

# The implementation of an adaptive traffic light concept in regards to tram access in a complex intersection

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**Abstract-** Case study on the solution of the implementation of an adaptive traffic light concept in regards to tram access of in the intersection created between the Decebal Bvd-Aradului Path-Primariei Street of Oradea Municipality. Description of the proposed solution for the intersection Decebal Bvd-Aradului Path- Primariei Street

## 1. Introduction

The intersection of the Decebal Bvd-Aradului Path-Primariei Street is an intersection in a well-defined geometric form, being systematized from a topological point of view. The topological intersection of the Decebal B-Calea Aradului – Street Primariei is arranged as a roundabout. The elimination of conflicts between vehicle flows is solved classically by the location of the "Give Way" indicators located on the four entries of the roundabout. Once entered in the roundabout the vehicles have priority to rotate around it and engage on any of the exits.

## 2 Case study

This is on the solution of the implementation of an adaptive traffic light concept in regards to tram access in the intersection created between the Decebal Bvd-Aradului Path-Primariei Street in Oradea Municipality, adapted to the requirements of public transport.

The particularity of this roundabout is the path of the tramway and their circulation. It is in two different situations. The first refers to the entry of trams in the roundabout and the second resolution of the conflicts between tram movements and the circulation of vehicles inside the roundabout. In the first situation, the trams entering the roundabout are deprived of priority in relation to vehicles already engaged inside the roundabout. In the second situation, once penetrate in the roundabout, trams have priority over the rest of the vehicles. This regulation is flagged with " Attention Tram " indicators located in the intersection and presented in accordance with figure 1, 2, 4, 5, to be presented in the following.

It is clear that the need to prioritize tram access in the roundabout based on the general policy of prioritizing public transport with the other traffic participants. In this case, as outlined above, the prioritization of trams can only be achieved by the traffic lights of the conflicts between them and the rest of the participants, vehicles, and pedestrians.

As a result, we describe the circulation flows of vehicles that have access to this intersection as follows:

- Exit from the Primariei Street to Decebal Bvd has the right turn to the Train Station, heading forward to the Aradului Path with the possibility of turning left in the roundabout to the Decebal Bvd;

- The exit of the Aradului Path to Decebal Bvd to the right, after the vehicles cross the passage of pedestrians with the button on the Aradului Path, benefit from a strap, which removes from the regulation by traffic lights this relationship, the direction of walking forward is regulated by traffic lights;
- For the flow of vehicles entering the intersection on the meaning of walking the Decebal Bvd towards the Zoo the movement of vehicles is regulated at the roundabout entrance for both the forward direction and the right turn through the road signs, and at the level of the conflict point between the traffic flow of the tramways on the path of its running and the flow of movement of vehicles on the rolling track within the roundabout, the circulation is regulated by traffic lights both for the sense of movement Decebal Bvd towards the Zoo and for the meaning of walking Decebal Bvd towards the Train Station at the entrance of the roundabout.

The conflicts that occur at the level of pedestrian passage with the flow of vehicles and tramways generated by walking directions present the following characteristics: the passage of pedestrians from the Primariei Street, the passage of pedestrians from the Decebal Bvd and the passage of pedestrians from Aradului Path is flagged by road markings, with road signs being light by an adaptive system at the request of pedestrians, by actuating a pedestrian button equipped with a sensor for referral of applications-phase dedicated to crossing the passage of to pedestrians. [3], [4], [10].

### **3. Describing the proposed solution**

To prioritize access to the roundabout and through it by trams, as we have already suggested, it is necessary to request the conflict points between trams and the rest of the traffic participants, as well as between pedestrians and the rest of the participants in traffic.

Not being general traffic lights, classical, which should have solved all the conflicts between the traffic participants, the function of the traffic light of this atypical intersection will be similar to that of the railway crossings. More clearly, only the conflicts between trams and the rest of the traffic participants and the conflict between pedestrians crossing the pedestrian crossings related to the intersection with the rest of the participants will be resolved. The rest of the circulation will be regulated, as outlined above, through the established prioritization of a roundabout.

The intersection traffic lights will work on request, that means a general state of calling for a request from the trams and the phase that will serve them access and crossing the roundabout, called the phase on demand, applications for the serving of pedestrian are related and conditioned by tram movements. In this way, the circulation of vehicles will be interrupted only at the appearance of trams and at the request of pedestrians, which will be conditioned by the circulation of trams.

Through this systematization and traffic lights, the ability to pass and retrieve traffic flows at the intersection level, increases, so the level of service increases by increasing the safety of road streams for vehicles, public transport and for pedestrians using modern traffic lights and by markings and indications.

The intersection traffic lights must resolve the following conflicts between the traffic flows of the tramways on their path and the traffic flows of vehicles on the driving path, as well as the conflicts occurring at the level of crossings pedestrians with the circulation flows intersecting them as follows:

- The exit of Primariei Street to go forward to Aradului Path road and turn right towards the train station;
- Exit from the Aradului Path direction forward and turn right towards the Decebal Bvd;
- Entrance to the intersection on the way to Decebal Bvd towards the Zoo on the forward direction and turning right towards the Aradului Path
- Entrance to the intersection on the way to Decebal Bvd towards the Train Station on the direction forward.
- Crossing the Bvd Stefan cel Mare by pedestrians;
- Crossing the Primariei Street by pedestrians of pedestrian crossings located at the exit of this street.

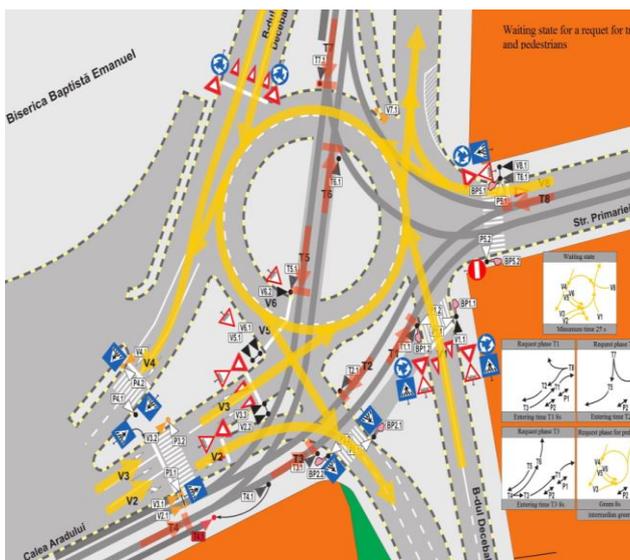
- Crossing by pedestrians of pedestrian crossings on the Aradului Path located in the proximity of its intersection with the roundabout on the Decebal Bvd
- Crossing by pedestrians of pedestrian crossings from the Decebal Bvd located in the proximity of the roundabout on the Decebal Bvd on the Zoo side.

These conflicts that occur in this intersection are the consequences of intersecting traffic flows that are generated by the road of motor vehicles on the one hand and the other side of the traffic flows that are generated by the tramway, will be solved by an atypical traffic light in the motion phases on demand generated by the demand of tram movements and pedestrian crossings:

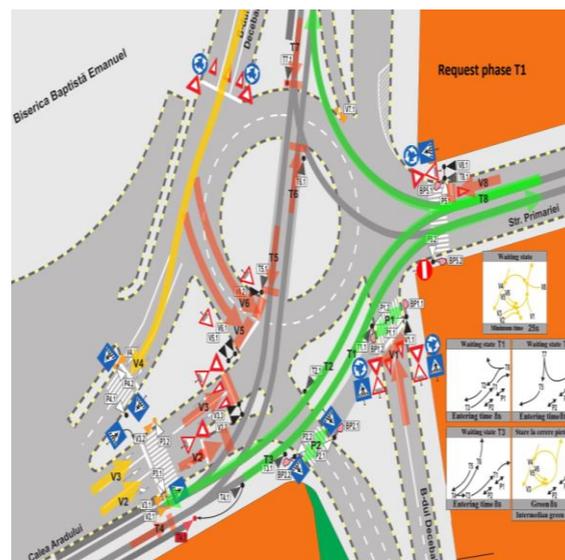
### 3.1 Phase I

**The calling phase of an application for crossing the intersection of tram or pedestrians**, allows the movement of vehicles only on the front and right directions of the Primariei Street, the movement of the self-propelled both ways on the Decebal Bvd as well as turning right towards the Aradului Path, the movement of motor vehicles in the forward and right direction of the Aradului Path route on the Decebal Bvd;

**In this phase or calling the state** of a tram request or requested by pedestrians P5.1/P5.2. The traffic lights in the intersection will function as follows: Vehicle traffic lights V1.1, V2.2, V3.3, V5.1, V6.1, V6.2, V8.1 works on FLASHING YELLOW, Pedestrian traffic Lights P5.1, P5.2 on RED and all tram traffic lights T1.1, T2.1, T3.1, T4.1, T5.1 T6.1, T 7.1 and T8.1 indicate STOP (Figure1).



**Figure 1.** Calling phase of an application for crossing the intersection for tram or pedestrians



**Figure 2.** Phase on request crossing intersection for tram T1

### 3.2 Phase II,

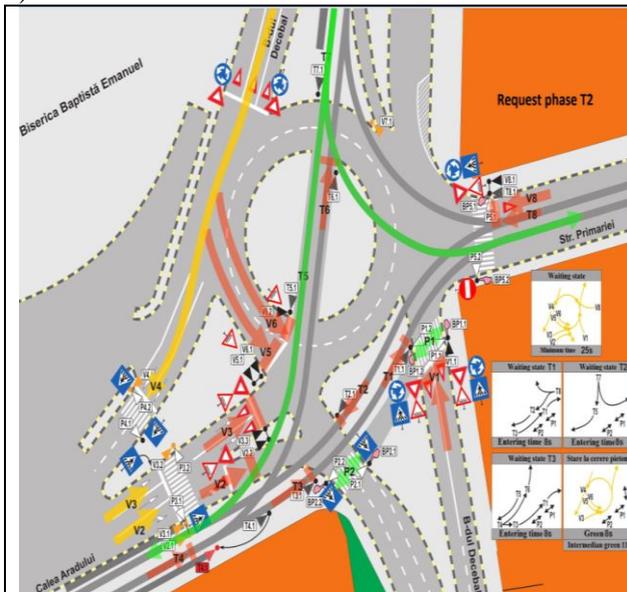
On-demand phase for the T1 tram allows the movement only for the trams circulating on the Primariei Street direction towards the Aradului Path and those that drive to the station on Decebal Bvd, the traffic lights on all directions before and the right turns will see red.

In this phase on request of the T1 tram, which serves the demand of tram coming from Primariei Street, the traffic lights at the intersection will function as follows: Vehicle traffic lights: V1.1, V 2.2, V3.3, V5.1, V6.1, V6.2, V8.1 will be on the RED color, The traffic lights of pedestrians P5.1, P5.2 on RED, and tram traffic lights T1.1, T2.1, T3.1, and T8.1 indicate FORWARD while T4.1, T5.1 T6.1 and T7.1 indicate STOP. (Figure 2).

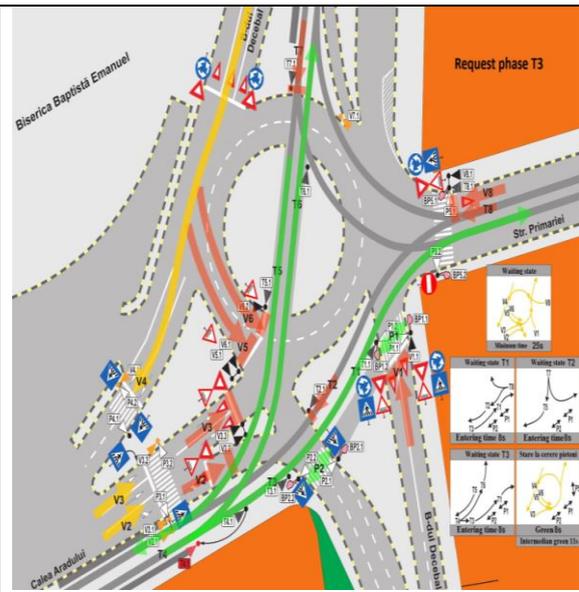
### 3.3 Phase III

On-demand phase for the tram T2, allows the movement of only trams that run on the Decebal Bvd to the left to Primariei Street and turn right towards the Aradului Path, the vehicle traffic lights on all directions forward and the turns to the right will have red.

In this phase on request of the tram T2, serving tramways that circulate and have access to the intersection of the Primariei Street, the traffic lights in the intersection will function as follows: V1.1, V2.2, V3.3, V5.1, V6.1, V6.2, V 8.1 will be RED, pedestrians P5.1, P5.2 on RED, and tram traffic lights T 5.1 and T 7.1 indicate FORWARD while T1.1, T2.1 T3.1, T4.1, T6.1 and T8.1 indica STOP (Figure 3)



**Figure 3.** Phase on request crossing the intersection for the T2 tram



**Figure 4.** Phase on request crossing the intersection for the T3 tram

### 3.4 Phase IV

Phase on demand for the T3 tram, allows the movement of only trams that circulate on Aradului Path, turning left towards the Decebal Bvd and forward direction to the Primariei Street, the traffic lights on all directions forward and the cornering at the right will have red.

In this phase at the request of the T3 tram, serving the tramways coming from the Aradului Path, the traffic lights in the intersection will function as follows: pedestrians P5.1, P5.2 on RED, and tram traffic lights T1.1, T3.1, T4.1, T 5.1 and T6.1 indicate FORWARD while T2.1, T7.1, and T8.1 indicate STOP (Figure 4).

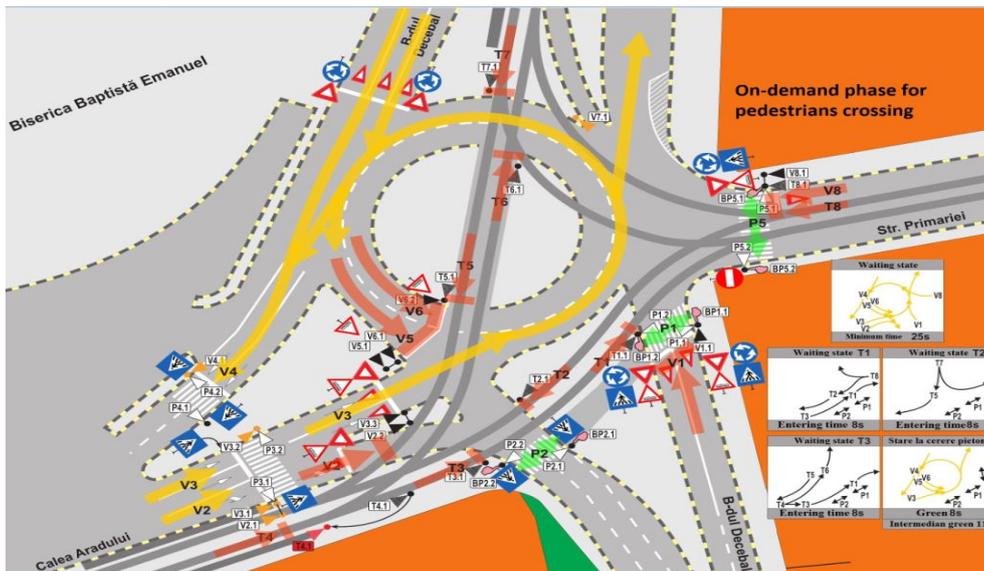
### 3.5 Phase V

Phase on demand for pedestrian traverses the Primariei Street, and, Decebal Bvd, allows the movement of pedestrians only requesting the demand to circulate on pedestrian crossings on the Street Primariei and Decebal Bvd, vehicle traffic lights and tramways on all directions forward and the corners to the right will have red.

In this phase on demand for the P5 pedestrians serving pedestrians crossing the Primariei Street, the traffic lights in the intersection will function as follows: V1.1, V2.2, V3.3, V5.1, V6.1, V6.2 will function on FLASHING YELLOW, V8.1 on RED color, pedestrians P5.1, P5.2 on GREEN, and tram traffic lights T1.1, T2.1, T3.1, T4.1, T5.1 T6.1, T7.1 and T 8.1 indica STOP (Figure 5).

## 4. Recommendation

I recommend the City Hall of Oradea to conduct a traffic study on which to design the regulation of the circulation in this intersection by reconfiguring the topological and extending the traffic lights system for solving all conflicts



**Figure 5.** Phase IV, on-demand phase for pedestrians crossing the Primariei Street

## 5. Conclusions

With an almost no interruption in the field of traffic lights from 1998, almost 21 years, I see that I have never encountered such a situation before. Traffic lights are made primarily to increase the safety of the participants in traffic, introducing clear restrictions materialized by the RED color of the traffic light or STOP in the case of trams. In this case, we have a mixed traffic light combined with regulation with indicators. For this reason, the signaling must be explicit, placed visibly in order not to create ambiguities.

The monitoring of the chosen solution implies selecting some measurable parameters; the performance index shall be analysed based on the result. These measurable parameters can be, for example, duration of time, "green" allocated to each phase. Based on this measurable parameter we can calculate the percentage, "green" used from the total maximum allotted time, as well as the optimum cycle duration and the distribution of the "green" times allocated to this cycle. Adjusting the parameters in the function can be done as a result of graphic representations and the repetition of the whole process, following the analysis of this aspect can be carried out a study that will lead to the optimal variant chosen. Measuring the efficiency of traffic crossings and analysis of implemented programs requires an integrated system for collecting traffic data, registering them for a reasonable period, transferring them through a network of Communication in computing and finally processing center, graphical representation, and analysis, making statistical reports.

To solve these deficiencies, the author proposed the solution to implement a concept of adaptive traffic light system presented in this work and which currently solves this problem.

## References

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