



# Capacity Building Workshop

## on the implementation of Advanced Traffic Management System (ATMS)

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### Session 3: The Functions and Components of an Advanced Traffic Management System (ATMS)

# Contents

- Definition of ATMS
- Objectives of ATMS
- Features of ATMS
- Components of ATMS
- Functions of ATMS
- ATMS Applications



# Definition of Advanced Traffic Management System

- A primary subfield within the Intelligent Transportation System (ITS).
- A top-down management perspective that integrates technology
- Used to improve the flow of vehicle traffic and improve safety.
- Real-time traffic data flows into a Traffic Management Center (TMC) where it is integrated and processed and may result in actions taken the goal of improving traffic flow.

# Objectives of ATMS



Increase Average  
Travel Speed



Reduce Vehicle  
Delays



Improve Quality  
of Traffic Flow



Reduce Number  
of Collisions

# Features of ATMS

Monitor and visualize traffic conditions in real time



Help decision makers and transport planners



Alert for closed or congested road and weather conditions



Detect and provide Incident management

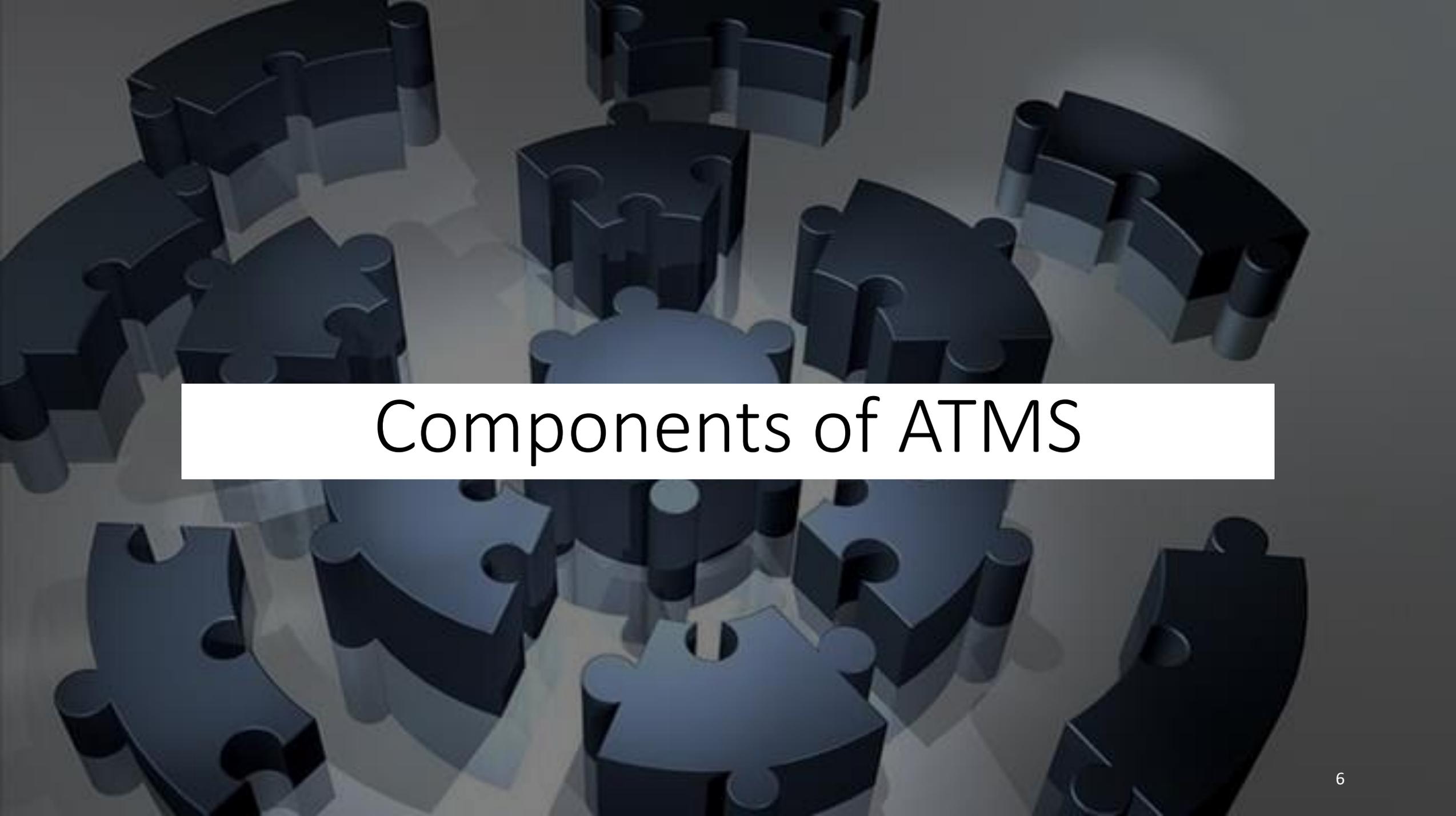


Provide multimodal traveler information services



Increase in traffic system's efficiency





# Components of ATMS

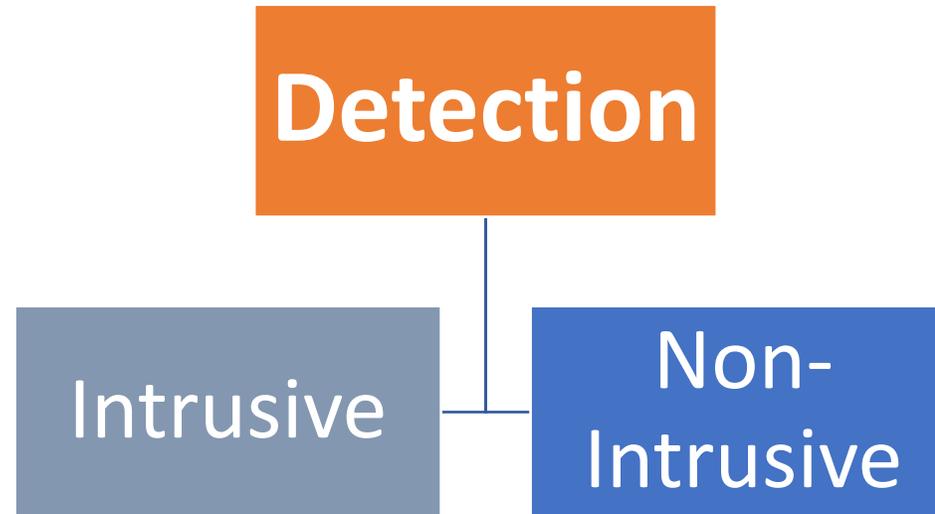
- Pneumatic Road Tube
- Inductive Loop Detector (ILD)
- Magnetic Sensors
- Piezoelectric Sensors

**Advantages:**

- Mature Technology

**Disadvantages:**

- High installation costs
- Traffic disruptions during installation
- Can be damaged by heavy traffic
- Frequent maintenance and Repairs



- Microwave Radar Sensors
- Infrared Sensors
- Ultrasonic Sensors
- Acoustic Array Sensors
- Image Processing
- Closed Circuit TV (CCTV)
- Automatic Vehicle Location

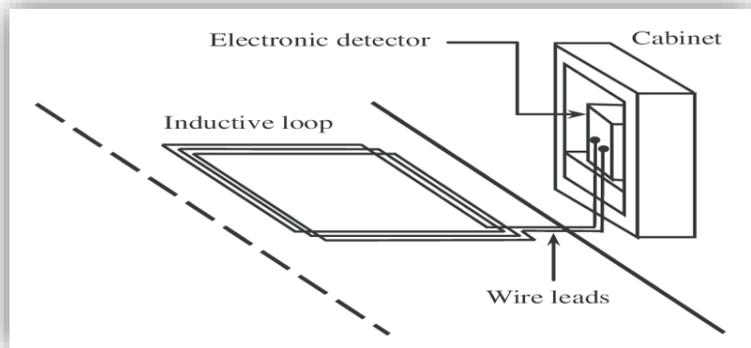
**Advantages:**

- No road damage
- Provide additional traffic information
- Function under severe weather conditions (snow, fog, rain, ...)
- Function under poor lightening conditions

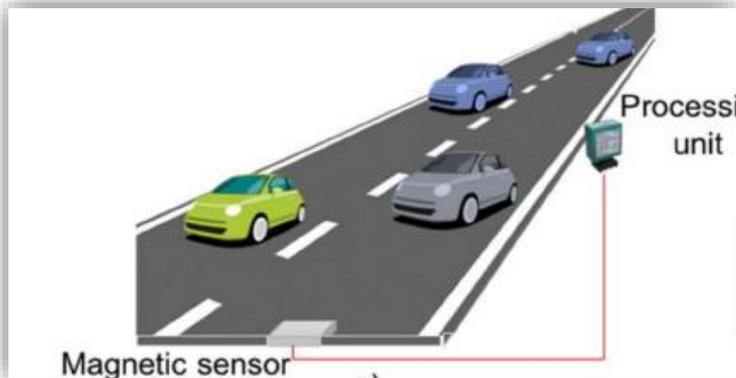
**Disadvantages:**

- Expensive
- High maintenance costs

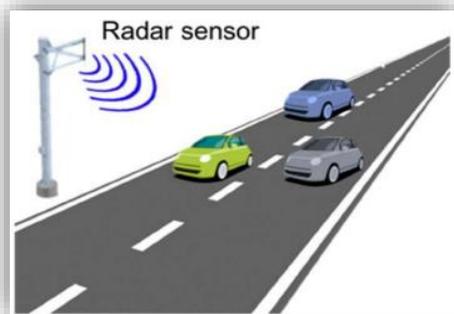
**Inductive Loop Detector**



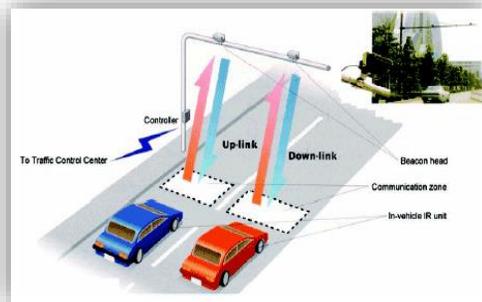
**Magnetic Sensor**



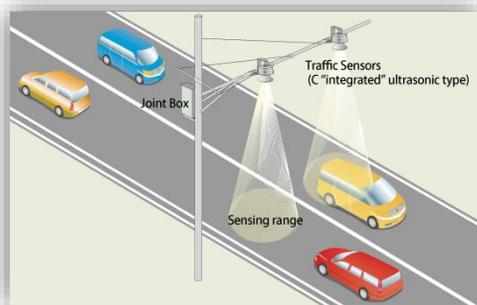
**Piezoelectric Sensor**



**Microwave Radar Sensor**



**Infrared Sensor**



**Ultrasonic Sensor**

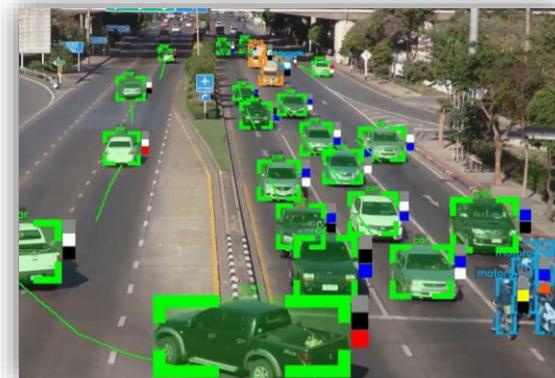


**Acoustic Sensor**

**CCTV Camera**



**Video Image Processing**



**Automatic Vehicle Location**



# Detection Summary Table

Detector Type	Vehicle Presence	Speed	Occupancy	Vehicle Classification
Inductive Loop Detector **	✓	✓	✓	✓
Magnetic Sensors	✓	✗	✗	✗
Piezoelectric	✓	✓	✗	✓
Microwave Radar	✓	✓	✗	✗
Infrared Sensors	✓	✓	✓	✓
Ultrasonic Sensors	✓	✓	✓	✓
Acoustic Sensors	✓	✓	✓	✓
Video Image Processing & CCTV*	✓	✓	✓	✓

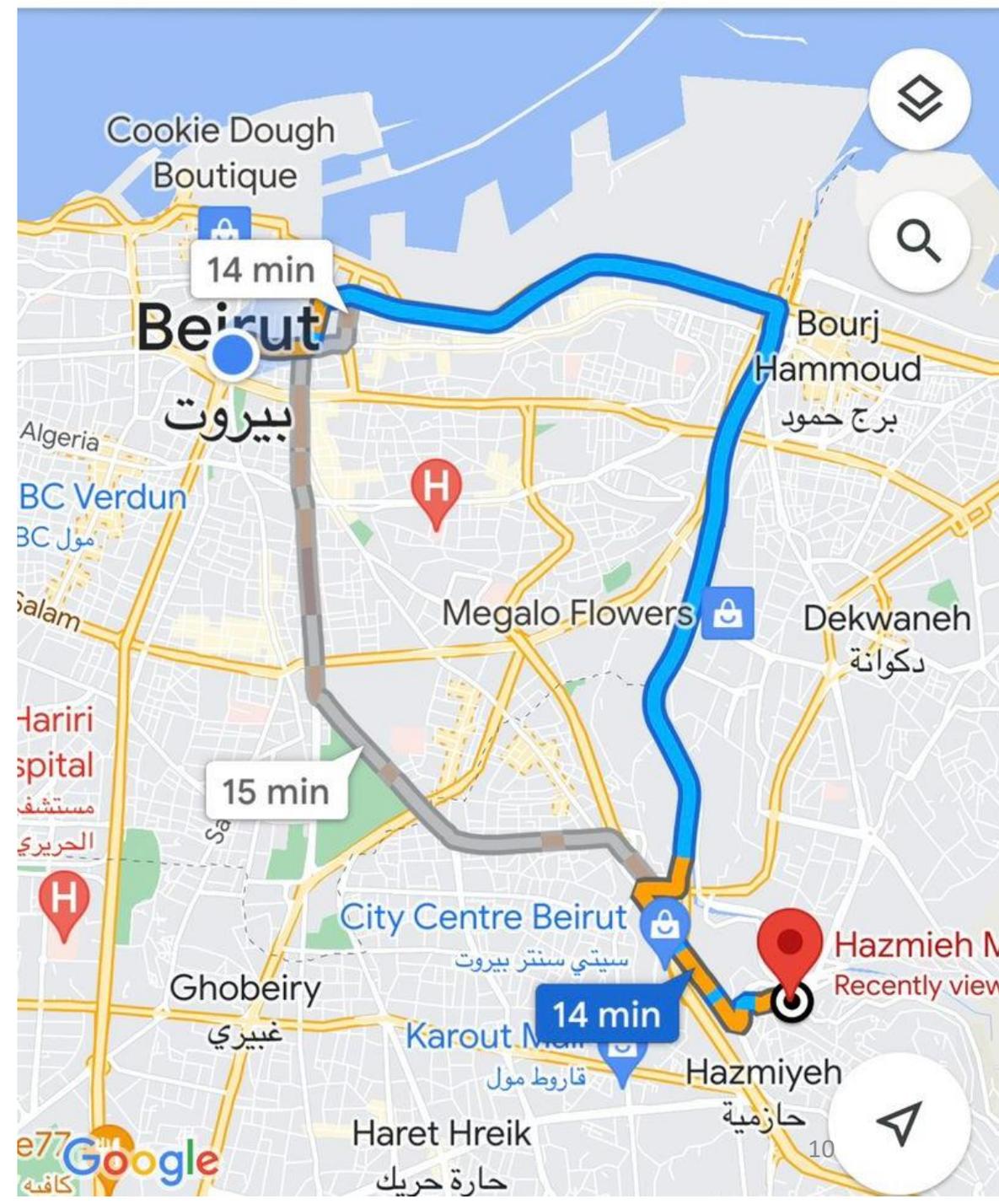
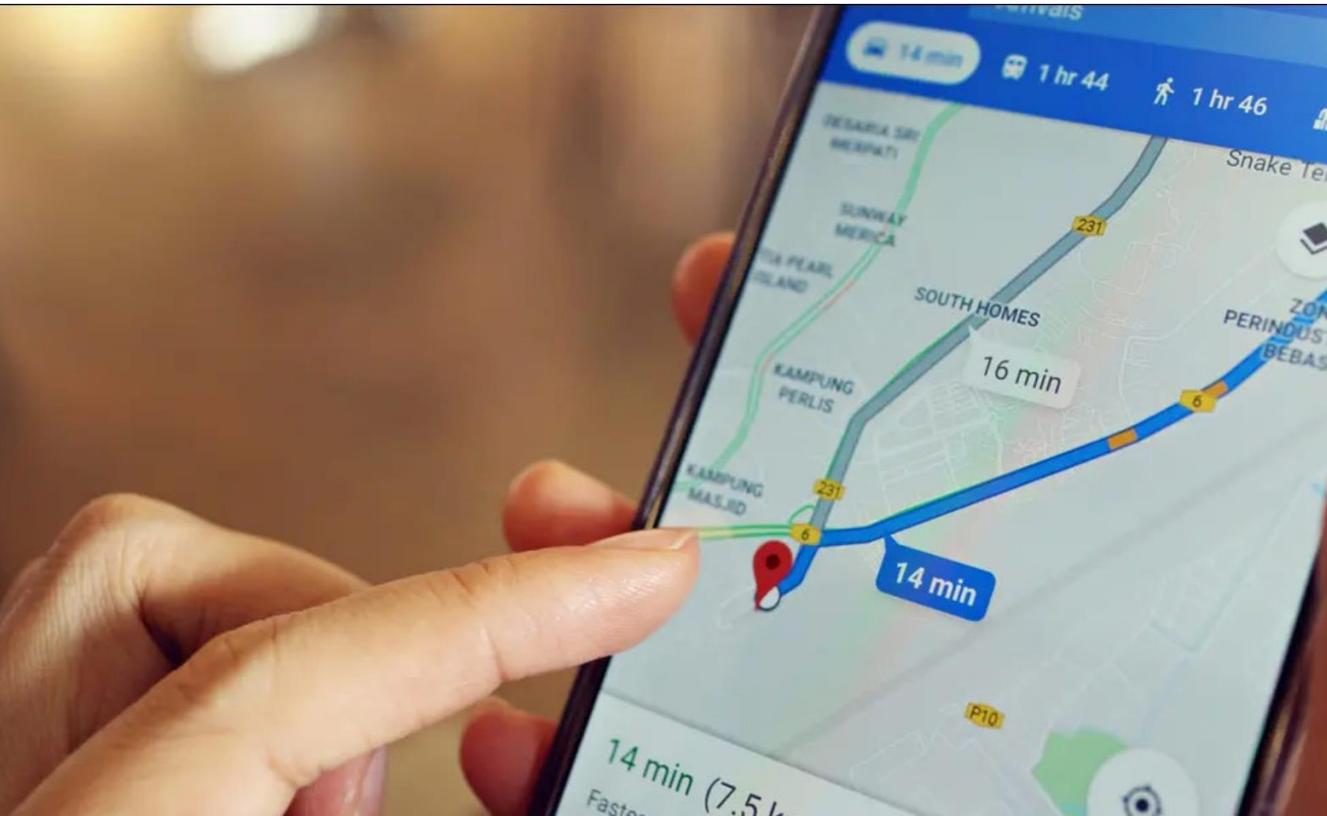
\* Widely used for Incident Detection

\*\* Widely used for Incident Detection and in Advanced Signal Traffic control system

# Remote Sensing Satellite Applications



- Detect Congestion
- Advise road users of alternate routes
- Estimate average travel time



# Hardware

## 1. Computers

Receive information from field devices and sensors;

- Communicate data from the control center to field devices
- Process data to derive meaningful traffic parameters from real-time data collected by sensors; and archive the data collected.

2. **Graphical displays** in the control center (array of video screens)

3. **Traffic controllers** on site

4. **Variable/Dynamic Message Signs**

# Software

- Data Processing software for real-time collected traffic data
- Incident detection algorithms:
  - Comparative-type or pattern recognition algorithms
  - Catastrophe theory algorithms
  - Statistical-based algorithms
  - Artificial intelligence-based algorithms





# Communications

- Vehicle-to-Vehicle (V2V)
- Vehicle-to-infrastructure (V2I)
- Communications among the components of a control center and between the control center and the field devices.
  - Communications within the center is accomplished via a local area network (LAN), or wirelessly
  - Communications between the center and the field devices take place via a wire-line communication system (e.g., fiber optic, coaxial cable, twisted pair) or wireless system is used.



# Functions of ATMS

1. Incident Management
2. Congestion Management
3. Corridor Management and Network Management
4. Travel Demand Management



# 1. Incident Management

## Description:

Early detection and response to unscheduled events

## Advantages:

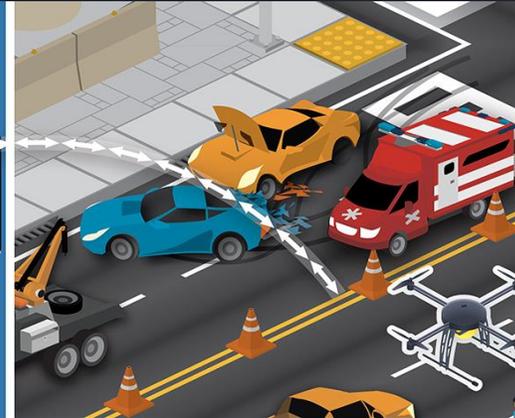
- ✓ Maximize the use of available roadway capacity
- ✓ Reduce the impact of non-recurring congestion
- ✓ Reduce the overall duration of an incident
- ✓ Increase traffic safety



**Traffic Incident**



**Traffic Operation Center**



**Traffic Incident Response**

# Incident Management (Cont'd)



## Verification

- Occur at Traffic Management Center
- Use of CCTV cameras



Incident occurs

# 01

Detection

## Detection

- Automatic incident detection (algorithms, machine learning)
- Motorist call-in services
- Citizenship and police reporting



# 02

Verification

# 03

Response

## Response

- Automated response plan generation (Variable Message Signs)
- Manual Communication for traveler information (Radio, TV, text messages, social media, ...)
- Pre-determined response agency (TMC, Redcross, Security,...) communications



## Recovery

- Going back to Normal operating conditions

# 04

Recovery

Clearance



## 2. Congestion Management

### **Description:**

Employing a variety of traffic management and control strategies to mitigate the negative impacts of recurring congestion.

### **Advantages:**

- ✓ *Optimize roadway capacity*
- ✓ *Decrease Delay*
- ✓ *Minimizing fuel consumption and vehicle emissions*
- ✓ *Improve road safety*

# Congestion Management (Cont'd)

## Steps Required:



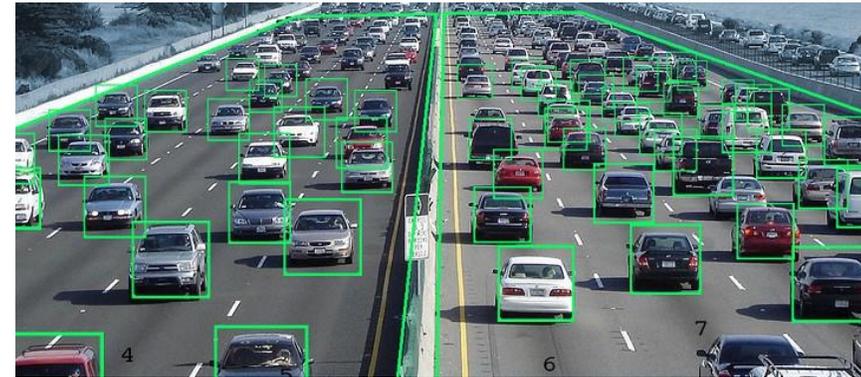
Traffic Congestion  
Monitoring/  
Vehicle Detection

Advanced Traffic  
Controller

Pre-trip and en-  
route Advisory

## Traffic Congestion Monitoring/ Vehicle Detection:

- GPS Vehicle Tracking
- Video cameras + Image Processing (Machine learning)
- IOT/crowdsourced data (info from driver's smart phones)





## Advanced Traffic Controller

- Traffic Data Processing
- Level-of-service and speed calculation across some routes



Beirut, Lebanon



## Pre-trip and en-route Advisory

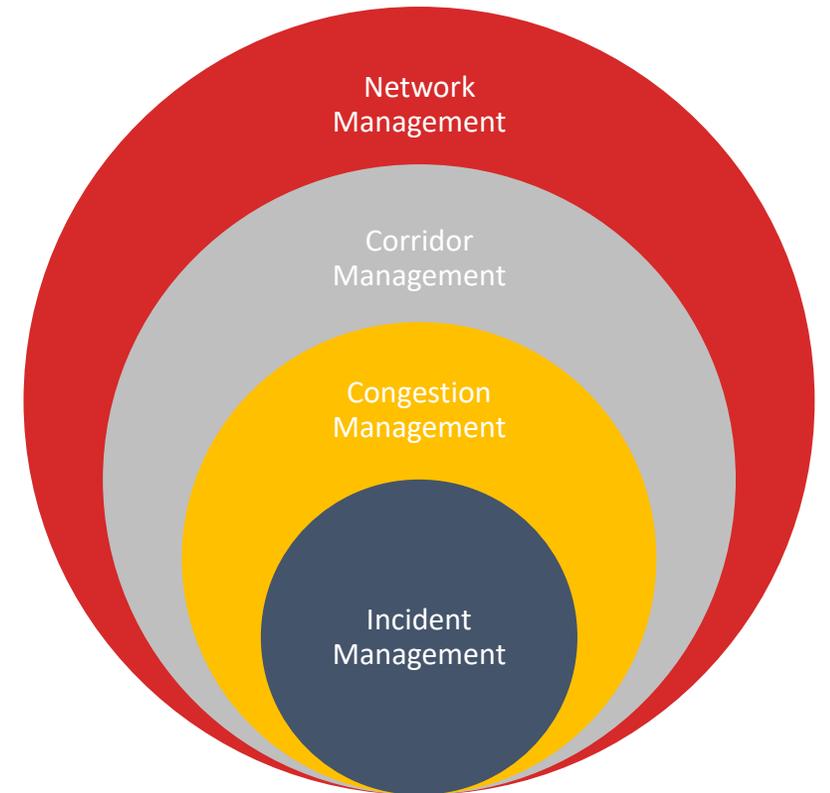
*Real-time Traffic Information Dissemination to road users through:*

- Variable/Dynamic Message signs
- Radio messages
- Phone Text messages
- Social media

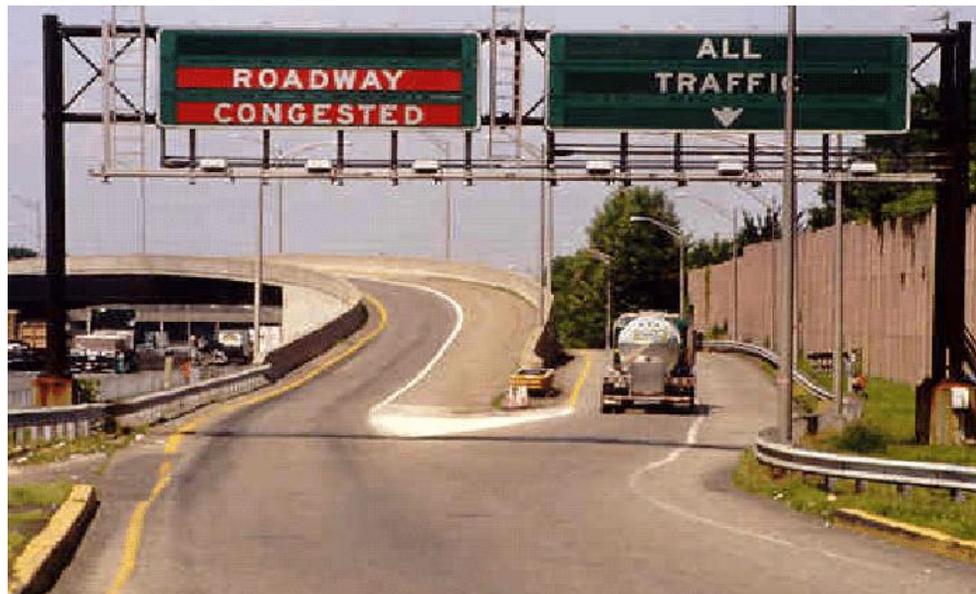


# 3. Corridor Management and Network Management

- Involves the application of several traffic management strategies within a specific corridor/network to ensure that available capacity is well utilized, and the overall corridor/network operates efficiently.
- Balancing the **level of service** among alternate parallel routes within a corridor/network as a function of current conditions.



# Corridor Management and Network Management (Cont'd)



## Diversion Strategies:

- Diversion of traffic to alternate routes **should not** be actively promoted **unless** current traffic condition data is available for the alternate route, and traffic control systems are available to respond to the increase in traffic flow.
- The ATMS gathers detailed travel data from each route and runs an algorithm to determine which route is the fastest at that point in time.
- Information can then be disseminated to motorists through a variety VMS and other traveler information devices

## 4. Travel Demand Management:

- Improving traffic flow by managing travel demand.
- Achieved through one of the following strategies:
  1. **Electronic Road Pricing:** additional user charges and differentials based on time, place, distance of travel, and vehicle type to effect changes in travel behaviour.
  2. **Pre-Trip Travel Information:** real-time traveler information can be provided through a mobile application, website, social media, etc....

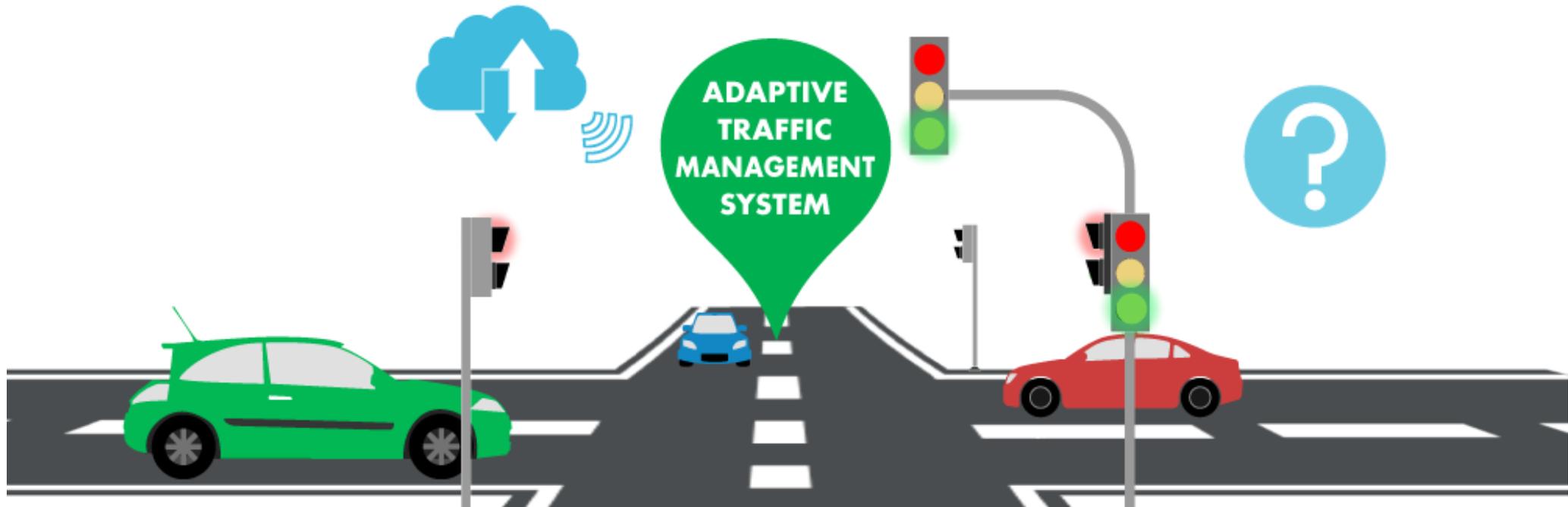


# ATMS Applications

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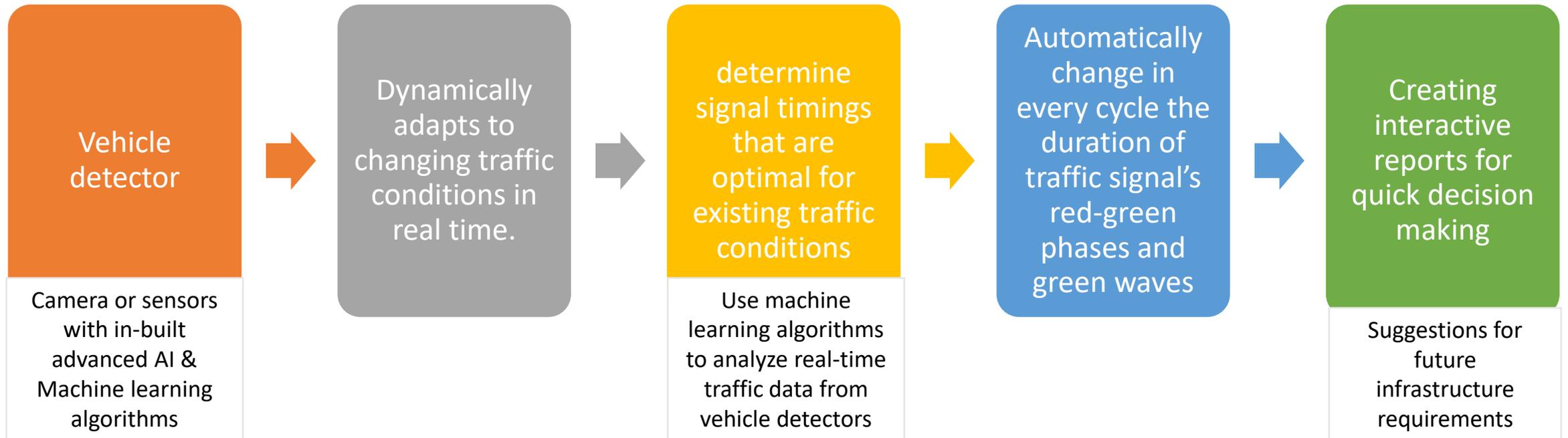
# 1. Adaptive Traffic Control System

- Adapts to real time traffic patterns to optimize the traffic flow by dynamically changing:
  - 1) Green split timings
  - 2) Offsets
  - 3) Phase sequence
- Algorithm adjusts traffic signal timings continuously based on traffic demand at the intersections and anticipated arrivals from adjacent intersections.



# Adaptive Traffic Control System (cont'd)

## PROCESS



# Adaptive Traffic Control System (cont'd)

## ADVANTAGES



Increase Travel  
Speeds



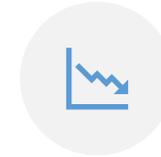
Reduce Vehicle  
Delays



Reduce Travel  
Time



Less CO<sub>2</sub>  
Emissions



Reduce Number  
of Accidents



Less Fuel  
Consumption



Increase  
Operational  
Efficiency



Better and  
smoother Traffic  
Flow



Create a platform  
for sharing traffic  
to other systems

## 2. Automated Road Speed Enforcement

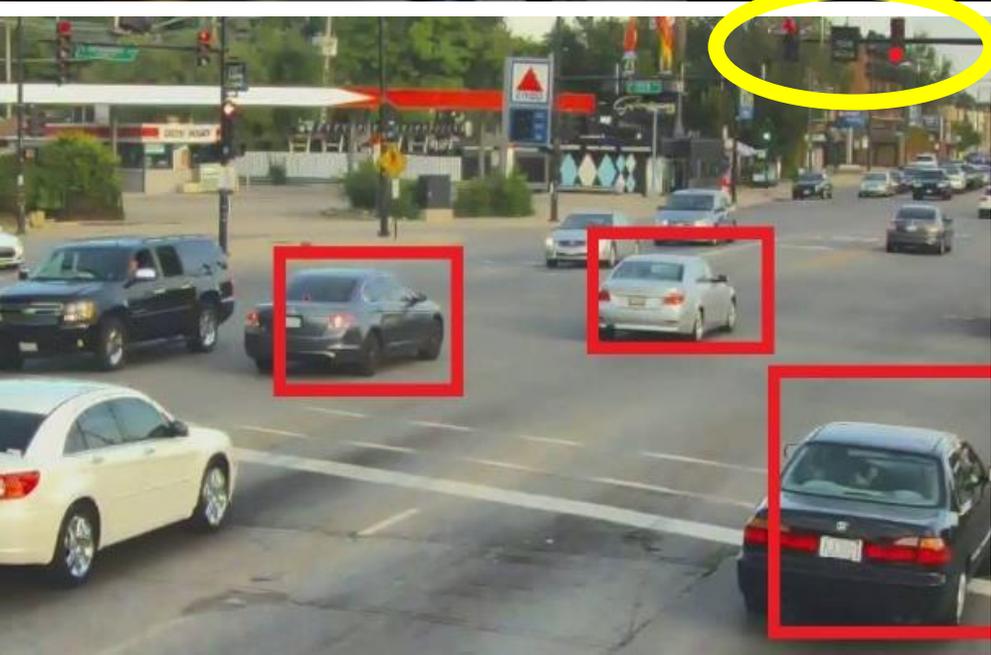
### Features:

1. A warning for vehicles that have crossed the maximum allowed speed on a specific route by showing the vehicle speed on bigger display.
2. A determination of violated vehicles license plates caught by Automated Number Plate Recognition (ANPR) system, with an online penalty imposed for speed violation

### Advantages:

- ✓ Increase road safety





### 3. Automated Red Light Violation Detection

- Detection of the license plate for violating vehicles (vehicles crossing the intersection on the red light).
- Online penalty imposed for speed violation

#### Advantages:

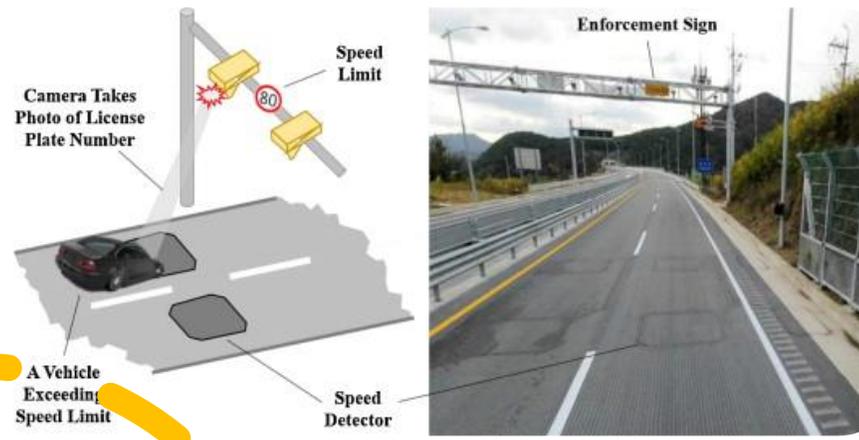
- ✓ Increase road safety
- ✓ Better and smoother traffic flow
- ✓ Reduce the number of accidents during traffic congestion

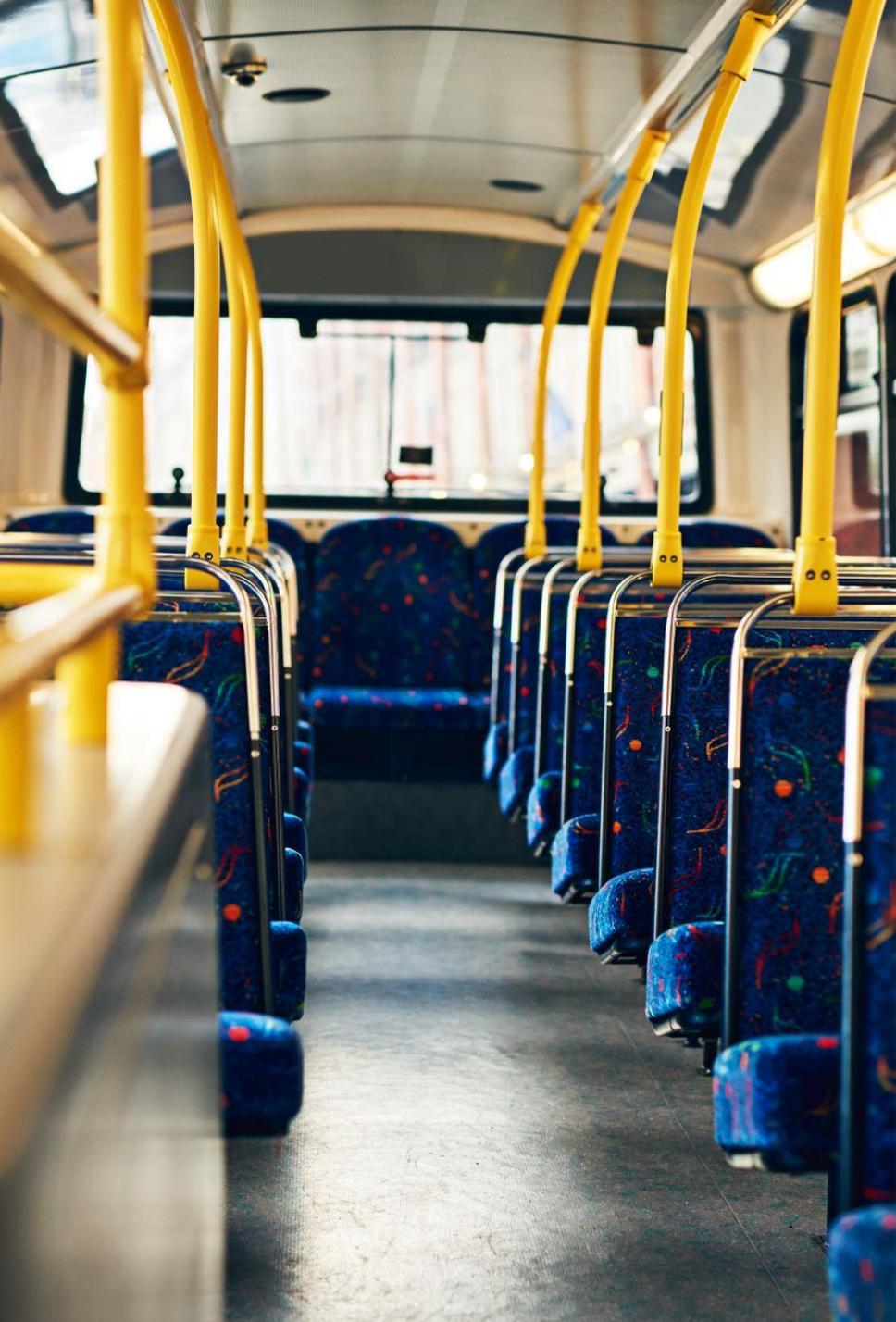
# Automated Number Plate Recognition

- A computer vision practice that allows devices to read license number plates on vehicles quickly and automatically, without any human interaction



1. The ANPR camera captures images that contain a license plate (video stream or photo).
2. The plate is detected using machine learning and computer vision processes (Object Detection)
3. OCR software is applied to the detected plate area to return the license plate number in text format. The converted number is usually stored in a database for integration with other IT systems.





## 4. Transit/Bus Priority Signal



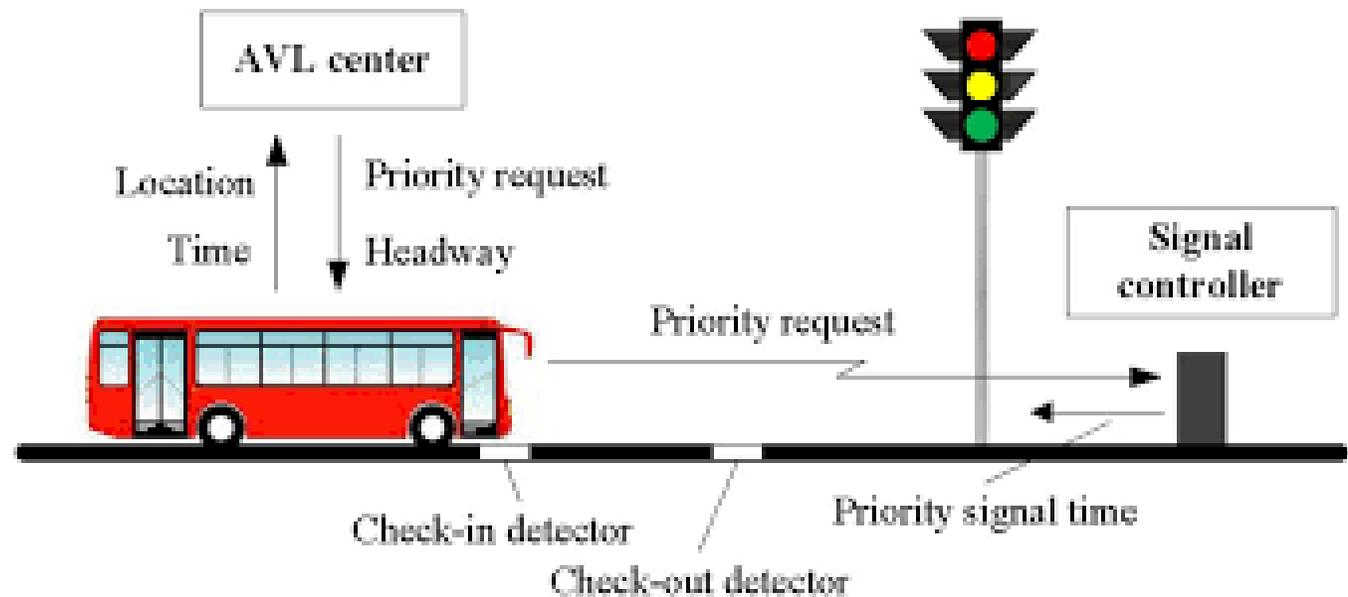
Rely on detecting transit vehicles as they approach an intersection and adjusting the signal timing dynamically to improve service for the transit vehicle.

### **Advantages:**

-  Reduce travel times for buses
-  Improve bus schedule adherence and transit efficiency
-  Encourage people to use public transportation

# Transit/Bus Priority Signal (cont'd)

- Transit Vehicle Detection (AVL, Loop or Radar)
- Priority Request sent to signal controller
- Dedicated transit/bus traffic signal time adjustments



## 5. Lane Control

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- Used to manage traffic on a multi-way road or highway.
- Allow or forbid traffic to use one or more of the available lanes by the use of Green lights or arrows (to permit) or by red lights or crosses (to prohibit).
- Used for incident management

## 6. Traffic-Responsive Ramp Metering

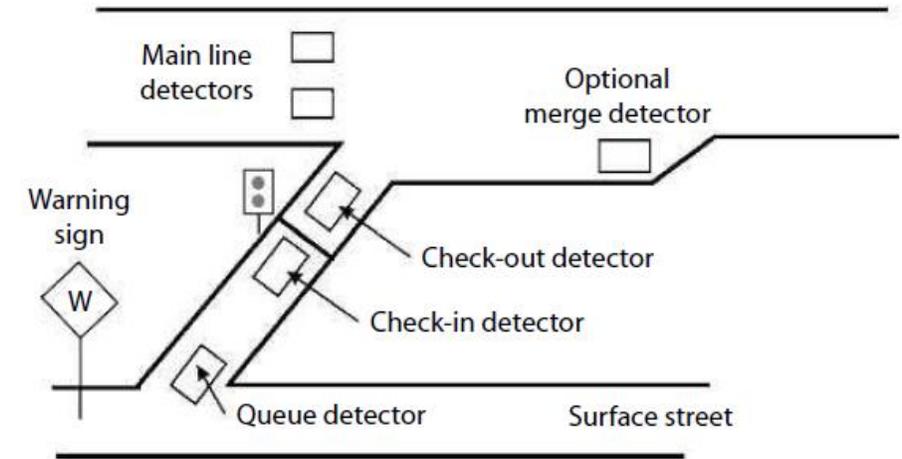
Involves the regulation of vehicle entry to a freeway system by traffic signals at the entrance ramps.

### **Strategy:**

- Vehicle Detectors
- Obtain real-time measurements of current traffic flow parameters (Demand-Capacity Control, Occupancy Control)
- Use of traffic responsive metering algorithm coordinated with the local controller to determine the maximum ramp metering rate that would ensure the quality of traffic flow

### **Advantages:**

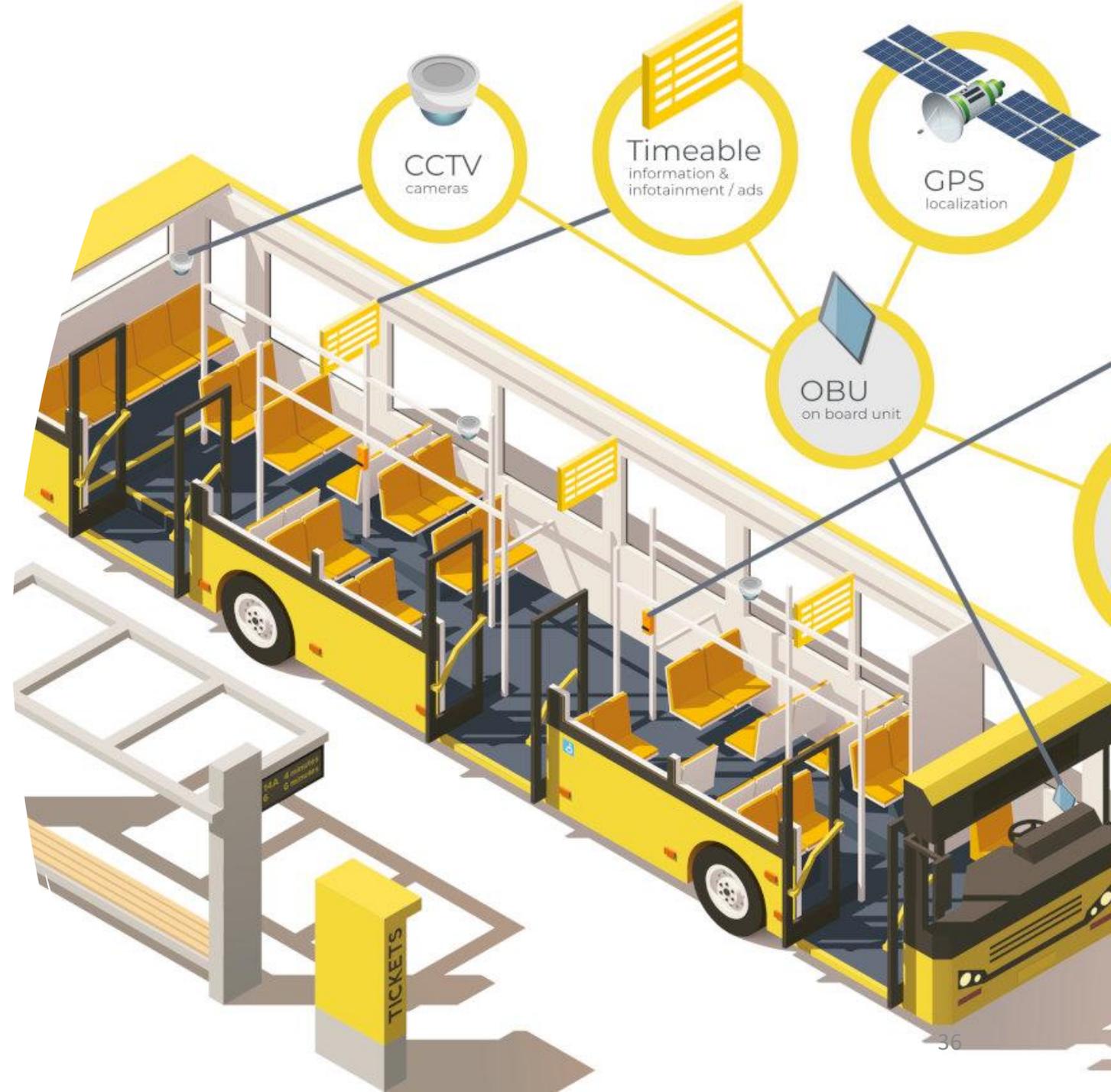
- Reduce recurrent congestion during peak hour periods
- Improve safety when some geometric deficiencies exist.



# 7. Public Transportation Management

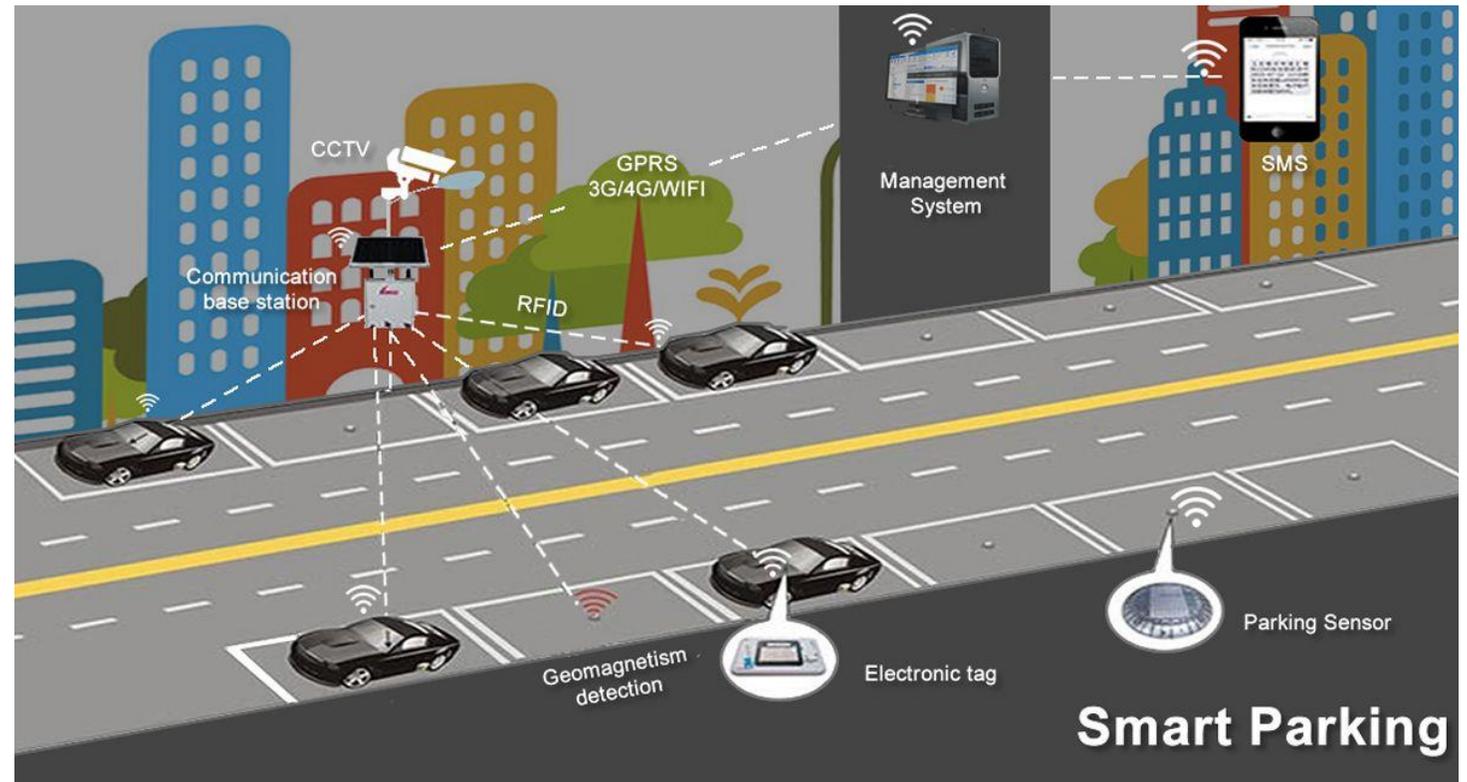
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- Travel time estimation for public transport system
- Real time transport tracking
- Smart paying methods



## 8. Smart Parking Management

- Avoiding unwanted blockage on roads due to parking
- Notification of availability of parking spaces
- Prebooking of parking spaces online (Web/Mobile App)
- Parking fees can be paid online





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*thank  
you*