MULTIAGENT SYSTEM MODELING IN LOGISTICS TASKS FOR EMERGENCY SITUATIONS

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INTRODUCTION

As an emergency situation we can take the situation which was not planned or expected from the schedule or route and which demonstrates replacing problems. The problems could occur in the following situations: closed street, closed bridge, absence of electricity, faults with traffic lights, obstacles on the road etc.

For the solution of these problems Transport Management system is to be developed (TMS).

The mathematic model is a graph where the curves are streets and peaks are crossings of the roads. For replanning the schedule Deikstra algorithm is used for the shortest way searching from a particular point till the point of destination.

Monte-Carlo method is applied for the for modeling the system of environment development.

For the assessment of model's correspondence to the real situation Flash tool is applied.

TRANSPORT MANAGEMENT SYSTEM

Transport Management system is demonstrated in Fig.1. TMS shows the situation on the roads, taking facts and information, which comes from different sources and notifies on unexpected events on the road.

If this information is obtained TMS proves it, defines the environment situation ,

Sensors are installed at the problematic places of the streets. As the sensors laser detectors are used , which are apllied with ICS agent processing at the real time data, its development automatically asks for additional information, defines the importance of the situation. If the condition is important it automatically switches to the Crisis Management system (CMS). It uses the information, applies the decision making system (DMS), which works with the prognosing of the development course and/or duration and makes a decision on replaning of schedule and/or defining additional transport and/or safety brigadge call. Information System (IS) contains actual IS and Geographic IS (GIS). It consists of all types of information and objects, all transport schedules and routes as well as information of safety service and other. On the basis of the knowledge the information is processed from different sources for the clear and comprehensively idea of the present situation.

TMS obtains data using agents. Co-operation with other agents goes through interface agents.

Information and Communication System (ICS) agents operate with information collection from sensors and other systems, information storage, knowledge reflection, which allows to the systems analyse the knowledge and data transporting through the communication structure.

Subject agents have enough knowledge in the special area for example weather.

For obtaining data from IS question agents are applied.

Prognosing agents forecast the following situations using information from subject agents, IS and Case based systems (CBS).

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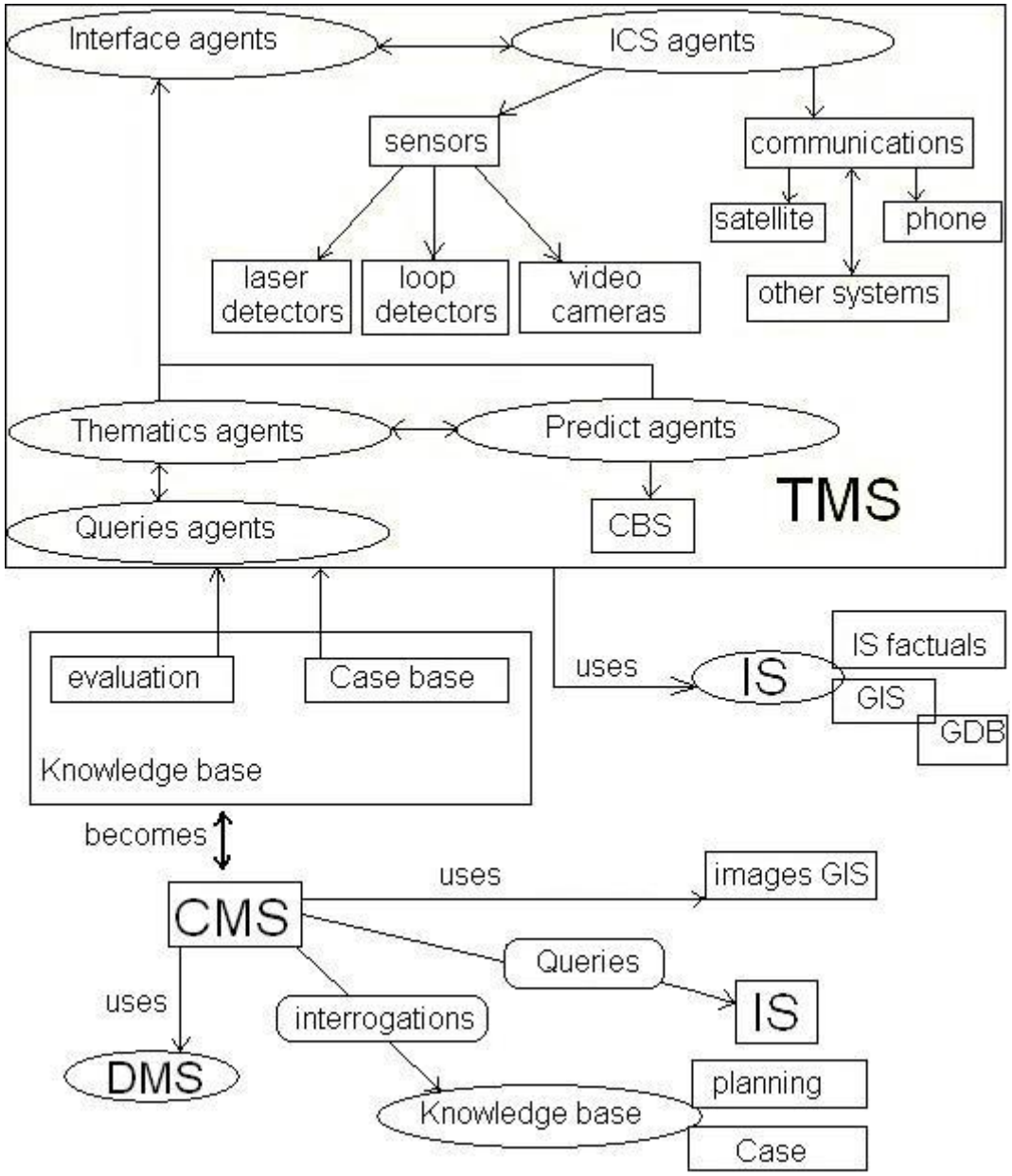
identify transport, size and speed, define unexpected cases, time and transport dencity and send the information to TMS, videocameras, with which ICS agents distinguish unexpected cases and send visual information, loop detectors with the help of which admission time is calculated.



1. figure. Transport Management System

MATHEMATIC MODEL

Mathematic model is developed for Riga region which contains buses, troleybusses and trams.

This Riga region is shown in Fig.2. With the help of this map A correspondent graph was developed where the streets are curves and peaks are crossings of the roads. The graph is in Fig.3.

The peaks are marked with letters A* for the streets which correspont to some routes and letter B* for the streets, which could be used for the additioal routes. In the graph with oriented pointer only those roads are shown which are one-way streets, the others can be both-directions.

If at any cross (peak) an emergency situation is developed, then this peak is not appropriate and the curves (streets) which go to theis peak are not applied.

At the crossroads sensors are installed. Laser detectors are installed at all the peaks of the graph A*, additional road (loop)

detectors are installed also B*, but videocameras are at all the important crosses on the basic roads – they are the graph peaks: AG, AH, AI, AJ, AK and AL.

The goal is during minimum time through the crossroad where an emergency situation is defined. Goal function:

$$M = \min [t_{Ai} , t_{An}] ,$$

where M – route,
t – time,
Ai – starting peak,
An – final peak.

Sensors of additional roads measure the speed of the transport and with the using of ICS calculate admission time :

$$T = S / V,$$

where T – admission time,
S – length of the curve,
V – speed of the vehicle.

The obtained T are used as variable of Deiktra algorithm. With this algorithm the shortest way is calculated:

$$T(Aj) = \min[T(Aj), T(p) + w(p, T(Aj)],$$

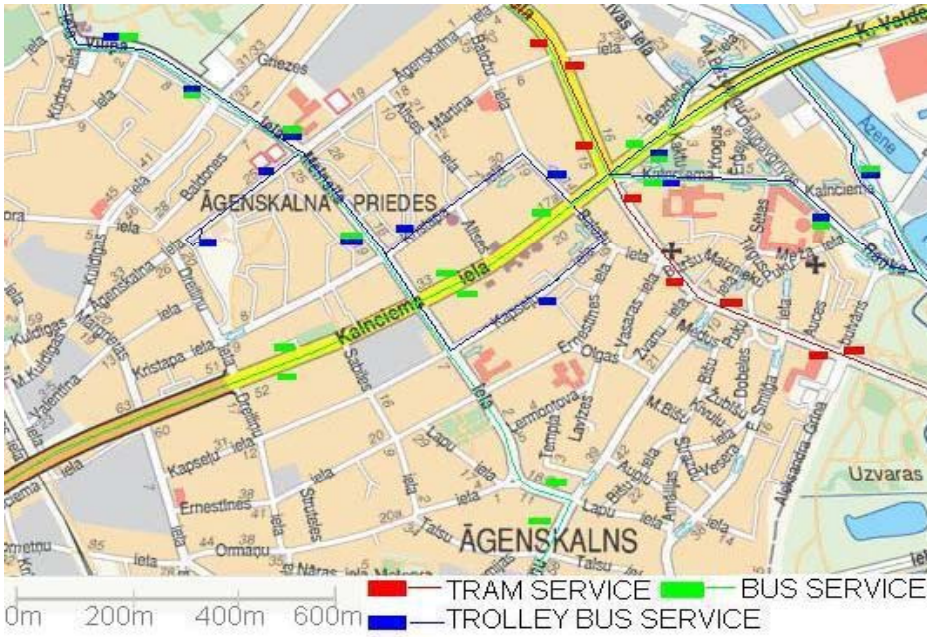
where T(Aj) – variable for the considered peak,

p – variable peak which can be considered or not considered at the shortest way.

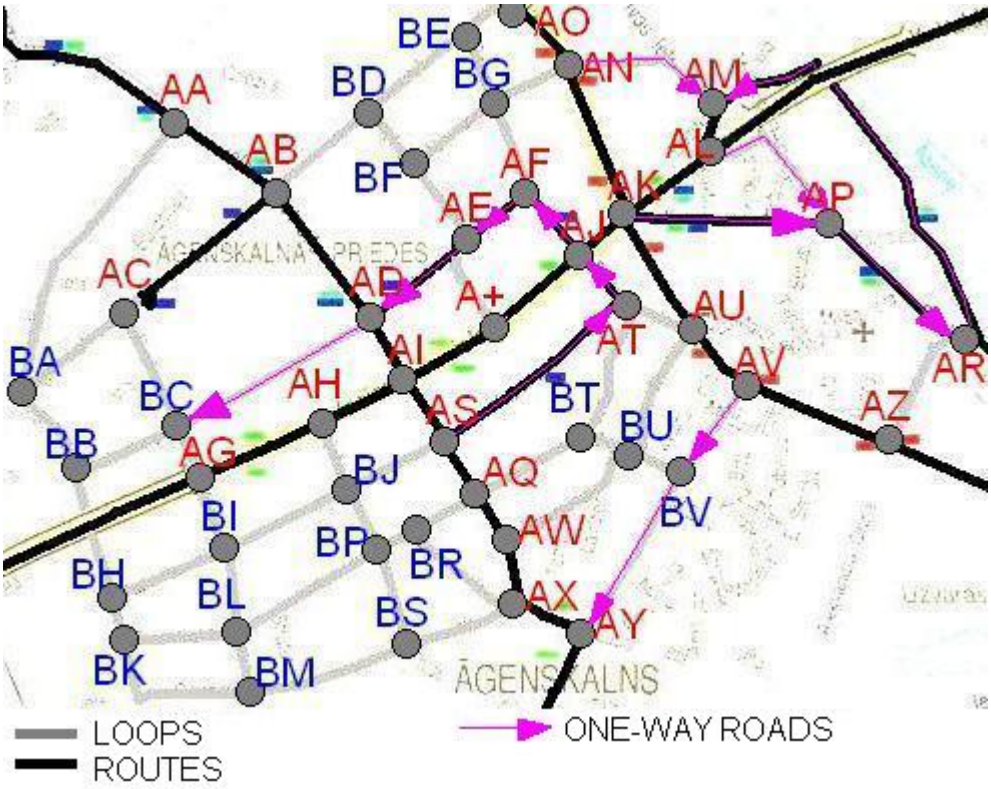
w – weight between the peaks.

if T(p) + w(p, Aj) < T(Aj)

then T(Aj):= T(p) + w(p,Aj)



2. fig. Riga map



3. fig. Graph of the roads

BASIC ALGORITHMS OF THE OPERATION

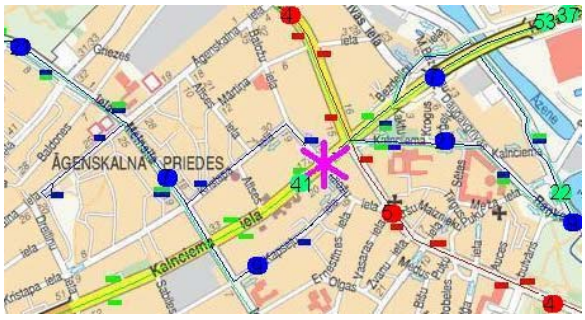
1. Defining of the enviornment situation place;
2. Defining of the enviornment situation type;
3. Difficulty level of the situation;
4. Prognosing of the development course and/or duration;
5. Decision on replaning of schedule and/or defining additional transport and/or safety brigadge call.;
6. Defining of the additioal roads admission time;
7. Replaning of schedule with the help of Deiktra algorithm;
8. Returning to point 4.

DIGITAL EXAMPLE

We develop the environment situation using Monte Carlo method. For example, the emergency situation happened at 11:14. The type of situation as accident, very hard, the place is crossroad – AJ.

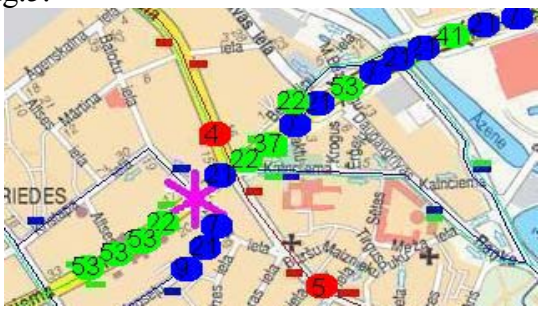
Police and ambulance are called. The forecasted duration by the release of the cross is 99 minutes. The motion could be seen on Web using tool Macromedia Flash MX.

Fig.4 demonstrates the situation at the moment of the accident – the place of the vehicles at that moment.



4. fig. Accident

If TMS is not applied that in an hour situation will achieve traffic jam situation , fig.5.



5. fig.. Situation in an hour without TMS

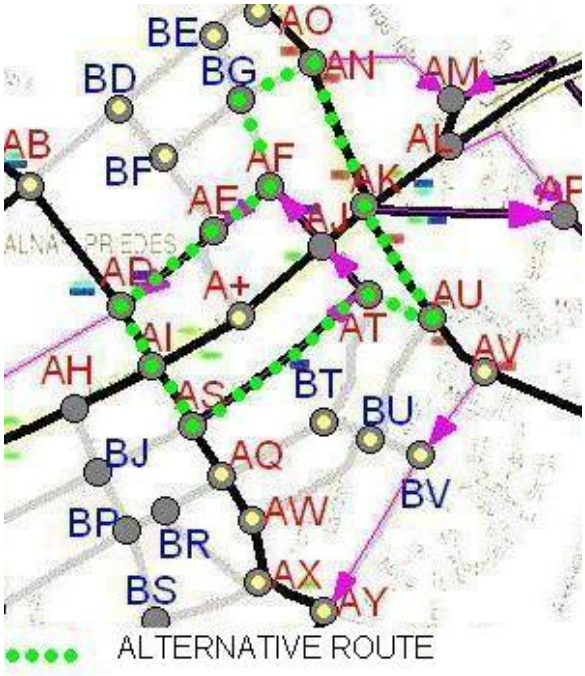
With TMS to avoid it schedule replaning is developed.

As the troleybusses can not run along additional ways then they are stayed at the stops by the moment when the forecasted time till the releasing of the cross is equal to the time necessary for the troleybusses to achieve this crossroad. The same situation is with the trams.

Busses can run along additional road. Then the schedule is replaned for some time. The schedule replaning is developed with Deikstra algorithm for searching the shortest way to go around the closed cross. For the application of this algorithm using additional raod indicators, an admission time of the road (curve) is calculated. The applied variables are shown in table, where they are calculated from the indicators and at the cross these variables are equal to the time which is necessary to release the crossroad.

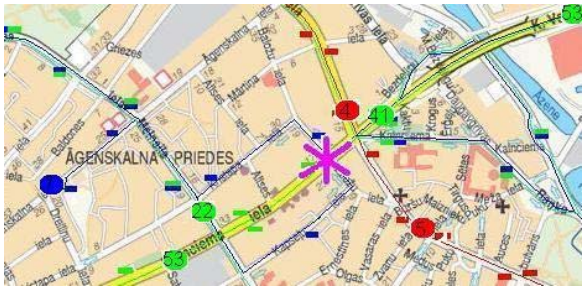
curve	weight	curve	weight	curve	weight
AB - BD	0,3	AS - AI	0,216	A+ - AJ	99
AB - AD	0,369	AS - AT	0,51	BD - AB	0,3
AD - AI	0,2	AS - AQ	0,2	BD - BE	0,3
AD - AB	0,369	AT - AJ	99	BD - BF	0,2
AE - AD	0,3	AT - AU	0,216	BE - AO	0,192
AE - BF	0,256	AT - BT	0,346	BE - BD	0,3
AE - A+	0,235	AU - AK	0,323	BE - BG	0,216
AF - AE	0,216	AU - AT	0,216	BF - AE	0,256
AF - BG	0,256	AU - AV	0,216	BF - BD	0,2
AI - AD	0,2	AU - BU	0,323	BF - BG	0,256
AI - AS	0,216	AV - AU	0,216	BG - AF	0,256
AI - A+	0,278	AV - BV	0,276	BG - AN	0,235
AJ - AF	99	AQ - AS	0,2	BG - BF	0,256
AJ - AK	99	AQ - AW	0,192	BT - AT	0,346
AJ - A+	99	AQ - BT	0,3	BT - AQ	0,3
AK - AJ	99	AW - AQ	0,192	BT - BU	0,192
AK - AN	0,346	AW - AX	0,2	BU - AU	0,323
AK - AU	0,323	AW - BU	0,3	BU - AW	0,3
AN - AK	0,323	AX - AW	0,2	BU - BT	0,192
AN - AO	0,216	AX - AY	0,216	BU - BV	0,192
AN - BG	0,235	AY - AX	0,216	BV - AY	0,439
AO - AN	0,216	A+ - AE	0,235	BV - BU	0,192
AO - BE	0,192	A+ - AI	0,278		

Using Deikstra algorithm the routes shown in fig.6. have been found.



6. fig. New alternative route for buses

Ax the troleybuses are waiting now and buses use another routes traffic jam is excluded. Then the situation in an hour will look like in fig.7.



7. fig. situation in an hour using TMS

CONCLUSION

Using TMS passenger transporting problem and street release in the situation accident was solved.

The system is valid and it could be seen in Web environment, in the map where the transport moving in its own route is seen.

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