

Intelligent Urban Traffic Control System

Project Overview

Goal:

To model a coordinated urban traffic network including intersections, a roundabout, and public transport hubs.

Core Technology:

Java-based Petri Net framework (OETPN).

Key Components:

- Two main Intersections (Intersection1, Intersection2).
- One central Roundabout.
- Integrated BusStation and TaxiStation.
- Dedicated PedestrianController.



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System Architecture Overview

Overview:

The project consists of multiple interconnected Petri Net modules running on unique network ports.

Main Components:

- **Intersection 1:** A dynamic 4-lane crossroads.
- **Intersection 2:** A dynamic 3-lane T-T-intersection.
- **Roundabout:** A central 3-lane circular traffic handler.
- **Public Transit Hubs:** Dedicated Bus and Taxi stations.
- **Safety Features:** Integrated Pedestrian Controller.

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Intersection 1 & Controller 1

Intersection 1 Logic:



- **Logic:** A 4-way junction with priority lane management.

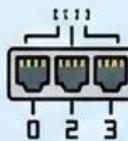


- **Priority Lane:** Specifically identifies priority vehicles (buses) to bypass standard timing logic.

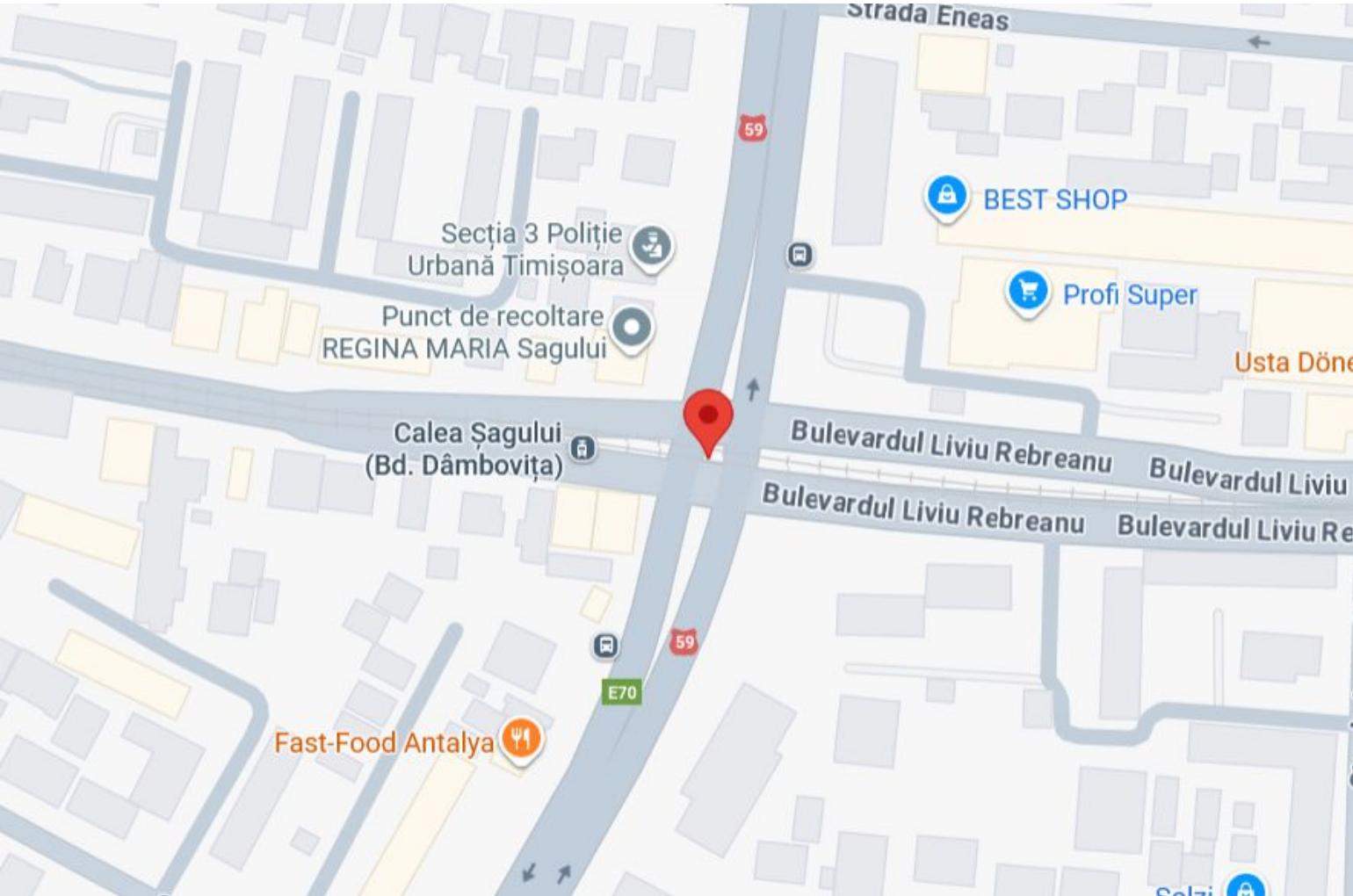
Controller 1 & Network:

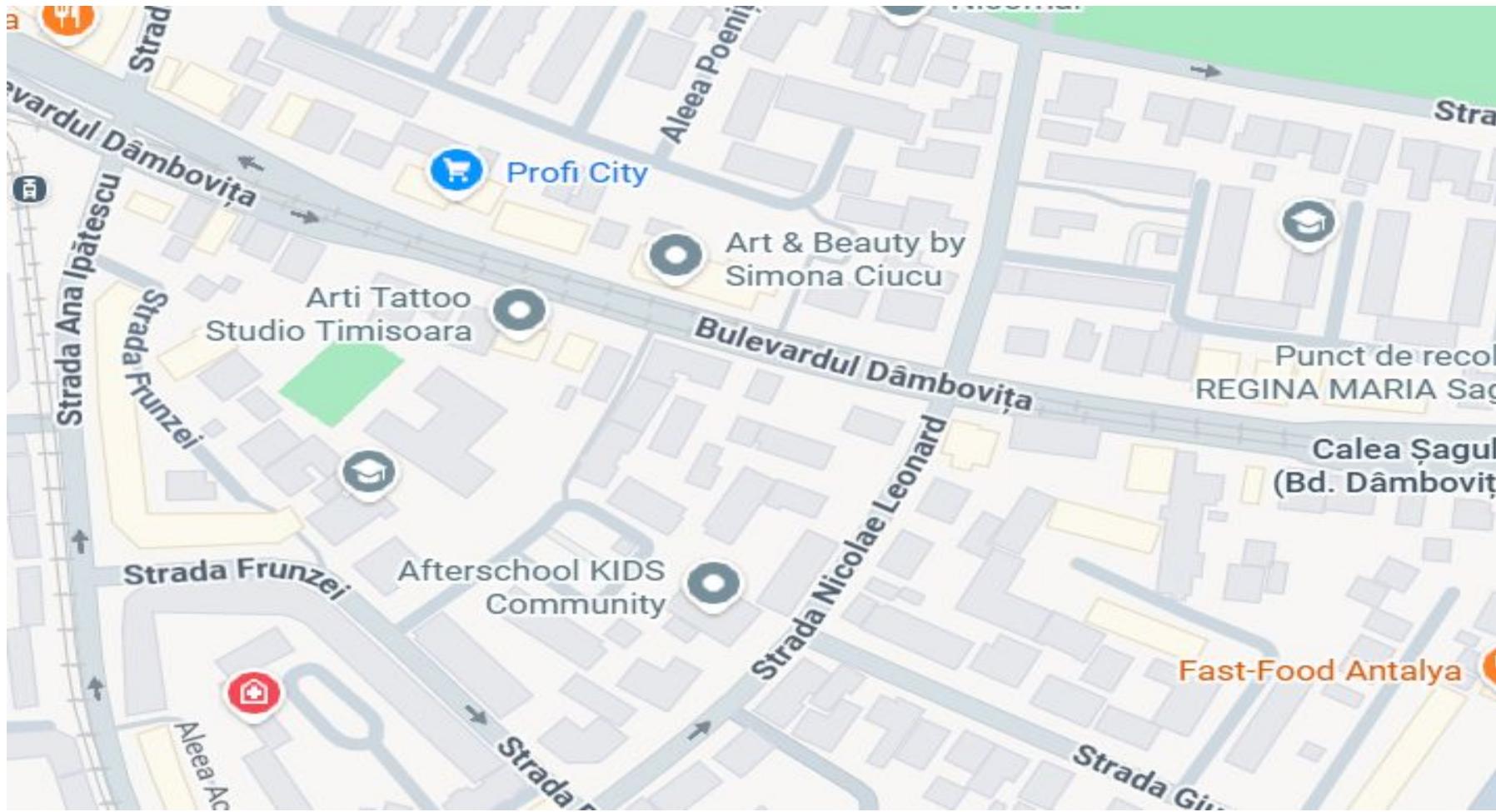


- **Controller 1:** Dynamically adjusts green light timings based on lane occupancy sensors (in1 to in4).



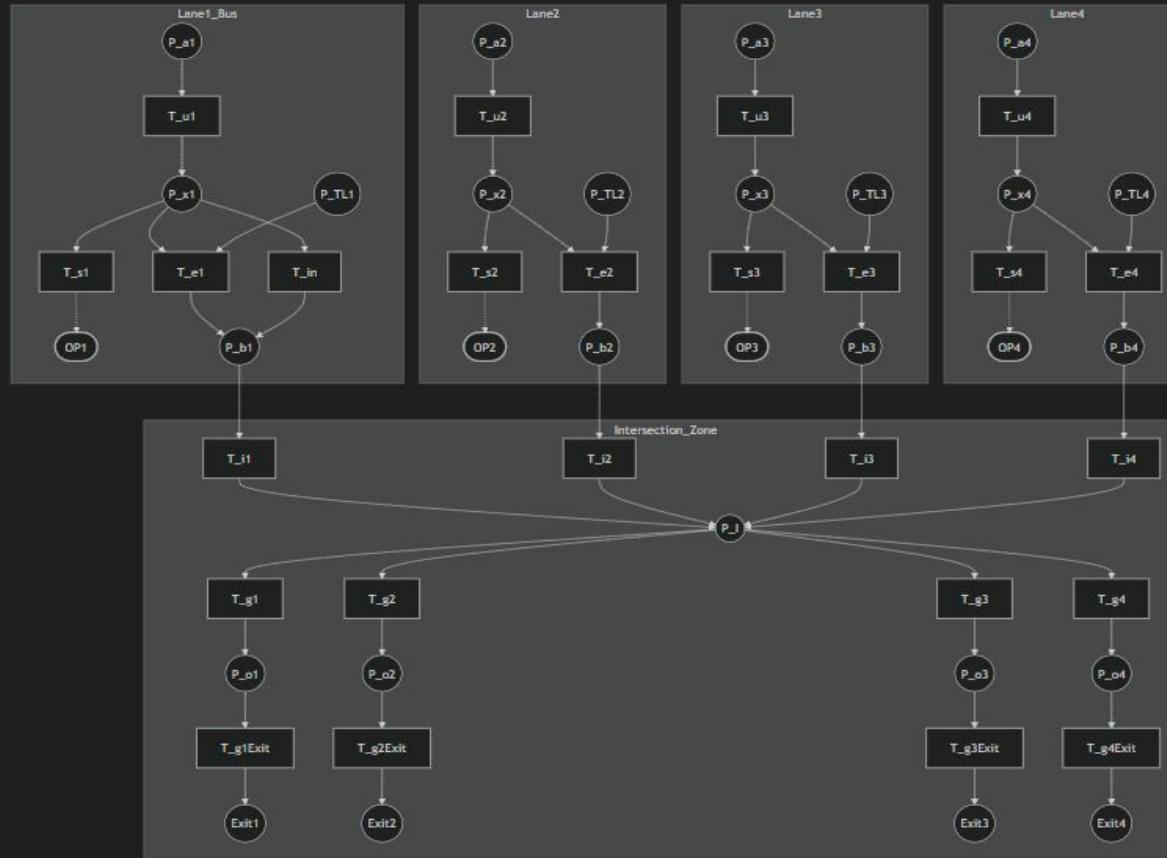
- **Network Config:** Intersection logic on port 1081; Controller on port 1091.





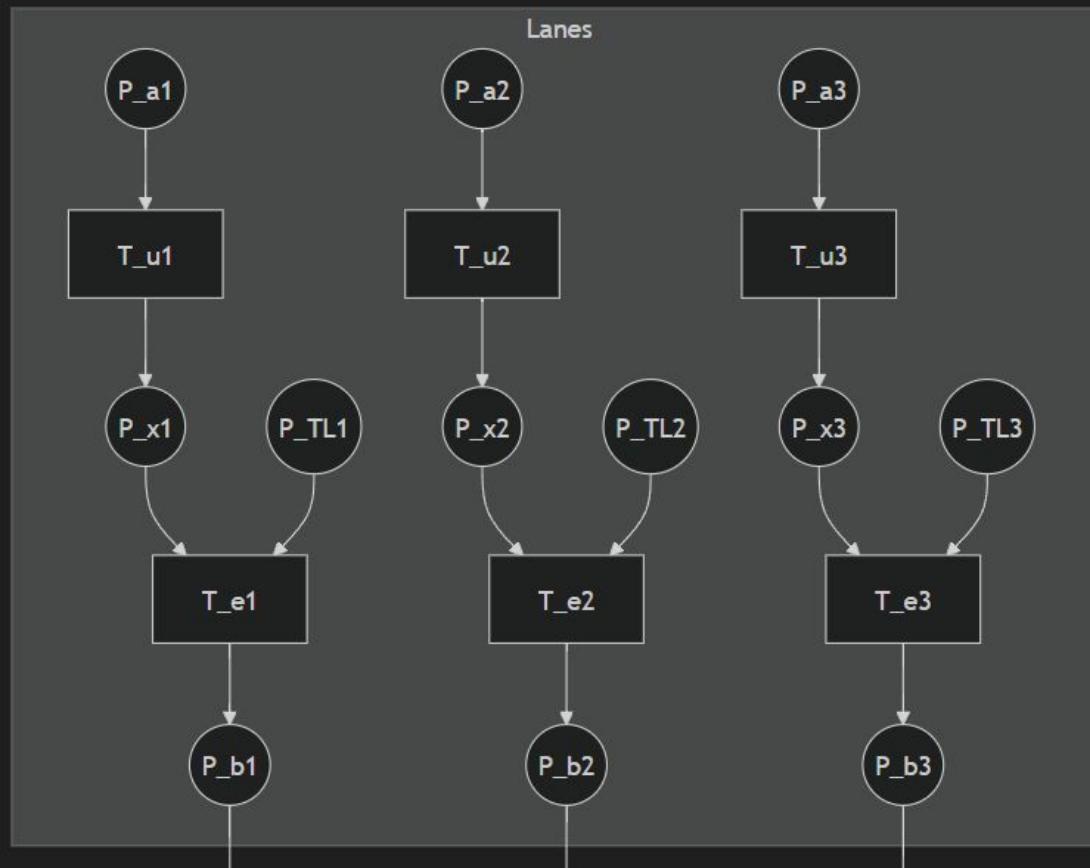
1. Intersection 1 (Crossroads)

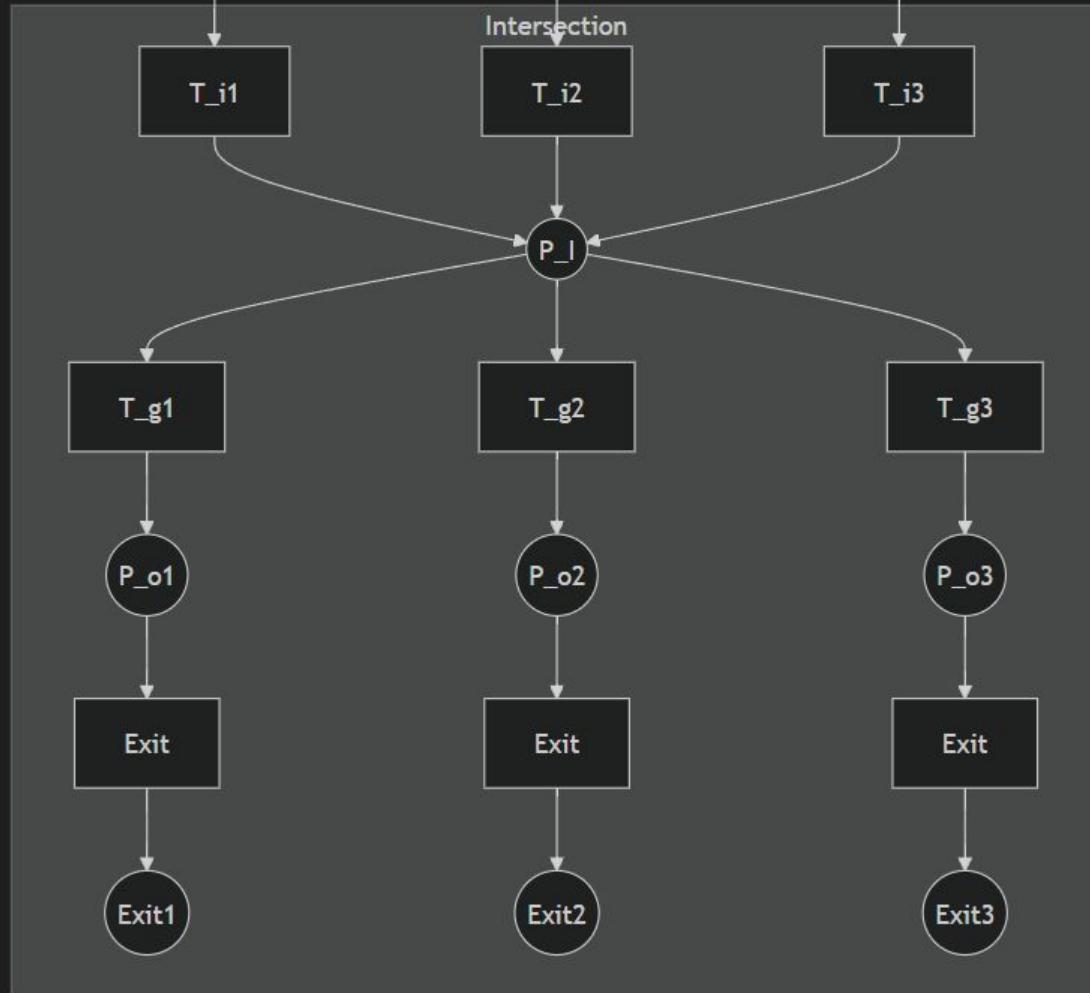
A 4-way intersection. Lane 1 is a Priority Bus Lane.



2. Intersection 2 (T-Intersection)

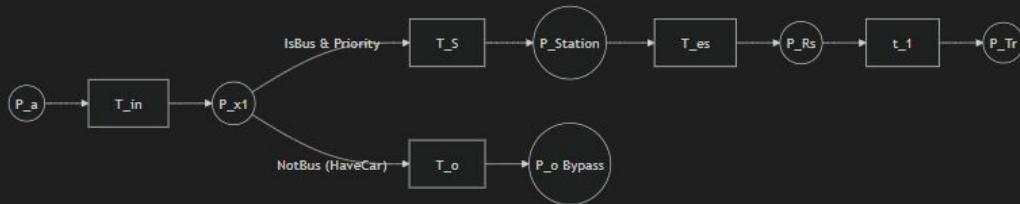
A 3-way intersection (Lanes 1, 2, 3).





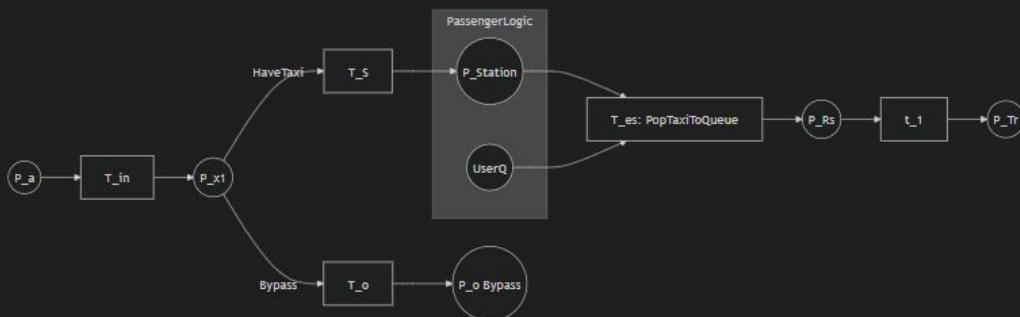
3. Bus Station

Handles Bus entry and exit logic.



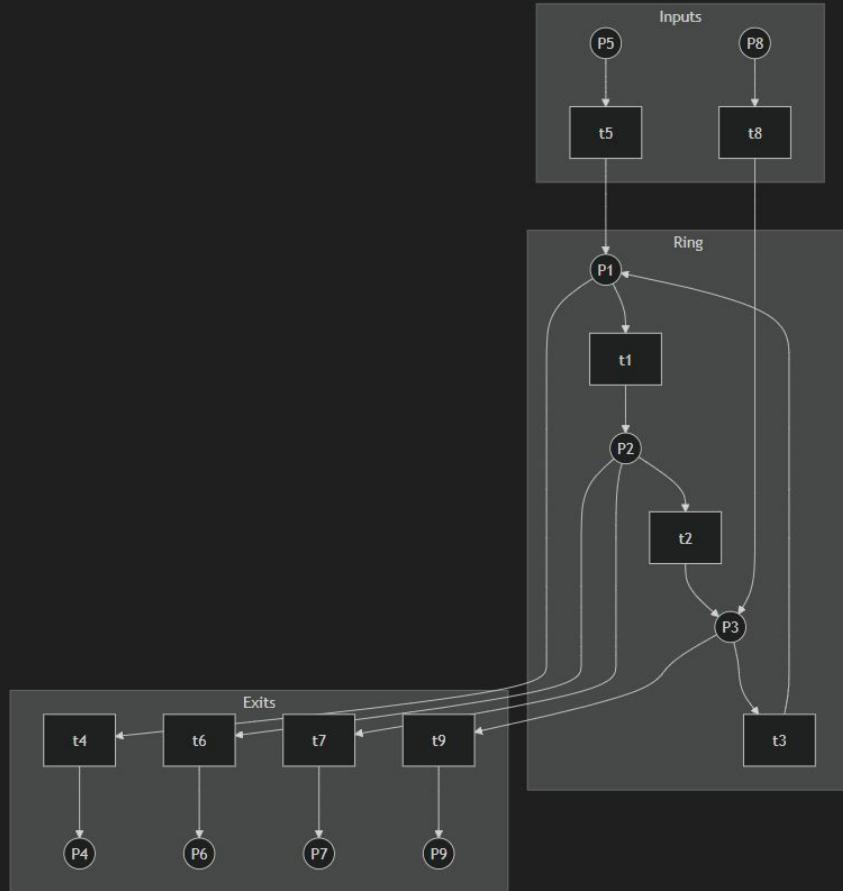
4. Taxi Station

Similar to Bus Station, but includes a User Queue for passengers.



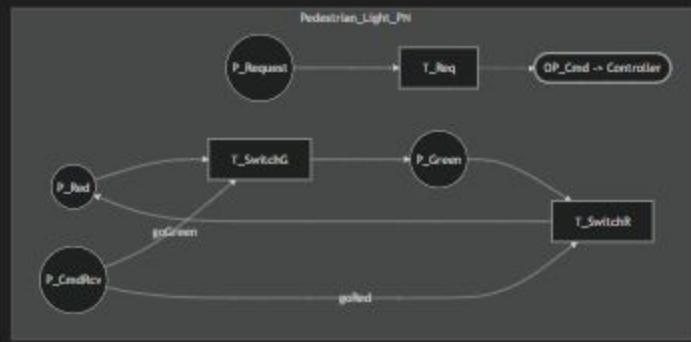
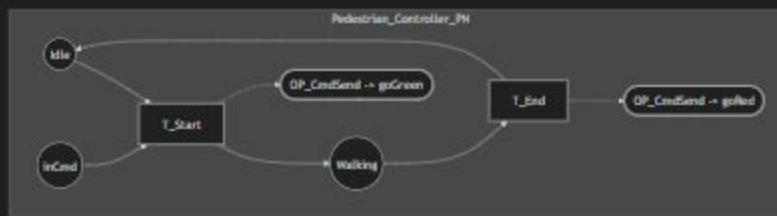
5. Roundabout

Circular traffic logic.



6. Pedestrian Controller

Two interacting Petri Nets.



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Intersection 2 & Controller 2

Intersection 2 Logic:



- **Logic:** A 3-lane T-intersection.

Controller 2 & Network:



- **Controller 2:** Manages 3 signal phases with dynamic delays ranging from 2 to 11 units depending on traffic density.



- **Network Config:** Intersection logic on port 1082; Controller on port 1092.

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Central Roundabout

Roundabout Design & Capacity:

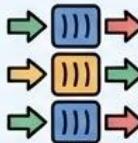


- **Design:** Uses a series of interconnected queues (P1, P2, P3) to represent circular traffic flow.



- **Capacity:** Each lane segment in the roundabout has a defined size capacity (Size = 3) to prevent deadlocks.

Flow Control & Network:



- **Flow Control:** Manages three distinct input buffers (P5, P7, P8) and output buffers (P4, P6, P9).



- **Network Port:** 1083.

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Public Transit: Bus & Taxi Stations

Bus Station (Port 1084):



- Implements priority car detection and station entry logic.



- Includes a road segment (P_{Rs}) with a transition delay of 10 units for boarding/alighting simulation.



Taxi Station (Port 1085):



- Distinguishes between regular cars and taxis.



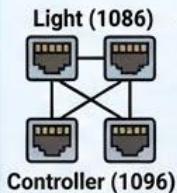
- Features a “User Queue” (UserQ) logic where taxis must wait for users before exiting.



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Pedestrian Safety System

Architecture & Request Logic:

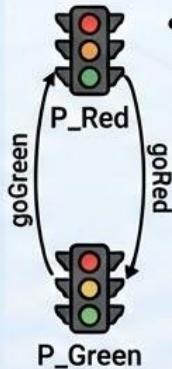


- Architecture: Divided into two sub-nets: Pedestrian Light (Port 1086) and Pedestrian Controller (Port 1096).



- Request Logic: Pedestrians use an input panel to send a crossing request (T_{Req}) over the network to the controller.

State Machine:



- State Machine: Switches between P_{Red} and P_{Green} states via goGreen and goRed network commands.

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Petri Net Modeling - Intersections

The following models represent the visual Petri Net logic for the main junctions.

Figure 1: Structural model of Intersection 1

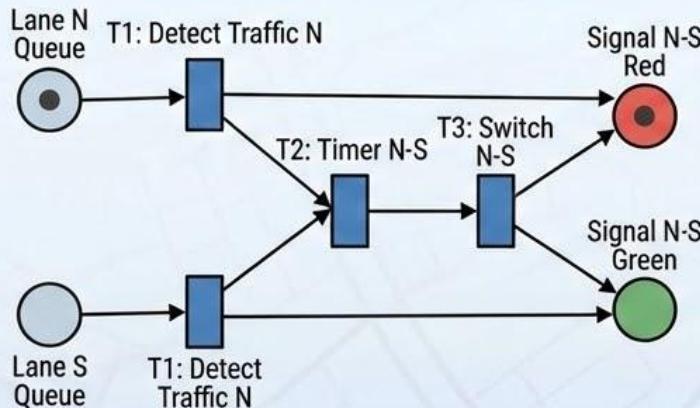


Figure 2: Petri Net detail for Intersection 2

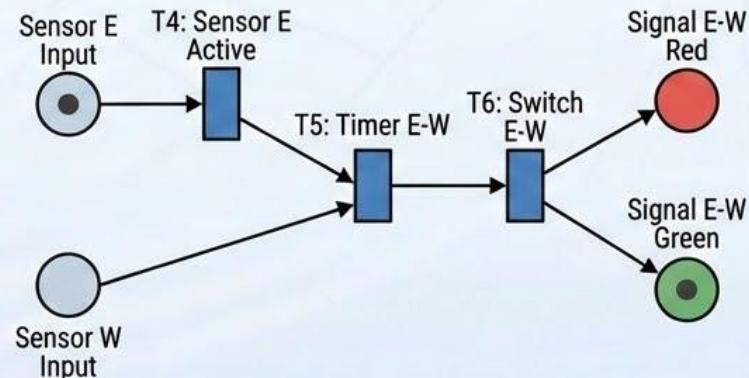


Figure 1: Structural model of Intersection 1
shows lane queues and signal transition logic.

Figure 2: Petri Net detail for Intersection 2
includes input sensors and traffic light signal states.

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Petri Net Modeling - Roundabout & Stations

These diagrams illustrate the flow for complex movement areas and public transport stops.

Figure 3: The circular queue architecture

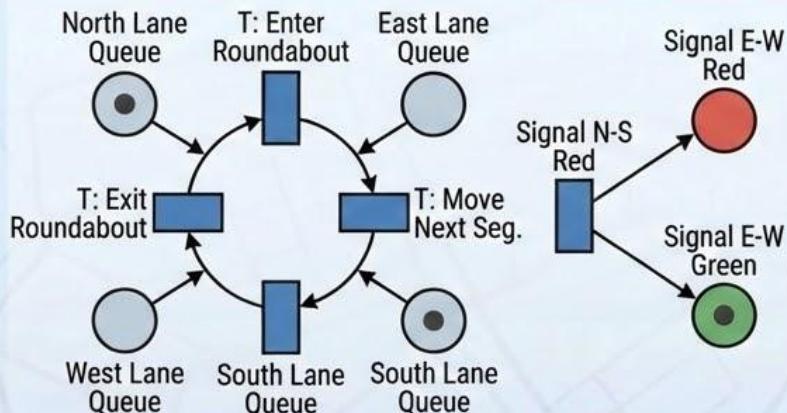


Figure 3: The circular queue architecture of the system's central roundabout.

Figure 4: Petri Net modeling the entry,

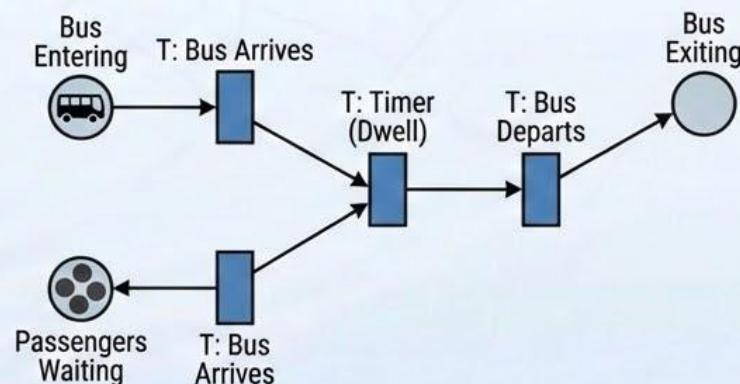


Figure 4: Petri Net modeling the entry, station dwell time, and exit for buses.

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Station Detail Logic

Further details on the entry and exit mechanisms for the transit stations.

Figure 5: Zoomed-in views of station

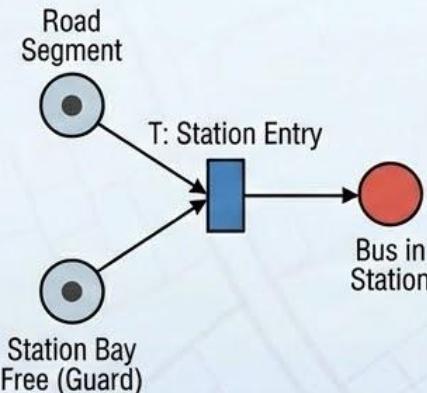


Figure 6: Zoomed-in views of road segment

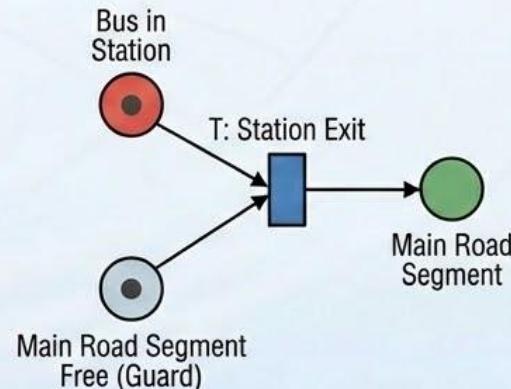


Figure 5: Zoomed-in views of station transition guards... shows station transition guards and road segment handover logic.

Figure 6: Zoomed-in views of road segment handover logic... shows station transition guards and road segment handover logic.

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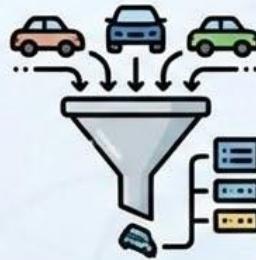
Execution & Simulation

Launcher



The **RunAll.java** file initializes all components simultaneously using multi-threading.

Input Generation



Uses **InputCarFP.java** to inject variable traffic loads into the system for testing.

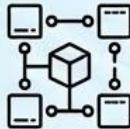
Monitoring



Real-time visualization is provided via the **PetriNetWindow** class class for each active net.

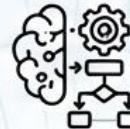
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Conclusion



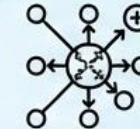
Modular Design

Each urban component is an independent agent communicated via network ports.



Intelligent Control

The system uses dynamic delays and priority logic to optimize traffic flow.



Scalability

New intersections or stations can be added by simply defining new Petri Net objects and network connections.

