Objective:

The primary objective of the traffic light control system is to ensure a safe and efficient flow of traffic at the two-intersection road network, thereby minimizing congestion and reducing the risk of accidents.

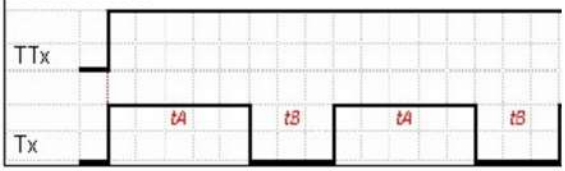
Interface:

The interface consists of:

Timer

T1	Timers	FSM_Clock

Function L: Flasher unit; control held down asynchronously
tA time: 015.0 s
tB time: 010.0 s



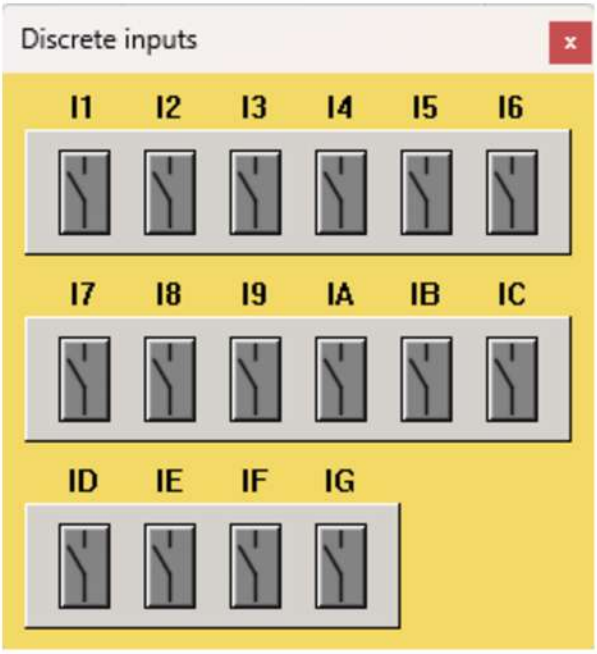
Physical outputs

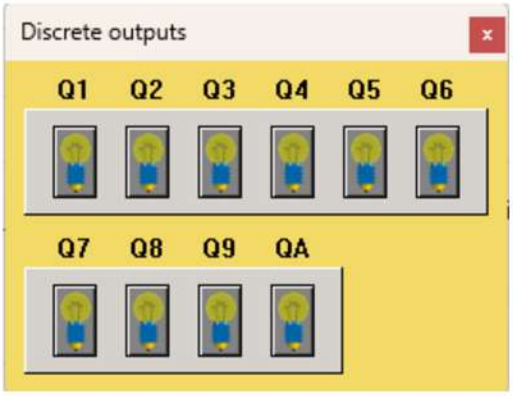
No	Symbol	Function	Latching	Location of (L/C)	Comment
Q1	Q	Discrete outputs	No	(18/6)	A_R
Q2	Q	Discrete outputs	No	(6/6)	B_R
Q3	Q	Discrete outputs	No	(19/6)	C/D_R
Q5	Q	Discrete outputs	No	(9/6)	Arrow_G
Q6	Q	Discrete outputs	No	(7/6)	Arrow_Y
Q7	Q	Discrete outputs	No	(20/6)	A_Y
Q8	Q	Discrete outputs	No	(21/6)	B_Y
Q9	Q	Discrete outputs	No	(16/6)	C/D_Y
QD	Q	Discrete outputs	No	(13/6)	A_G
QE	Q	Discrete outputs	No	(8/6)	B_G
QF	Q	Discrete outputs	No	(15/6)	C/D_G

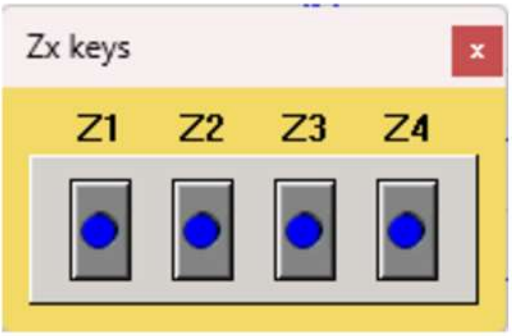
Configurable functions

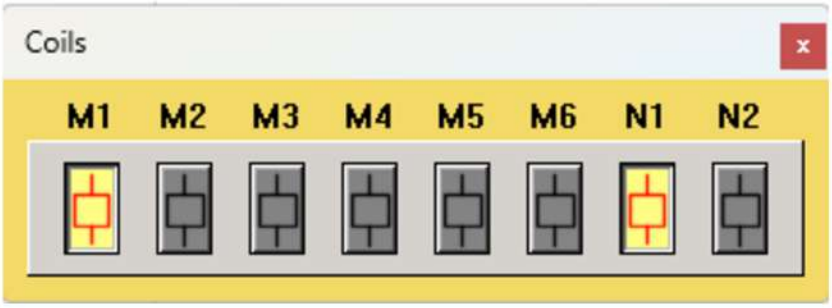
No	Symbol	Function	Lock	Latching	Parameters	Location of (L/C)	Comment
C1	061	Counters	No	No	Value to attain: 0 Pulses Output ON when the preset value is reached	(2/6) (22/6)	Pair_Counter
M1	M	Auxiliary relays	---	No	No parameters	(3/6) (6/1) (9/1) (13/1)	FSM_1
M2	M	Auxiliary relays	---	No	No parameters	(4/1) (7/1) (10/6) (14/1)	FSM_2
M3	M	Auxiliary relays	---	No	No parameters	(4/6) (8/1) (12/1)	FSM_3
M4	M	Auxiliary relays	---	No	No parameters	(11/6) (19/3) (20/1)	FSM_4
M5	M	Auxiliary relays	---	No	No parameters	(5/6) (15/1) (17/1)	FSM_5
M6	M	Auxiliary relays	---	No	No parameters	(12/6) (16/1) (18/1)	FSM_6
N1	M	Auxiliary relays	---	No	No parameters	(14/6) (18/3)	FSM_1/2/3
N2	M	Auxiliary relays	---	No	No parameters	(5/1) (17/6)	FSM_5/6
T1	T	Timers	No	No	See details below	(1/6) (2/1) (3/1) (10/1) (23/6)	FSM_Clock
V1	V	Counter comparators	No	---	C1 + 0 = 1	(3/3) (10/3)	FSM_(1 ? 2)
V3	V	Counter comparators	No	---	C1 + 0 = 2	(4/3) (11/3)	FSM_(3 ? 4)
V5	V	Counter comparators	No	---	C1 + 0 = 3	(5/3) (12/3)	FSM_(5 ? 6)
V7	V	Counter comparators	No	---	C1 + 0 = 4	(22/1)	

In the simulation, every input is depicted as a switch, and each output is symbolized by a light bulb. The push button is characterized as Zx Keys. Similarly, counter values and coil states are illustrated below.









Function blocks

No	Function	Label	Type	Preset	Current	Lock	Comment
001	Timer	T1	L: Asymmetrica	T1A = 015.0 S T1B = 010.0 S	T1A = 015.0 S T1B = 004.2 S	No	FSM_Clock
002	Counters	C1	Output ON wh	C1 = 00000	C1 = 00001	No	Pair_Counter
003	Counter comp	V1	C1 + 0 = 1			No	FSM_(1 ? 2)
004	Counter comp	V3	C1 + 0 = 2			No	FSM_(3 ? 4)
005	Counter comp	V5	C1 + 0 = 3			No	FSM_(5 ? 6)
006	Counter comp	V7	C1 + 0 = 4			No	

Key Map:

The lamps that will be controlled are the following:

Green Arrow: Q5

Yellow Arrow: Q6

Road A Red Light: Q1

Road A Yellow Light: Q7

Road A Green Light: QD

Road B Red Light: Q2

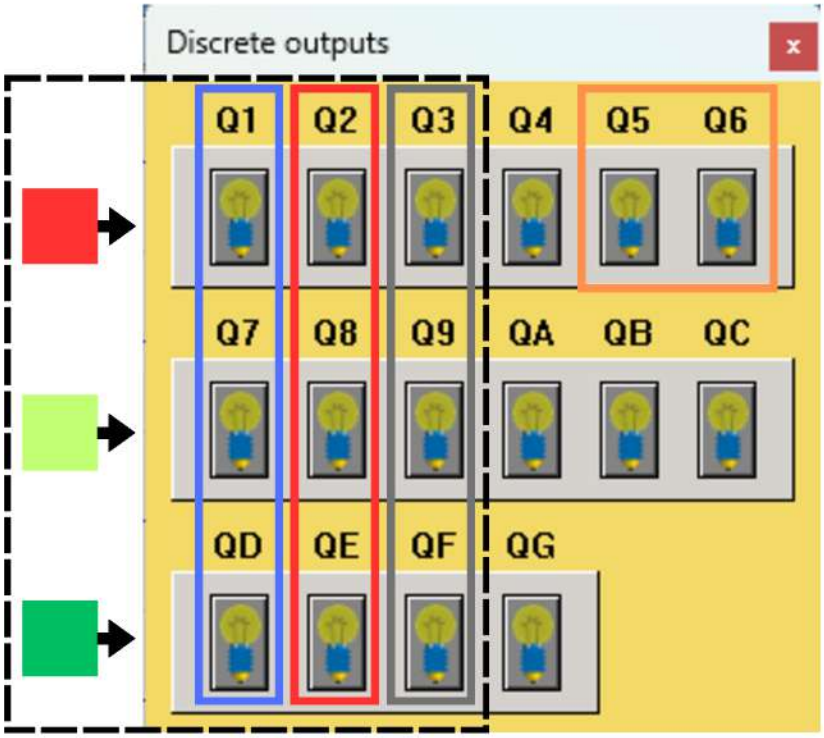
Road B Yellow Light: Q8

Road B Green Light: QE

Road C&D Red Light: Q3

Road C&D Yellow Light: Q9

Road C&D Green Light: QF



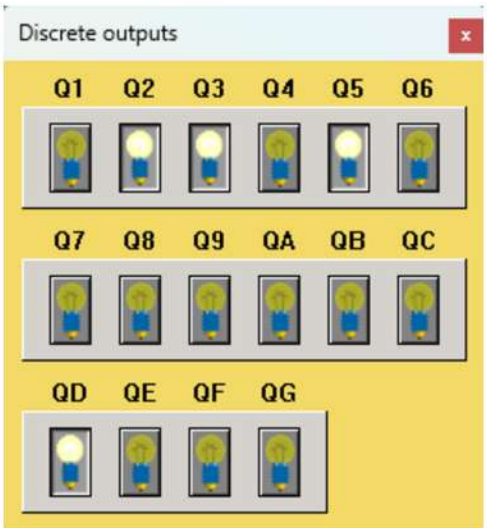
Traffic Light States:

- **State 1:** Green Arrow and Green Light on Road A, with Red Light on Roads B, C, and D

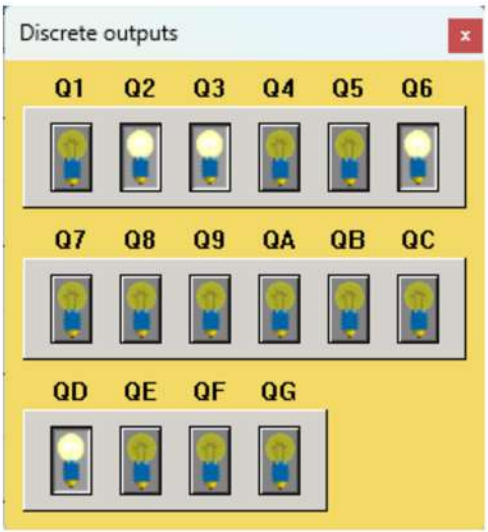
(15 seconds)

- **State 2:** Yellow Arrow and Green Light on Road A, with Red Light on Roads B, C, and D

(10 seconds)



State 1



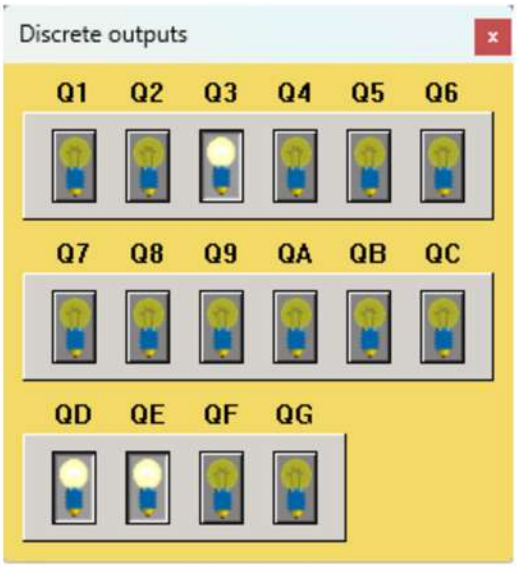
State 2

- **State 3:** Green Lights on Roads A and B, with Red Light on Roads C and D.

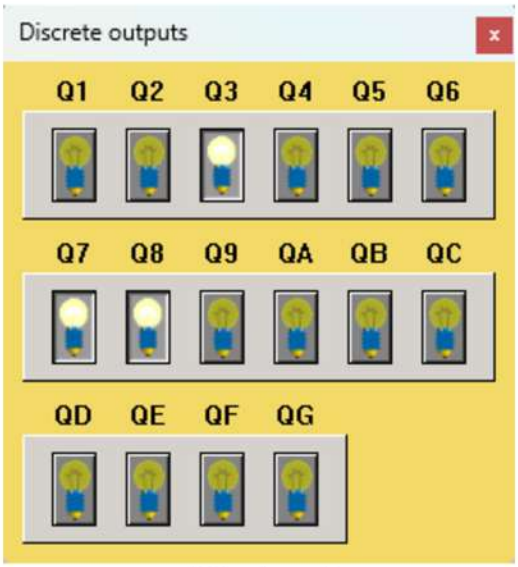
(15 seconds)

- **State 4:** Yellow Lights on Roads A and B, with Red Light on Roads C and D

(10 seconds)



State 3



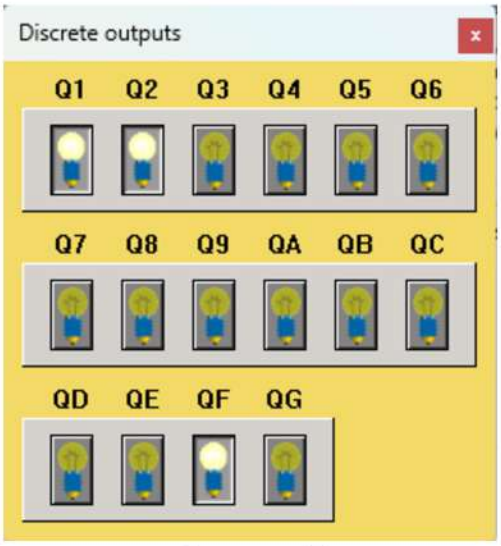
State 4

- **State 5:** Green Lights on Roads C and D, with Red Light on Roads A and B

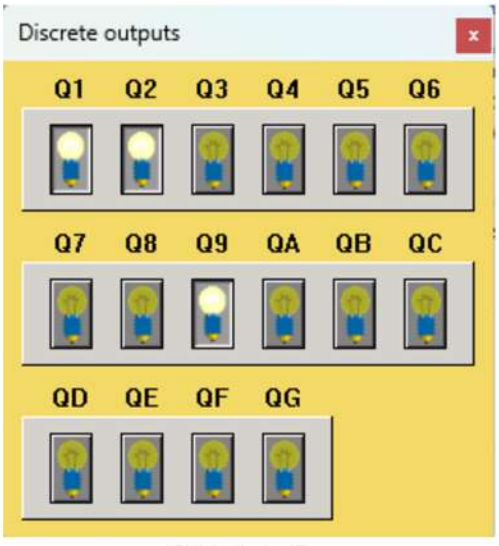
(15 seconds)

- **State 6:** Yellow Lights on Roads C and D, with Red Light on Roads A and B

(10 seconds)



State 5

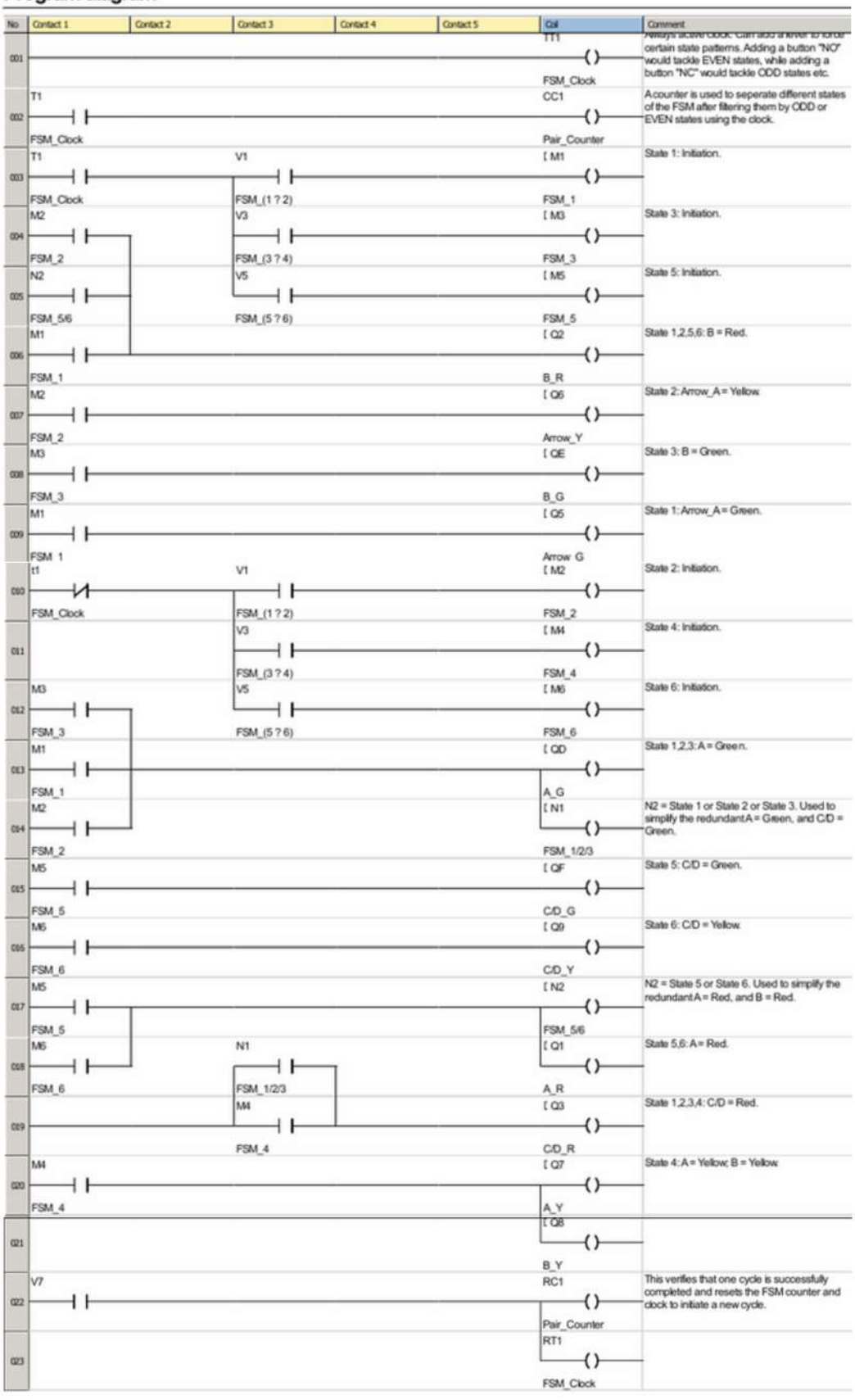


State 6

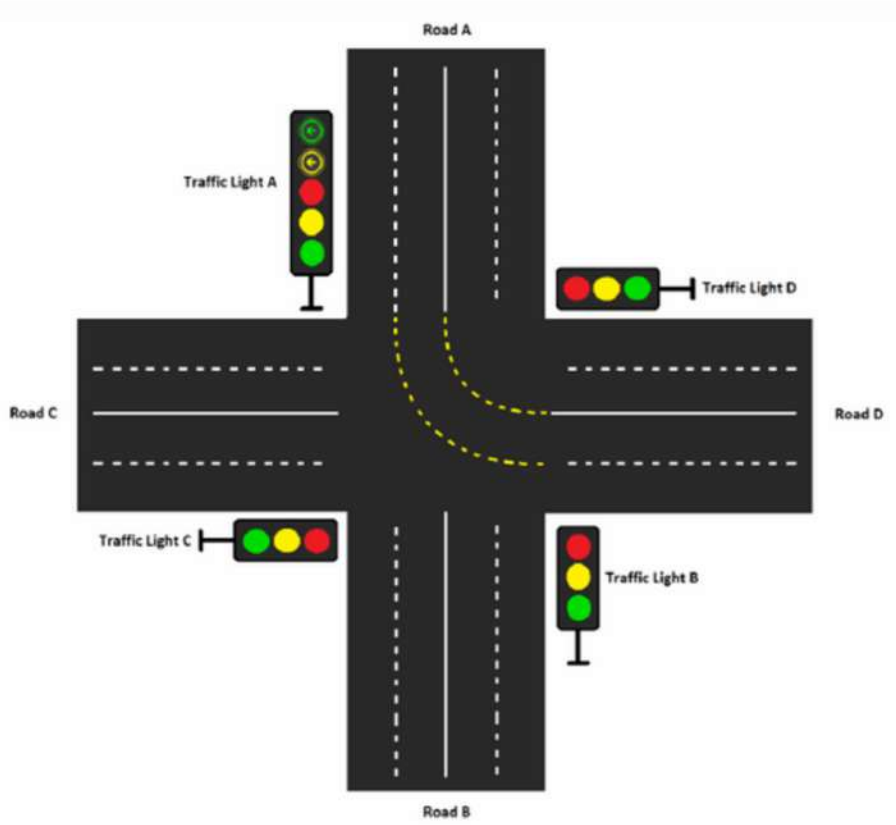
The System:

Below is the system design that fulfills the objective and focuses on all the scenarios listed.

Program diagram



The Design:



Key features include:

- **Controlled Left Turns:** The system controls left turns on Road A, allowing them only during specific states and restricting them during others to reduce the risk of accidents.
- **Yellow Light Warning:** The system provides a yellow light warning before changing the traffic lights to red, allowing drivers to slow down and prepare to stop, and reducing the risk of accidents.
- **Fixed Time Intervals:** The system operates on fixed time intervals, with each state having a designated duration to ensure a predictable and consistent traffic flow, and minimize congestion.

Estimated Price Breakdown:

- 3 Standard Traffic Lights: $3,500 - $4,000
- 1 Traffic Light with Arrow: $1,500 - $1,600
- PLC: $200 - $300
- Mast Arms: $28,000 - $30,000
- Installation: $5,000 - $5,500

- Total: $38,200 - $41,400

Additional Suggestions:

- **Traffic Sensors:** Integrate traffic sensors to monitor traffic volume and adjust the timing of the traffic lights accordingly, optimizing traffic flow and reducing congestion.
- **Emergency Vehicle Preemption:** Implement emergency vehicle preemption to prioritize emergency vehicles and ensure their safe passage through the intersection.
- **Redundancy and Backup Systems:** Incorporate redundancy and backup systems to ensure the system remains operational in the event of a failure or power outage.
- **Traffic Light Synchronization:** Synchronize traffic lights with adjacent intersections to create a smooth and efficient flow of traffic, reducing congestion and minimizing travel times.

Conclusion:

The system is designed to be simple and efficient, with a straightforward sequence of states that minimizes complexity and reduces the risk of errors, making it easier to implement and maintain.