Relationship between application scale and maximum time latency in Intelligent Transport Solutions

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Victor L. Knoop
Hans van Lint
Jasper Vries
Leon Kester
Igor Passchier

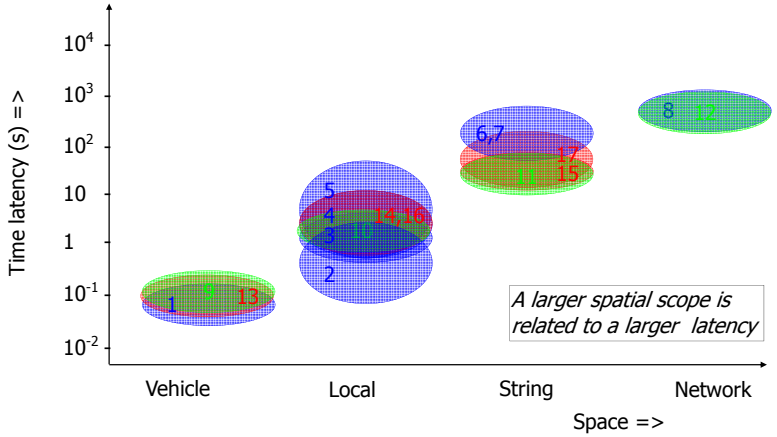
Victor L. Knoop, PhD.
TRAIL Research School
Delft University of Technology
Transport & Planning
v.l.knoop@tudelft.nl

Abstract

This paper investigates the relationship between the spatial scope of a traffic control measure and the maximum time latency of data used for this control measure. This means how old the data can be when the control action is determined, and includes data collection time, aggregation, communication and processing times. For a wide variety of measures it holds that larger areas allow for larger time latencies. If generalized, this can be used to determine the time latency for a desired control action, or it can be used to determine the smallest spatial scope given the latency of the current ITS systems.

Nr	Control application	Time	Geographic
	Freeway		
1	Adaptive cruise control	80ms	Vehicle
2	Merging assist: Need for information of the surrounding vehicles	0.1-1 s	Local
3	Guaranteed green for trucks	1 s	Local
4	Homogenenize traffic: Need for information of surrounding and downstream vehicles	1-10 s	Local
5	Incident detection: Warning of upstream traffic for traffic congestion	1-60 s	Local
6	Traffic management in case of traffic conditions deviating from daily patterns	1-10 min	String
7	Stop-and-go wave removal by reduction of speed limits	1-10 min	String
8	Rerouting over a network	10 min	(Sub)network

Nr	Control application	Time	Geographic
	Urban		
9	Collision avoidance (vulnerable road user)	0.1s	vehicle
10	Indication of time to green at traffic light	1s	local
11	Green wave	1 min	String
12	Urban routing to available car park	10 min	(Sub)network
	Miscellaneous		
13	Vehicles that parallel park themselves	0.1s	Vehicle
14	Routing in P-garage to free spots	1-10s	String
15	Bus arrival prediction	1 min	String
16	Emergency vehicle priority at traffic light	1-10s	Local
17	Emergence vehicle green wave	10-100s	String



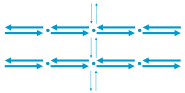
Spatial scales

1.**Vehicle**

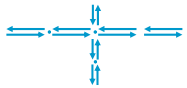
2.**Local**
a) Node
b) Segment / Link

3.**String** - multiple local elements combined, one main direction

4.**Network** - more than one string:
a) Two or more parallel main roads



b) Two or more crossing main roads

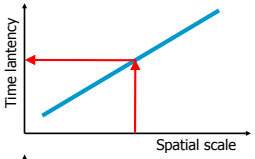


Other dimensions: expectations

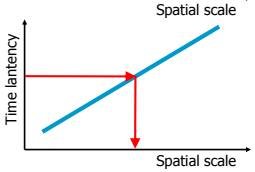
- Availability:
  what fraction of the data is available
- Accuracy:
  how large are the errors in the available data

Application

1. For a desired spatial scale of control, the maximum latency can be determined

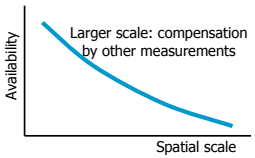


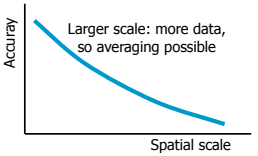
2. For current systems, the latency determines the minimum spatial size of the control area



Temporal scales

1. **Latency**
   How old can the information be before it is outdated =>
   implications for measuring, processing, aggregation and communication
2. Duration of a control action
   How long is the control action
   (not considered here)





Conclusions

The maximum latency that an ITS system can have is related to the spatial scale of the control. The larger the spatial scale, the larger the allowed latency. Road authorities can use this relationship when specifying the (hardware) system requirements for an intended ITS system. Alternatively, given the available hardware, the road authority can determine what is the smallest spatial scale at which they can control. Similar relationships are expected for accuracy and availability.

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Transport & Planning
Delft University of Technology