

2.6
lane
marked part of a road that is wide enough to accommodate one vehicle

2.7
link
union of separated two points on the road, tied by single or plural *lanes* (2.6)

2.8
lost lane
lane (2.6) which is merged into another *lane* (2.6)

2.9
occupancy
percent of time that a detector indicates a vehicle is present over a total time period

2.10
phase
signal controller timing unit associated with the control of one or more movements

2.11
saturation flow rate
equivalent hourly rate at which vehicles can traverse an intersection approach, assuming a constant green indication at all time and no loss time

Note 1 to entry: It is expressed in vehicles per hour or vehicles per hour per lane.

2.12
split
time assigned to a *phase* (2.12) during coordinated operations

Note 1 to entry: It may be expressed in seconds or percent.

2.13
time-of-day control
signal timing plans associated to specific hours of the day associated with fluctuations in demand

2.14
vehicle detector
device used to count and/or determine the presence of a vehicle

3 Categories of targeted signal control method

In this Technical Report, the simulation conditions shall be classified in the following categories according to the main purpose of the targeted signal control method:

a) signal control for isolated intersection;

b) area traffic control.

4 Signal control for isolated intersection

4.1 Simulation condition

4.1.1 Simulator

By disclosing simulator being used, it becomes possible to indicate whether the simulator is suitable for evaluating the functions of targeted signal control and to guarantee reproducibility of the evaluation. For this purpose, the following items about simulator information shall be disclosed:

a) manufacturer of the simulator;

b) product name;

c) version.

It is important to calibrate simulation models to validate the simulation results. An example of the criteria for the calibration can be found in "Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software" by The Federal Highway Administration. The validation of simulation models are out of scope of this Technical Report, but simulation models should be disclosed.

4.1.2 Road network

The following items shall be disclosed as road network conditions under simulating:

a) number of links;

b) number of lanes (and number of additional lanes and lost lanes, if it exists);

c) length of links (in meters);

d) direction of each link (should be illustrated with arrows in figures);

e) geometry of links (how each link is connected to other links and intersections).

If each link can be used by particular vehicles (e.g. dedicated buses, bicycles), then the vehicle types shall be disclosed.

4.1.3 Vehicle detector

Generally, signal control systems are thought to achieve better performance as more detectors are installed, but the cost of installing detectors increases with the numbers of detectors. Moreover, there are some areas in the field where detectors are difficult to install. Thus, by disclosing the detector conditions, it becomes possible to evaluate the cost effectiveness of the targeted system and to let third parties know whether the conditions are practical or if the simulation is for theoretic quality assessment.

For this purpose, the following items shall be disclosed for detector conditions under simulating:

a) location of vehicle detector (can be shown as Figure A.1);

b) detection area (e.g. square measure, shape);

c) items collected with vehicle detectors for signal control (e.g. traffic volume, occupancy);

d) lane usage for vehicle detector (e.g. right turn only, right turn plus through);

e) when using information collection methods other than a detector (e.g. probe data), then their outline and collection items;

f) when using information collection methods that are not feasible to use in the field, then their outline and collection items.

4.1.4 Traffic conditions and simulation time

The effect of the signal control system depends on traffic conditions, so the conditions and the variations over the time of the simulation shall be disclosed.

For this purpose, the following items shall be disclosed for traffic flow conditions under simulating:

a) types of demand (vehicle types and their percentages of total vehicle demand);

b) public transit (routes and volume, in case of evaluating the influence of public transit);

c) pedestrians (crosswalk and volume, in case of evaluating the influence of pedestrians);

d) traffic demand (input traffic volume of each link and turning ratio at the intersection);

e) vehicle generation distribution (e.g. uniform distribution, Poisson distribution);

f) saturation flow rate (vehicles/lanes/green timing);

g) average speed (km/hour);

h) simulation time (seconds);

i) simulation resolution (how many steps per second calculations are operated);

j) pre-simulation time (the time to create initial traffic conditions before simulation evaluation, excluding simulation time).

Traffic conditions should be general enough so that third parties can rationally evaluate the performance and compare it to other algorithm. Each traffic control system will have its strong traffic conditions and weak traffic conditions. The performance of signal control under changing traffic conditions is essential. Therefore, input traffic volume should be changed cyclically to be normal, near saturated, and over saturated in order to prove the signal control system is applicable to all these conditions, or good in particular traffic conditions, and to show the performance under changing traffic conditions.

4.1.5 Signal control

The performance of signal control depends on clearance time, cycle length, upper and lower limits of split, and other conditions, so those conditions shall be disclosed. When using the time-of-day control method without vehicle detectors as the reference system, its periods of transition between time of day plans and the details of timing within those periods shall be disclosed. For these purposes, as a condition of signal control at the intersection, the following items shall be disclosed if applicable:

a) phase pattern (these conditions can be disclosed as Figure A.3):

  1) variable or fixed;

  2) sequence;

  3) constrained conditions (in case of variable);

b) clearance time:

  1) variable or fixed;

  2) initial clearance time, upper limit and lower limit (in case of variable) or fixed clearance time (in case of fixed) (in seconds);

c) cycle length:

  1) variable or fixed;

2) initial cycle length, upper limit and lower limit (in case of variable) or fixed cycle length (in case of fixed) (in seconds);

d) split:

1) variable or fixed;

2) initial split, upper limit and lower limit (in case of variable) or fixed split (in case of fixed) (in seconds or percent);

e) other signal control parameters:

1) contents;

2) variable or fixed;

3) constrained condition (in case of variable);

f) priority control (in case of implementation):

1) type of vehicle to give priority to (transit vehicle, emergency vehicle, heavy vehicle etc.);

2) priority rules.

Setting the signal control conditions, such as clearance time, cycle length, and upper and lower limit of split as impractical values to gain better performance shall be avoided.

4.1.6 Simulation system configuration

The information about the composition of the simulation system indicates how much processing and communication delays in the field are reflected to the simulation. Therefore, the following items shall be disclosed concerning how the simulator and the signal control system are linked (via API, via communication interface, etc.).These items can be disclosed as Figure A.5.

a) Structure of the device and the software of the simulator and the targeted signal control system.

b) Data flow of the device and the software of the simulator and the targeted signal control system.

4.2 Methods of presenting simulation results

Evaluation of simulation results is essential for simulation experiments. Therefore, the following items as the results of simulation shall be disclosed so that third parties can evaluate them fairly. Detailed contents of each item should be able to be used to rationally evaluate the characteristics of signal control methods.

4.2.1 Signal control parameter

Parameters of signal controls during simulation shall be disclosed so that the behaviour of the simulation and the values of evaluation index in 4.2.2 are proved to be appropriate, and so that the simulation result do not serve as outputs from black boxes.

For this purpose, the time change of following variables as the results of signal control simulation at intersection shall be disclosed:

a) order of phases;

b) cycle length (in seconds);

c) split (in seconds or percent);

d) other signal control parameters.