Traffic Management System

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April 2016

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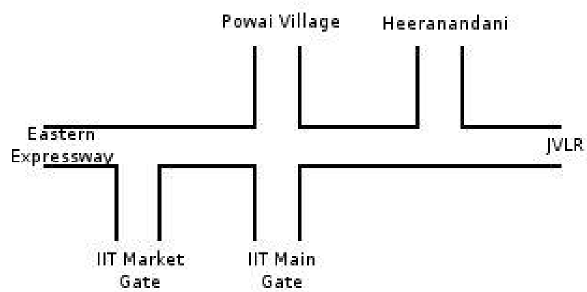
1 Objective

We aim to design a traffic management system for the three traffic lights which impact IITB. We will control the three traffic lights : YP gate, Main Gate and the Pizza Hut junction. Using the average traffic observed on different roads connected to these junctions, we can figure out the optimal timings for the different lights in order to prevent infinite queue at any of the lights.

2 High Level Architecture

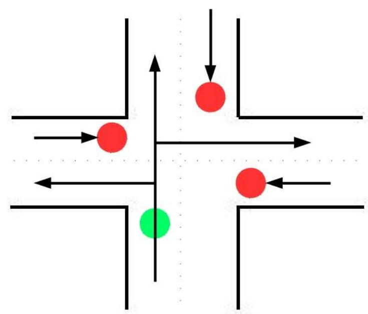
We have three cross roads to manage :



- YP junction - This joins the YP gate road entering IIT to the main JVLR-Eastern Expressway road. So this has essentially three roads meeting each other. Thus there can be a total of 6 types of flows of traffic (from every road to every other road). There will be a total of three traffic lights one for each of the roads.
- Main gate junction - This connects the JVLR-Eastern Expressway road to the road entering IIT main gate and the road going to Powai village. So this has essentially four roads meeting each other. Thus there can be a total of 12 types of flows of traffic (from every road to every other road).There will be a total of four traffic lights one for each of the roads.
- Pizza Hut junction - This joins the road entering Heeranandani to the main JVLR-Eastern Expressway road. So this has essentially three roads meeting each other. Thus there can be a total of 6 types of flows of traffic (from every road to every other road). There will be a total of three traffic lights one for each of the roads.

To manage one crossroad we can adopt several strategies. We must ensure that two traffic flows must not cut each other at the same time. Broadly we can do two kind of things :

1. At one time we allow traffic flows incoming from one particular road and block all the other incoming roads i.e we allow all the three flows of traffic (left, straight, right) from one of the roads and the other roads are allowed only the default left traffic flow (which does not block any other flow). The following diagram illustrates it :

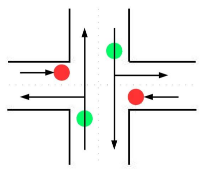


2. The next strategy is to allow multiple flows from different incoming roads in such a way that the heavy flows are given more time as compared to the lighter flows. Although this would be a little more involved than the previous strategy, it can give better results because it can allocate more time to heavy flows. Example : Say there is heavy traffic going from south to north and north to south but very little going into east and west roads. As per the previous strategy here we cannot let both the N-S traffic and the S-N traffic flow at the same time because only one incoming road would be open.

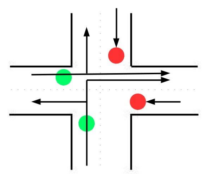
3 Description of functionality of the blocks

We can implement the traffic management system for three way junctions by implementing two modules. One to compute the time for multiplexing and the other to compute the state transitions of that traffic light based on the output(time slots) generated by the previous block.

Consider the 3 way case. The input to the compute-time-block are the backed up traffic at the 3 ways of the junction and the speed of vehicles at the junction. The output of the junction is valid only at the points of time when the second block is in the start/idle state, i.e. one cycle is completed(based on previous computation). The output of this block is the time slots for the various



(a) Straight N-S flow



(b) Right flow from S and straight from E

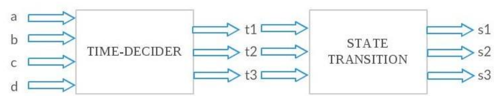
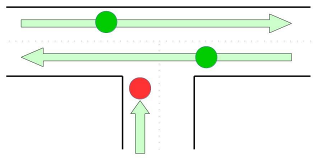


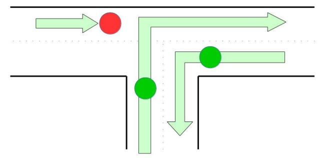
Figure 1: Block Diagram for three way junction

states corresponding to the states of the various traffic lights facing the 3 ways of the junction. The output of this block is fed into state-transition-block.

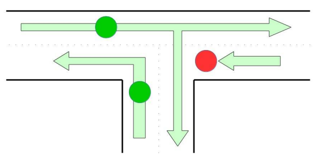
The state-transition-block simulates the states of the traffic lights for the 3 ways on the junction. For the traffic control system we have designed 3 states, such that traffic is allowed to move from any way to any other in atleast one state. The state-transition-block allots time to these states based on the inputs from the compute-time-block. After completion of every cycle the state-transition-block sets the time slots for the 3 states based on the input from the compute-time block. The state-transition-block gives output as the state of the traffic lights represented by 3 bit vectors(representing various states of signals)



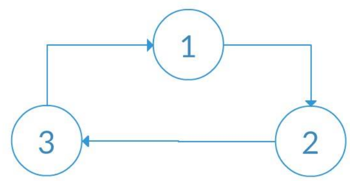
(a) State 1



(b) State 2



(c) State 3



(d) State Transition Diagram for three way

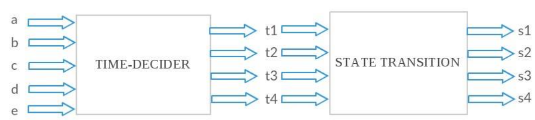
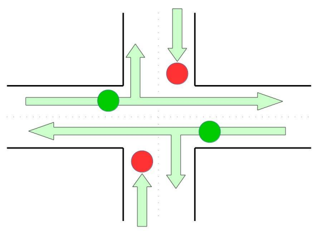


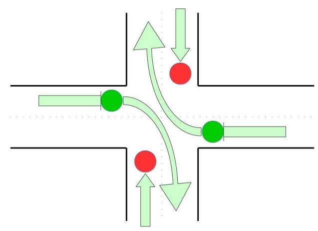
Figure 2: Block Diagram for four way junction

4 Plan for testing and verification

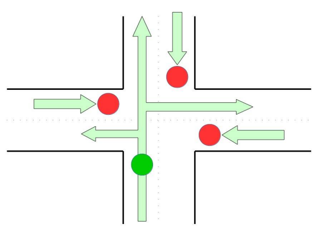
- We will create a test-bench which supplies the above described blocks with the backed up rows for each junction along with the average speed on each junction as input.
- The test bench will compute the backed up rows of traffic as the simulation proceeds based on the output of state of the signals at every junction and after every cycle this information is supplied as input to the above described traffic-light-control blocks.
- For testing we try out different traffic flows and see how the blocks behave and monitor the number of backed up rows on each junction. For example,



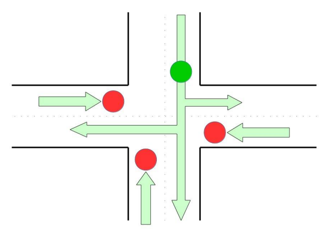
(a) State 1



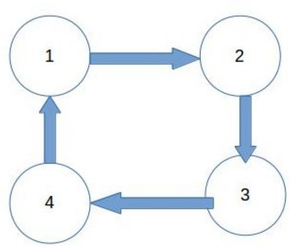
(b) State 2



(c) State 3



(d) State 4



(e) State Transition Diagram for four way we modulate the traffic flow directions and the traffic values(which are not specified) and run the system.

- Corner cases include the traffic flows where some way on the junction is assigned low traffic or very high traffic flow arbitrarily. Since, the traffic flow being high or low has direct impact on the number of backed up rows, they have been accounted for in the model. If number of backed up cars is more on any side that side is given more time to clear the traffic. Similarly, if the number of backed up rows is less and the traffic flow is less as well, then that way on the junction is allotted lesser time.
- We monitor the number of backed up rows as computed by the test bench after every cycle and make sure that it is under some bound. We expect the number of backed up rows to decrease with time implying good traffic management.

5 Assumptions and Constraints

- The net traffic going into the system equals net traffic going out. The test bench suitably assigns traffic flows within the system(based on lanes, etc.) such that the above constraint is met.
- The traffic going into Powai vilage, market gate, main gate and Heeranandani is taken to be negligible in comparison to the Eastern Expressway and JVLR traffic. And hence the calculations are done accordingly.
- For sides on junctions where number of cars coming in is not specified, in the test bench we assume some reasonable values, such that net traffic going in equals net traffic coming out.
- We assume that when traffic light is green all of the lanes are being used to free up the traffic.
- We are considering service lanes to be part of the main road as any other lane.
- For the AP problem, discretization error creeps in. That is we cannot update the values of backed up traffic every second and so we do so every 6 seconds. This results in some rounding errors which might not give us the expected solution everytime.
- We have defined the directions as if the IIT Main Gate is towards the south. Please take testbench readings accordingly.

6 Calculations and Proof

The idea behind the equations is that the outgoing traffic per lane at each of the three roads at the junction should be higher than the incoming traffic per lane over the complete signal cycle. Thus, we are working in the first derivative.

Also, an important assumption all throughout the calculations is that the cars going sideways from the main road is negligible. Hence, we assume that in one clock cycle, some random number of cars (≤ 7) go sideways. Similarly, the same is assumed for the cars coming from the side-roads where the rate of incoming traffic is not given in the problem statement.

For each junction, based on the rate of incoming traffic, we would get a lower bound on v (i.e. outgoing traffic) naming it v_{min}. The calculations are explained below. Thus, we assure that the v $\geq v_{min}$, the system won't have infinite queue at any junction. If v < v_{min}, then things would get tighter. For values of v close to v_{min}, we have made sure it would still work in most cases, but there might be very few cases for which buffer keeps queueing up.

6.1 Non AP Problem

Here, we have made a two-tier system. Depending on the buffer or the number of cars backed, the times decided can change. So, if we have low-load, we would use a lower value of time. On the contrary, if we have a peak load, we use a much higher value of time, so as to clear the backed up traffic.

Let $in1$ and $in2$ be the traffic rates for the west-bound traffic and the east-bound traffic respectively. As per the inputs, $in1 = 100$ and $in2 = 120$. The number of lanes for the west-bound traffic and the east-bound traffic are 5 and 6 respectively.

6.1.1 Market Gate

Let v be the rate at which vehicles cross the signal at green light per minute per lane. Let t_1, t_2 and t_3 be the times given for the three states at the Market Gate junction in minutes. The number of lanes in the Market Gate road is 1.

For the market gate junction, we add 10 vehicles to the east bound traffic to account for cars that may have joined the main road from the main gate junction or the Hiranandani junction.

As per the state diagram, the west-bound traffic has a green signal for state 1 and 3. On the contrary, the east-bound traffic has a green signal for state 1 only. Hence, the below equations -

$$\frac{100}{5} * (t_1 + t_2 + t_3) \leq v(t_1 + t_3)$$

$$\frac{120 + 10}{6} * (t_1 + t_2 + t_3) \leq vt_1$$

The cars going into and coming from IIT at the market gate are negligible so we put $t_2 = 12s$ and $t_3 = 12s$. The value of 12s is assumed by this equation -

$$t_2 v \geq 7$$

We also have a heuristic equation which says that t_1 must be feasible, i.e. it must have a upper bound. It can be specified by this equation -

$$t_1 \leq 1.5$$

Using this we obtain the equations as -

$$t_1 * (v - \frac{130}{6}) \geq \frac{26}{3}$$

From the two above equations, we get $v \geq 28$. Thus, we have obtained a lower bound on v.

For the low load, value of t_1, we assume $v > 30$. So, we get the value of $t_1 = 60$ sec. For a high load value, we double the value t_1 (i.e. 120 sec). High load is defined if the number of cars is greater than 100.

6.1.2 Main Gate

Let v be the rate at which vehicles cross the signal at green light per minute per lane. Let t_1, t_2, t_3 and t_4 be the times given for the four states at the Main Gate junction. The number of lanes in the IIT Main Gate road and the Powai Village are 1 each.

For the main gate junction, we add 5 vehicles to the east bound traffic to account for cars that may have joined the main road from the Hiranandani Junction gate junction. We also add 5 to the west-bound traffic to account for the cars that may have joined the main road from the Market Gate Junction.

As per the state diagram, the west-bound traffic and the east-bound traffic hav a green signal for state 1. It is green for right in state 2, but we neglect it, since very less cars go sideways. So, the equations for the main-road traffic are -

$$\frac{100+5}{5} * (t_1 + t_2 + t_3 + t_4) \leq vt_1$$
$$\frac{120+5}{6} * (t_1 + t_2 + t_3 + t_4) \leq vt_1$$

The cars going into IIT at the main gate are negligible so we put $t_2 = 12s$. Now the similar equation for Powai Village road would be -

$$8(t_1 + t_2 + t_3 + t_4) \leq vt_3$$

And the equation for IIT Main Gate road would be -

$$5(t_1 + t_2 + t_3 + t_4) \leq vt_4$$

We can put the feasibility equation as before and obtain a bound on v in a similar fashion. Here, we obtain a higher value of v_{min} because we need to clear traffic at the Powai Village road and the Main Gate road and allot some time there. During this time, the east-west signals would be red, leading to queuing and hence, we need a higher v to clear the extra backed up traffic.

The values of $t_3 = 24$ sec and that of $t_4 = 15$ sec. For low load, we get a value of v to be around 40. For this, $t_1 = 60$ sec. For a high load, $t_1 = 84$ sec $t_3 = 30$sec and $t_4 = 18$sec.

6.1.3 Hiranandani Junction

Let v be the rate at which vehicles cross the signal at green light per minute per lane. Let t_1, t_2 and t_3 be the times given for the three states at the Pizza Hut junction in minutes. The number of lanes in the road coming out of HN is 3.

For the pizza hut junction, we add 10 vehicles to the east bound traffic to account for cars that may have joined the main road from the main gate junction or the Market Gate junction.

As per the state diagram, the east-bound traffic has a green signal for state 1 and 3. On the contrary, the west-bound traffic has a green signal for state 1 only. Hence, the below equations -

$$\frac{100+10}{5} * (t_1 + t_2 + t_3) \leq v(t_1 + t_3)$$
$$\frac{120}{6} * (t_1 + t_2 + t_3) \leq v * t_1$$

The cars going into Hiranandani at the pizza hut junction are negligible so we put $t_3 = 12s$.

The equation for the cars coming out of Hiranandani is as follows -

$$\frac{15}{3} * (t_1 + t_2 + t_3) \leq v(t_2)$$

We can put the feasibility equation as before and obtain a bound on v in a similar fashion. The lower bound on v is similar to that of Market Gate Junction.

The value $t_2 = 12$ sec. For the low load, value of t_1, we assume $v > 30$. So, we get the value of $t_1 = 60$ sec. For a high load value, we double the value t_1 (i.e. 120 sec). High load is defined if the number of cars is greater than 100.

6.2 AP Problem

Unlike the last time where we employed a two-tier system, we have kept a dynamic system where the values of times of the states will change according to the input. The inputs are checked before the signal cycle starts and the value remains constant for the next entire cycle. So this an important assumption that the inputs remain constant for sufficient time (2-3 minutes) before changing.

Also, we would expect the traffic to gradually change (as in real life situations) and not have sudden peaks.

Let $in1$ and $in2$ be the traffic rates for the west-bound traffic and the east-bound traffic respectively. Defining a new variable α. Basically, α is used to measure quantitatively whether east-bound traffic or the west-bound traffic is heavy. Accordingly, the equation corresponding to that would govern the value of t_1. The idea is to replace occurrences of $in1$ and $in2$ throughout the equations by α. Thus, we are over-estimating to get a looser equations.

Also, highlighting an important assumption across all the calculations in this section. Since we have a dynamic system, for some values of v, $in1$ and $in2$, the values of t_1 might become very high and this may not be feasible. So, we have restricted the maximum value of t_1 to be 90 sec. Similarly, we have put a lower bound on t_1 as well and t_1 won't be lesser than 20 sec.

6.2.1 Market Gate

Let v be the rate at which vehicles cross the signal at green light per minute. Let t_1, t_2 and t_3 be the times given for the three states at the Market Gate junction.The number of lanes for the west-bound traffic and the east-bound traffic are 5 and 6 respectively.

For the market gate junction, we add 10 vehicles to the east bound traffic to account for cars that may have joined the main road from the main gate junction or the Hiranandani junction. Also, α is computed here as follows -

$$\alpha = max(\frac{in2}{5}, \frac{in1 + 10}{6})$$

As per the state diagram, the west-bound traffic has a green signal for state 1 and 3. On the contrary, the east-bound traffic has a green signal for state 1 only. The equations are -

$$\alpha(t_1 + t_2 + t_3) \leq v(t_1 + t_3)$$
$$\alpha(t_1 + t_2 + t_3) \leq vt_1$$

From the two above equations, the stronger one is the second one. (i.e. if the second equation is true, the first one is automatically true) So, we are solving the problem using the second equation and not the first equation.

The cars going into and coming from IIT at the market gate are negligible. So, for them as we had assumed that a maximum of 7 cars can pass through a complete signal cycle, we obtain the following equations -

$$vt_3 \geq 7 \qquad vt_2 \geq 7$$

Using Guassian Elimination, we can obtain a single equation in terms of t_1, v and α. The equations obtained after solving are as follows -

$$t_3 \geq \frac{7}{v} \qquad t_2 \geq \frac{7}{v}$$

$$t_1 \geq \frac{14 * \alpha}{v * (v - \alpha)}$$

We impose a feasibility condition on t_1 as follows -

$$t_1 \leq 1.5$$

By solving the above equations, we again would get a lower bound on the value of v. Similarly as before, for values of v $< v_{min}$, we try our best to keep the system working, but a few cases may lead to unbounded increase in the buffer. To deal with such cases, we have introduced the boundedness in the value of t_1 as explained earlier (20-90 sec).

6.2.2 Main Gate

Let v be the rate at which vehicles cross the signal at green light per minute per lane. Let t_1, t_2, t_3 and t_4 be the times given for the four states at the Main Gate junction. The number of lanes in the IIT Main Gate road and the Powai Village are 1 each.

For the main gate junction, we add 5 vehicles to the east bound traffic to account for cars that may have joined the main road from the Hiranandani Junction gate junction. We also add 5 to the west-bound traffic to account for the cars that may have joined the main road from the Market Gate Junction.

Here α is defined as follows -

$$\alpha = max(\frac{in1 + 5}{6}, \frac{in2 + 5}{5})$$

As per the state diagram, the west-bound traffic and the east-bound traffic hav a green signal for state 1. It is green for right in state 2, but we neglect it, since very less cars go sideways. So, the equations for the main-road traffic are -

$$\alpha(t_1 + t_2 + t_3 + t_4) \leq vt_1$$
$$\alpha(t_1 + t_2 + t_3 + t_4) \leq vt_1$$

Since both the equations are the same, we can take either of them.

The cars going into IIT at the main gate are negligible. So, as we had assumed that a maximum of 7 cars can pass through a complete signal cycle, we obtain the following equation -

$$7 \leq v * t_3$$

Now the similar equation for Powai Village road would be -

$$8(t_1 + t_2 + t_3 + t_4) \leq vt_3$$

And the equation for IIT Main Gate road would be -

$$5(t_1 + t_2 + t_3 + t_4) \leq vt_4$$

Using Guassian Elimination, we can obtain a single equation in terms of t_1, v and α. The equations obtained after solving are as follows -

$$t_2 \geq \frac{7}{v}$$

$$t_4 \geq \frac{(t_1 + \frac{7}{v} + t_3) * 5}{v - 5}$$

$$t_3 \geq \frac{(t_1 + \frac{7}{v} + \frac{5*t_1}{v-5} + \frac{35}{v*(v-5)}) * 8}{v - 8 - \frac{40}{v-5}}$$

$$t_1 \geq \frac{(t_2 + (t_2 + \frac{35}{v*(v-5)}) * (\frac{8}{v-8-\frac{40}{v-5}}))}{\frac{v-5}{\alpha} - 1 - (\frac{8}{v-8-\frac{40}{v-5}}) * (1 + \frac{5}{v-5})}$$

We can put the feasibility equation as before. By solving the above equations, we again would get a lower bound on the value of v. Similarly as before, for values of v < v_{min}, we try our best to keep the system working, but a few cases may lead to unbounded increase in the buffer. To deal with such cases, we have introduced the boundedness in the value of t_1 as explained earlier (20-90 sec).

Here, we obtain a higher value of v_{min} because we need to clear traffic at the Powai Village road and the Main Gate road and allot some time there. During this time, the east-west signals would be red, leading to queuing and hence, we need a higher v to clear the extra backed up traffic.

6.2.3 Hiranandani Junction

Let v be the rate at which vehicles cross the signal at green light per minute per lane. Let t_1, t_2 and t_3 be the times given for the three states at the Pizza Hut junction in minutes. The number of lanes in the road coming out of HN is 3.

For the pizza hut junction, we add 10 vehicles to the east bound traffic to account for cars that may have joined the main road from the main gate junction or the Market Gate junction.

In this case, α is calculated as follows -

$$\alpha = max(\frac{in2 + 10}{5}, \frac{in1}{6})$$

As per the state diagram, the east-bound traffic has a green signal for state 1 and 3. On the contrary, the west-bound traffic has a green signal for state 1 only. Hence, the below equations -

$$\alpha(t_1 + t_2 + t_3) \leq v(t_1 + t_3)$$
$$\alpha(t_1 + t_2 + t_3) \leq v * t_1$$

From the two above equations, the stronger one is the second one. (i.e. if the second equation is true, the first one is automatically true) So, we are solving the problem using the second equation and not the first equation.

The cars going into Hiranandani at the pizza hut junction are negligible. So, as we had assumed that a maximum of 7 cars can pass through a complete signal cycle, we obtain the following equation -

$$vt_3 \geq 7$$

The equation for the cars coming out of Hiranandani is as follows -

$$\frac{15}{3} * (t_1 + t_2 + t_3) \leq v(t_2)$$

Using Guassian Elimination, we can obtain a single equation in terms of t_1, v and α. The equations obtained after solving are as follows -

$$t_3 \geq \frac{7}{v}$$

$$t_2 \geq \frac{5 * (t_1 + t_3)}{(v - 5)}$$

$$t_1 \geq \frac{\alpha * t_3 * v}{(v - 5) * (v - \alpha)}$$

We can put the feasibility equation as before. By solving the above equations, we again would get a lower bound on the value of v. Similarly as before, for values of v $< v_{min}$, we try our best to keep the system working, but a few cases may lead to unbounded increase in the buffer. To deal with such cases, we have introduced the boundedness in the value of t_1 as explained earlier (20-90 sec).

7 Values to be found

7.1 Max Waiting Time

Max Waiting time at MarketGate junction: With the assumption that the car gets cleared in one complete cycle of signal state transitions. Then the max waiting time for our system can be

$$(120 + 12 + 12) = 144sec$$

Max Waiting time at MainGate junction: With the assumption that the car gets cleared in one complete cycle of signal state transitions. Then the max waiting time for our system can be

$$(84 + 12 + 30 + 18) = 144sec$$

Max Waiting time at Hiranandani junction: With the assumption that the car gets cleared in one complete cycle of signal state transitions. Then the max waiting time for our system can be

$$(120 + 12 + 12) = 144sec$$

7.2 Mean time through the three lights

We shall calculate mean waiting time through the three lights under the condition that the system is in equilibrium and at each junction the buffer gets cleared up in 1 signal cycle.

Suppose you are coming from the eastern expressway. You can go if the signal is green, i.e. in states 1 and 3. Else, you need to halt and wait.

Either ways, you'll have to wait for the buffer before you to clear up before you can cross the junction. Say you arrive at a time x seconds after the red light begins. The buffer before you would have grown to (per lane) αx. Also say the red light will be on for a total of R seconds. Now you will have to wait for $R-x$ seconds for the traffic before you to start moving. Once the light turns green, it will take $\frac{\alpha x}{v}$ seconds for the buffer before you to clear up. Thus it will take a total of :

$$W_t = R - x + \frac{\alpha x}{v}$$

If your vehicle arrives at the green light directly, still you will have to wait for the buffer before you to clear up. Say you arrive x seconds after the previous green light has ended (i.e. $x - R$ seconds after the new green light starts), the buffer accumulated would be αx out of which $v * (x - R)$ would have cleared out while the light was green. So the total waiting time would be :

$$W_t = \frac{\alpha x - v(x - R)}{v} = R - x + \frac{\alpha x}{v}$$

Now to find mean waiting time we integrate x over 0 to $R + G$ where G is the time for which the light is green. The mean waiting time is :

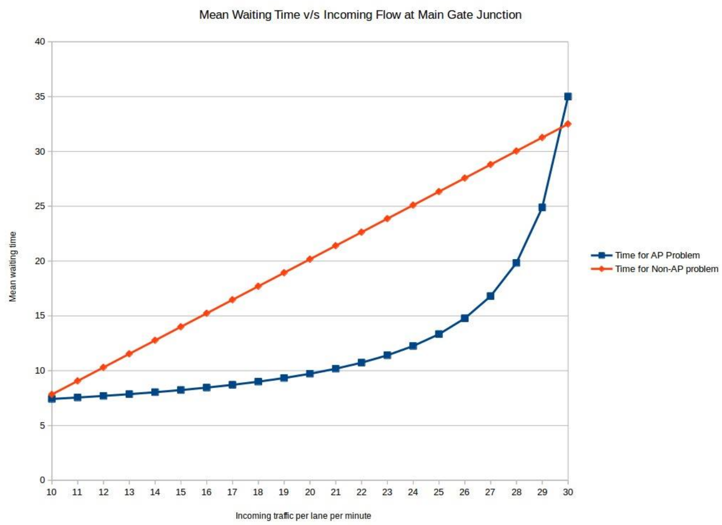
$$MW_t = \int_0^{R+G} R - x + \frac{\alpha x}{v} dx = \frac{R(1 + \frac{\alpha}{v}) + G(\frac{\alpha}{v} - 1)}{2}$$

For $v = 45$ we get the following plot of mean waiting times for the main gate for different values of α. Note that to calculate times for non-AP problem we have fixed $R = 51$ and $G = 60$ whereas for the AP problem we have adapted R and G as per α and v with regard to the formula described earlier.

Assuming a average speed of 40 km/hr and 800m as the distance between the Market Gate and Main Gate and between Main Gate and Pizza Hut junction, we get the total inter-junction time as 144 seconds. The mean waiting time at main gate (assuming an average value of v to be 40 and $\alpha = 20$) would be 15 seconds. The total of the mean waiting times at Hiranandani and Market gate (assuming same values) would be 35 seconds (22.5 for one junction and 12.5 for another depending upon which direction you are travelling). Therefore the total mean time to cross three junctions would be $35 + 15 + 144 = 194$ seconds.

7.3 Peak Load

We assume a reasonable value of v would not be greater than 45. Along with this we must also ensure that the signal cycle must not be larger than 3-4



minutes otherwise the max waiting time will become exceedingly large. By these assumptions, we calculate the maximum value of α using the inequation for t_1 in terms of α and v.

$$t_1 \geq \frac{(t_2 + (t_2 + \frac{35}{v*(v-5)}) * (\frac{8}{v-8-\frac{40}{v-5}}))}{\frac{v-5}{\alpha} - 1 - (\frac{8}{v-8-\frac{40}{v-5}}) * (1 + \frac{5}{v-5})}$$

On putting the value of $t_1 = 2$ and $v = 45$, we get $\alpha = 22$. Therefore, theoretically we cannot handle more than 110 cars on the road going from Eastern-freeway to JVLR (5 lanes) or 132 cars on the road going from JVLR to Eastern freeway (6 lanes). The actual load is expected to be lesser than this as actual v might be lower and we would expect a lower waiting time. So, practically the load handled by the system would be lesser than this.

AP: For handling higher peak load, we must allow higher waiting times in order to avoid an infinite queue. To handle such a condition, we can:

- Allow fewer cars to join the subsidiary roads from the main road. In this way, we can reduce the times for cars to move into these roads and increase the time of green light in the main road. As per our current constraint, no more than 7 cars move into the subsidiary roads per signal cycle. If we further restrict this number to say, 3 cars per signal cycle - we get at the market gate $t_2 \geq \frac{3}{v}$. For $v = 45$, we can cap t_2 at 5 seconds. Similarly, we can also cap t_3 at 5 seconds. This would allow lesser traffic on the main road to to get backed up and so it can remain green maximum amount of time. The same will hold for the other two junction.

- Allow waiting time to increase further. If we allow for higher mean and max waiting times, we can increase the time for which the main roads get green light. This will lead to larger queues on the subsidiary roads and larger waiting times for both the main road as well as the subsidiary roads.

8 How the work was shared

Although all of the team members will contribute in every aspect of the project and all of us will take responsibility for all parts of the project, we expect questions and specific queries in these parts of the problem to be handled by these people:

- High Level Architecture - Sanat, Tanmay
- Mathematical Calculations - Sanat, Tanmay
- VHDL coding - Tanmay, Sohum, Navneet
- Test bench - Sohum, Navneet
- Presentation and report making - Sanat, Navneet

9 Pedestrian Movement

We have accounted for pedestrian movement as follows for the Main Gate Junction and Market gate junction. Hiranandani Junction will be crossed in a way similar to the market gate:

Figure 3: If the pedestrian on the left of market gate junction wants to cross the main road

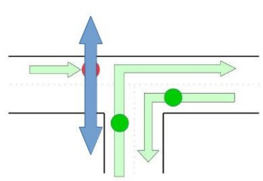


Figure 4: If the pedestrian wants to go across the side road

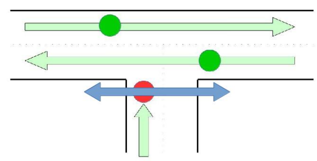


Figure 5: If the pedestrian on the right of market junction wants to cross the main road

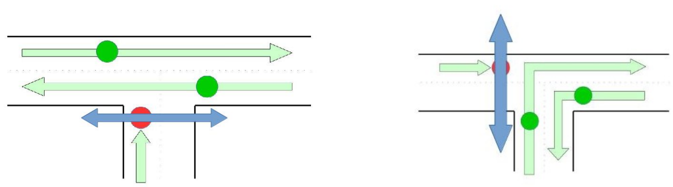


Figure 6: Main Gate If the pedestrian wants to go from top left to top right then

Figure 7: Main Gate If the pedestrian wants to go from bottom left to bottom right then

Figure 8: Main Gate If the pedestrian wants to go from bottom left to top left then