A PRESENTATION OF TRAFIC MANAGEMENT

PRESENTED BY:

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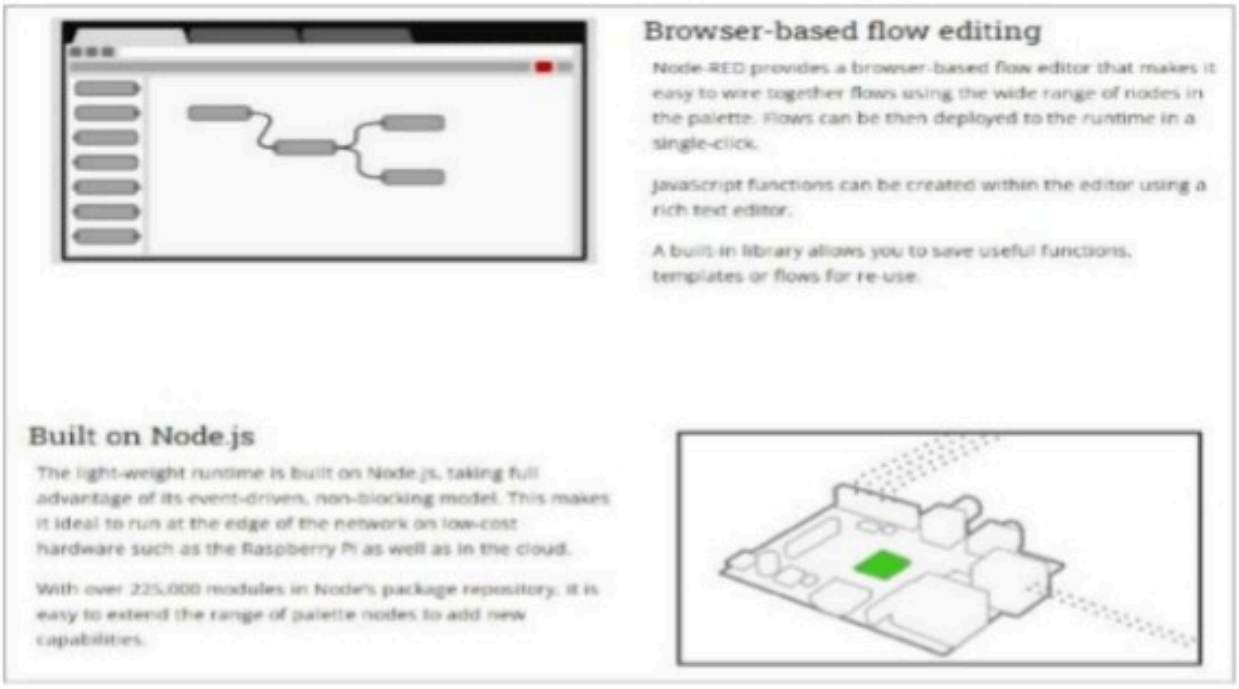


Fig. 2: Node-RED platform built on Node.js (Source: nodered.org)

In the installation directory of Node.js, the npm command is used to install Node-RED, as follows:

```
E:\>cd nodejs
E:\nodejs>npm i node-red
```

Node-RED can be installed on multiple platforms, including open source hardware devices, IoT devices, the cloud, or on dedicated servers. Its cloud deployment can be done on IBM Cloud, Microsoft Azure, SenseTecnic FRED, and Amazon Web Services. To work with IoT, fog and edge scenarios, it can be installed on Raspberry Pi, BeagleBone Black, or Arduino. These devices support the interfacing of IoT sensors for multiple applications.

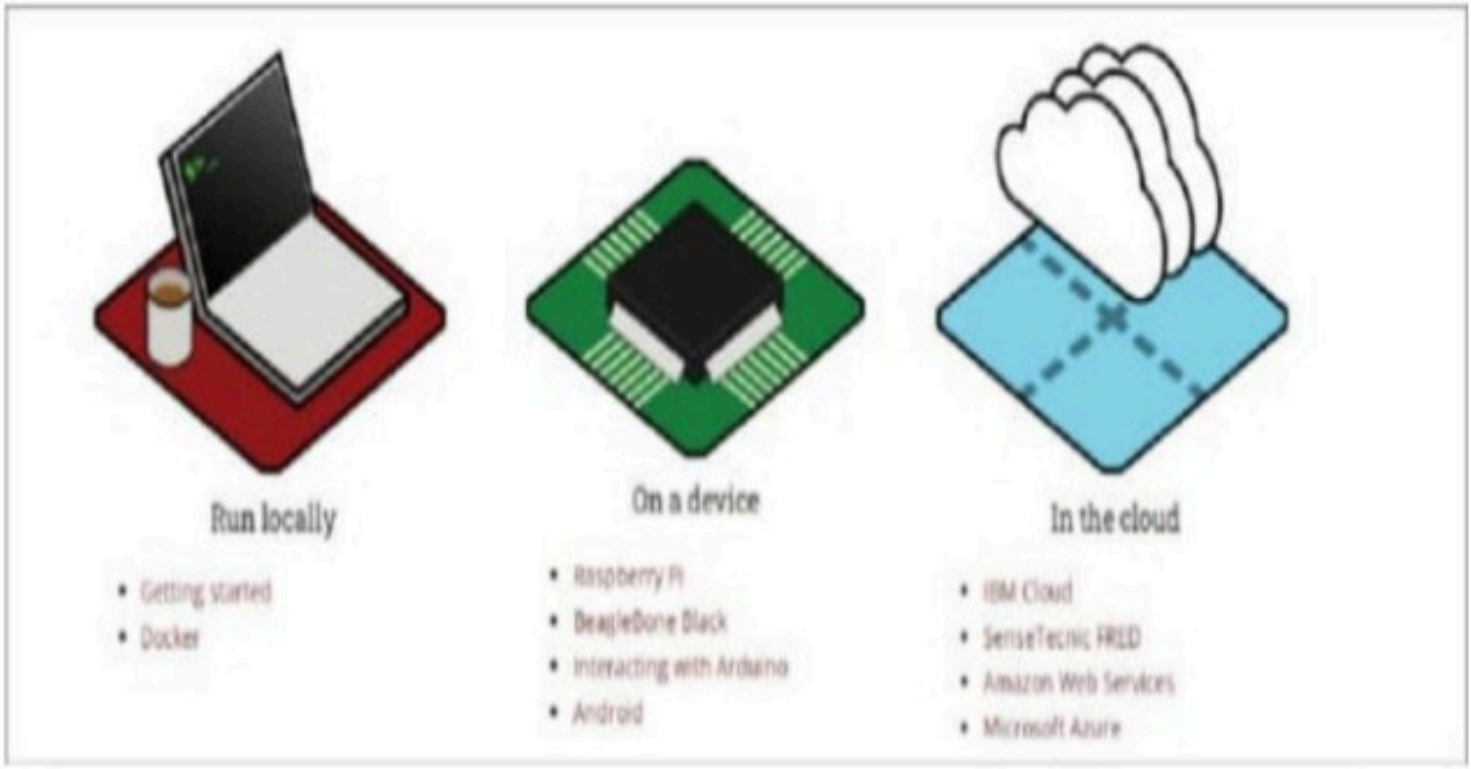


Fig. 3: Installation options for Node-RED (Source: nodered.org)

To run Node-RED on a dedicated system, the node-red command is executed to start the server. A local host based IP address with port number is generated, on which the programming for IoT, edge computing, etc, is done.


node-red
E:\nodejs>node-red
21 Nov 09:55:07 - [info]
Welcome to Node-RED
21 Nov 09:55:07 - [info] Node-RED version: v1.0.4
21 Nov 09:55:07 - [info] Node.js version: v12.16.1
21 Nov 09:55:07 - [info] Windows_NT 6.1.7600 x64 LE
21 Nov 09:55:15 - [info] Loading palette nodes
21 Nov 09:56:27 - [warn]
21 Nov 09:56:27 - [warn] [node-red-contrib-noble/noble] Error: Cannot find module 'bluetooth-hci-socket'
Require stack:
- E:\nodejs\node_modules\node-red-contrib-noble\node_modules\noble\lib\hci-socket\hci.js
- E:\nodejs\node_modules\node-red-contrib-noble\node_modules\noble\lib\hci-socket\bindings.js
- E:\nodejs\node_modules\node-red-contrib-noble\node_modules\noble\lib\resolve-bindings.js
- E:\nodejs\node_modules\node-red-contrib-noble\node_modules\noble\index.js
- E:\nodejs\node_modules\node-red-contrib-noble\noble\node-red-contrib-noble.js
- E:\nodejs\node_modules\node-red\node_modules\@node-red\registry\lib\loader.js
- E:\nodejs\node_modules\node-red\node_modules\@node-red\registry\lib\index.js
- E:\nodejs\node_modules\node-red\node_modules\@node-red\runtime\lib\nodes\index.js
- E:\nodejs\node_modules\node-red\node_modules\@node-red\runtime\lib\index.js
- E:\nodejs\node_modules\node-red\lib\red.js
- E:\nodejs\node_modules\node-red\red.js
21 Nov 09:56:27 - [warn]
21 Nov 09:56:27 - [info] Settings file : C:\Users\kumargaurav\.node-red\settings.js
21 Nov 09:56:27 - [info] Context store : 'default' [module=memory]

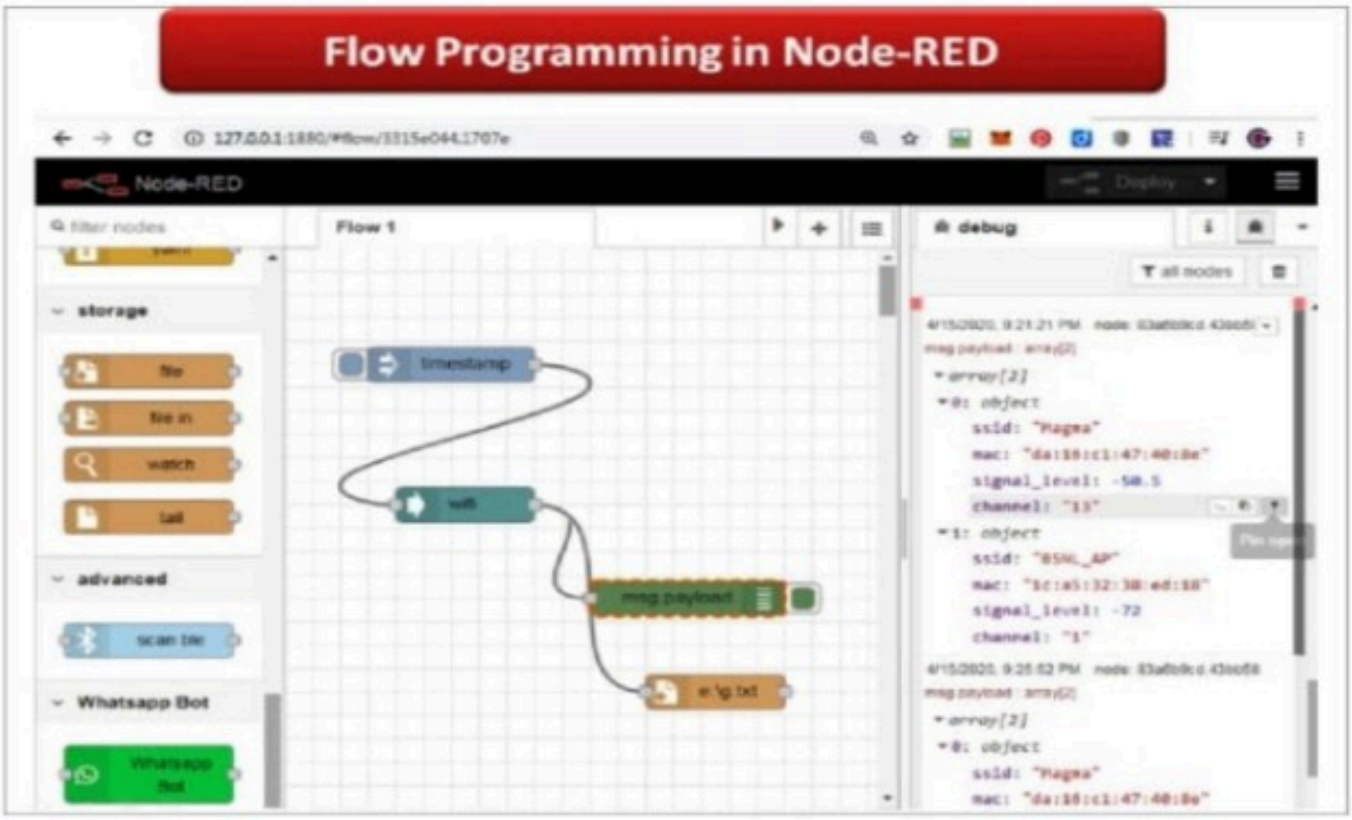
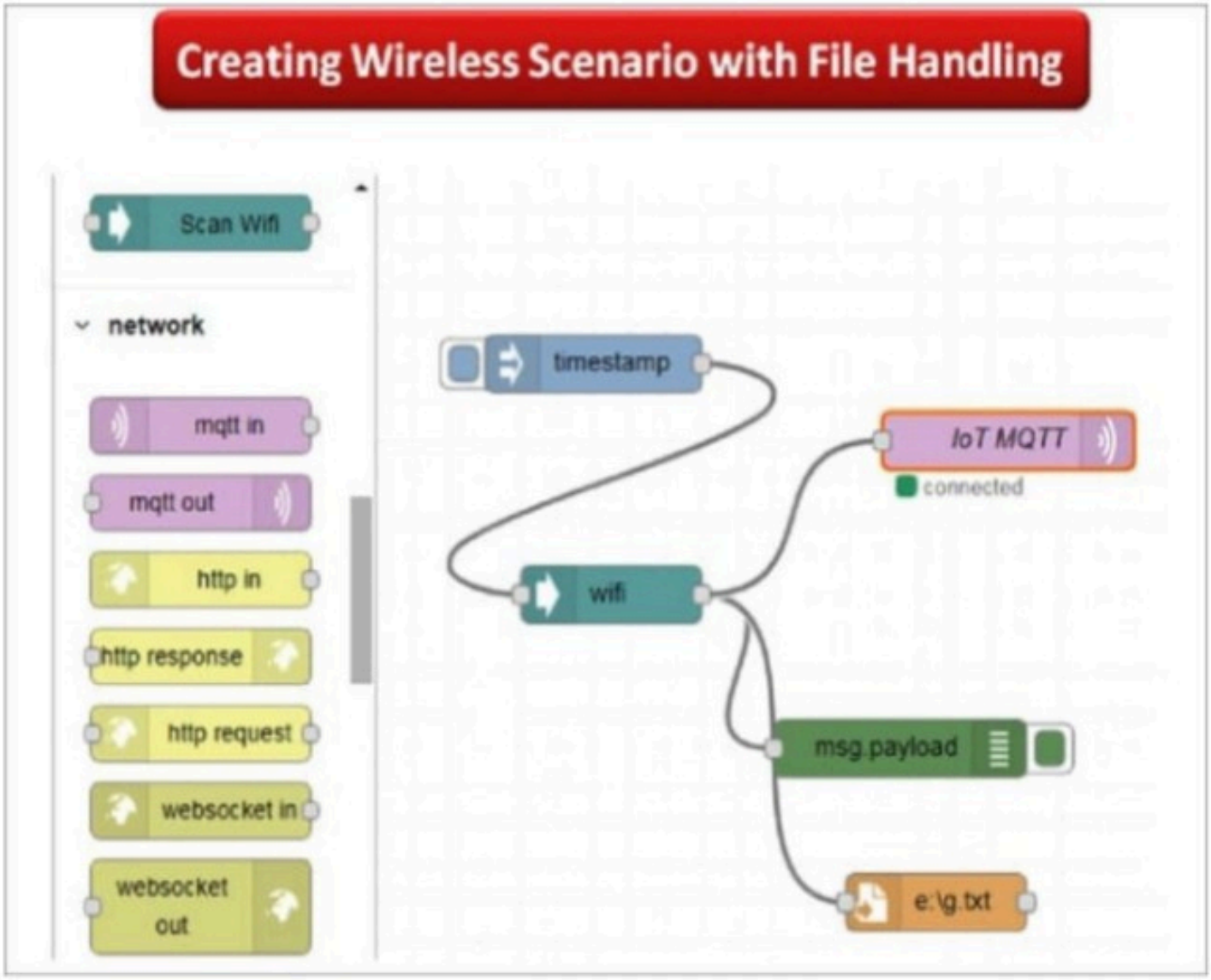


Fig. 6: Creating a flow diagram in Node-RED with Wi-Fi interfacing

The message queueing telemetry transport (MQTT) protocol is available in the Node-RED palette to help it work with IoT. It is used as an IoT broker for real-time interfacing and communication with sensors. An IoT scenario is created by the file handling module, capturing data from sensors and using the MQTT protocol to interface it with Wi-Fi. After running this scenario on a single click, the results are visible on the right side panel of Node-RED. Similar other structures can be created and deployed for

dynamic communication with IoT devices.

Researchers and engineers can create IoT scenarios as per their requirements with the customisation and addition of packages on Node-RED.



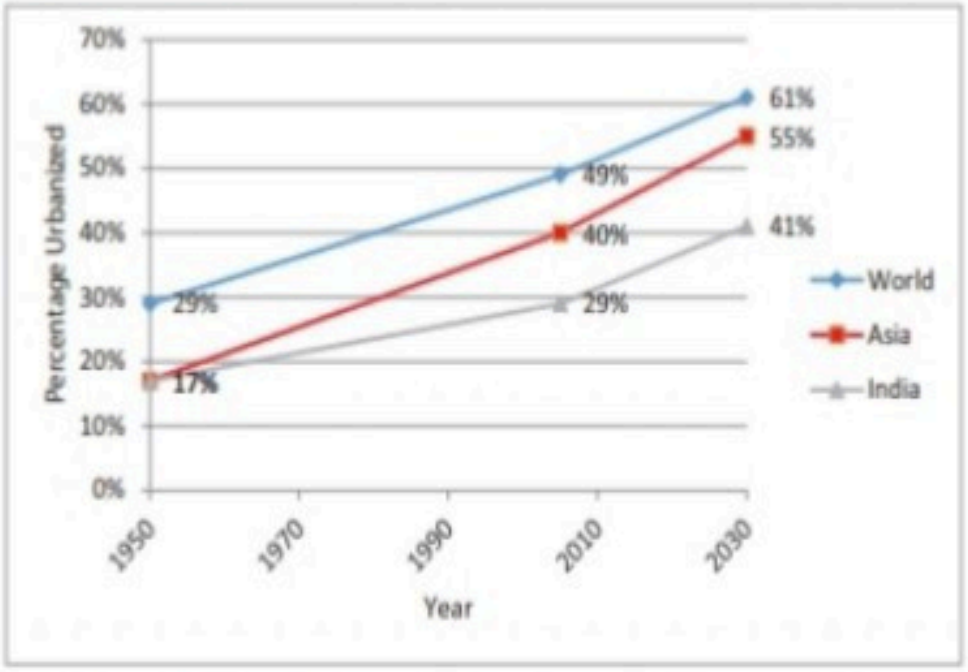
Chapter 1

Need of Toolkit

1.1 Introduction

One of the defining characteristics of modern civilization is the congregation of people in urbanized areas. Another characteristic is the need of high mobility for people living in these areas. Mobility is needed for the basic purpose of commuting from home to work as well as to fulfil a number of other needs, such as, health care, recreation, social interaction, and education. The need for mobility is met increasingly by private modes, not only in the developed countries but also in emerging nations such as India. According to the Ministry of Urban Development, Government of India, between 1981 to 2001 population in 6 major Indian cities increased twofold while motor vehicles increased eightfold. This situation is not going to get any better as can be seen from Figure 1.1, which shows the rate of urbanization in India and other regions of the World in 1950 and 2005 along with the projected rate for 2030 (ADB 2006).

Figure 1.1: Urbanization Trends



The figure shows that the percentage of people living in urbanized areas in India is lower than those in Asia as a whole or the world. According to the projection by the Asian Development Bank (ADB) India's urbanization rate will also remain lower than that of the other two regions in the future, but it will be over 40%. One direct consequence of this increase in urbanization combined with the growth in motorized modes of travel will be that the level of congestion on urban roads will also increase. If urban roads in Indian cities are considered to be congested now, they will be even more so in the coming years unless some drastic measures are taken by road managers.

Signal time composition	Signal time composition	Signal time composition
Classical method	Classical method	QAP method - 2
Calibration issues	Calibration issues	Self calibrating

(Source: C-DAC)

Factors affecting ATC System:

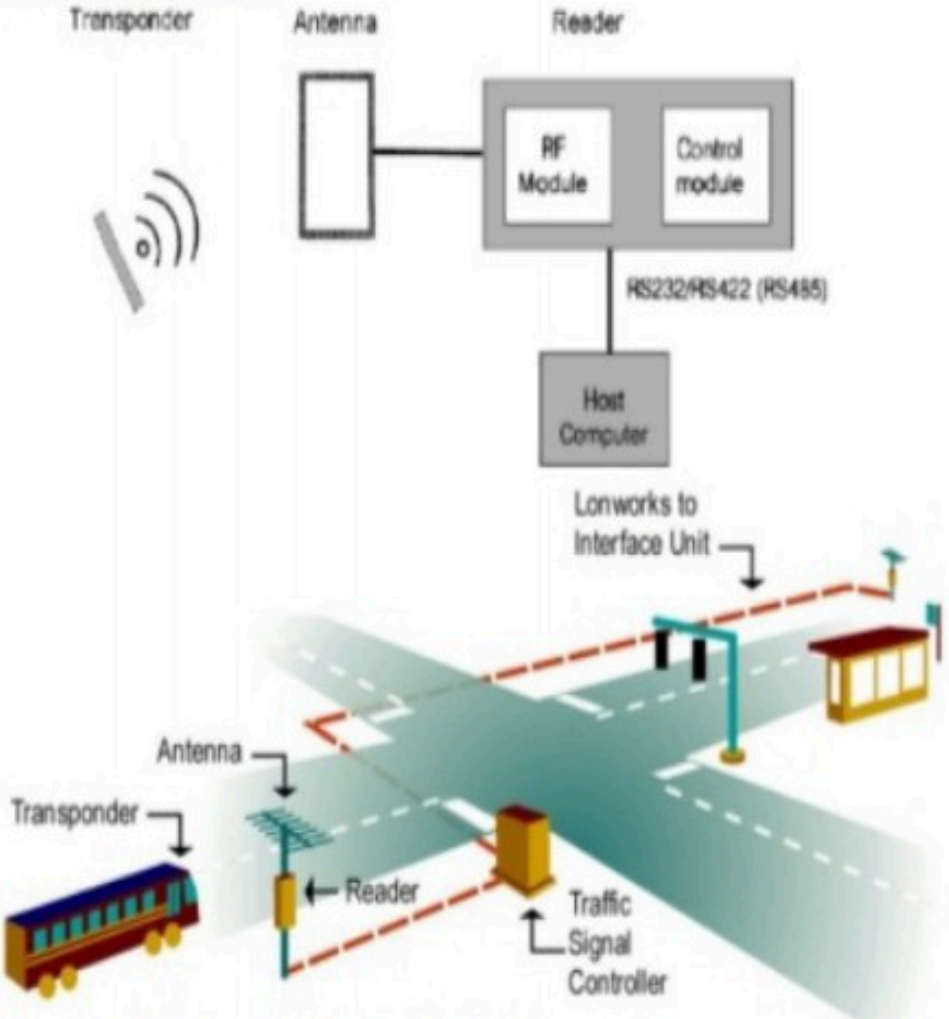
- Lane indiscipline, slip roads, on-street parking, Heterogeneous and non motorized traffic, power or communication reliability are major factors that affect the performance of ATC system.

ATC system for public transport, emergency vehicles and pedestrian.

Now a day's most of the ATC system take care of signal timing for pedestrian and provide green wave to public transport and emergency vehicles like ambulance, police vehicles, VIP vehicles. But the real benefit can only be seen when the buses, emergency vehicles are equipped with GPS based onboard unit (OBU).

This OBU unit transmits the signals to traffic controller unit at road side and traffic control unit immediately process the request and manage the green signal to provide priority to that vehicles. In this way the ATC can take provide priority to public transport system? Similarly automatic pedestrian detection system at intersection can take care of green signals for pedestrians while crossing the road.

Figure 5.3: Working of RFID system for providing priority to public transport at traffic signals (Ref Photo. Steve Muench and www.scribd.com)



As it is not in the scope of this work so further details are not provided.

One international model "CORDON" is multi target photo radar system can capture the data from four lanes simultaneously along with wrong lane detection and lane violations automatically.

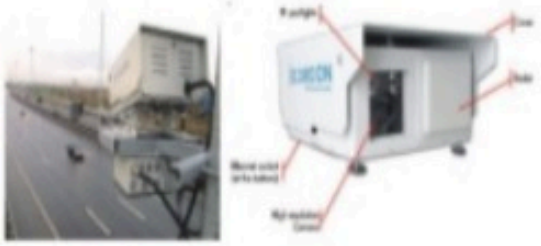


Figure 5.6: "Cordon Model. Its working methodology is shown as

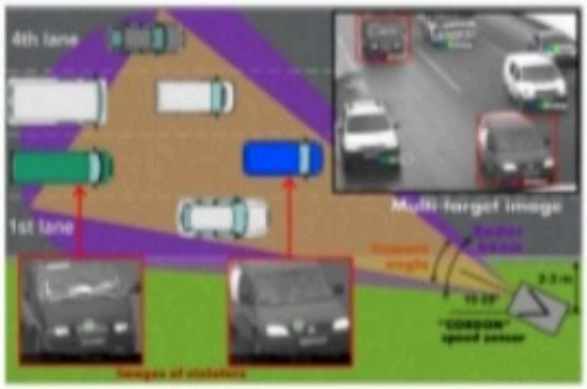


Figure 5.7: Working Methodology of Cordon machine Source www. Simicon.com)

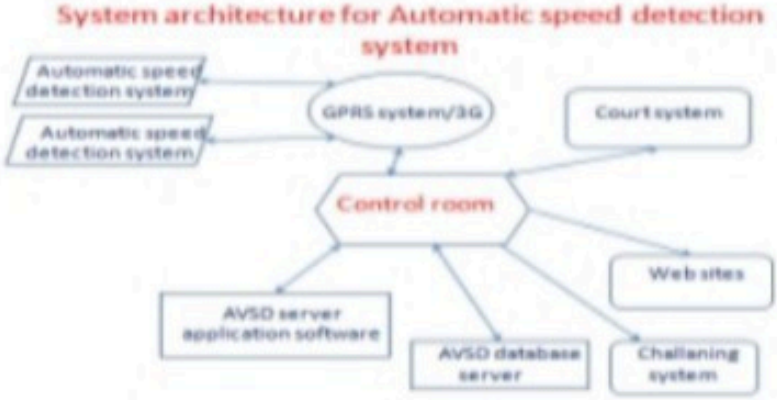


Figure 5.8: System architecture for Automatic Speed Detection System

5.5.4 Red-light Violation Detection System and Stop-line Violation Detection System

This system is normally taken care by previously mentioned system or more specifically by CCTV based system. The scope of above stated system is vast and requires more advanced system configuration. The above stated system is capable for handling multiple objectives but due to cost it is not desirable to cover the whole city or major network

What is Red light violation and stop line violation system?

It is a system comprising of sensor/ detection system, camera system, software and communication system to capture violations automatically

Types of system

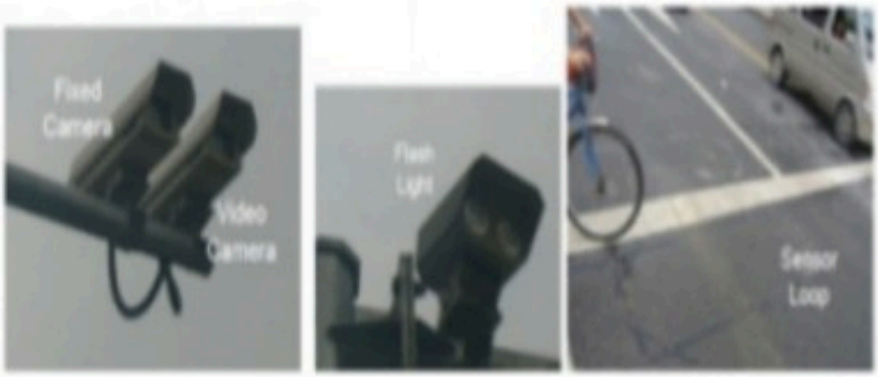
- First one is using the inductive loop detector based system
- Second one is using above ground sensors like radar/ microwave/ laser based system
- Third one is using the capability of camera for sensing

This system is also capable of capturing stop line violations.

Figure 5.11: Showing stop line violation detection system

(Source: Ravi Kumar, C - DAC)

Figure 5.12: Photo of Red-light Violation Detection



Working of type II is shown in Figure 5.13.

Figure 5.13: Working of type II model for Red-light Violation Detection System

Components of system

At field

- **Ist Type:** Sensor loops (inductive loops) detection system, Camera unit (video camera, still camera, flash light/IR illuminator)
- **IInd type:** laser detection system/ radar/ microwave system, camera unit
- **IIIrd type:** Camera unit (itself capable of detection also)
- Controller unit, storage unit

Communication system

- Back – end system
- Server
- Application software
- Workstation, printer

Working of IIIrd type

In this type of system the sensing job (with help of software also) and camera work is carried out by one unit itself. Rest of the working is same as shown in above mentioned types

The KRIA Company provides software "T-EXSPEED" that converts 'CORDON' camera which works for sensing also. In that case there is no need of any additional sensors. But adding infra red facility the system is capable for taking snaps in night also.

Figure 5.14: Output generated by RLVD system (Source: www. Kria.biz)

How it Works?

Once the location is selected and vehicle is stationed such that the drivers should not watch it or recognise easily

Figure 5.16 Other model of Interceptor Vans

Source: www. Roadflow.co.uk

If vehicle is fitted with mast then erect the mast and check the orientation of camera.

If it is first type of system in which the operator has to operate the system then operator should take his defined seat to watch the violation. It is also called old or first generation system. In this case the operator focus on incoming vehicle by targeting camera towards (or for outgoing as per setting and facility available) vehicle. He can move the camera, zoom, pan, tilt at object. On the basis of speed readings or any visual violations, he manually triggers the system to record the evidence. Naturally it is tiring job for operator to sit in vehicle and this usually decreases the efficiency, ultimately productivity.

In automatic system, once the system is on i.e. set to work, then there is no need for operator to interact with the system. It will detect the violations automatically in the view range of system. The ANPR system recognizes the number plate and the system records the offence and visual evidence. The available mobile communication system can transmit the whole data to control room in real time.

If the system is supported by GPS system then Global Positioning System (GPS) coordinates/location, date, time through real time clock, vehicle image with registration plate, speed limit, vehicle speed, distance, laser beam width and ID of equipment with date of last calibration will be recorded as a part of challan. The same data will be transmitted to control room.

Components of system

In vehicle

- ASDS/ ANPR camera unit, infra red unit (handheld/ fitted on tripod/fitted in vehicle/ top mounted on vehicle – hydraulic or mechanical mast
- Laptop, printer, application software
- Recording, playback, editing and storage system
- GPS system
- Secondary power system with sufficient backup

Communication and data transfer system

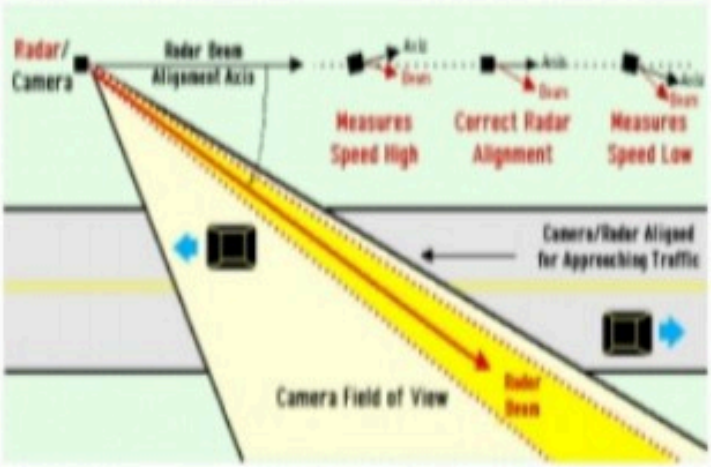
Back-end/ control room

- Server, workstation
- Printer
- Application software and image processing-video analytic software,
- Support database system

Limitations

This system is also having some limitation especially for single camera based system. The system work on the basis of input received from camera/ laser unit. The range and view angle creates a limitation of this system. What so ever violation falls in their range only that will be captured

Figure 5.17: Limitations of Radar system



The other limitations are not discussed due to security reasons (Source. Photo www. copradar.com)

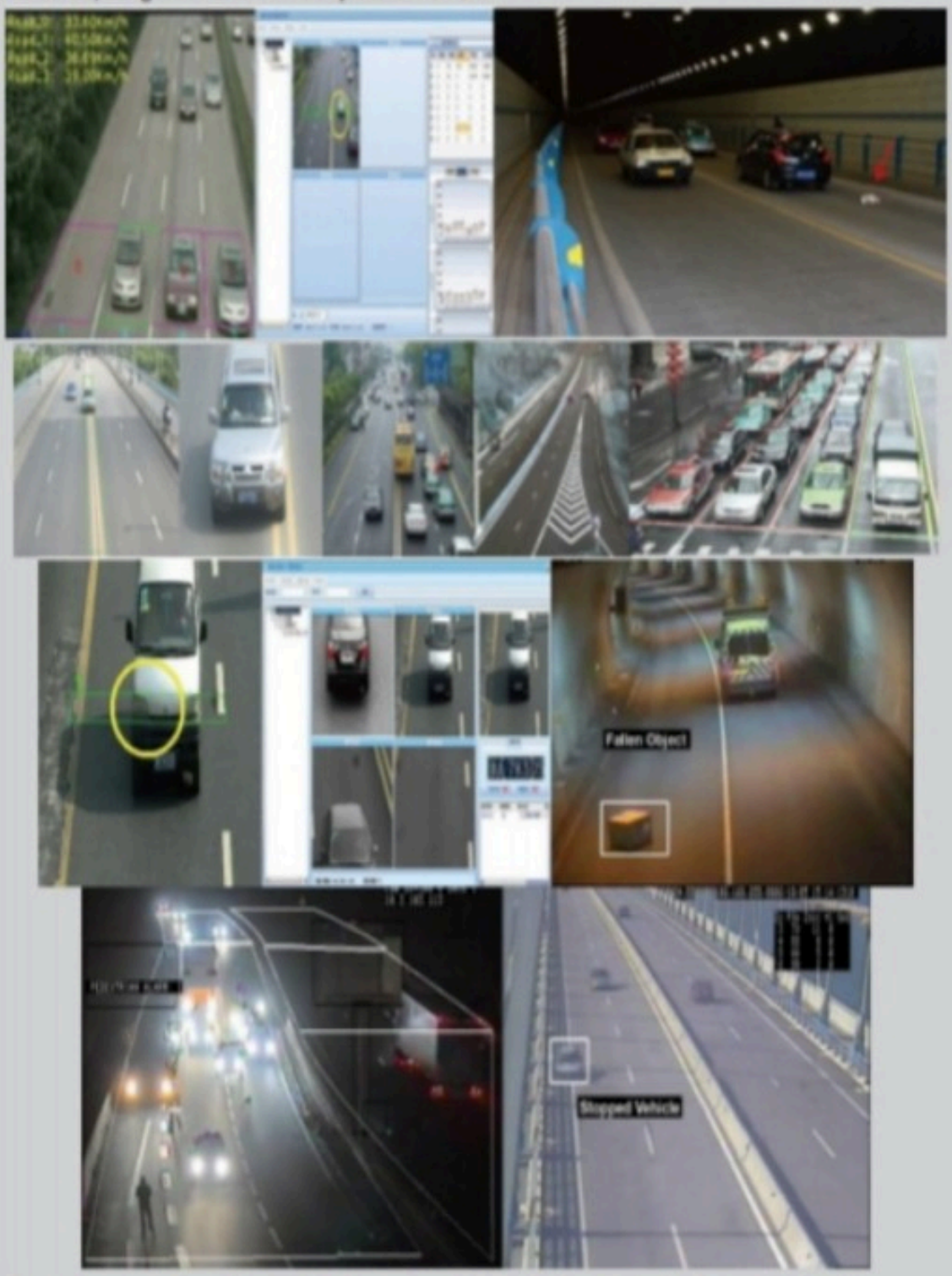
Other equipments available worldwide: One of the systems developed by Russian company **"SIMICON"** is a handheld speed measuring device, named **"BINAR",** which can not only measure the speed and also take visual of that vehicle simultaneously. This system can also be fitted in car. It consists of two embedded video cameras one with wide-angle lens and second with long-focus lens and speed meter system. This simultaneously records the traffic violation and its video clips

Figure 5.18: Simicon Model,

Its features

- Select the target oncoming and outgoing
- Work in stationary mode and mobile mode
- Recording in two modes, wide angle and zoom type
- Record speed, date, time, location and target image simultaneously
- Accuracy up to 150 meters in recognising the registration number plate of vehicle
- Recording and saving video clips in SD card up to 32 GB capacity
- Automatic self testing, Logging of all events
- Bluetooth 2.0 wireless connection to external device
- PC based software for data transfer and for printing the clips with event
- Rechargeable from vehicle power and facility of battery backup
- Fitted in car with the help of mounted bracket, also having remote control

Figure 5.20: Capturing the fallen objects, vehicle crossing median (lane violation), park vehicle or incidence, congestion and number plate of vehicle



Source Photo. www jacksound.cn and www. traficon.com. It also converts information into statistical data.

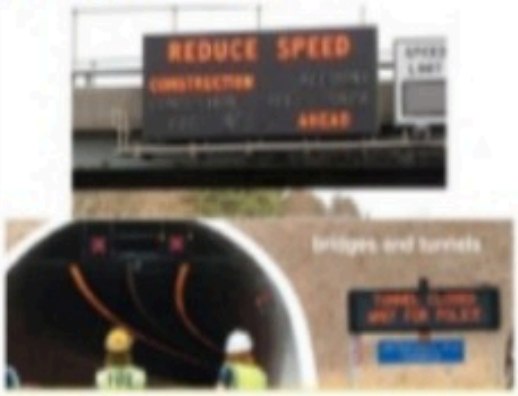
How it Works?

Whenever any object or vehicle enters (come) in the range of camera's view field, the intelligent software (device) use the video detection technique (like Trip line or closed loop tracking or data association tracking or any other) to detect and generate a signal to system. On that basis system

Categories of VMS: Basically the VMS can be used in two modes i.e. Fixed text message sign and defined text message sign. The fixed type is more or less same as static types of signage with difference that it can be switched off when it is not required while static type is displayed all times. On content basis the VMS can also be classified as informative type, directing type, guiding type, warning type and multiple informative types. These types are displayed in followings figures.

Figure 5.22: Different types of VMS system

Fixed text message sign; fixed message is displayed when the message is to be displayed. Otherwise it is in off mode. There is no choice to change the message



Defined text message sign; pre-defined or stored message are displayed depending on traffic conditions. It is capable to display any type of message, figures and symbols. In advanced system, the video image can also be displayed, but that is against the basic use of VMS.

Informative type; gives information about traffic jam, congestion conditions, construction notices, special event notices, weather conditions and travel time between two destinations

Directing; gives direction to motorists to move in particular direction

Warning; gives message to follow the rules

Guiding; these messages guide the driver for alternative route

Multiple Informative Types;

Components of system

In field

- Display system
- Controller and control unit
- Power backup system

Communication system

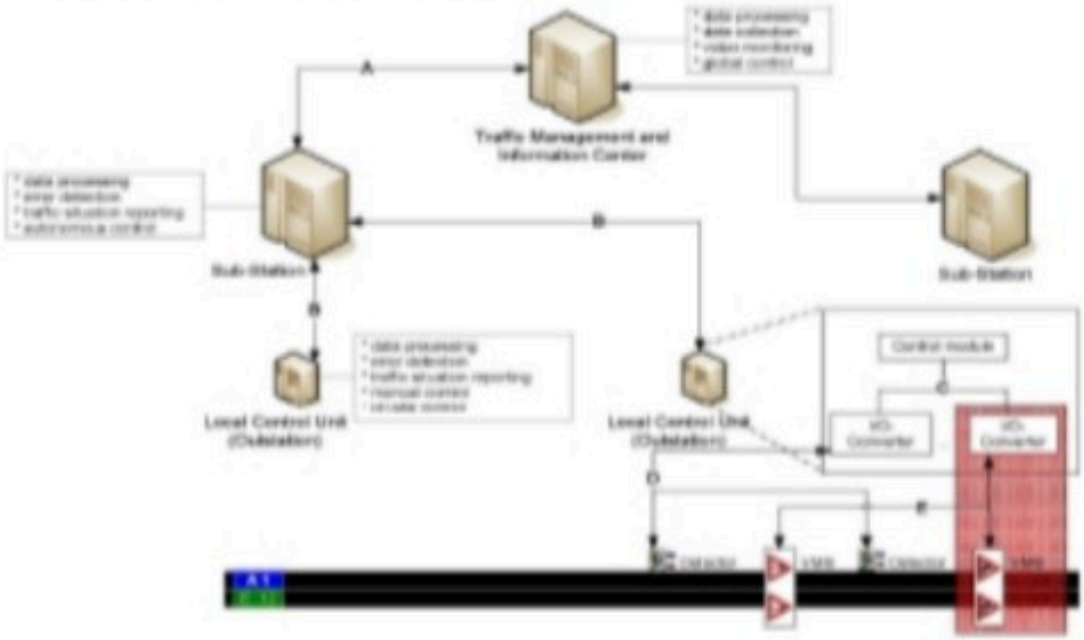
- Control room
- Server, workstation

How it Works?

Depending on traffic condition or as per requirement the message is displayed on VMS units installed on network. Actually the set of messages for different situations are already stored in server and operator has to simply choose the message as per direction and push to VMS unit. It is also possible for operator to deliver/ send different type of messages to different VMS units. The facility is also available that in case of connectivity failure the VMS unit can display pre defined message with the help of local controller/control unit. If there is no power or any malfunction in VMS unit the information will be communicated back to control room (using power backup system) instantly so that operator can take appropriate action.

The system architecture for VMS system as part of traffic management system defined by Hannes Kulovits, Christoph Stogerer and Wolfgang Kastner is shown in Figure 5.23.

Figure 5.23 system architecture for VMS system



Source: 10th IEEE Intl. Conference on Emerging Technologies and Factory Automation (ETFA '05) Volume 2, September 2005

The major benefits of VMS can be seen in reduction of frustration of drivers. The slow traffic or congestion usually increases the frustration and impatience among drivers. This impatience is converted in form of

The optical fiber must be preferred over copper wire based system. The wireless system (mobile/ 2G/ 3G) is preferable over optical fiber system.

Data collection in simple way:

In following one system is discussed for which the manufacturer claims that it is low cost and highly accurate equipment to collect road side traffic data. An Australian company "CEOS" developed a equipment "TIRTL" (The Infra red Traffic Logger/ Transportable Infra-Red Traffic Logger) that can counts, classify, determines the lane and speed of passing vehicle.

Single system that is non-invasive, capable of monitoring/ collecting data for multilane, uni-directional and bi-directional traffic. (Source CEOS Industries)

Figure 5.27 AVCC machine

Major applications of TIRTL

- Automatic vehicle detection, counting, vehicle classification and speed measurement
- Speed and red-light enforcement (if connected with camera system)
- Incidence detection (if installed at an interval of 500 meter each)
- Auditing toll data
- Heavy vehicle enforcement – over height and over-length vehicle detection
- Bus lane enforcement, lane violations
- Traffic monitoring for real time applications
- WIM support providing vehicle count and classified data, communication and data logging

How it Works?

A TIRTL installation consists of Transmitter (Tx) and Receiver (Rx) pair located on opposite sides of the road. The transmitter unit is essentially a torch of light with two different frequencies (or infra-red beams) which then produce two Parallel beams and two crossed beams called "beam event". Whenever any vehicle enter in its influence zone then these beams break called "break beam event". Once the vehicle crosses then the beam is once again return back to its original path and it is called "make beam event". These events create light pulses. The Receiver unit detects these "event" from these four infra-red Beams caused by the wheels of passing vehicles, and uses the intelligent software to analyse the timings of the light pulses to produce vehicle classifications (Source CEOS Industries).

Figure 5.28: working of AVCC machine

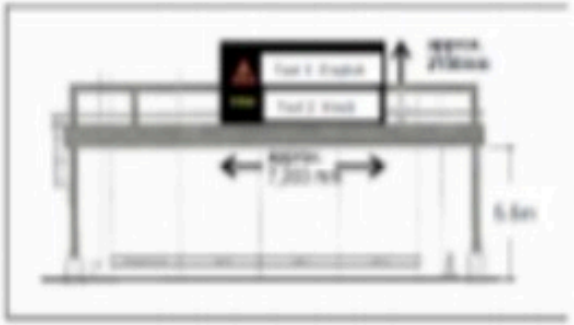
- Inter word spacing should be 75 to 100% letter height
- The uppercase or mixed case message is much better for single word and lower case for longer textual message.

The characteristics of cantilever mounted VMS systems as mentioned above are discussed. Some time road geometries or need for displaying different messages for different lanes force to use gantries mounted VMS system. Especially for more than 4, lanes gentry mounted VMS system is suggested for better effectiveness as the cantilever mounted sign take more reading time by drivers driving in extreme opposite lane. It is also useful when junctions are too closed. The Wisconsin department of transport provides the design for gantry mounted VMS system including cantilever as shown in following

Type of VMS	Height Requirement	
Overhead Sign Bridge	16 feet from roadway crown to lowest point on the sign. Note typically the lowest point is the base of the catwalk	
Cantilever	18 feet from roadway crown to lowest point on the sign.	
Shoulder Mounted	6 feet from the roadway crown to the base of the sign.	

VMS installation as per guidelines of Federal Transit Administration, USA

The Delhi Traffic police suggested following type of VMS for national highway, expressway



(ii) "–"represents that there is no VMS at this offset for this speed

(iii) Type B VMS has 320 mm character height; Type C VMS have 400 mm character height

The VMS types are shown in following sections

Message unit:

The message consists of units of information. Unit describes one separate piece of data that used by driver to take decision. A ideal unit should be of two words but can go up to four words

Ex; A unit of two words - No entry. Ex; A unit of four words - road closed, take diversion

Ex; message of three units; No entry

10.00 am to 12.00 am

Take diversion

Message length:

It is suggested that ideal message length is of 8 words message. Each word may of maximum of 4 to 8 characters.

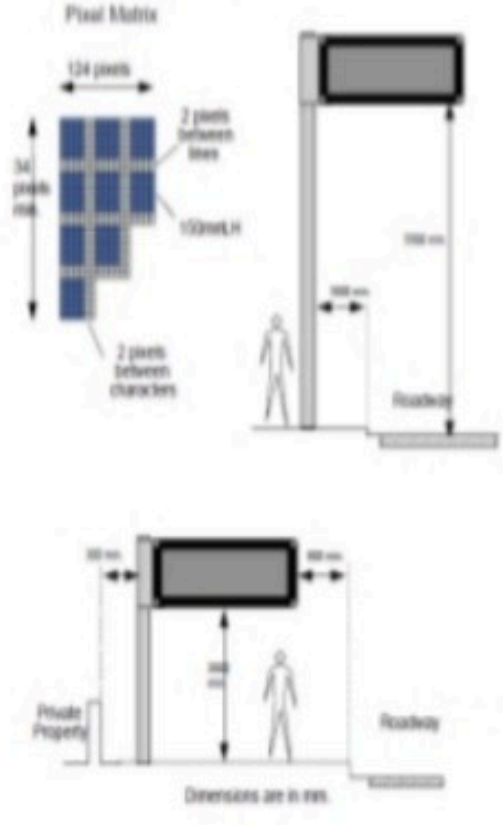
Pictogram:

The pictogram should be as per IRC – 67.

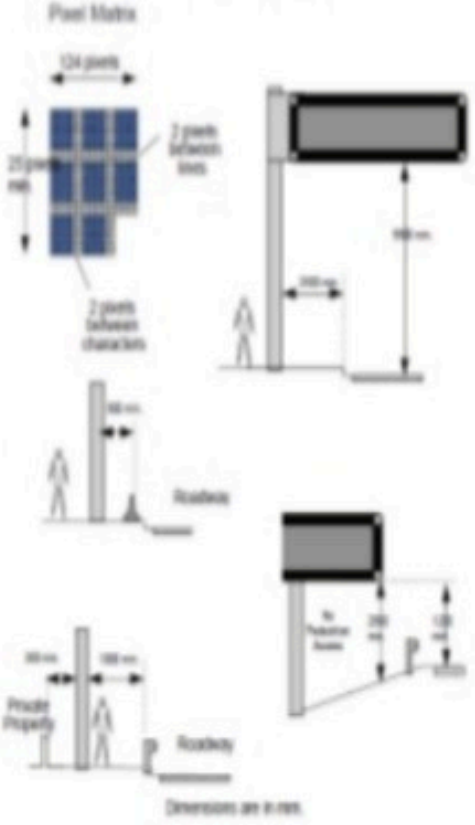
VMS display type:

As per RTA guidelines the Type A and Type B VMS are shown in the following

VMS of type A



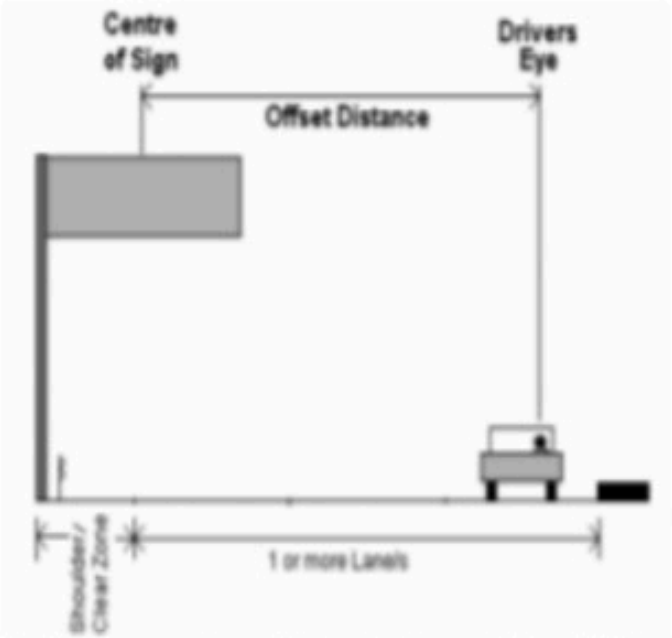
VMS of type B



4. As per Delhi Traffic Police the message should remain at least 15 seconds for National Highway and for 20 seconds for access control expressway.

5. As per RTA (The Road and Transport Authority, NSW, Australia) guidelines, the driver used to take on average 3 seconds to screen the complex message. On this assumption, the RTA (RTA guidelines PN 028/G, TDT 2005/02b) provided the following table for legibility/ sight distance and VMS types. The various combinations of approaching speed, offsets and suggested VMS types are shown in this table

Definition of offset



Therefore, in the diagram above, for typical lane widths of 3.5m and a clearance/footpath/shoulder width of 2m the offset would approximately be:

Drivers Eye + Lane + Lane + Shoulder - (half sign width)

(3.5 – 1.0) + 3.5 + 3.5 + 2.0 – 3.0 = 8.5m

Offset from centre of sign to Drivers eye (metres)		Sight Distance (SD_{min}) & Type of VMS Req'd	Speed Zone (km/h)					
			60	70	80	90	100	110
	0 – 6 m	SD_{min}	180	200	220	240	260	280
		VMS TYPE	B	B	B	C	C	C
	6 – 9 m	SD_{min}	205	225	245	265	285	305
		VMS TYPE	B	B	C	C	C	C
	9 – 12 m	SD_{min}	230	250	270	290	310	-
		VMS TYPE	B	C	C	C	C	-
	12 – 15 m	SD_{min}	255	275	295	-	-	-
		VMS TYPE	C	C	C	-	-	-
	15 – 18 m	SD_{min}	280	300	-	-	-	-
		VMS TYPE	C	C	-	-	-	-
	18 – 21 m	SD_{min}	305	-	-	-	-	-
		VMS TYPE	C	-	-	-	-	-

(i) SD_{min} = Minimum sight distance required to sign face (in meters)

Figure 6.2 Speed map and Right of way of network Kochi

Source: IInd Semester M. Plan (TP) SPA, 2013

Figure 6.3 Showing CW and level of service of Kochi

Source: IInd Semester M. Plan (TP) SPA, 2013

Functional specification of system

1. PTZ (pan, tilt and zoom) camera system should be one well integrated unit with IP based solid state color camera with zoom lens, focusing, pan and tilt mechanism along camera mounting assembly.
2. The cameras units can be installed on cantilevers or poles or mast or sign bridges. So camera mounting unit must able to support the weight of camera unit and withstand maximum wind velocity expected in city.
3. If camera unit is roof top mounted, then it must have minimum distance of 300 mm between mounting and building face.
4. The field camera unit should have digital camera control receiver (CCR) that can receive or respond signals from control room.
5. The CCR must be compatible with camera control software such that the operator can remotely control the zoom in/out, tilt up/down, pan right/left, focus near/far, iris open/ close, iris control manual/ automatic and camera on/off.
6. The same features should also be available locally with main power switch, fuse etc.
7. The CCR should able to communicate to control room about any malfunctions or fault.
8. The units are installed in a way so that maintenance job can be done easily
9. System should be weather proof and rust proof
10. The system must be supported by secondary power back up system
11. The system should work between 0^0 to 50^0 centigrade.
12. It should work in 24x7 mode in day and night conditions
13. It should have facility of remote monitoring of different zones simultaneously on video wall of on operators terminals.
14. The appropriate communication should be provided such that all field units can transmit the data on-line in real-time
15. The working and operation status of each unit should be displayed at operators' consol or on video wall (on GIS map)
16. System must have automatic fault management/ reporting system-like no power, no communication etc.
17. The user can set the frame rate of each camera for live, still or for motion recording.

Functional specification for application software

1. The software should able to capture and store data as specified in scope and in above functionalities.
2. The system should allow easy maintenance and updating of master and transition files if any.

[{"id":"7f6ec11d.5dbf98","type":"rpi-gpio out","z":"
a78c170b.f51c08","name":"Red LED","pin":"11","set":
true,"level":"0","freq":"","out":"out","x":408,"y":198,"
wires":[]},{"id":"4a36e764.7ed18c","type":"rpi-gpio
out","z":"a78c170b.f51c08","name":"Yellow LED","pin":
"13","set":true,"level":"0","freq":"","out":"out","x":420,"
y":276,"wires":[]},{"id":"d5de14ed.413e3","type":"rpi-
gpio out","z":"a78c170b.f51c08","name":"Green LED","
pin":"15","set":true,"level":"0","freq":"","out":"out","x":
419,"y":352,"wires":[]},{"id":"fa63a4cb.439d88","type
":"rpi-gpio in","z":"a78c170b.f51c08","name":"Vehicle
Presence","pin":"7","intype":"down","debounce":"25","
read":false,"x":219,"y":284,"wires":[["578fa5a8.
45a25c"]]},{"id":"578fa5a8.45a25c","type":"function"
,"z":"a78c170b.f51c08","name":"Traffic Light Control"
,"func":"var vehiclePresent = msg.payload;\n\nif
(vehiclePresent === 1) {\n   return { payload: \"red
\" };\n} else {\n   return { payload: \"green\" };\n}","
outputs":1,"noerr":0,"x":436,"y":284,"wires":[["
7f6ec11d.5dbf98","d5de14ed.413e3"]]},{"id":"
ae3c1a62.0c6ee8","type":"inject","z":"a78c170b.
f51c08","name":"Simulate Vehicle Presence","topic":""
,"payload":"1","payloadType":"num","repeat":"","crontab
":"","once":false,"onceDelay":0.1,"x":255,"y":392,"wires
":[["578fa5a8.45a25c"]]},{"id":"a3e7e4c8.7e2ca","
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Vehicle","topic":"","payload":"0","payloadType":"num","
repeat":"","crontab":"","once":false,"onceDelay":0.1,"x":
243,"y":440,"wires":[["578fa5a8.45a25c"]]},{"id":"
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f51c08","group":"3be0b607.86f8f2","order":0,"width
":0,"height":0,"name":"","label":"Traffic Light","
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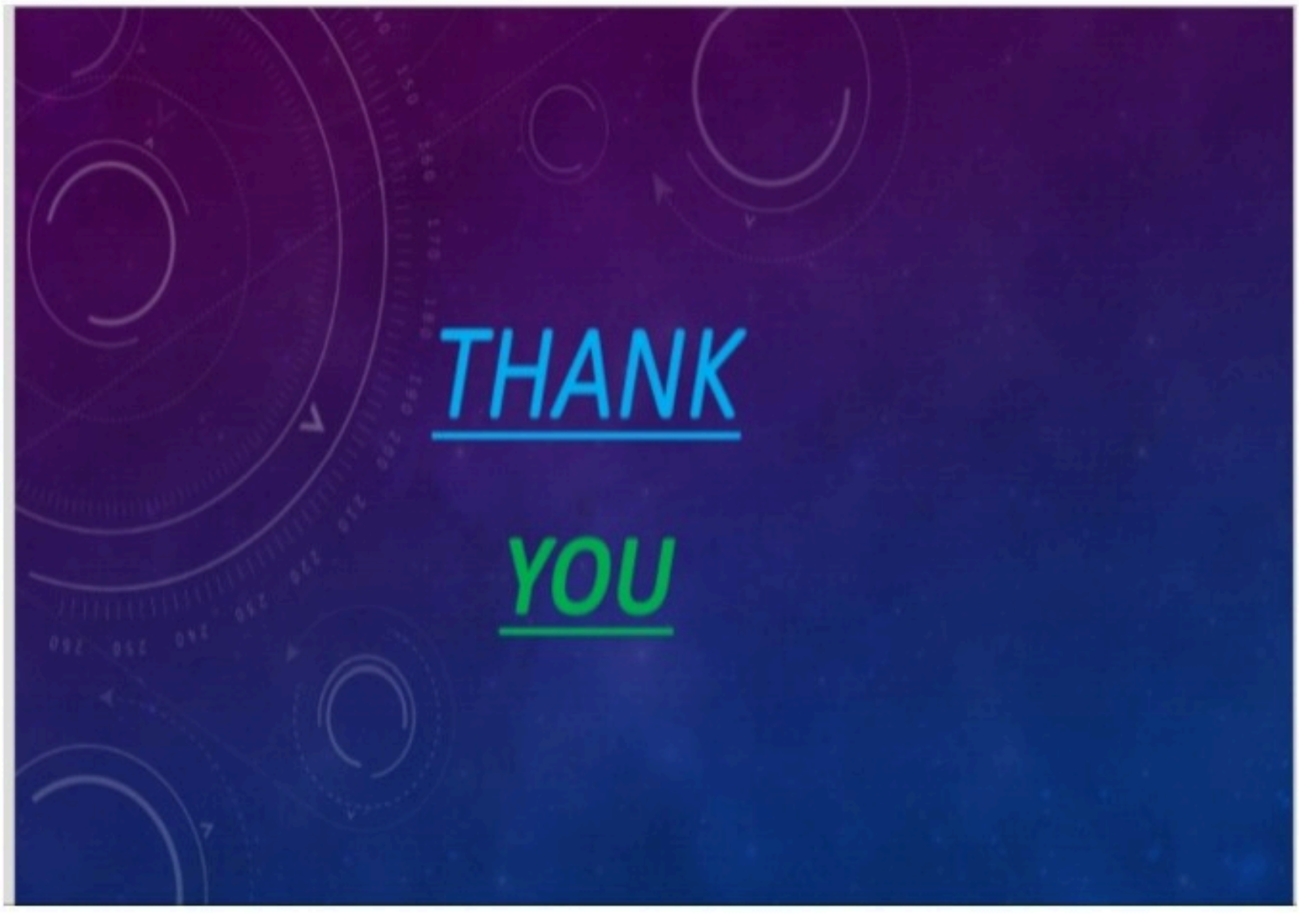
valueType":"str"},{"color":"#FFFF00","value":"yellow","
valueType":"str"},{"color":"#00FF00","value":"green","
valueType":"str"}],"allowColorForValue":false,"

"},{"color":"#00FF00","value":"green","valueType":"
str"}],"allowColorForValue":false,"showGlow":true,"
nameLED":"LED","x":672,"y":310,"wires":[]},{"id":"
3be0b607.86f8f2","type":"ui_group","name":"Traffic
Control","tab":"d52eae99.b91af8","order":1,"disp":
true,"width":"6","collapse":false},{"id":"d52eae99.
b91af8","type":"ui_tab","name":"Home","icon":"
dashboard","order":1,"disabled":false,"hidden

Output:

In this simplified example, the system simulates traffic lights based on the presence or absence of vehicles. When a vehicle is detected, the red LED lights up, indicating a stop. When there's no vehicle, the green LED lights up, indicating traffic flow.


THANK
YOU