TRAFFIC SIGNAL CO-ORDINATION AS AN ITS MEASURE FOR URBAN ARTERIALS IN CHENNAI CITY

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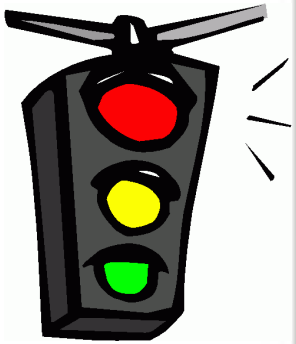
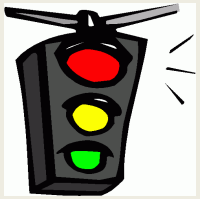
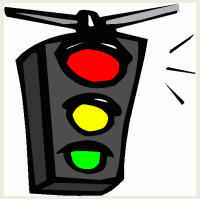




Introduction

- Traffic is increasing at a rapid pace on the roads proportional to the increase in population.
- The traffic problem is faced by all big cities in all the countries.
- As the traffic increases it causes traffic congestion.
- Different approaches can be used to minimize the traffic problem such as
  - Public transport – Improved
  - Communication mechanisms – expanded
  - Proper handling – Signal time



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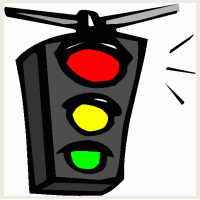
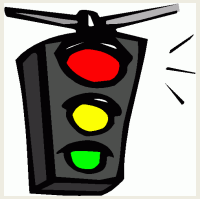
- The first two approaches require many resources as money, labor, area etc.
- They seem very difficult to achieve in many places due to lack of resources.
- Control of traffic light signal timings is one of the least expensive and most effective means of reducing vehicular congestion in metropolitan road networks.
- In urban areas where traffic signals are nearby, the coordination of adjacent signals is important and gives great benefits to road users by increasing the utilization per unit time in the peak hours.



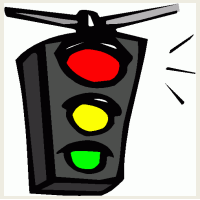
Signal Co-ordination

- Optimized traffic signal timing plans are designed to:
  - Progress traffic
  - Reduce overall vehicle delay
  - Reduce travel time
  - Reduce fuel consumption
  - Reduce vehicle emissions
  - Reduce neighbourhood infiltration
  - Reduce road congestion lowering driver frustration



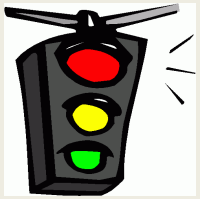
Key Elements of Traffic Signal Co-ordination

- Cycle length
- Split times
- Offset
- Phasing order



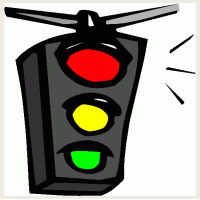
Disadvantages of Fixed Time Traffic Controllers

- The timing plans are based on historical data, which may not be an accurate reflection of typical conditions.
- The timing plans rapidly age and the benefits achieved decrease.
- The system cannot respond to unpredictable events.



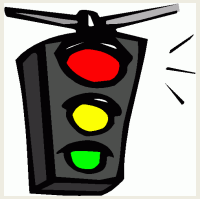
Advantages of signal co-ordination

- Minimizes vehicle delay time for main street vehicles.
- Provides optimum green time for main street vehicles.
- If traffic is light on side street, the green signal may return to main street early.



Review of Literature

- Ranjini et al (2011) - modeled an Adaptive road traffic control system using UML (Unified Modeling Language) - technique for controlling the traffic in highway network using signals - automatically controlled by detectors.
- Kohler and Strehler (2010) - modeled a cyclically time-expanded network and a corresponding mixed integer linear programming formulation - both the coordination of traffic signals and the traffic assignment.
- Howell W (2006) - developed a simulation optimization algorithm for determining the traffic light signal timings for an intersection of two one-way street traffic flows.



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- Jansuwan and Narupiti (2005) - assessed the effectiveness of Split Cycle Offset Optimization Technique (SCOOT) in Bangkok - micro simulation technique.
- Brain Park (2003) - evaluated existing traffic signal optimization programs including Synchro, TRANSYT-7F - genetic algorithm optimization using real world data.
- Lee et al - suggested a methodology in which the primary objective was to delay or eliminate intersection blockage. The framework included the preliminary identification of the cause of the problem and categories of treatments available (Proper signalization, provision of turn-bays, shorter cycle-length to avoid spillback, etc).

Traffic Signal Timing Procedure

DEVELOP A PHASING PLAN

↓

CONVERT VOLUMES TO THROUGH-VEHICLE EQUIVALENT

↓

DETERMINE CRITICAL-LANE VOLUME

↓

DETERMINE YELLOW & ALL RED TIME

↓

DETERMINE CYCLE LENGTH

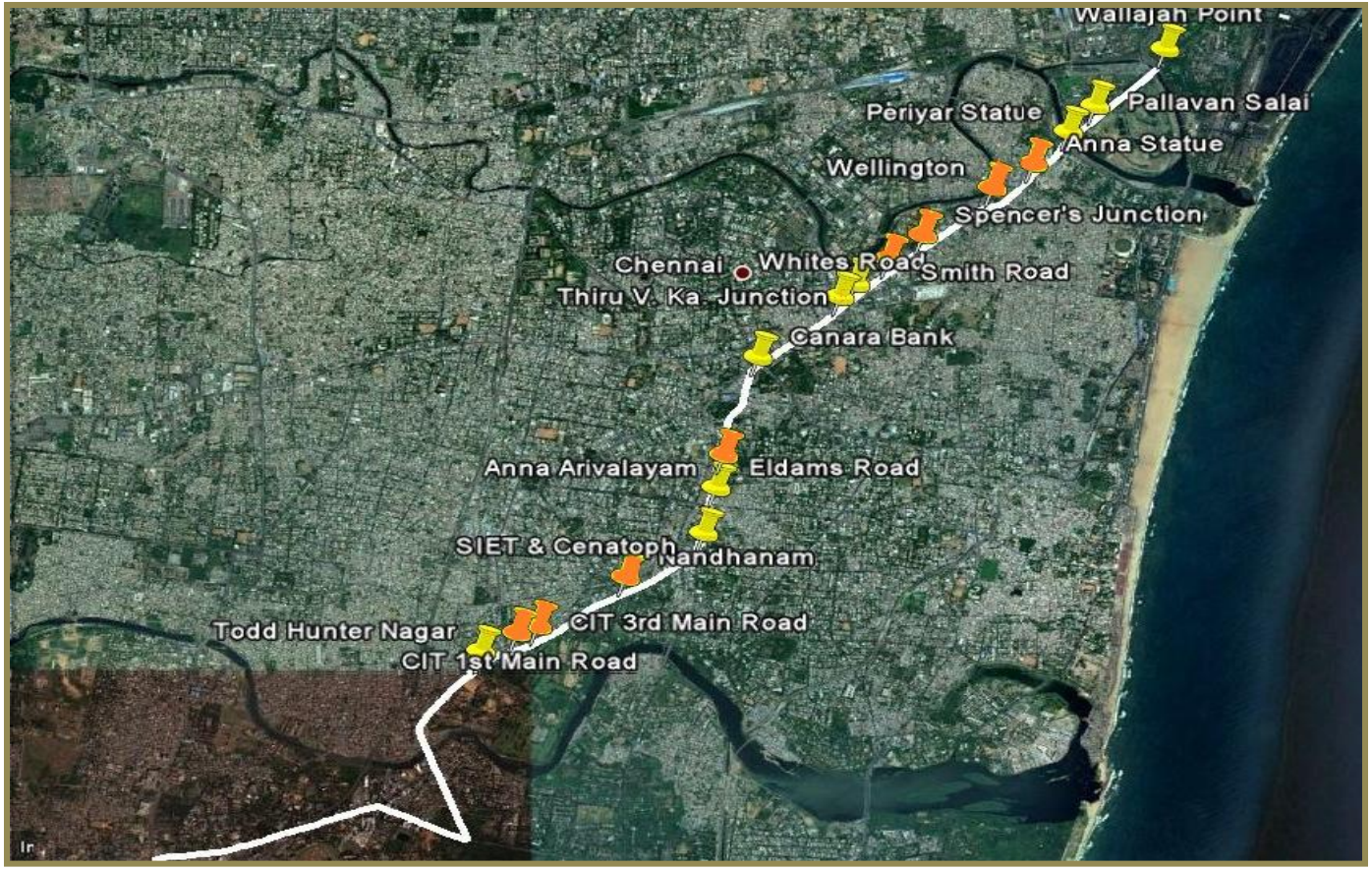
↓

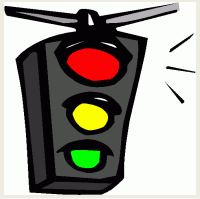
DETERMINE GREEN TIME FOR EACH PHASE

↓

CHECK PEDESTRIAN REQUIREMENTS

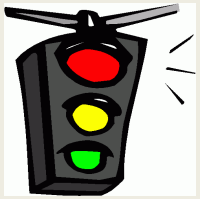
Study Area


Wallajah Point
Pallavan Salai
Periyar Statue
Anna Statue
Wellington
Spencer's Junction
Chennai
Whites Road
Smith Road
Thiru V. Ka. Junction
Canara Bank
Anna Arivalayam
Eldams Road
SIET & Cenatoph
Nandhanam
Todd Hunter Nagar
CIT 3rd Main Road
CIT 1st Main Road

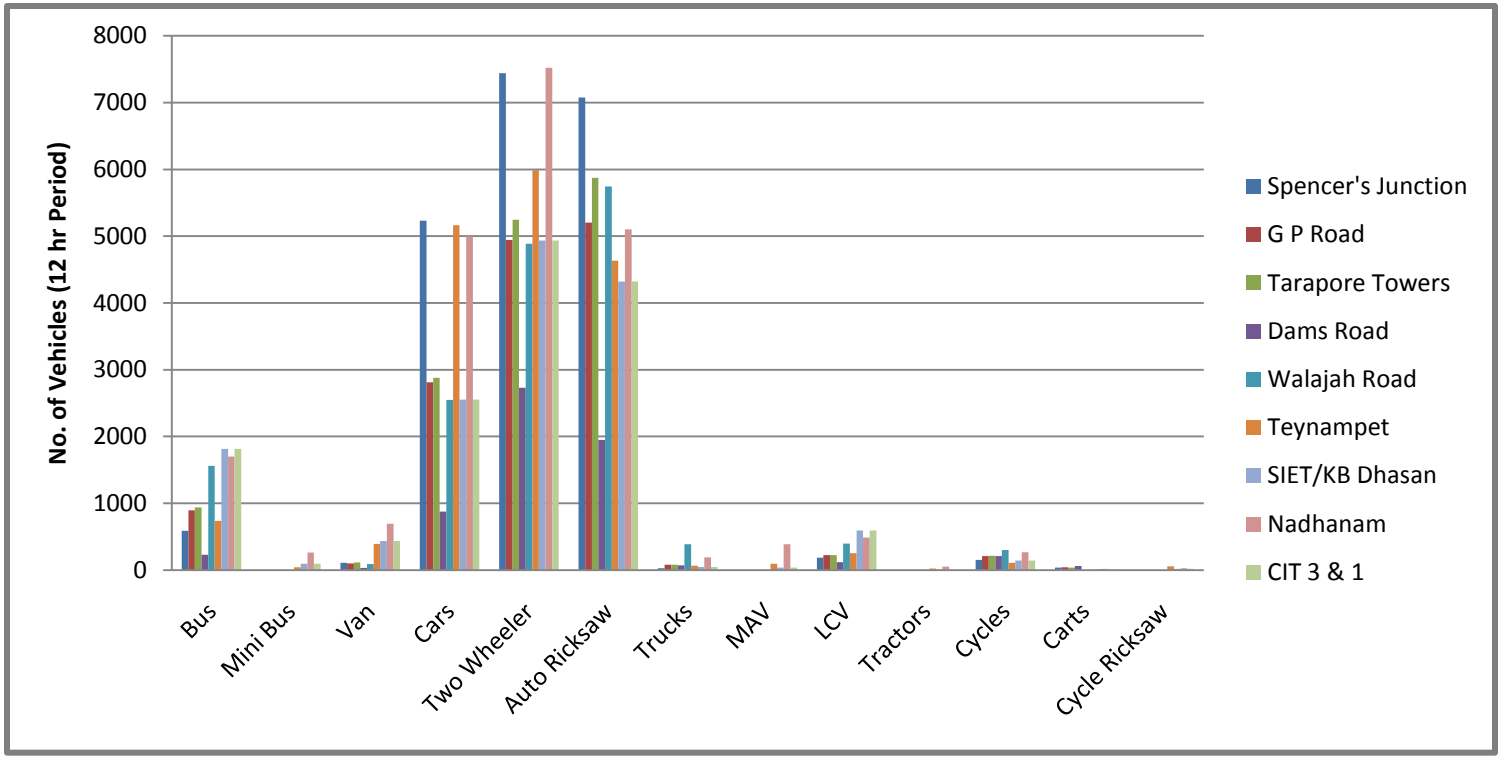


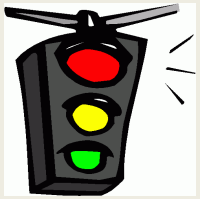
Data Collection

- Cycle lengths and phase timings – CCTP, Chennai
- Classified volume counts – CE(H) Metro, Chennai

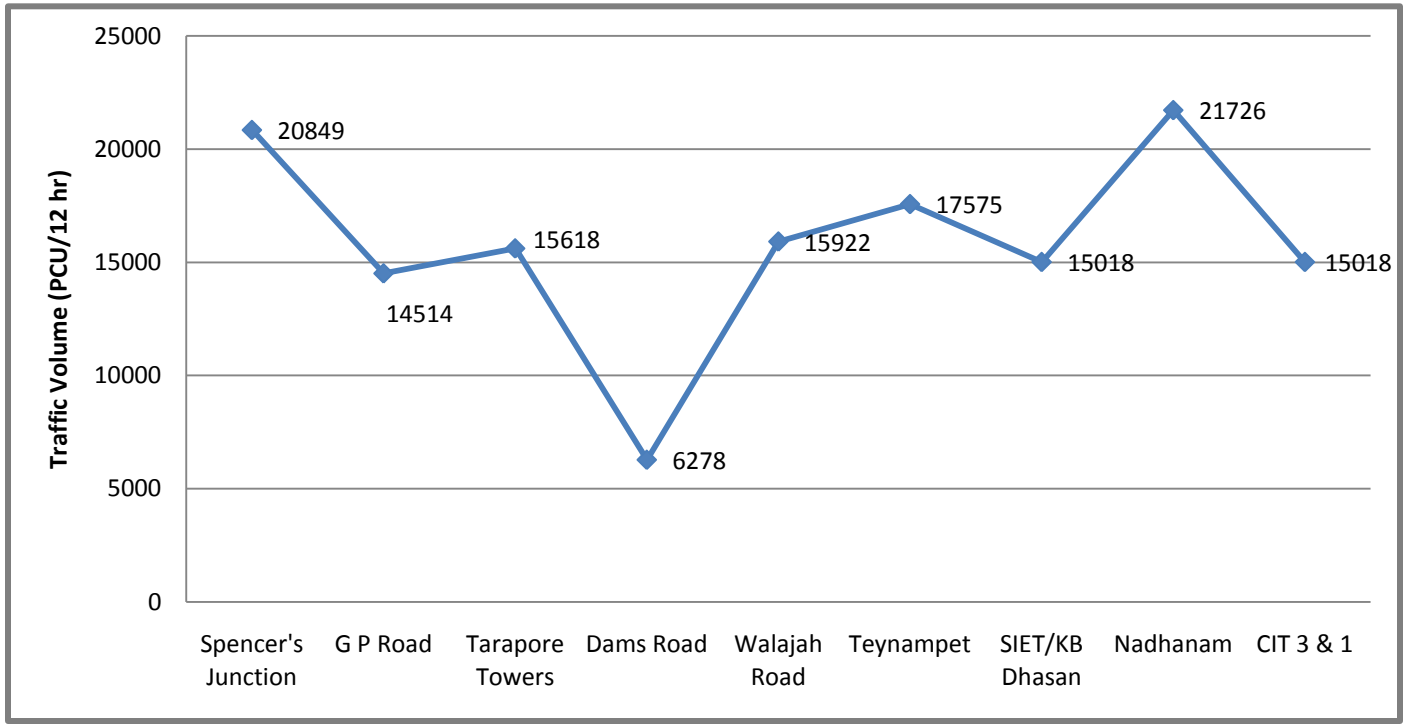


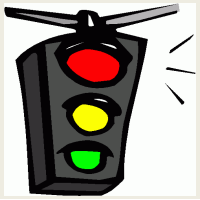
Classified Traffic Volume at the Intersections





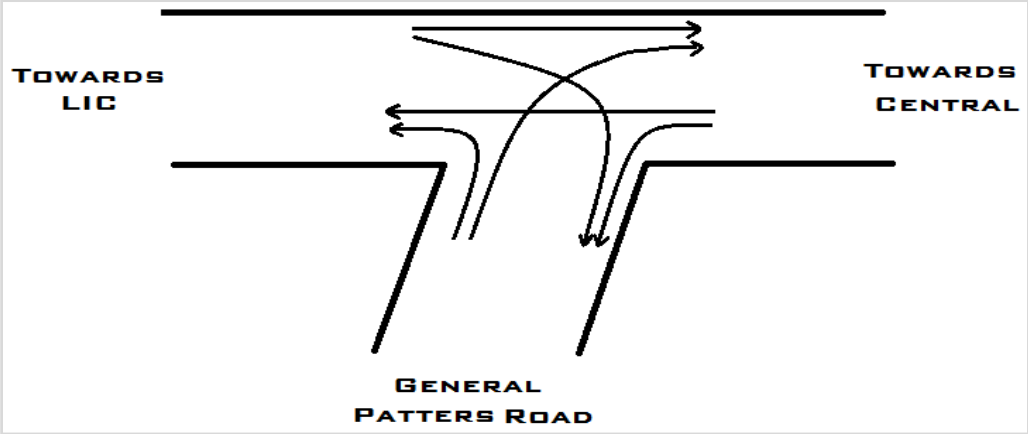
Total Traffic Volume at the Intersections





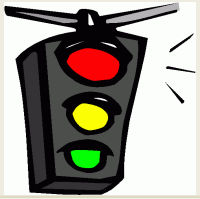
Design of Signal (G.P Road Junction)

- Optimum cycle time
  - 140 seconds
- Effective Green time/cycle
  - 90 seconds

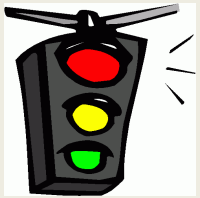


Cycle Length at Intersections along the Arterial

S.No	Junction/Plan	Length (m)	Adopted Cycle Length
1	Wallajah Gate	-	75
2	Pallavan Salai	828	75
3	Periyar Statue	335	90
4	Anna Statue	450	90
5	G P Road	460	90
6	Spencer	765	100
7	Smith Road	390	90
8	Thiruvika	375	120
9	Whites Road	200	160
10	Canara Bank	930	90
11	Anna Arivalayam	1010	110
12	Eldams Road	345	100
13	SIET	475	150
14	Nandhanam	800	165
15	CIT 3rd Main Road	900	70
16	CIT 1st Main Road	200	145
17	Todd Hunter Nagar	320	110



Intersections (Spencer's)



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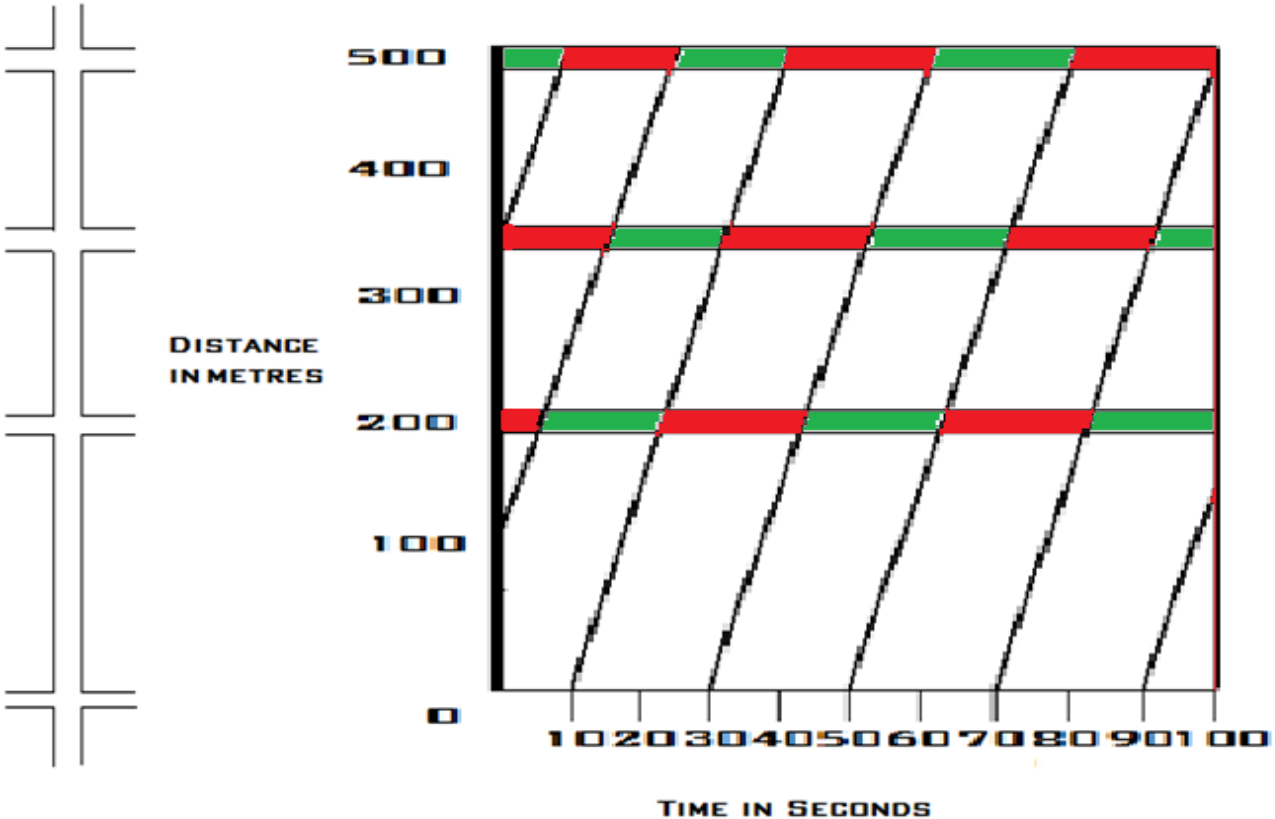
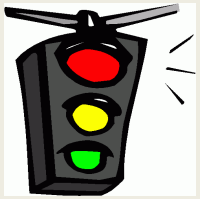
EXIDE
MRF TYRES
வைட்ஸ் சாலை
Whites Road


CHURCH OF SOUTH INDIA
SOWBAKIYA FASTFOOD & RESTAURANT

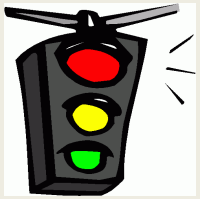
Typical Time and Space Diagram for Linked Signals





Signal Co-ordination Software

- **CORridor SIMulation (CORSIM)**
  - a widely used simulation software in the United States.
  - It consists of simulation software for arterial networks (NETSIM) and freeways (FREESIM).
- **TRANSYT (Traffic Network Study Tool)**
  - a macroscopic, deterministic model.
  - uses a hill-climbing optimization model for obtaining the near-optimal signal timing plan.
  - explicitly optimizes phase lengths and offsets for a given cycle length.



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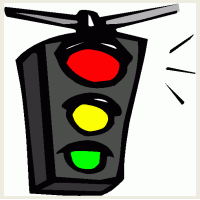
- **PASSER**
  - is a macroscopic simulation model designed to optimize signal timing.
  - can optimize signal timings for arterials, diamond interchanges and networks (including arterials)
  - parameters to provide good progression on arterial streets

- All three software are macroscopic and are incapable of optimizing signal timing in oversaturated conditions.



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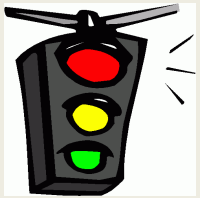
- **SYNCHRO**
  - a signal optimization program that was developed with objective of analyzing and simulating a network of signalized intersections.
  - It generates a detailed summary report on capacity, level of service, lanes, volumes, timing, queue lengths, blocking problems, delay, stops and fuel consumption.



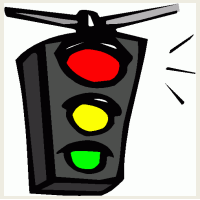
Delay at Signalized Intersection

Webster's Formula

$$d = \frac{c\,(1-\lambda)^2}{2\,(1-\lambda x)} + \frac{x^2}{2q\,(1-x)} - 0.65\left(\frac{c}{q^2}\right)^{1/3} x^{(2+5\lambda)}$$

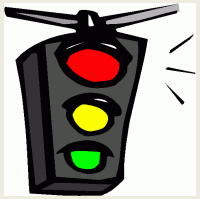
Where,

d	-	Average delay / vehicle on particular arm
λ	-	Proportion of cycle length which is effectively given for the phase under consideration
x	-	Degree of saturation
c	-	Cycle length
g	-	Effective green time
q	-	Flow
s	-	Saturation flow



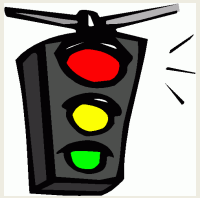
Findings

- The offsets of 9 of 17 signals on Anna Salai are optimized in this study.
- The cycles times were calculated with the help of signal design and the delays were estimated using Webster's formula.
- The total delays in the stretch were found by approximating half the value of cycle time in the 9 junctions.
- 538 seconds (nearly 9 minutes) of delay can be reduced in the stretch of Anna Salai during peak hours if the signals are synchronized.
- Travel time saving has to be multiplied by Traffic Volume, Peak Hour Factor, Number of days and value of Travel cost to arrive the overall savings.



Conclusions

- Signal co-ordination significantly improves the performance of network operations.
- Using traffic counts, the cycle times of the signals were calculated and offset optimization has been done.
- It is found that nearly 20 minutes of delay can be reduced in the total Study Stretch during peak hours.
- The road user cost (travel time, fuel consumption, etc) is reduced by Signal Synchronization.



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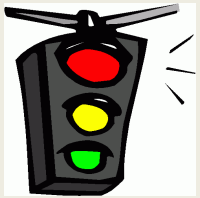

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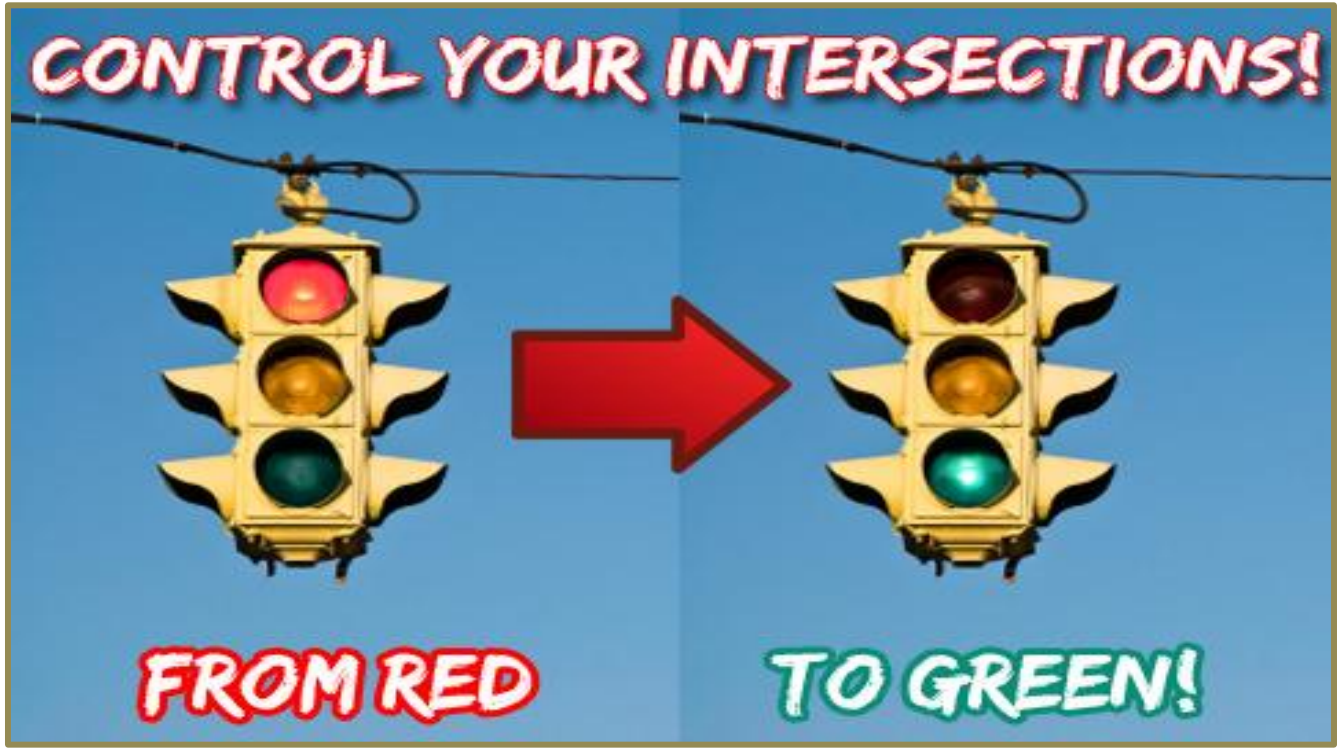

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