

Young Researchers Seminar 2009

Torino, Italy, 3 to 5 June 2009

**Definition of optimum placing of data objects
of transport telematic system – “Routing
orientation system”.**

Andrey Vorobyev



An uninformed transit traffic flow:

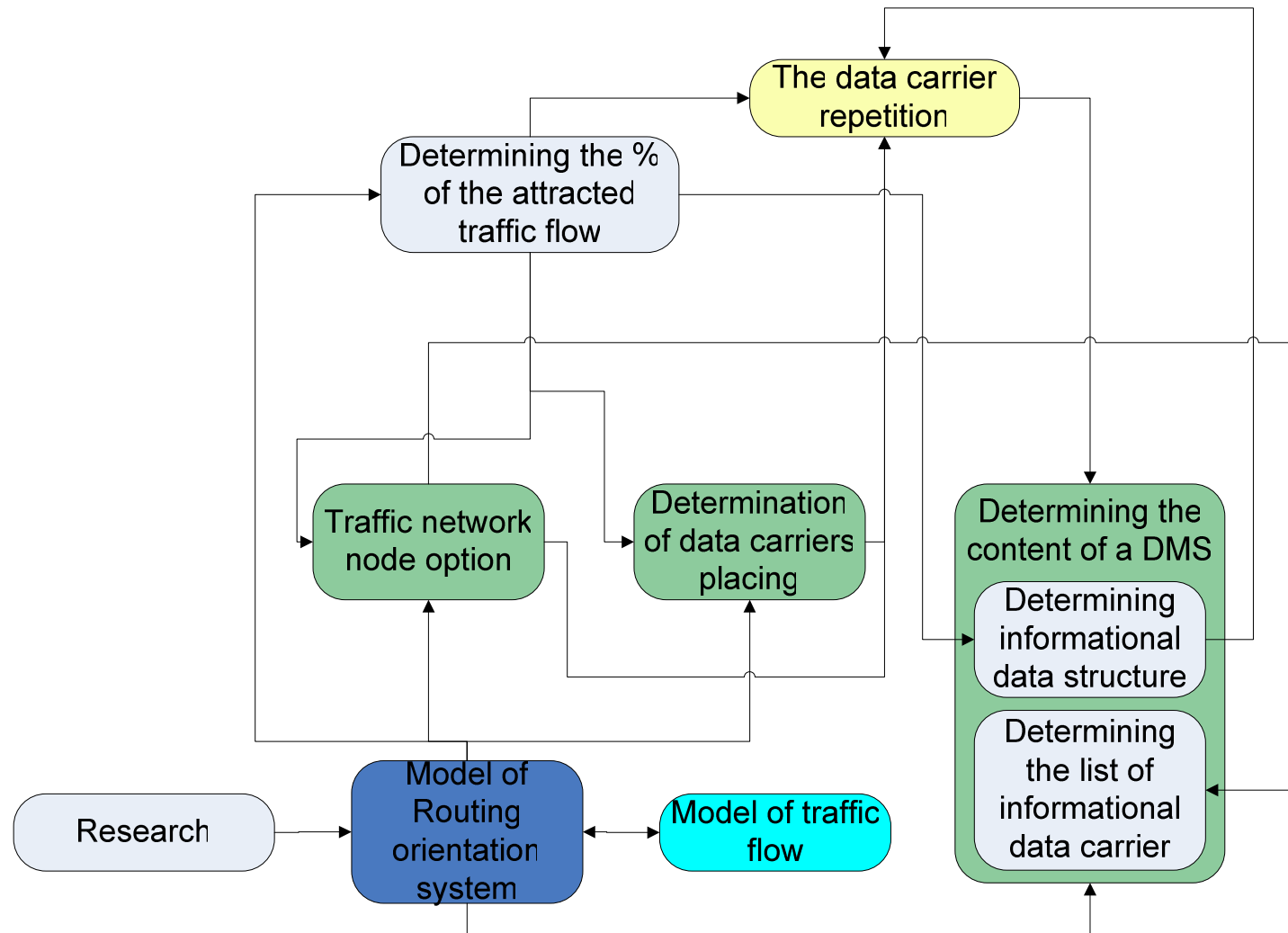
- Too many reruns because of insufficient self-orientation on the road;
- Too many shifts from one traffic lane to another because of psychological discomfort during the way;
- High probability of an abrupt shift from one traffic lane to another or across several lanes;
- General accident behavior on the road caused either by abrupt breakings or by running on unreasonably low speed or by running on the right-right traffic lane or by general traffic situation. All mentioned is caused by the fear of missing the turn.

Actualisation of Routing orientation system

A well-planned dynamical Routing orientation system provides a higher level of safety to unprotected flow participants and so helps to avoid negative consequences.

Routing orientation system is aimed to help the driver to orient himself on the route and to inform him constantly of his locality on this route. The Routing orientation system is based on taking into account a driver not acquainted with the route.

Routing orientation system knowledge domain



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The model should take into account the following parameters:

- Transport flow parameters – flow intensity, density and the mix of traffic;
- Topology of the network of streets part;
- Type of a data carrier.

The existing methods of determine optimal distance from traffic signs to road branching in Russia.

- State Standard GOST R 52289-2004. Rules of application of road signs, traffic lane markings, traffic lights, road guards and routing devices.
- Methodical recommendations to routing orientation on the road (1990).

Methodical recommendations to routing orientation on the road.

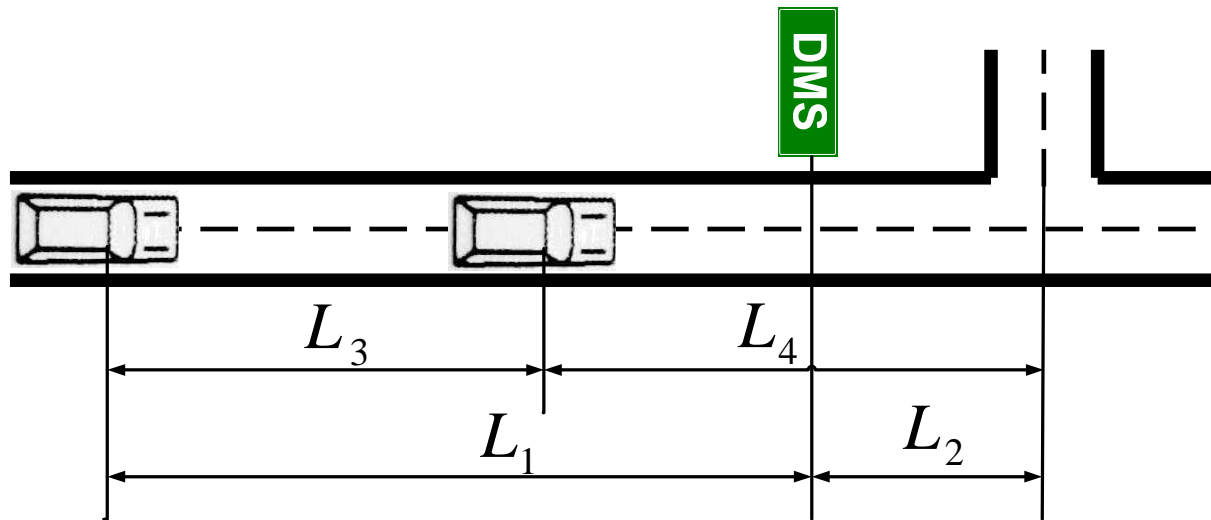
$$L_2 = 0,5v_1 + 0,02(v_1^2 - v_2^2) - 3,5l_0$$

- V_1 - 85% speed of the free vehicle flow on approach to a supposed place of the sign placing, km/h;
- V_2 - 85% speed of the turning vehicles, km/h;
- l - the remoteness of the right edge of a sign from strait-line trajectory of the vehicle running on the left-left traffic lane in this direction;
- 0,5; 0,02 and 3,5 – coefficients taking in account time for making a decision of the driver, slowing down with comfort and the possibility to read and percept the sign, respectively.

This method doesn't take into account:

- Transport flow parameters – flow intensity, density and the mix of traffic;
- Topology of the network of streets part;
- Type of a data carrier.

Development of determining principles of optimal distance from traffic signs to road branching.



$$L_1 + L_2 = L_3 + L_4$$

Which leads to:

$$L_2 = L_3 + L_4 - L_1$$

L_1 – distance to data carrier within view.

L_2 - distance to data carrier to be found.

L_3 – distance a vehicle runs from the moment of detection of data carrier till the moment of taking a decision to change the lane.

L_4 – distance necessary for the maneuvering.

Factors affecting to varieties of the model

Varieties	Affecting factors
L1	<ol style="list-style-type: none">1.Type of data carrier.2.Type of beating.3.Type of data carriers acting.
L3	<ol style="list-style-type: none">1.Time for reading information in a data carrier.2.Time for making a decision.3.Hindrance duration.4.Speed of the vehicle.5.Type of beating.6.Type of data carriers acting.
L4	<ol style="list-style-type: none">1.Lane changing time.2.Speed of the vehicle.3.Maneuvering track.

Distance to data carrier within view.

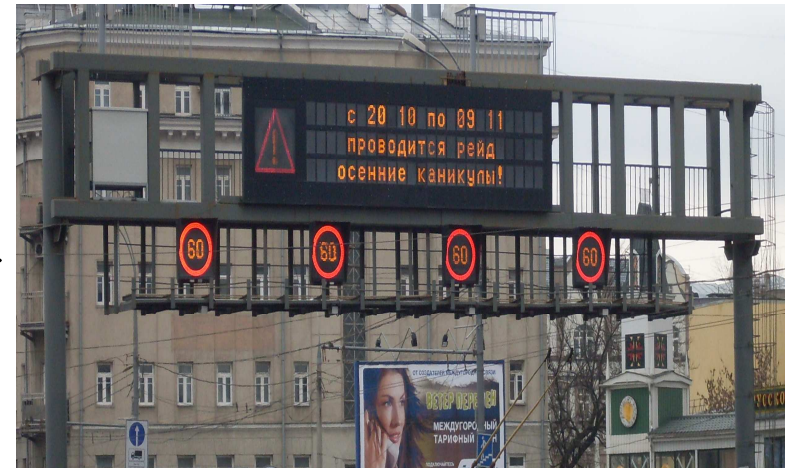
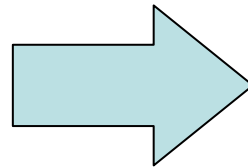
Probability	Speed of a vehicle, km/h			
	40	60	80	100
	Angle threshold, angle minutes			
85 %	8,6	8,6	9,1	9,4
95 %	10,2	10,5	11,0	11,6
Ophthalmic comfort conditions	11,6	12,3	12,9	13,8

Angle threshold of perception depending on speed.

Average maximal distance to a data carrier within view depending on the size of data carrier 1.

№	Type of data carriers acting	Average maximal distance to a data carrier, m
1	Reflective surface	85
2	Highlight (always)	120
3	Highlight (twinkle)	140

Influence of heavy goods vehicles on the distance to data carrier within view.



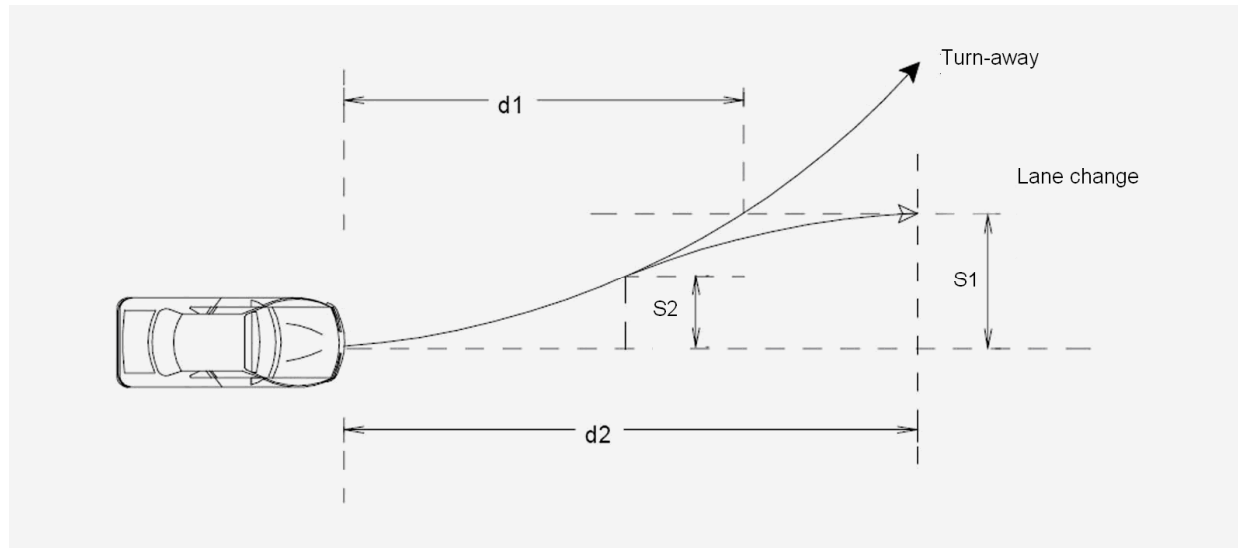
Probability of heavy goods vehicles to hinder is determined by their density in traffic flow. If hindrance probability is more than 85% data carrier is either to be paced higher which worsens detection or to be placed above the road.

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Distance necessary for the maneuvering.

Kinematical model



$$d_2 = 2\sqrt{\frac{S_1 V^2}{gA_y}} - \left(\frac{S_1}{2}\right)^2$$

and

$$t = \sqrt{\frac{2S_2}{gA_y}}$$

d - distance, meters;

V - velocity, m/sec ;

S_1 - lateral distance moved, meters;

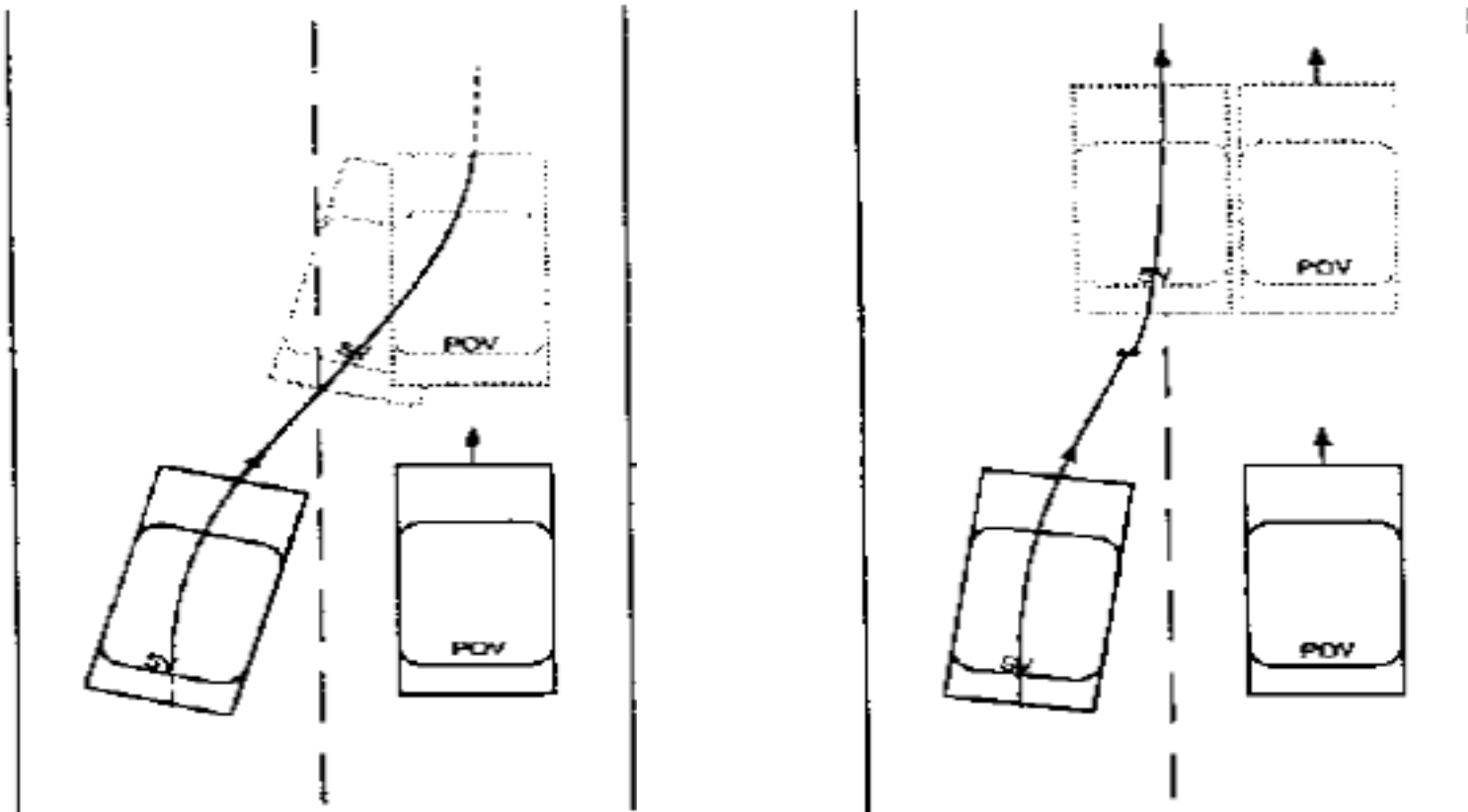
S_2 - lateral distance point at which the turning movement reverses itself;

A_y - the overall lateral slip coefficient;

g - the acceleration of gravity (9,81).

Distance necessary for the maneuvering.

The model with account of traffic flow density

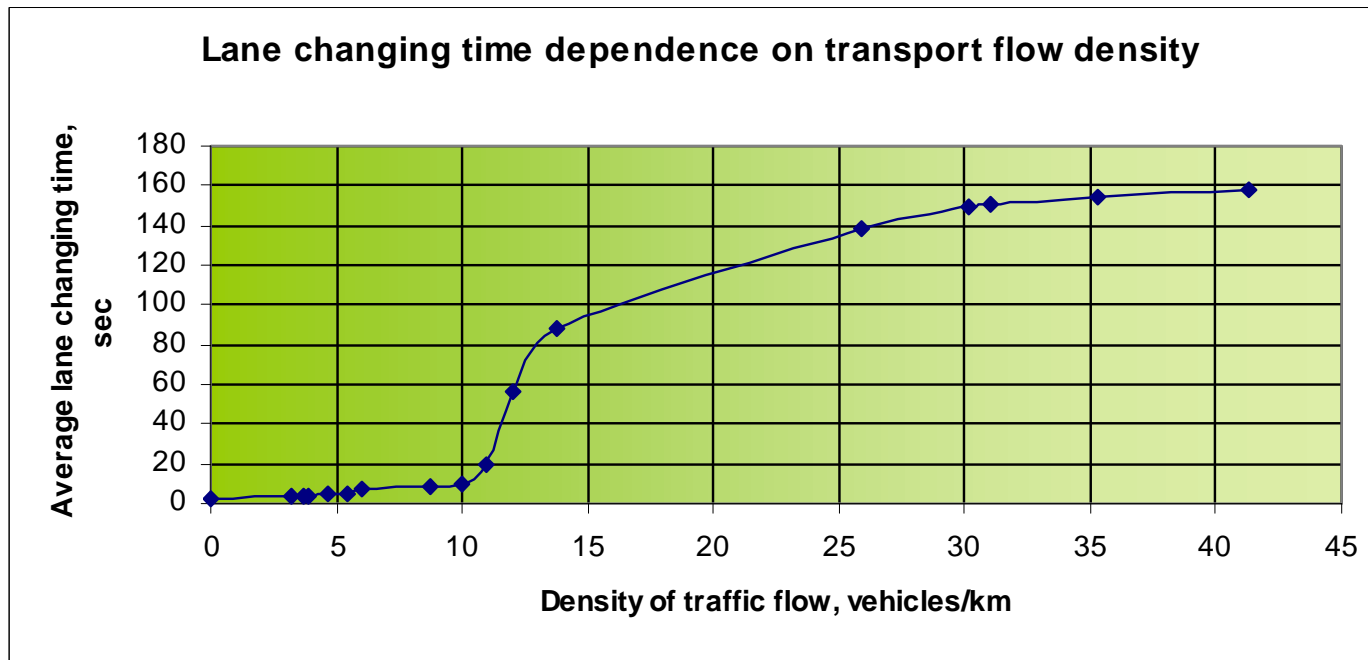


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Distance necessary for the maneuvering.

The model with account of traffic flow density



$$L_4 = \frac{V}{3,6} \cdot t (n - 1)$$

V – average or 85% probable speed of vehicle, km/h;
 $3,6$ – conversion coefficient from km/h into m/sec;
 t – time of changing adjoining lanes, sec;
 n – number of same direction lanes.

Distance a vehicle runs from the moment of detection of data carrier till the moment of taking a decision to change the lane.

Speed, km/h	Distance l , m, under the number of syllables on the road sign																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
50	17	18	18	18	19	19	19	20	21	22	23	24	25	27	27	28	29	31	33	34
60	20	20	21	21	22	22	23	24	25	26	27	28	29	31	32	34	35	37	39	41
70	24	24	26	26	26	26	27	28	29	30	32	33	34	36	38	40	41	44	46	48
80	27	27	28	28	29	30	31	32	33	34	36	37	39	41	43	45	47	50	52	55
90	30	31	32	32	33	34	35	36	37	39	40	42	44	46	49	51	52	56	59	62

$$L_3 = \frac{l}{k}$$

l – distance on which the driver perceps the information and fulfills his decision, is counted from the table, m;

t_1 – time of the driver’s perception of information and fulfillment of his decision, sec;

k – reaction coefficient.

Distance a vehicle runs from the moment of detection of data carrier till the moment of taking a decision to change the lane.

**Driver behaviour for different types of data carriers and different types of data carriers acting.
The result of hierarchical analyzing.**

		Reaction coefficient, k		
		Type of data carriers acting		
№	Type of data carriers	<i>Reflective surface</i>	<i>Highlight (always)</i>	<i>Highlight (twinkle, flash)</i>
1	Road Sign	0,361	0,637	0,855
2	Data Display with constant information	0,342	0,603	0,81
3	DMS	0,323	0,57	0,765

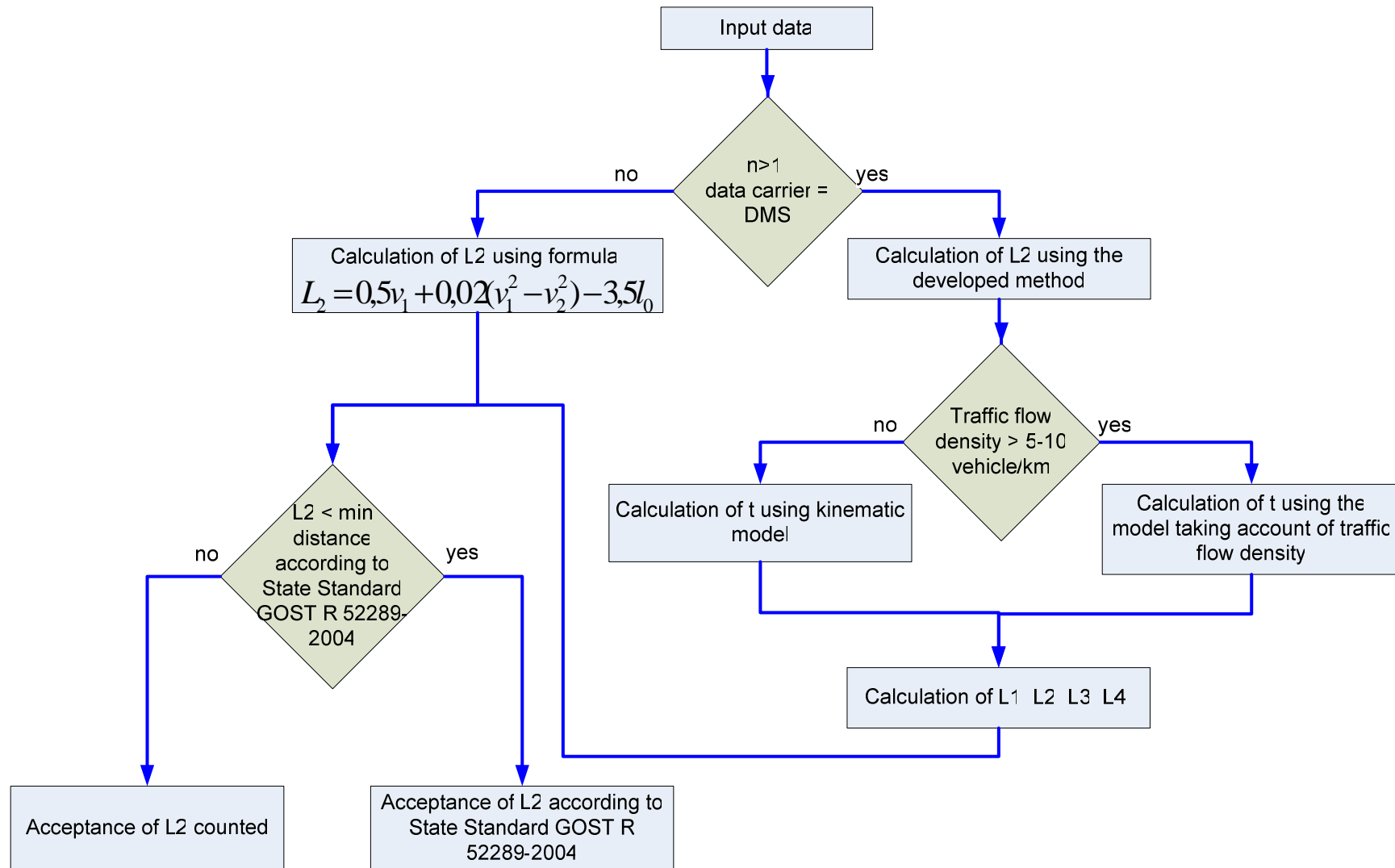
Calculation of optimal distance from data carriers' placing to road branching.

$$L_2 = L_3 + L_4 - L_1 \longrightarrow L_2 = \frac{l}{k} + \frac{V}{3,6} \cdot t (n - 1) - L_1$$

L1 – distance to data carrier within view.
L2 - distance to data carrier to be found.
L3 – distance a vehicle runs from the moment of detection of data carrier till the moment of taking a decision to change the lane.
L4 – distance necessary for the maneuvering.

V – average or 85% probable speed of vehicle, km/h;
3,6 – conversion coefficient from km/h into m/sec;
t – time of changing adjoining lanes, sec;
n – number of same direction lanes.
l – distance on which the driver perceives the information and fulfills his decision, is counted from the table, m;
k – reaction coefficient.

Application schema of the developed method



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Conclusion and next work.

At the moment there isn't any standard regulating requirements to DMS or methods determining logistic of their placing.

The very work is aimed to improve the existing methods of routing orientation.

The method takes into account such factors as:

- traffic flow characteristics,
- parameters of the section,
- psychophysiology of the driver.

Conclusion and next work.

The development of requirements to the repetition of information taking account of human memory model of work and information perceptual peculiarities of Russian drivers are supposed to become continuation to this scientific work.

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Thanks for attention

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