1. **INTRODUCTION**
   1. **OBJECTIVES OF PROJECT**

The primary objective of the project is to develop a model that can help to manage the traffic and in short make life much more easier. Traffic congestion is one of the major problem of every metro city in the world. And it reaches it's peak during the offices hours in the morning and in the evening when they get back. Its real annoyance and can only can understood by someone faces it on daily basis. So a solution to the problem like this is a must and this is what exactly we are doing through this project.

A lot of thinking goes into how to reduce the traffic even its by a minute factor. There are infact some solutions that people have thought of are and in place in various parts of the world (discussed in future sections). But not to forget that those are highly area specific solutions and can never be implemented in a country like India. With its vast population and traffic arrangements it needs it own traffic management system that takes into account all these factors.

And the solution we are proposing clearly does that. Moreover, as we unfold our hypothesis in upcoming sections, it will be more clear what else these other implementations lack compared to our model.

* 1. **HISTORICAL BACKGROUND**

Before traffic lights, traffic police controlled the flow of traffic. A well-documented example is that on London Bridge in 1722.Three men were given the task of directing traffic coming in and out of either London or Southwark. Each officer would help direct traffic coming out of Southwark into London and he made sure all traffic stayed on the west end of the bridge. A second officer would direct traffic on the east end of the bridge to control the flow of people leaving London and going into Southwark.

On 9 December 1868, the first non-electric gas-lit traffic lights were installed outside the Houses of Parliament in London to control the traffic in Bridge Street, Great George Street, and Parliament Street. They were proposed by the railway engineer J. P. Knight of Nottingham who had adapted this idea from his design of railway signalling systems and constructed by the railway signal engineers of Saxby & Farmer. The main reason for the traffic light was that there was an overflow of horse-drawn traffic over Westminster Bridge which forced thousands of pedestrians to walk next to the Houses of Parliament. The design combined three semaphore arms with red and green gas lamps for night-time use, on a pillar, operated by a police constable. The gas lantern was manually turned by a traffic police officer with a lever at its base so that the appropriate light faced traffic. The signal was 22 feet (6.7 m) high. The light was called the semaphore and had arms that would extend horizontally that commanded drivers to "Stop" and then the arms would lower to a 45 degrees angle to tell drivers to proceed with "Caution". At night a red light would command "Stop" and a green light would mean use "Caution".

Although it was said to be successful at controlling traffic, its operational life was brief. It exploded on 2 January 1869 as a result of a leak in one of the gas lines underneath the pavement and injured the policeman who was operating it.

In the first two decades of the 20th century, semaphore traffic signals like the one in London were in use all over the United Stateswith each state having its own design of the device. One example was from Toledo, Ohio in 1908. The words "Stop" and "Go" were in white on a green background and the lights had red and green lenses illuminated by kerosene lamps for night travelers and the arms were 8 feet (2.4 m) above ground. It was controlled by a traffic officer who would blow a whistle before changing the commands on this signal to help alert travelers of the change. The design was also used in Philadelphia and Detroit. The example in Ohio was the first time America tried to use a more visible form of traffic control that evolved the use of semaphore. The device that was used in Ohio was designed based on the use of railroad signals.

In 1912, a traffic control device was placed on top a tower in Paris at the Rue Montmartre and Grande Boulevard. This tower signal was manned by a police woman and she operated a revolving four-sided metal box on top of a glass showcase where the word "Stop" was painted in red and the word "Go" painted in white.

An electric traffic light was developed in 1912 by Lester Wire, a policeman in Salt Lake City, Utah, who also used red-green lights. On 5 August 1914, the American Traffic Signal Company installed a traffic signal system on the corner of East 105th Street and Euclid Avenue in Cleveland, Ohio. It had two colours, red and green, and a buzzer, based on the design of James Hoge, to provide a warning for colour changes. The design by James Hoge allowed police and fire stations to control the signals in case of emergency. The first four-way, three-colour traffic light was created by police officer William Potts in Detroit, Michigan in 1920. Ashville, Ohio claims to be the home of the oldest working traffic light in the United States, used at an intersection of public roads from 1932 to 1982 when it was moved to a local museum. Many pictures of historical traffic lights appear at a Traffic Signal Trivia page.

The tower was the first innovation that used the three-coloured traffic signal and appeared first in the City of Detroit, where the first three-coloured traffic light was built at the intersection of Michigan and Woodward Avenues in 1920. The man behind this three-colour traffic light was police officer William Potts of Detroit. He was concerned about how police officers at four different lights signals could not change their lights all at the same time. The answer was a third light that was coloured amber, which was the same colour used on the railroad. Potts also placed a timer with the light to help coordinate a four-way set of lights in the city. The traffic tower soon used twelve floodlights to control traffic and the reason for a tower in the first place was that at the time the intersection was one of the busiest in the world, with over 20,000 vehicles daily.

Los Angeles installed its first automated traffic signals in October 1920 at five locations on Broadway. These early signals, manufactured by the Acme Traffic Signal Co., paired "Stop" and "Go" semaphore arms with small red and green lights. Bells played the role of today's amber or yellow lights, ringing when the flags changed—a process that took five seconds. By 1923 the city had installed 31 Acme traffic control devices. The Acme semaphore traffic lights were often used in Warner Bros. Looney Tunesand Merrie Melodies cartoons for comedic effect due to their loud bell.

The first interconnected traffic signal system was installed in Salt Lake City in 1917, with six connected intersections controlled simultaneously from a manual switch. Automatic control of interconnected traffic lights was introduced March 1922 in Houston, Texas.

In 1922 traffic towers were beginning to be controlled by automatic timers. The first company to add timers in traffic lights was Crouse Hinds. They built railroad signals and were the first company to place timers in traffic lights in Houston, which was their home city. The main advantage for the use of the timer was that it saved cities money by replacing traffic officers. The city of New York was able to reassign all but 500 of its 6,000 officers working on the traffic squad; this saved the city $12,500,000.

After witnessing an accident between an automobile and a horse-drawn carriage, African American inventor, Garrett Morgan, filed a U.S. patent for a traffic signal.[23]Patent No. 1,475,024 was granted on 20 November 1923 for Morgan's three-position traffic signal.

The first traffic lights in Britain were deployed in Piccadilly Circus in 1926. Wolverhampton was the first British town to introduce automated traffic lights in 1927 in Princes Square at the junction of Lichfield Street and Princess Street.

Melbourne was the first city in Australia to install traffic lights in 1928 on the intersection of Collins and Swanston Street.

The twelve-light system did not become available until 1928 and another feature of the light system was that hoods were placed over the light and each lens was sand-blasted to increase daytime visibility.

Both the tower and semaphores were phased out by 1930. Towers were too big and obstructed traffic; semaphores were too small and drivers could not see them at night.

The first traffic light in South India was installed at Egmore Junction, Chennai in 1953. The city of Bangalore installed its first traffic light at Corporation Circle in 1963.

The control of traffic lights made a big turn with the rise of computers in America in the 1950s. Thanks to computers, the changing of lights made Crosby's flow even quicker thanks to computerized detection. A pressure plate was placed at intersections so once a car was on the plate computers would know that a car was waiting at the red light. Some of this detection included knowing the number of waiting cars against the red light and the length of time waited by the first vehicle at the red. One of the best historical examples of computerized control of lights was in Denver in 1952. One computer took control of 120 lights with six pressure-sensitive detectors measuring inbound and outbound traffic. The system was in place at the central business district, where the most traffic was between the downtown area and the north and northeastern parts of the city. The control room that housed the computer in charge of the system was in the basement of the City and County Building. As computers started to evolve, traffic light control also improved and became easier. In 1967, the city of Toronto was the first to use more advanced computers that were better at vehicle detection. Thanks to the new and better computers traffic flow moved even quicker than with the use of the tower. The computers maintained control over 159 signals in the cities through telephone lines. People praised the computers for their detection abilities. Thanks to detection computers could change the length of the green light based on the volume of waiting cars. The rise of computers is the model of traffic control which is now used in the 21st century.

Countdown timers on traffic lights were introduced in the 1990s. Timers are useful for pedestrians, to plan whether there is enough time to cross the intersection before the end of the walk phase, and for drivers, to know the amount of time before the light turns green. In the United States, timers for vehicle traffic are prohibited, but pedestrian timers are now required on new or upgraded signals on wider roadways.

The history of traffic signals and signal systems in Toronto begins with the busy intersection of Bloor Street and Yonge Street in 1925. The following year saw the installation of signals at many more intersections.

The introduction of computers into the realm of traffic control was pioneered in Toronto in 1959. Metro Council has concluded that improvements to traffic signal control were needed to complement the rapid expansion of the arterial road network. Metro Council authorized a small-scale pilot study to examine the practicality of introducing a new traffic signal system which could be centrally controlled through the use of an electronic computer.

At the time, only specialized analog type equipment was available in the industry, and this would result in huge costs to replace signal controller hardware, with limited opportunity to introduce innovative strategies in either the theory or practice of traffic control. A research report suggested that if a general purpose digital computer was operated in real time, it could take in traffic information from a large number of vehicle detectors, select timings and offsets, and optimize these for overall system efficiency. Although this suggestion appeared attractive, some doubts were expressed concerning the ability of a digital computer to perform in the required manner. Therefore, a network of 15 signals was controlled in various ways ranging from pre-timed to fully traffic responsive to test the feasibility. This proved to be so successful that it was decided to proceed with the full scale system.

Metro proceeded with the installation of the world’s first full-scale, real-time, automatic traffic control computer in June 1963. A key to success was that the Metro Roads and Traffic Department had been granted authority over all existing or new signals within the then Metropolitan Toronto. The first phase of the system required the installation of 1,000 vehicle detectors, and the connection of each controller through leased telephone lines to the computer, which was located on the main floor of the Old City Hall. In a comparative sense, it was the second largest on-line control system in the world, exceeded only by the North American Air Defense Command (NORAD) installation.

Initially the system was responsible for 500 signals, but as Metropolitan Toronto grew, so did the number of signalized intersections that were to be controlled. Unfortunately the original traffic computer was capable of controlling only 1,164 intersections, and Toronto soon surpassed that figure as the city experienced rapid growth. In 1978 it was decided that a replacement system was necessary. This new traffic control center was located underground as part of the Sheppard subway station on the Yonge Line. It became operational in the early 1980s.

By the mid-1980s, the capacity of the Gardiner/Lake Shore corridor had reached its limit. A feasibility study confirmed the benefits of installing a corridor traffic management system (CTMS). Construction of the CTMS was approved in 1987 by Metro Council. However, around the same time it was becoming apparent that Toronto could benefit from the development of an Integrated Traffic Control Centre (ITCC) which would combine the operation of the corridor system with the traffic signal control system. The implementation of this ITCC was subsequently approved in 1989.

**1.3. RELEVANCE**

The development of traffic control systems for urban streets has paralleled the development and use of the automobile. After World War I, rapid growth in automobile traffic led to requirements for special personnel, signals and systems to address the problem.

In typical urban areas, approximately two-thirds of all vehicle-miles of travel, and even a higher percentage of vehicle-hours of travel, take place on facilities controlled by traffic signals [1]. To a major extent, therefore, the quality of traffic signal operation determines urban vehicular traffic flow quality.

Traffic signals originated with signaling system technology developed for railroads. In 1914 [2], Cleveland, Ohio installed the first electric traffic signal in the United States. In 1917, Salt Lake City introduced an interconnected signal system that involved manually controlling six intersections as a single system [3]. In 1922, in Houston, Texas, 12 intersections were controlled as a simultaneous system from a central traffic tower. This system proved unique in its use of an automatic electric timer.

The year 1928 saw the introduction of a flexible-progressive pretimed system. Municipalities quickly accepted these pretimed systems and widespread installation followed in virtually every U.S. city.

However, early pretimed systems had limited flexibility. They could respond only to predicted traffic changes via preset changes on a time clock. But predicting traffic conditions proved difficult because of the needed data collection efforts. Agencies usually avoided timing changes because of the staffing and time resources required to make changes at each local intersection controller.

Traffic-actuated local controllers using pressure detectors became available during the period 1928-1930. These controllers proved a first step toward traffic-actuated control but applied only to isolated intersections.

In 1952, Denver, Colorado advanced the state-of-the-art of traffic control systems by developing and installing an analog computer control system. This system applied some actuated isolated intersection control concepts to signalized networks. Sampling detectors input traffic flow data, and the system adjusted its timing on a demand rather than time-of-day (TOD) basis. Over one hundred systems of this type were installed in the United States in the period 1952-1962.

In 1960, Toronto conducted a pilot study using a digital computer to perform centralized control functions [4]. The amount of traffic data available from this form of control proved a fortunate by-product. While the computer used for the test was archaic by today's standards - an IBM 650 with about 2,000 words of drum memory - the success of this control system approach encouraged Toronto to proceed with full-scale implementation. The city placed 20 intersections under computer control in 1963, and later expanded the system to 885 intersections by 1973.

International Business Machines (IBM) began a cooperative development in 1964 with the City of San Jose, California, to further develop a computer traffic control system [5]. The project used an IBM 1710 computer. Control concepts developed and implemented proved successful in significantly reducing stops, delays, and accidents.

Beginning in 1965, the City of Wichita Falls, Texas, contracted for the delivery of an IBM 1800 process control computer for traffic control. This system was placed in daily operation in 1966, controlling 56 intersections in the central business district. It was later expanded to include 78 intersections. San Jose, California, shortly thereafter made a transition to an IBM 1800 computer, and similar systems were installed in Austin and Garland, Texas; Portland, Oregon; Fort Wayne, Indiana and New York City. In these systems, traffic signals were controlled by using stored timing plans developed off-line.

In 1967, the Bureau of Public Roads, currently the Federal Highway Administration (FHWA), began to develop the Urban Traffic Control System (UTCS) Project. The system was installed in Washington, D.C., to develop, test, and evaluate advanced traffic control strategies [6]. Completed in 1972, it contained 512 vehicle detectors whose outputs determined signal timing at 113 intersections. Extensive data processing, communications, and display capabilities were made available to support traffic control strategy research. Later efforts produced the Extended and Enhanced versions of the software package that implemented these concepts.

The 1970s also saw continuing research and development of software packages and models for digital computer and microprocessor based traffic control systems. The Transport and Road Research Laboratory (TRRL) in Great Britain developed the advanced centrally controlled traffic system, Split, Cycle and Offset Optimization Technique (SCOOT), in the 1970s with implementation taking place in Glasgow and other cities in the 1980s. SCOOT has been installed in several North American cities including Toronto, ON. Another advanced system, Sydney Coordinated Adaptive Traffic System (SCATS), developed in Australia, has been implemented in many cities throughout the world. SCOOT and SCATS initiated the deployment of responsive control systems. Adaptive control techniques, represented by Optimized Policies for Adaptive Control (OPAC) and RHODES, have also begun to be implemented.

The demand for traffic management market is driven by factors, such as high demographic growth and hyper-urbanization in developing countries, and government initiatives for traffic management under smart cities models. With the increase in the deployment of smart transportation solutions among the smart cities, the traffic management market is expected to gain a major traction during the forecast period.The traffic management software segment is expected to contribute to the largest market share.The traffic management software segment is expected to hold the largest market share. The scope of this traffic management software covers smart signalling, route guidance, traffic analytics, and smart surveillance. There has been a tremendous increase in urban population, resulting in traffic congestions across the city, which has increased the need to manage and control the traffic. The traffic management software ensures streamlining of traffic information for predictive analytics and traffic enforcement.

Deployment and integration services segment is expected to grow at the highest CAGR during the forecast period. The deployment and integration services segment is expected to have the largest market share and projected to grow at the highest CAGR during the forecast period. Deployment and integration services help in reducing the deployment and integration time. These services are crucial for developing end-to-end traffic smart signalling, route guidance, traffic analytics, and smart surveillance solutions for the traffic management market. The increasing requirement for upgrading traditional traffic management systems to support various smart cities and traffic management drives the deployment and integration services segment in the traffic management market.

Europe is expected to contribute to the largest market share, whereas Asia Pacific to grow at the fastest CAGR during the forecast period. Europe is expected to hold the largest market share and dominate the traffic management market from 2017 to 2022. The region has been extremely responsive toward adopting the latest technological advancements, such as smart signalling and route guidance software. The major growth drivers for this region are the large-scale investments in the smart transportation and smart cities projects and need for better traffic management and control mechanisms. The Asia Pacific (APAC) region is in the initial growth phase; however, it is the fastest-growing region in the global traffic management market. Increased urbanization has resulted in traffic congestions. High adoption of solutions to minimize congestions, along with better traffic management and control, has led to a wider demand for traffic management solutions in the APAC region.

1. **LITERATURE SURVEY**

**2.1 INTRODUCTION**

**2.1.1 INTERNATIONAL STATUS**

|  |  |  |
| --- | --- | --- |
| Type | System | Country |
| Fixed time systems | TRANSYT | UK |
| Plan generation systems | SCATS | Australia |
| Traffic responsive centralised systems | SCOOT | UK |
|  | UTMS | Japan |
| Traffic responsive systems with distributed processing | OPAC | USA |
|  | PRODYN  UTOPIA / SPOT | FRANCE  ITALY |

**1. TRANSYT**

TRANSYT is an acronym for TRAffic Network StudY Tool, . The original TRANSYT model was developed by the Transport Research Laboratory in the United Kingdom. TRANSYT, version 7 was "Americanized" for the Federal Highway Administration (FHWA); thus the "7F." The TRANSYT-7F program and the original TRANSYT-7F manual were developed for the Federal Highway Administration (FHWA) under the National Signal Timing Optimization Project (NSTOP) by the University of Florida Transportation Research Center (TRC). TRANSYT-7F continues to undergo further development, and is currently maintained by the University of Florida's McTrans Center.

Capabilities :

* Simulation of existing conditions and future conditions
* Multi-period optimization, hill-climb optimization
* Lane-by-lane analysis, actuated control analysis
* Direct CORSIM optimization, CORSIM post-processing
* One-touch CORSIM animation, one-touch HCS analysis
* Optimization based on a wide variety of objective functions
* Explicit simulation of platoon dispersion, queue spillback, and queue spillover
* Flexibility in accepting U.S. customary units or metric units, right-hand drive or left-hand drive
* Genetic algorithm optimization of cycle length, phasing sequence, splits, and offsets

**2. SCATS**

The **Sydney Coordinated Adaptive Traffic System**, abbreviated **SCATS**, is an intelligent transportation system that manages the dynamic (on-line, real-time) timing of signal phases at traffic signals, meaning that it tries to find the best phasing (i.e. cycle times, phase splits and offsets) for a traffic situation (for individual intersections as well as for the whole network). SCATS is based on the automatic plan selection from a library in response to the data derived from loop detectors or other road traffic sensors.

SCATS uses sensors at each traffic signal to detect vehicle presence in each lane and pedestrians waiting to cross at the local site. The vehicle sensors are generally inductive loops installed within the road pavement. The pedestrian sensors are usually push buttons. Various other types of sensors can be used for vehicle presence detection, provided that a similar and consistent output is achieved. Information collected from the vehicle sensors allows SCATS to calculate and adapt the timing of traffic signals in the network.

SCATS is installed at about 42,000 intersections in over 1800 cities in 40 countries. In Australia, where the system was first developed, the majority of signalised intersections are SCATS operated (around 11,000).

**Features :**

**Instant fault detection and quick repair**

The ATC system is equipped with the function of fault detection and logging the fault detected in order to facilitate repair and maintenance. Should there be a telecommunication breakdown, the ATC junction controller concerned will switch to standalone mode and continue to function.

**Traffic adaptive operation**

ATC systems provide advanced method of traffic signal control called Traffic Adaptive Control where the operational timing plans including cycle length, splits and offsets are continuously reviewed and modified in small increment, almost on a cycle-by-cycle basis, to match with the prevailing demand measured by the detectors connected to the on-street traffic controllers.

**3. SCOOT**

Split Cycle Offset Optimization Technique/Urban Traffic Control (SCOOT/UTC) – SCOOT is an adaptive traffic control system that determines its traffic timing plans based on real-time information received from vehicle detectors located on the approaches to signalized intersections. Like MTSS, SCOOT relies on telephone communication to maintain signal coordination. UTC is a traffic control system that operates in tandem with SCOOT; it also relies on telephone communications. UTC provides pre-determined signal timing plans and is used as a stopgap measure if SCOOT is not available. SCOOT signals are sometimes called "smart" signals.

Split Cycle Offset Optimisation Technique (SCOOT) is a real time adaptive traffic control system for the coordination and control of traffic signals across an urban road network. Originally developed by the Transport Research Laboratory for the Department of Transport in 1980, research and development of SCOOT has continued to present day. SCOOT is used extensively throughout the United Kingdom as well as in other countries.[[Institute of Highway Engineers - SCOOT 1]](https://en.wikipedia.org/wiki/Split_Cycle_Offset_Optimisation_Technique#cite_note-2)

SCOOT automatically adjusts the traffic signal delays to adapt to traffic conditions, using data from [traffic sensors](https://en.wikipedia.org/wiki/Traffic_light_control_and_coordination#Dynamic_control). Sensor data is gathered from sensors within clusters of road crossings called "regions", and used to guide crossing timing decisions throughout each region. SCOOT has been demonstrated to yield improvements in traffic performance of the order of 15% compared to fixed timing systems.

**4. UTMS**

Universal traffic management system (UTMS) is a new and comprehensive project that includes an integrated traffic control system, advanced mobile information system, mobile operation control system, dynamic route guidance system, public transportation priority system and environment protection management system. The National Police Agency, Japan (NPA), which governs the Japanese traffic management, has been promoting to introduce an advanced traffic management system called UTMS. UTMS is based on a broader concept like the IVHS in the United States and the DRIVE in Europe. From the viewpoint of traffic control using an automatic control system, this paper deals with four categories: the optimum control of the signal control system, the traffic information service system, the advanced traffic control system supported by a traffic data acquisition system, and the goal of UTMS.

**5. OPAC**

The Real-time Traffic Adaptive Control System (RT-TRACS) represents a new, state-of-the-art system in advanced traffic signal control. It has been developed cooperatively by a team of U.S. academic, private and public researchers under the guidance of the Federal Highway Administration (FHWA). The system provides a framework to run multiple traffic control algorithms, existing ones as well as new adaptive algorithms. The OPAC (Optimized Policies for Adaptive Control) control strategy, which provides a dual capability of distributed individual intersection control as well as coordinated control of intersections in a network, is the first adaptive algorithm implemented within the RT-TRACS framework. OPAC was the first comprehensive strategy to be developed in the U.S. for real-time traffic-adaptive control of signal systems. This paper presents the operational features of the OPAC algorithm and describes the implementation and-field testing of OPAC within the RT-TRACS system.

OPAC (Optimization Policies for Adaptive Control) is a computational strategy for demand-responsive decentralized traffic signal control that is being developed and tested in the United States. The strategy has the following features:

(1) it calculates controls that approach the theoretical optimum.

(2) it requires on-line data from upstream approach detectors and from neighboring intersection

(3) it forms a building block for demand-responsive decentralized control in a network. Performance of the strategy was studied through simulation and by field testing.

**6. PRODYN**

PRODYN is an algorithm able to compute in real time the best signal settings with respect to the delay criterion for any flow demand in traffic networks. The hierarchical algorithm uses Forward Dynamic Programming (FDP) to compute controls at the lower level (intersections) and decomposition coordination techniques at the upper level. The implementation on the field relies on the use of network structure of microprocessors the tasks of which are optimization and state estimation. The major goal to reach was to solve for such an application the dimensionality problem of FDP. Results show substential gains on delay to give an idea of about 16% with respect to fixed time policies.

A number of other models for traffic control systems have been proposed in the literature, employing a variety of techniques. Dynamic programming and decomposition techniques were used with DYPIC and in the 1980s with the PRODYN algorithm. PRODYN uses dynamic programming in a hierarchical fashion to make signal decisions at the intersection level, while using a decomposition coordination technique at the upper level of the traffic network .

**7. UTOPIA / SPOT**

UTOPIA or UTOPIA-SPOT is a traffic- dependent network control that stands for Urban Traffic Optimisation by Integrated Automation. The goal of UTOPIA is to minimize the loss times for motorized traffic on the condition that public transport has minimal loss times. UTOPIA has been developed in Milan. Helmond has the largest UTOPIA network in the Netherlands.

**Characteristics**

1. At UTOPIA, individual crossing points are optimized.

2. Intelligence is in regulators but also in a central computer.

**Operation**

Each intersection in the network is connected to another intersection in the network. A zone center can be found in each collection of connected intersections. So there are several zone centers in the network behind each other. The control in the zone center is continuously optimized to ensure optimal network control .

**Optimization Process**

The optimization process takes place every 3 seconds. First, the public transport system is optimized, after which the other target groups are handled. The target function is then optimized in each zone for in the following order:

1. traffic on feeding 'links' of the central intersection (zone center)
2. traffic from the central crossroads to downstream intersections
3. all traffic arriving at the zone center in 120 seconds

**Locations**

UTOPIA is widely used in Rome, Turin, Bologna and Milan, in some Scandinavian countries and in Romania and Poland. In the Netherlands, UTOPIA is being applied on a smaller scale in Eindhoven, 's-Hertogenbosch, on the road network of Schiphol and in Nieuwegein, Veenendaal and Rhenen. The city with the largest UTOPIA network in the Netherlands is Helmond, which has a completely city-wide network UTOPIA network. The city of The Hague also started in 2010 and 2011 with the introduction of UTOPIA on a few strands in the network.

**7. TransSuite Traffic Control System (TransSuite TCS)**

TransSuite TCS is a hybrid traffic control system that relies on second-by-second communication to monitor signal operations but relies on field equipment to maintain coordination (i.e. the field equipment can maintain signal coordination for about 24 hours if there is a loss of communication). TransSuite TCS does not directly control signal movements but commands each intersection controller to follow a timing plan that resides within its local database. TransSuite then verifies that the controller adheres to the commanded timing plan. Intersection controllers are monitored and controlled through a user interface. TransSuite TCS supports a variety of phase-based controllers.

**2.1.2 NATIONAL STATUS**

As per a World Bank report, the density of India’s highway network (0.66) is on par to that of the United States (0.65) and several times greater than that of China (0.16) or Brazil (0.20). In metropolitan and major Indian cities like Mumbai, Delhi, Ahmedabad, Bangalore, Chennai and Hyderabad, traffic is growing four times faster than the population. With increased urbanization and increase in vehicular traffic, cities everywhere are battling an increase in demand and an inability to build sufficient infrastructure to cope. While the Government has been laying emphasis on building roads, bridges and underpasses and creating alternative modes of mass public transport systems, this may not be sufficient to address the traffic congestion. Traffic management has always posed a challenge in India and it may continue to become more difficult with every passing day unless we start building some intelligence into the way we look at resolving these issues. The solution lies in leveraging advanced technologies and intelligent solutions. Some intelligent traffic management systems are already being implemented in cities like Delhi and Bangalore making an impact in the form of reduced congestion less fatal accidents. Other cities are likely to follow suit soon.

Subset of a larger subject, Intelligent Transportation System (ITS), intelligent traffic management systems assist road authorities in maximizing the operational performance and reliability of all aspect of the road network. Intelligent Transport Systems (ITS) is essentially the application of computer and communications technologies coming in aid of the transport problems. This may involve the use of CCTV in strategic junctions, vehicle presence detectors, in-road magnetic loop detectors and other remote video surveillance devices to assure automated control in good or bad weather and in varying traffic volumes. Based on real-time data and historical data, the traffic management system alters traffic signal cycles in real time, based on the in-situ sensors or surveillance devices, to respond to changing traffic conditions. These traffic control systems feed data from individual controllers at each intersection to master controllers that can synchronize a group of the individual controllers. The main control centre receives information from all master controllers, allowing operators to monitor the entire system continuously, issue control commands when necessary, and optimize deployment of field personnel as needed for operations and traffic security. Centralized information collection supports statistical analysis and historical files for subsequent strategic evaluation. A remote control centre backs up the main control centre for optimum security.

There is already some amount of research and resources being dedicated to this area. The Center of Excellence in Urban Transport (COEUT) set up in IIT-Madras comprises people from various disciplines and is working closely with the ministry on research in ITS. The centre works with various private firms who are developing innovative solutions for better transport. However, their prime challenge is the lack of systematic data collection. Collection of real-time traffic information on highway segments and surface street networks is critical for the success of an ITS or ITMS system. As mentioned above, data could be collected from videos, vehicle detectors, probe vehicles (automatic vehicle identifiers and automatic vehicle locators) or GPS. Most developed countries use inductive loop detectors (ILD) for applications like vehicle detection, incident detection, automatic traffic surveillance, real-time traffic adaptive signal control, and data for traveller, commercial and emergency information services, mainly because it can collect data without any need for public participation. However, the loop detectors designed for the developed countries are designed assuming lane discipline and homogeneous traffic which is absent in India. Also, the vast range of vehicular types (bicycle, two-wheelers, three wheeler, light motor vehicle, heavy motor vehicle) that need to be identified for accurate traffic data collection is a major challenge for the existing ILD systems.

The COURT at IIT-Madras has developed a new type of loop detector suitable for Indian traffic conditions. The principal components of an inductive loop detector system include one or more turns of insulated loop wire wound in a shallow slot sawed in the pavement, a lead-in cable that runs from the curbside pull box to the controller cabinet, and a detector electronics unit housed in the controller cabinet. When a vehicle passes over the loop or stops within the loop, it decreases the inductance of the loop. The change in inductance helps in identifying various parameters such as vehicle speed and vehicle length, which also helps in processing the current traffic speed and the traffic count in the specific area. It can also sense vehicles of different sizes (for example, it can identify a bus from a bicycle) as they go through the roadways. The data can be used for creating a traffic data centre where all traffic data can be archived and shared among the transportation researchers across India.

However, intelligent traffic management systems will be set up for failure despite the availability of technology and availability of data. Many cities have invested in a number of advanced traffic management systems which can be deemed to have failed to deliver the expected benefits due to the failure, not of the technical elements, but because of the failure of the institutional element. Success requires strong backup in terms of policy, legislation, regulation and relevant sector coordination and common action.

The Delhi police have a budget allocation of ` 82 crores of for funding the Intelligent Traffic Management System. The project will approximately cover 220 kilometres of urban major roads with around 240 signal intersections. The main components include a traffic control and management centre, a disaster recovery centre, an incident detection system on expressways and adaptive signal control of at-grade intersections. It will also involve a CCTV camera system, traffic information system with variable message signs, adaptive speed control on national highways, speed and red light violation cameras and a parking management system. However, despite the ambitious plans, previous tender requests failed to find a suitable bidder.

A similar scheme has also been implemented in Bangalore, where the State government has promised to spend Rs 79 crore to help Bangalore police improve traffic management. In Bangalore, the operation is run from the dedicated Traffic Management Centre, a technology centre at the heart of Bangalore’s police where a team remotely manages the city’s traffic. Nearly 120 cameras at different junctions are remotely monitored. Out of 300 traffic signals in Bangalore, 163 have already been connected to the traffic management centre. Of these, 120 are vehicle activated, meaning that if there is a four second period where no vehicles pass through, the signal automatically turns to red.

As part of the Mumbai City Mobility Management project, Traficon has been awarded a contract for installing nearly 700 vehicle presence detectors at Mumbai’s various busy road junctions controlled by traffic signals. By detecting both waiting and approaching vehicles, these intelligent ‘all-in-one’ cameras will be used for optimization of traffic signal timings and to cut down waiting time at traffic lights. Based on the information coming from these surveillance devices and Telvent’s in-road magnetic loop detectors in-situ sensors, Mumbai’s Adaptive Traffic Control System (ATCS) by Telvent alters traffic signal cycles in real time to respond to changing traffic conditions. Once fully operational, ATCS is expected to cut down waiting time at traffic signals by almost half.

For the city of Chennai, the decision to use Traficon’s integrated video sensor technology was taken after a competitive bidding mid-2010. Today up to 100 TrafiCam sensors are installed and operational to detect waiting vehicles at multiple intersections across the city.

KSRTC (Karnataka State Road Transport Corporation) will soon be implementing the intelligent transport system (ITS) for Mysore city under GEF (Global Environment Fund) SUTP (Sustainable Urban Transport Programme), the initiative by World Bank. The overall scope of implementation will consist of design, development, testing, installation, commissioning, training, operations, and management of facilities, for a period of three years by the winning bidder. The project plan covers 500 buses, 80 bus stops, and 10 bus terminals. It will have several components including vehicle tracking system, central control station, passenger information management system, communication subsystem, travel demand management, incident and emergency management system, operational and maintenance specification and fleet management system. Core technologies include geographical positioning system (GPS), electronic display systems, and information & communication technologies. The cost of the project is Rs. 19.13 crores that cover the capital costs and three years’ operating costs with a project contingency of 5%. There are further projects in the pipeline across India such as the implementation of ITS in Indore, Pune, etc.

According to the Centre for Development of Advanced Greater Hyderabad will have a master plan for Intelligent Transport System (ITS) soon. The study will cover the Outer Ring Road (ORR) with the main focus on the Inner Ring Road (IRR) and integration of traffic departments. The ITS is meant to support optimisation of traffic flow, reduce environmental impact on the transportation sector, reduce road accidents and promote efficiency in traffic and transportation operation and management. The study of ITS master plan will be undertaken in two phases and completed in 18 months by January 2013.

Again, while the above initiatives show immense promise, we need to develop standards of roads and customize traffic control devices to Indian conditions and mixed traffic conditions and need to update our legislation. Such modern practices of traffic management and case studies of their implementation in the developed countries should figure as an important part of the curriculum of police academies and schools. Modern tools and systems of enforcement are not available to traffic police authorities except in major metropolitan cities. In all, India has started taking baby steps in the implementation of intelligent traffic management systems and an integrated transport management system but the country still has a long way ahead.

**T**he Diamond City(Surat), which is witnessing tremendous growth in vehicular traffic, is gearing up for a smart traffic control system. All the traffic intersections, be it small or big, will soon have adaptive traffic control system (ATCS) based on sensors to regulate the flow of traffic.

An advanced signaling system used in several European countries as well as in China, the ITMS is being modified to suit Indian traffic conditions. A Thiruvananthapuram-based company has bagged the tender for installing ATCS in the city.

The civic body has identified around 267 traffic junctions where the smart sensors will be installed along with 398 high-density CCTV cameras. The virtual loop cameras of this intelligent traffic signal system would constantly read the density of traffic and adjust the green/red light duration accordingly to ensure there is more of red light on directions which have lesser vehicular density and more of green for routes having a greater number of vehicles.

At present, the traffic signals are controlled with fixed timers of 120 seconds. The commuters on the traffic signals have to stop for 120 seconds compulsorily, whether there is traffic or no traffic.

An integrated computer-based sensor system will control the duration of the red or green light at the traffic junctions, depending on the density of the vehicular traffic. These smart traffic signals will allow the free flow of vehicular traffic from one junction to another.

For the first time, this system would also ensure red lights on all directions to facilitate movement of pedestrians. The other type of facility is that pedestrians will cross half of the road while traffic flows on the other side. A 'hooter' will alert the pedestrians to cross in 10 to 20 seconds time when the pedestrian signal would turn green.

As per Regional Transport Office (RTO) figures, the city has around 29 lakh vehicles plying on the city roads. Every year, around 1.7 lakh vehicles are added onto the city roads.

1. **BLOCK DIAGRAM**

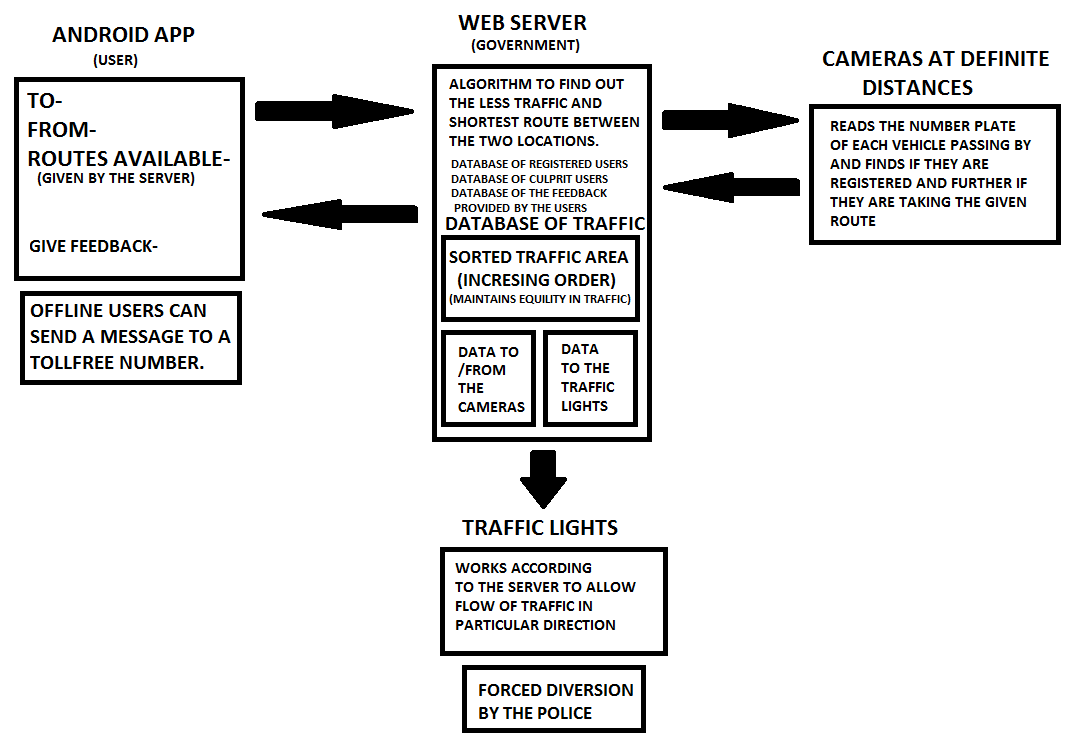


Fig 1: Complete Block Diagram

**ALGORITHMS**

1. Dijkstra's Shortest Path Algorithm

In Dijkstra’s algorithm, two sets are maintained, one set contains the list of vertices already included in SPT (Shortest Path Tree), another set contains vertices not yet included. With adjacency list representation, all vertices of a graph can be traversed in O(V+E) time using BFS. The idea is to traverse all vertices of the graph using BFS and use a Min-Heap to store the vertices not yet included in SPT (or the vertices for which shortest distance is not finalized yet). Min Heap is used as a priority queue to get the minimum distance vertex from the set of not yet included vertices. The time complexity of operations like extract-min and decrease-key value is O(LogV) for MinHeap.

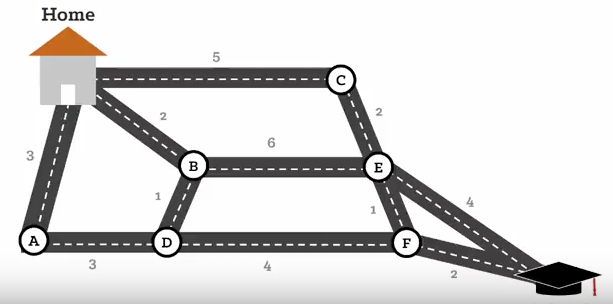


Fig 2: Graph Representation

Following are the detailed steps.

1) Create a Min-Heap of size V where V is the number of vertices in the given graph. Every node of min heap contains vertex number and the distance value of the vertex.

2) Initialize Min Heap with source vertex as root (the distance value assigned to source vertex is 0). The distance value assigned to all other vertices is INF (infinite).

3) While Min Heap is not empty, do the following

a) Extract the vertex with minimum distance value node from MinHeap. Let the extracted vertex be u.

b) For every adjacent vertex v of u, check if v is in MinHeap. If v is in MinHeap and distance value is more than a weight of u-v plus distance value of u, then update the distance value of v.

Time Complexity: The time complexity of the above code/algorithm looks O(V^2) as there are two nested while loops. If we take a closer look, we can observe that the statements in inner loop are executed O(V+E) times (similar to BFS). The inner loop has decreaseKey() operation which takes O(LogV) time. So overall time complexity is O(E+V)\*O(LogV) which is O((E+V)\*LogV) = O(ELogV)

Note that the above code uses Binary Heap for Priority Queue implementation. Time complexity can be reduced to O(E + VLogV) using Fibonacci Heap. The reason is, Fibonacci Heap takes O(1) time for decrease-key operation while Binary Heap takes O(Logn) time.

Notes:

1) The code calculates the shortest distance but doesn’t calculate the path information. We can create a parent array, update the parent array when a distance is updated (like prim’s implementation) and use it show the shortest path from source to different vertices.

2) The code is for undirected graph, same Dijkstra function can be used for directed graphs also.

3) The code finds shortest distances from source to all vertices. If we are interested only in shortest distance from the source to a single target, we can break the for the loop when the picked minimum distance vertex is equal to target (Step 3.a of an algorithm).

4) Dijkstra’s algorithm doesn’t work for graphs with negative weight edges. For graphs with negative weight edges, Bellman-Ford algorithm can be used, we will soon be discussing it as a separate post.

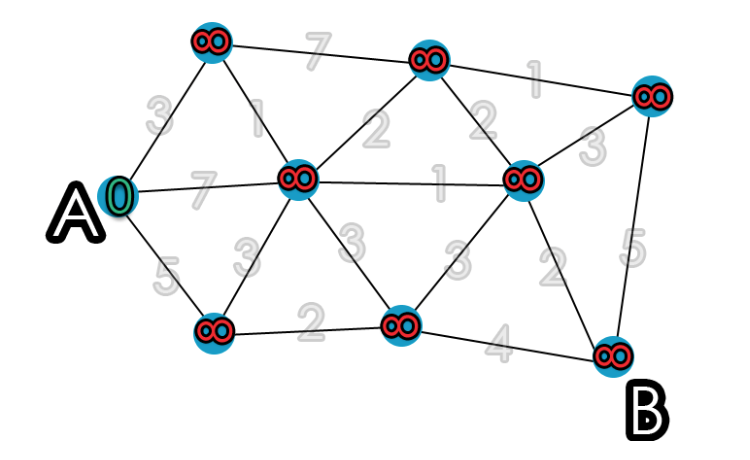


Fig 3: Graph Implementation

Pseudo-code

function Dijkstra(Graph, source):

dist[source] := 0 // Distance from source to source is set to 0

for each vertex v in Graph: // Initializations

if v ≠ source

dist[v] := infinity // Unknown distance function from source to each node set to infinity

add v to Q // All nodes initially in Q

while Q is not empty: // The main loop

v := vertex in Q with min dist[v] // In the first run-through, this vertex is the source node

remove v from Q

for each neighbor u of v: // where neighbor u has not yet been removed from Q.

alt := dist[v] + length(v, u)

if alt < dist[u]: // A shorter path to u has been found

dist[u] := alt // Update distance of u

return dist[]

end function}

There are different applications and special cases where the Dijkstra algorithm can be applied. In addition to routing, the calculation of distances can also be used for other areas where the euclidian distance is not the basis, but time or cost is.

In addition to the weighting of the edges, weights to the node can also be specified. This could be of use when the process of changing within the node "main station" is associated with high costs. In this case, the node receives its own weight, which has to be taken into account while computing the shortest paths.

The Dijkstra algorithm does not work with negative edge weights. If you want to run the shortest path calculation with negative edge weights, other algorithms such as the Bellman-Ford-algorithm must be used.

The Dijkstra algorithm is not suitable for all applications or types of graphs. Other algorithms include the Kruskal or Borùvka which are used to compute minimum spanning trees in undirected graphs.

1. Time-Series Analysis

A time series is a sequence of numerical data points in successive order. In investing, a time series tracks the movement of the chosen data points, such as a security’s price, over a specified period of time with data points recorded at regular intervals. There is no minimum or maximum amount of time that must be included, allowing the data to be gathered in a way that provides the information being sought by the investor or analyst examining the activity.

A time series can be taken on any variable that changes over time. In investing, it is common to use a time series to track the price of a security over time. This can be tracked over the short term, such as the price of a security on the hour over the course of a business day, or the long-term, such as the price of a security at close on the last day of every month over the course of five years.

Time series analysis can be useful to see how a given asset, security or economic variable changes over time. It can also be used to examine how the changes associated with the chosen data point compare to shifts in other variables over the same time period.

For example, suppose you wanted to analyze a time series of daily closing stock prices for a given stock over a period of one year. You would obtain a list of all the closing prices for the stock from each day for the past year and list them in chronological order. This would be a one-year daily closing price time series for the stock.

Delving a bit deeper, you might be interested to know whether the stock's time series shows any seasonality to determine if it goes through peaks and valleys at regular times each year. An analysis in this area would require taking the observed prices and correlating them to a chosen season. This can include traditional calendar seasons, such as summer and winter, or retail seasons, such as holiday seasons.

Alternatively, you can record a stock's share price changes as it relates to an economic variable, such as the unemployment rate. By correlating the data points with information relating to the selected economic variable, you can observe patterns in situations exhibiting dependency between the data points and the chosen variable.

Time series forecasting uses information regarding historical values and associated patterns to predict future activity. Most often, this relates to trend analysis, cyclical fluctuation analysis and issues of seasonality. As with all forecasting methods, success is not guaranteed.

**4. METHODOLOGY**

Many solutions have been proposed to solve the traffic related issues but the uniqueness of this model is that it predicts the traffic that is going to be in next 15 minutes, and accordingly we can manage the traffic.

An android app will be installed in the user’s phone (as 90% of the population that creates traffic have an android phone, this will not be an issue). Every user will be uniquely identified by his ID card i.e. Adhaar Card, PAN card, Driving license. During registration, the user has to mention the vehicle plate number.

Before going to a journey,15 minutes prior to the journey he will enter his journey details i.e. initial location, final location, two/four wheeler. This data will be handled by the government and according to the traffic that is going to be next 15 minutes, they will provide a suitable route for the user. If the server detects that major traffic is going to be in particular route, then the server can manually operate the traffic lights that are in between them and allow the respective flow of traffic. After user will get the route provided by the server. The various cameras (connected with a microcontroller) that will be installed at various places will get the vehicle plate numbers that are going to pass. If unknown plate number is detected (using image processing) then there are three possibilities -

1. Vehicle plate number is not registered.

2. Vehicle plate number is registered, but the user has not filled in the details prior to the journey.

3. Vehicle plate number is registered, but the user is not following the required path.

Unknown number plates will be scanned and pushed to the server. Where proper actions can be taken against them. It will alarm as soon as this kind of vehicles is passed so that police can catch them. Also, it will be a good idea to replace the hard copy driving license to an android app. So at regular intervals traffic police can check who all have installed an app at the same time it will be easy for the user to carry.

Nowadays a lot of cases came into picture related to the traffic police taking the bribe. If we implement this app license concept we can totally overcome this problem. As there will be a record of a number of culprit vehicle plate number on the server, so corruption can be decreased to a great extent.

After the user is reached to its required destination, the data will be popped out of the database. By this model, we can reach to every individual person for any information.

We will also store the real-time information about the amount of traffic on an edge of our graph. Using this stored data, we will be able to predict the traffic successfully. For this, we will be using time series analysis.

**5. EXPERIMENTATION**

Users android phone which is acting as an interface between the cloud and user-end will have a simple elemental-UI asking for route and vehicle option i.e. 2-wheeler or 4-wheeler. For the new users, we will ask them to register using AADHAR UID to uniquely identify everyone. Later On, after registration Users have to add there Driving license by doing this user can directly show the DL on the app. Fine and other penalties can be done digitally without any fraud.

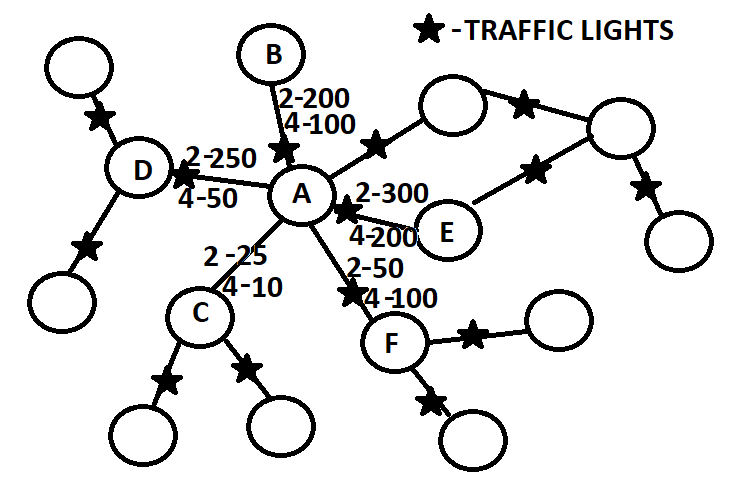
Accordingly, the data will be pushed to the cloud where we will update the database and other journey details. Starting and end of the journey will act as two nodes in our graph where weights on the edges will be updated according to the number of people in between the two locations i.e. in between two nodes.

We will have smart traffic lights where we will install Beaglebone-Black. Beaglebone will dynamically change the timing setting of the traffic light for smooth traffic flow.

Beaglebone will also be connected to the camera that will continuously scan the live traffic density within a particular area. Timing setting will depend on the image processing output from the camera. We will keep track of this data with there timestamps to do analysis via machine learning. So that we can find out which routes have higher traffic and at what duration of the day.

Using these data we can forcefully diverge the traffic to some other route at a certain instance of the day. These servers and traffic light components authentications will be given to police to facilitates its working.

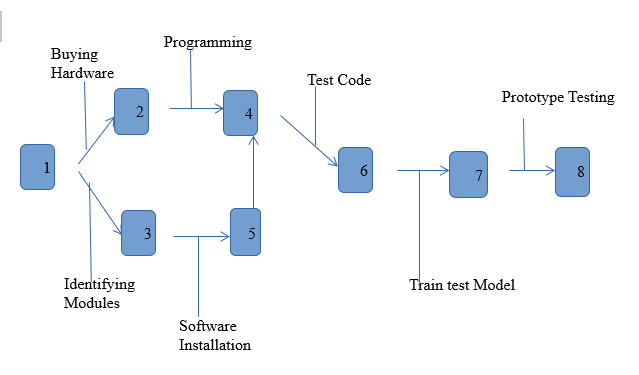
After we get data from the user onto the server further processing as we have discussed will occur and the server will send the required route to the users android app.

Fig 4: Traffic Structure

If we consider the above graph where each node represents an individual place and weights on the edges represents the number of two-wheelers and four-wheeler between two places. According to these weights, we can change the traffic lights settings accordingly. From the machine learning analysis, we can analyze where more number of traffic police are required.

We can also provide the feedback column in the Android app, where the user can give his query related to faulty roads and other related problems. This will be directly managed by the government so it will be easy to solve the problems. We can also provide emergency services in case of accident or robbery during the journey. We can design our system such that only specific number of trucks, cars, and motorbikes are there at any given instant, and if they are more in number we can even request the user to delay his journey for few minutes.We can even provide SMS service for the users who don’t have internet access.

**6. PROJECT SCHEDULE**



**FUTURE SCOPE**

Right now in the prototype phase, this model works intra-city. In future to expand it's operation, commuting between inter-city can also be supported.

To calculate traffic at much more real-time, image processing can also be used on various traffic intersections. Cameras can calculate the number of vehicles at each intersection and then correspondingly can plot a heat map, describing the density of traffic. It can be used as a supplement to our current traffic density calculator.