# Intelligent Transportation Systems for all Engineers and City Planners


## 3 PDH

**Professional Development Hours (PDH) or**
**Continuing Education Hours (CE)**
**Online PDH or CE course**

FDA, Inc.

**Intelligent Transportation Systems for Civil Engineers and City Planners**

**3 PDH course**

**Course Author:** Franco F. Davati, P.E.
**Provider:** DiscountPDH.com

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## COURSE DESCRIPTION

This course introduces Intelligent Transportation Systems (ITS) and their role in improving the safety, efficiency, and reliability of transportation infrastructure in the United States. The course presents the fundamental components of ITS, including traffic monitoring, communications, control systems, and traveler information. Emphasis is placed on practical applications that are relevant to civil engineers involved in planning, design, construction, operations, and maintenance of transportation facilities.

The course is written for a broad engineering audience and explains how ITS technologies are integrated into highways, arterial roadways, bridges, work zones, and traffic management centers.

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## LEARNING OBJECTIVES

After completing this course, the participant will be able to:

- Define Intelligent Transportation Systems and their purpose
- Identify the major components of ITS infrastructure
- Understand how ITS improves traffic operations and safety
- Recognize common ITS field devices and their functions
- Describe how data is collected, transmitted, and used in transportation systems
- Understand the role of civil engineers in ITS deployment
- Identify the benefits and cost effectiveness of ITS solutions
- Recognize emerging trends in smart transportation

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## 1. INTRODUCTION TO INTELLIGENT TRANSPORTATION SYSTEMS

Intelligent Transportation Systems (ITS) integrate traditional transportation infrastructure with advanced technologies to improve mobility, safety, and system performance.

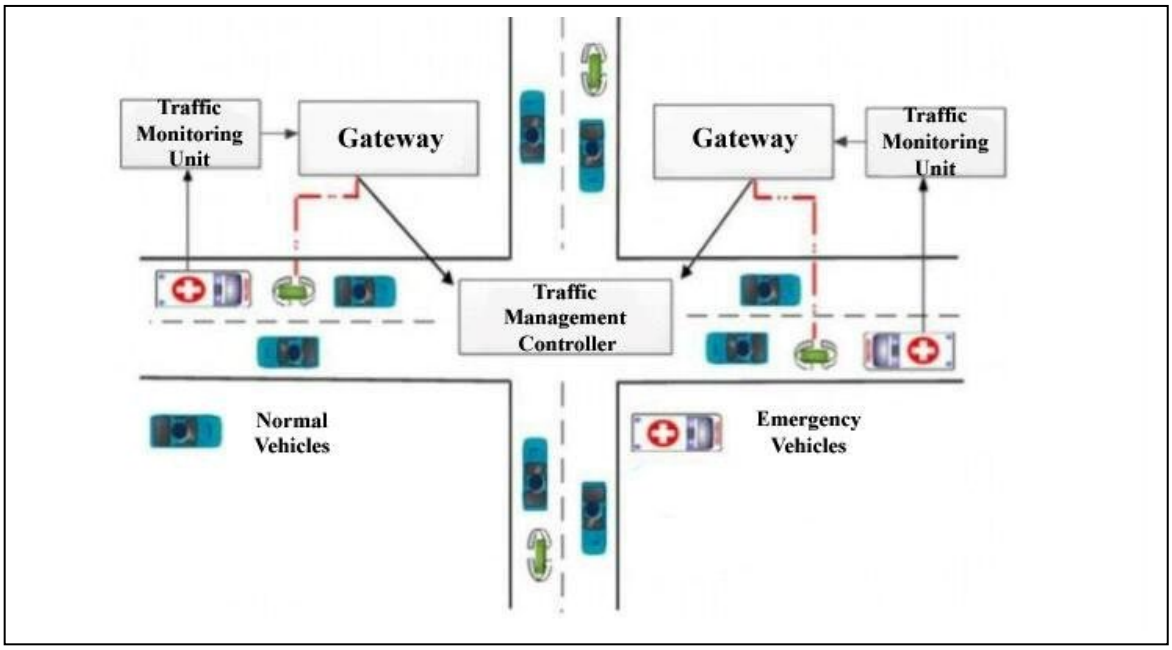
ITS combines:

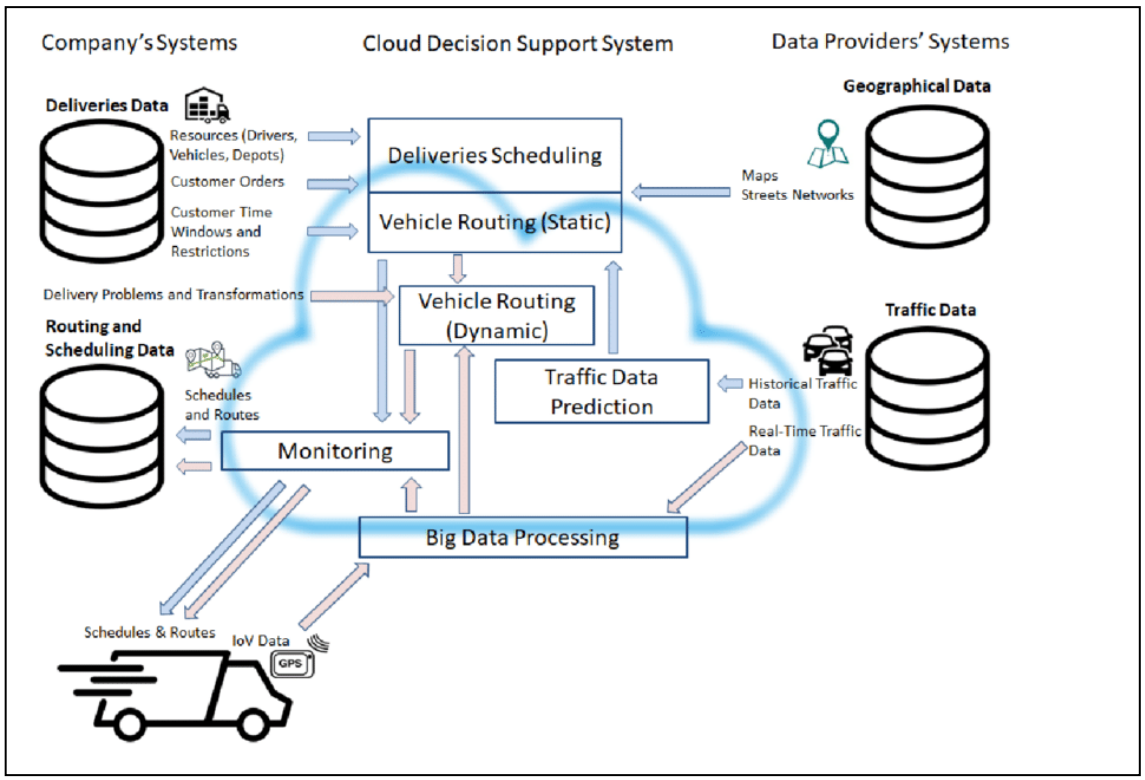
- Field devices
- Communications networks
- Data processing systems

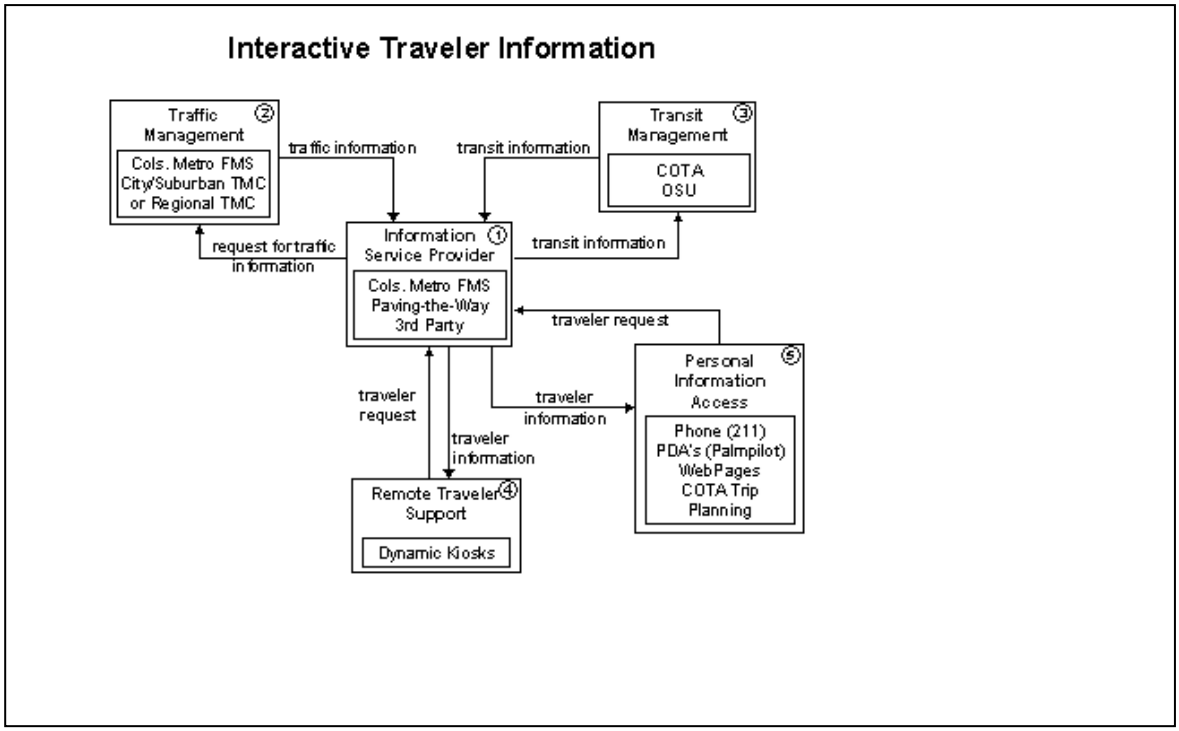
- Control strategies

to create a transportation network that can monitor conditions in real time and respond dynamically.

[**Figure 1 – Basic ITS system architecture showing field devices, communications, traffic management center, and users**]






**[Figure 1 – Basic ITS system architecture showing field devices, communications, traffic management center, and users]**

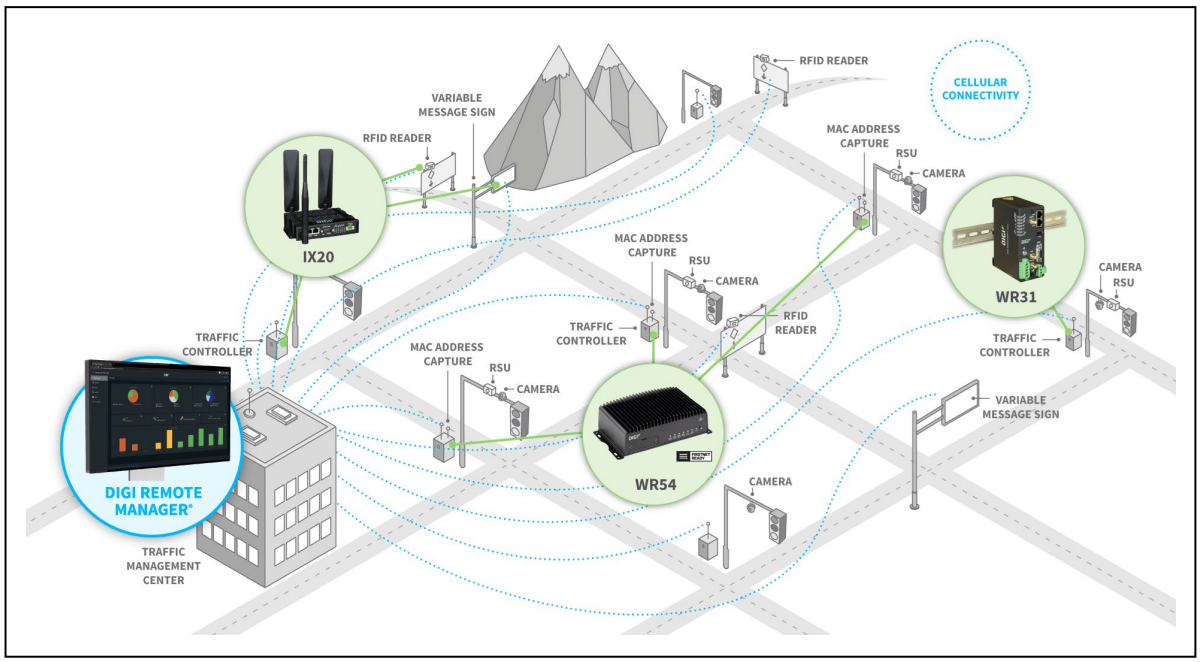
## 2. EVOLUTION OF TRANSPORTATION INFRASTRUCTURE

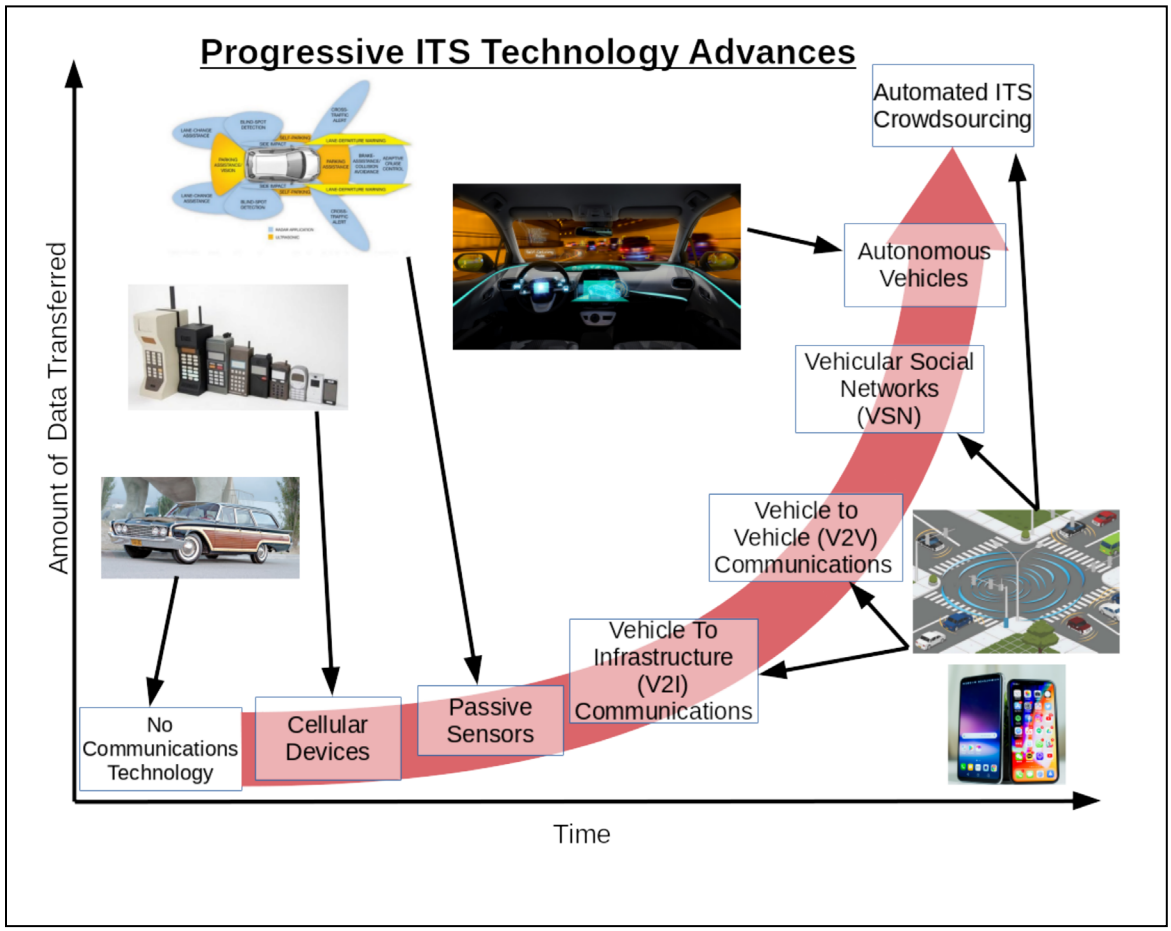
Transportation systems have evolved from:

- Static roadways
  to
- Signalized networks
  to
- Digitally connected corridors

Traditional infrastructure was designed for capacity.
Modern infrastructure is designed for **performance and real-time management**.

[**Figure 2 – Evolution from conventional roadway to smart transportation corridor**]


RFID READER
CELLULAR CONNECTIVITY
VARIABLE MESSAGE SIGN
RFID READER
MAC ADDRESS CAPTURE
RSU
CAMERA
IX20
WR31
MAC ADDRESS CAPTURE
RSU
CAMERA
CAMERA
RSU
TRAFFIC CONTROLLER
TRAFFIC CONTROLLER
RFID READER
TRAFFIC CONTROLLER
MAC ADDRESS CAPTURE
RSU
CAMERA
VARIABLE MESSAGE SIGN
WR54
CAMERA
DIGI REMOTE MANAGER®
TRAFFIC MANAGEMENT CENTER


Progressive ITS Technology Advances
Automated ITS Crowdsourcing
Autonomous Vehicles
Vehicular Social Networks (VSN)
Vehicle to Vehicle (V2V) Communications
Vehicle To Infrastructure (V2I) Communications
Passive Sensors
Cellular Devices
No Communications Technology
Amount of Data Transferred
Time

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**3. PURPOSE AND GOALS OF ITS**

The primary goals of ITS include:

- Improved safety
- Reduced congestion
- Better travel time reliability
- Faster incident response
- Improved environmental performance
- Enhanced traveler information

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**4. MAJOR COMPONENTS OF ITS**

ITS consists of four main elements:

**1. Sensing and Detection**

Devices that collect data from the field.

**2. Communications**

Systems that transmit data.

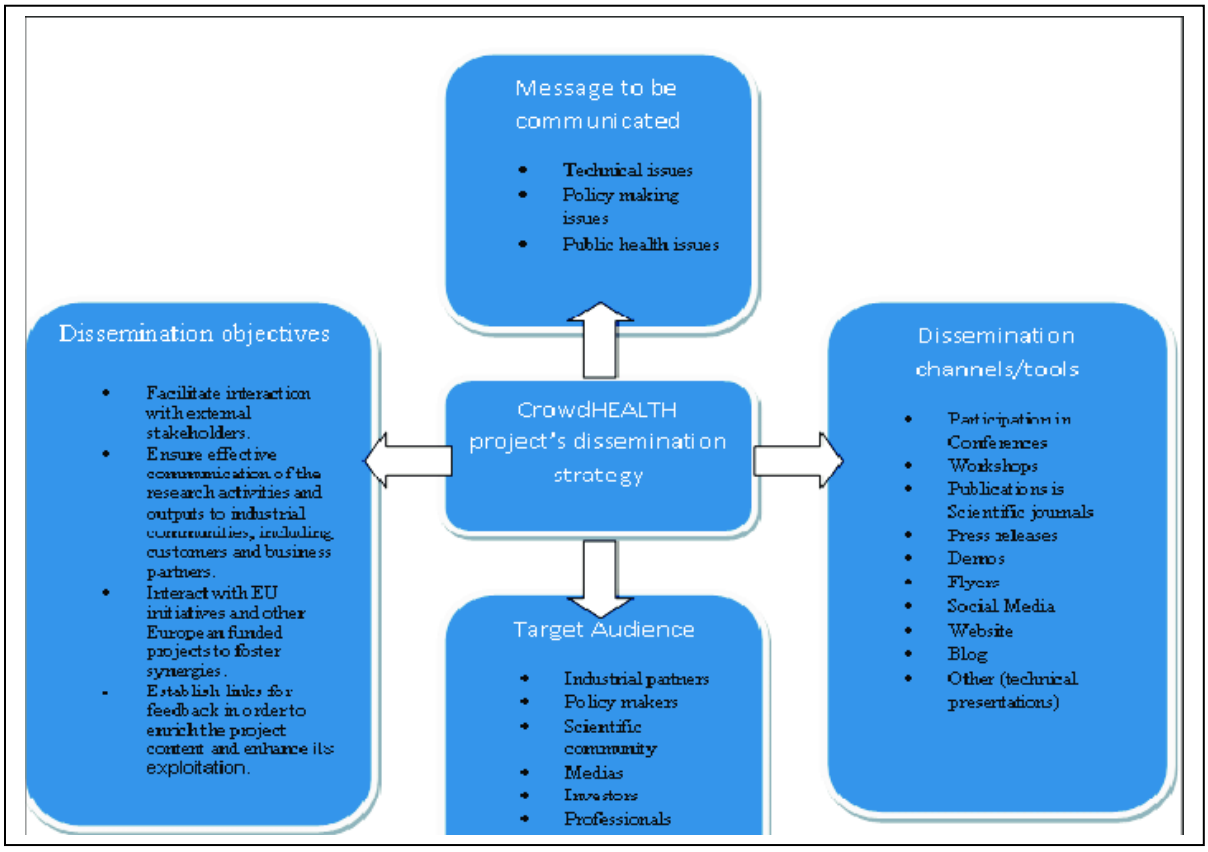
**3. Processing and Control**

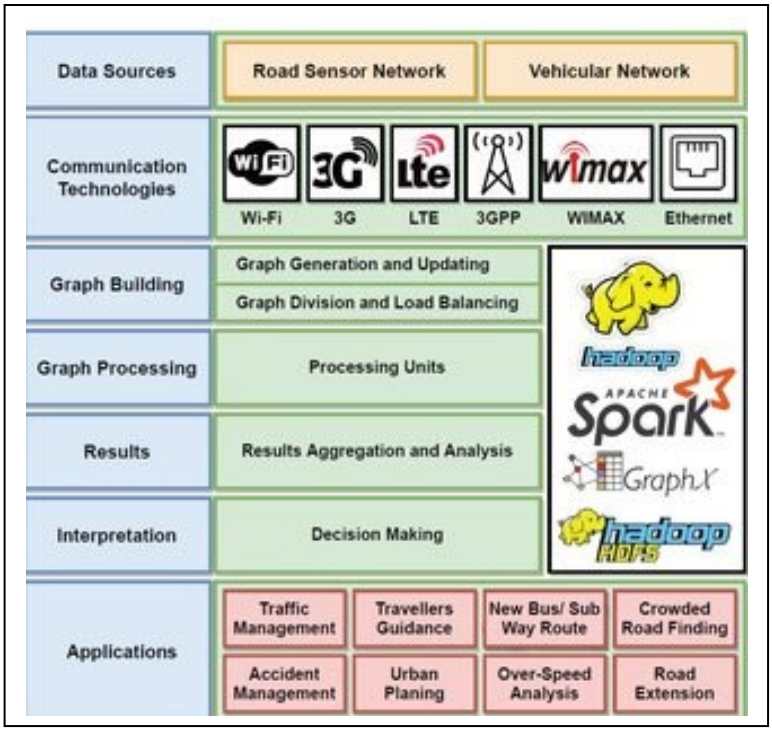
Centers where decisions are made.

**4. Information Dissemination**

Providing real-time information to users.

[**Figure 3 – Four major components of ITS**]



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**5. TRAFFIC MONITORING AND DETECTION SYSTEMS**

Common traffic detection technologies include:

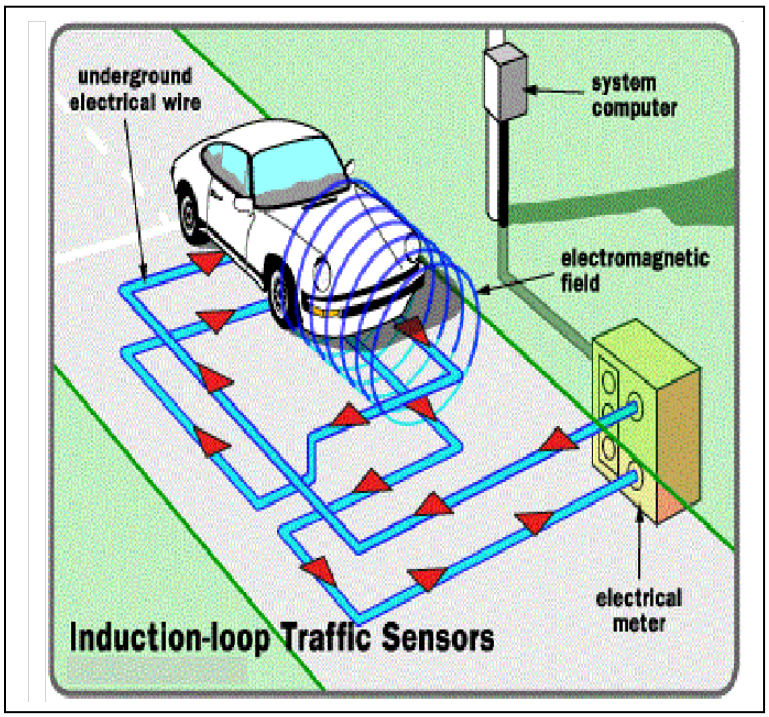
- Inductive loop detectors
- Video detection
- Radar and microwave sensors
- Bluetooth/Wi-Fi tracking
- Automatic vehicle identification

These systems provide:

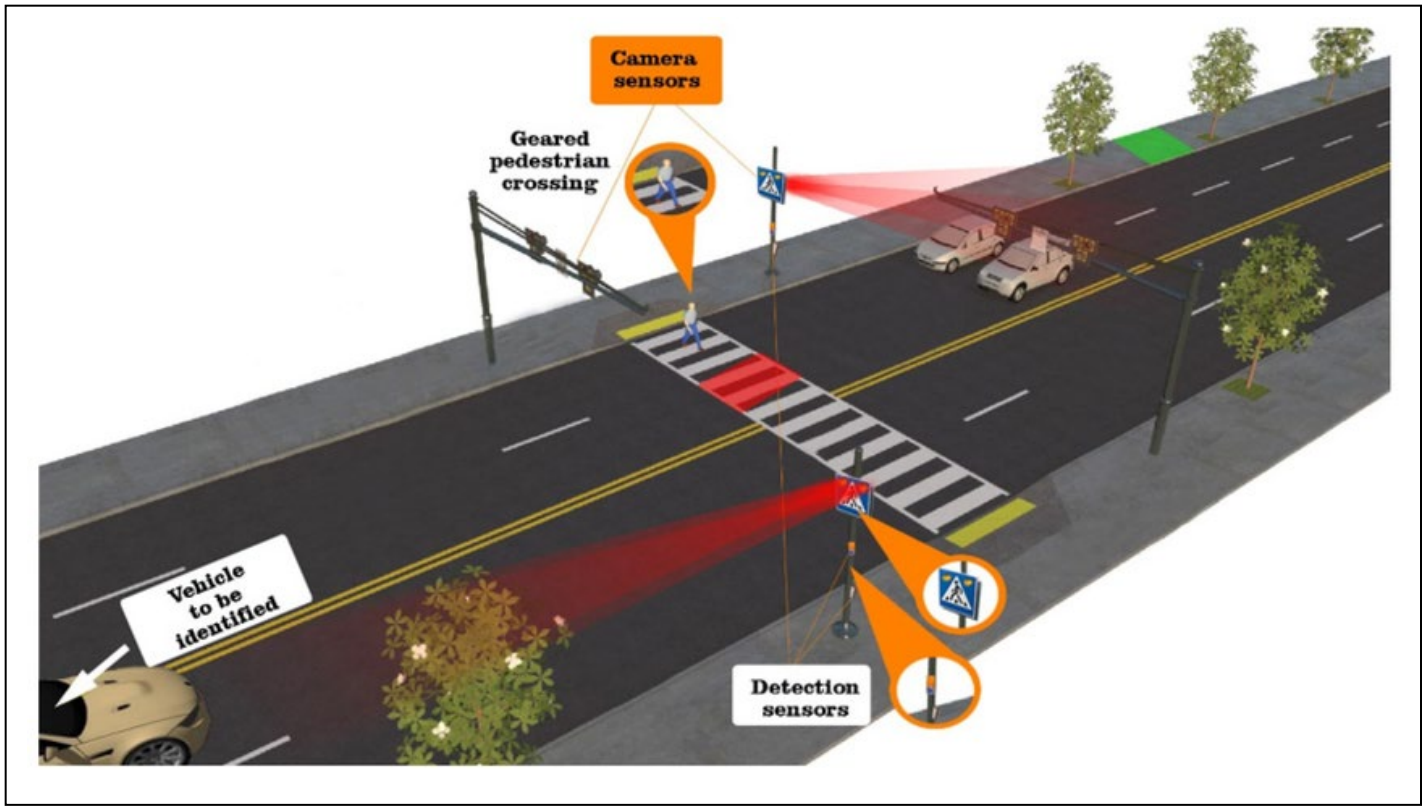
- Traffic volume
- Speed
- Occupancy

- Travel time

[**Figure 4 – Typical roadway traffic detection layout**]




Inductive Loop Detector


Camera sensors
Geared pedestrian crossing
Vehicle to be identified
Detection sensors

## 6. TRANSPORTATION COMMUNICATIONS SYSTEMS

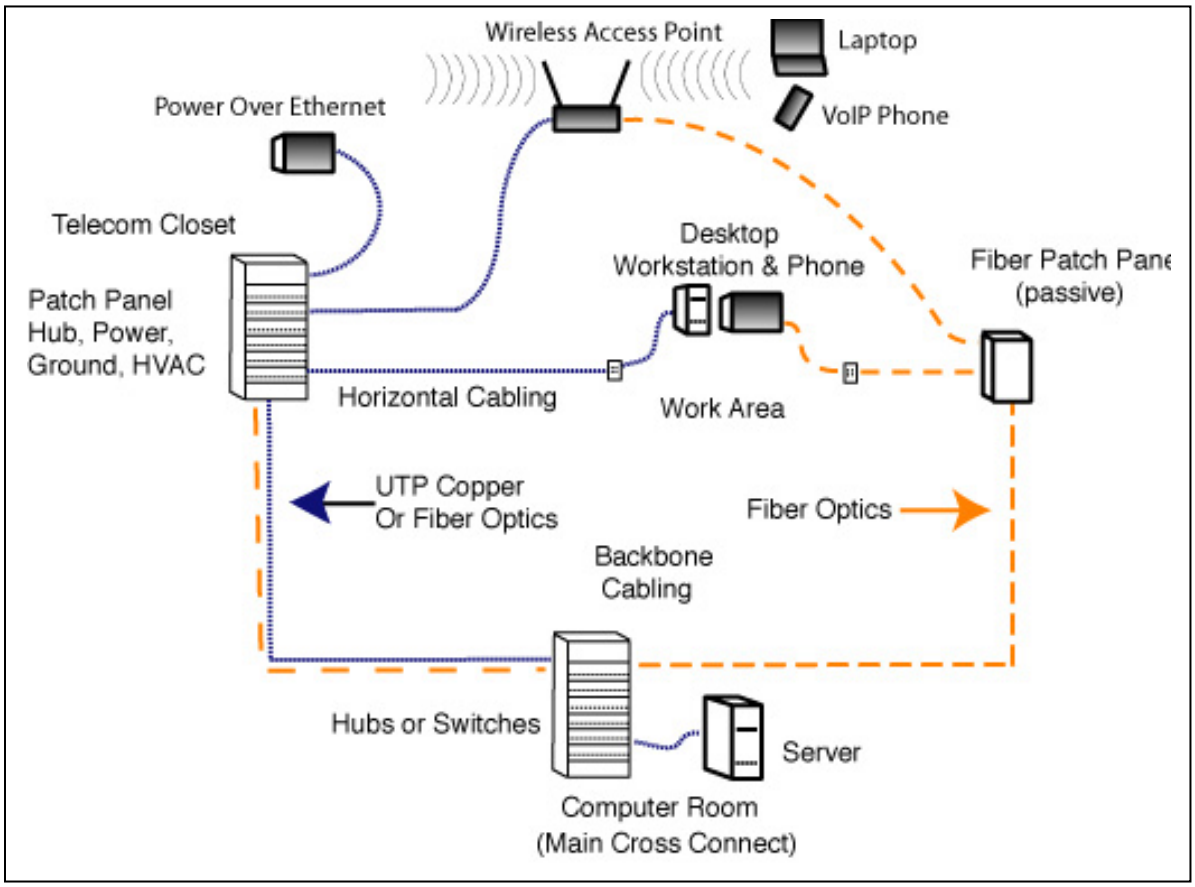
ITS relies on communications such as:

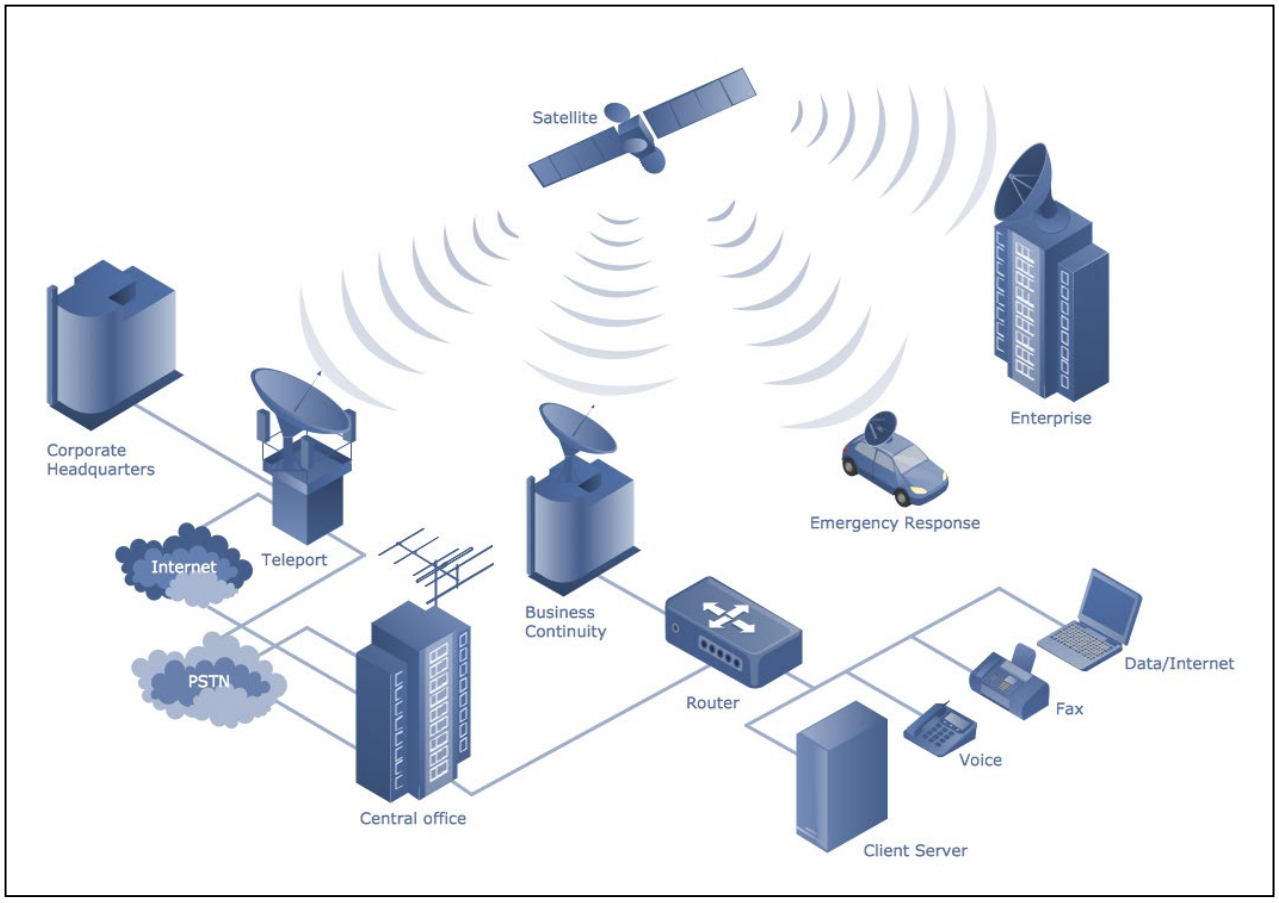
- Fiber optic networks
- Wireless communications
- Cellular networks

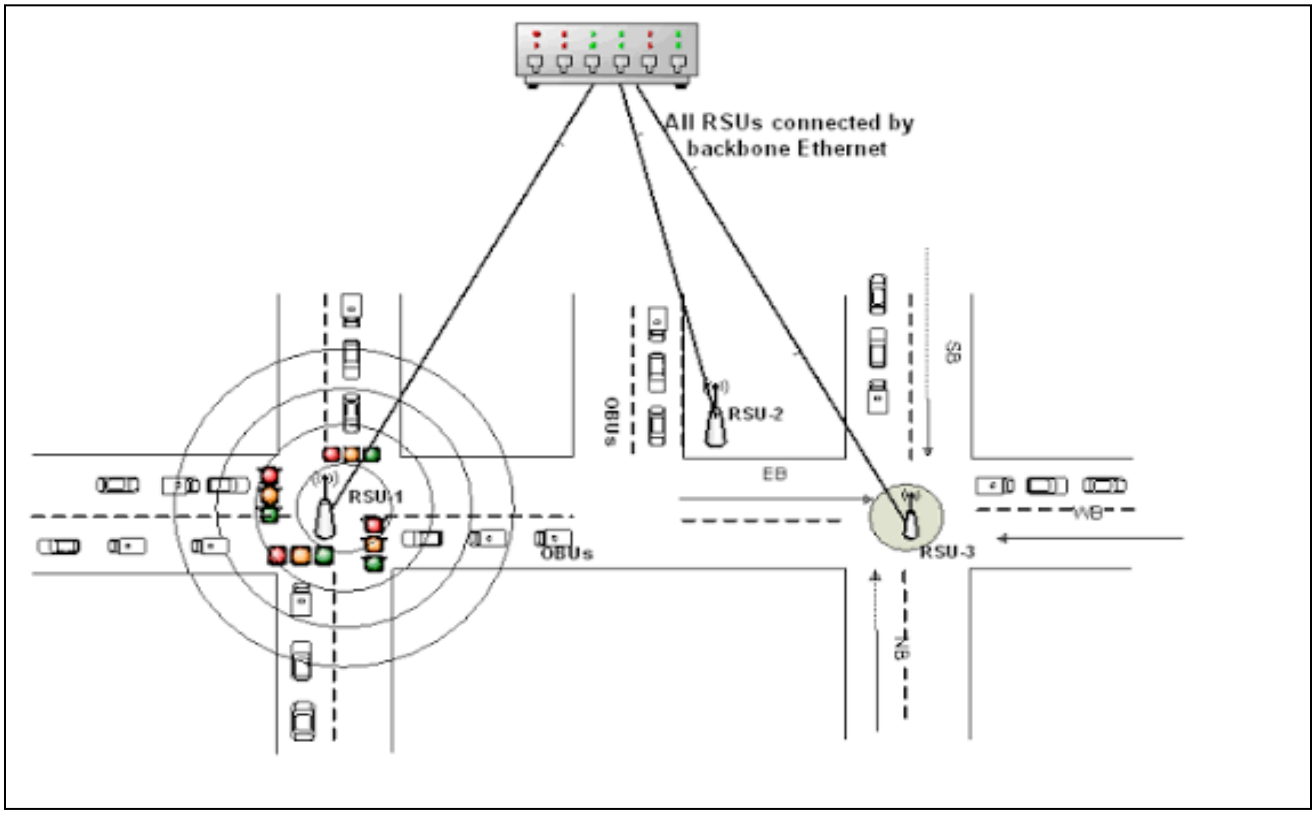
These systems connect:

- Field devices
- Control centers
- Emergency services
- Travelers

[**Figure 5 – Transportation communications network concept**]




Satellite
Enterprise
Corporate Headquarters
Emergency Response
Internet
Teleport
Business Continuity
PSTN
Router
Data/Internet
Fax
Voice
Central office
Client Server


All RSUs connected by backbone Ethernet
RSU-1
RSU-2
RSU-3
OBUs
OBUs
EB
WB
SB
NB

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## 7. TRAFFIC MANAGEMENT CENTERS (TMC)

A Traffic Management Center is the operational hub of an ITS system.

Functions include:

- Monitoring traffic conditions
- Controlling field devices
- Managing incidents
- Coordinating emergency response
- Disseminating traveler information

[**Figure 6 – Traffic Management Center operations concept**]


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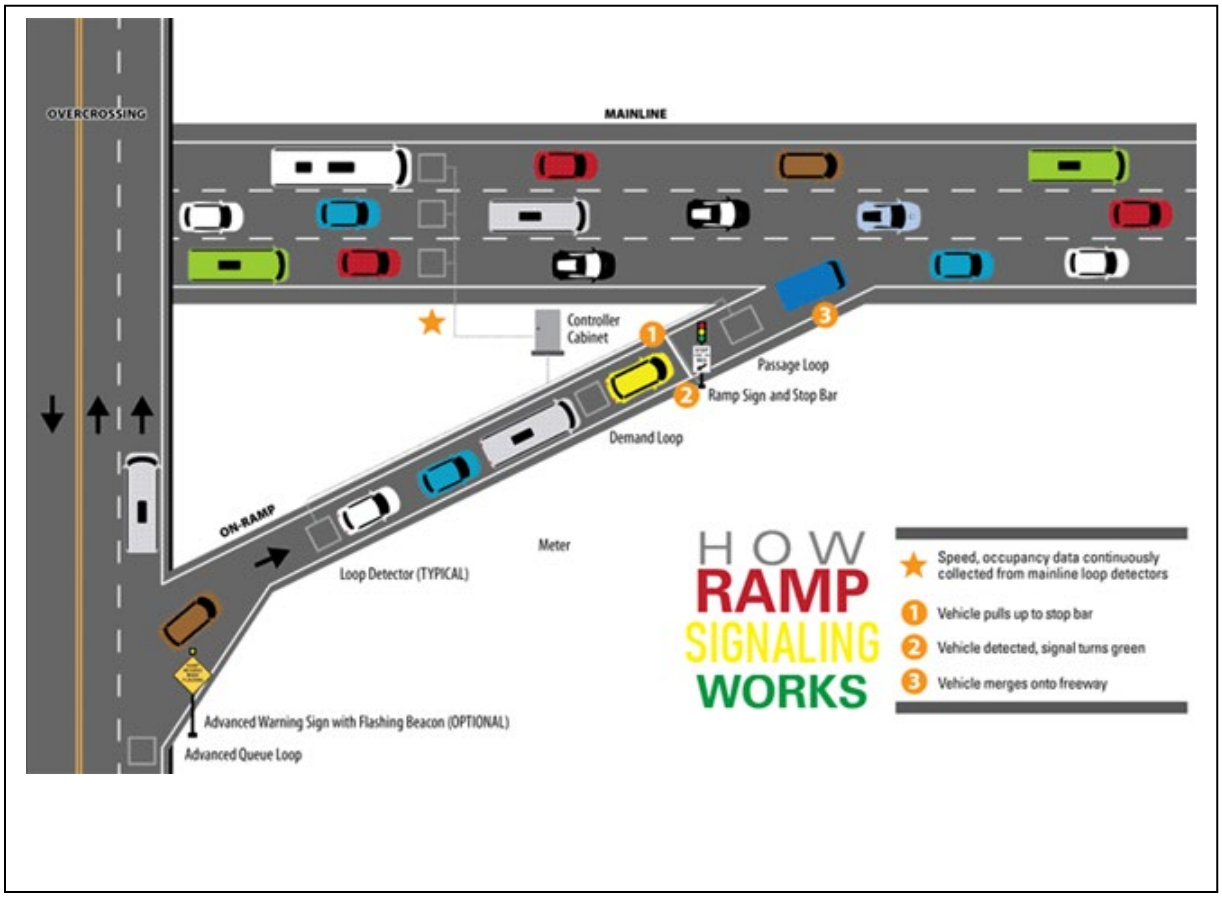
## 8. FREEWAY MANAGEMENT SYSTEMS

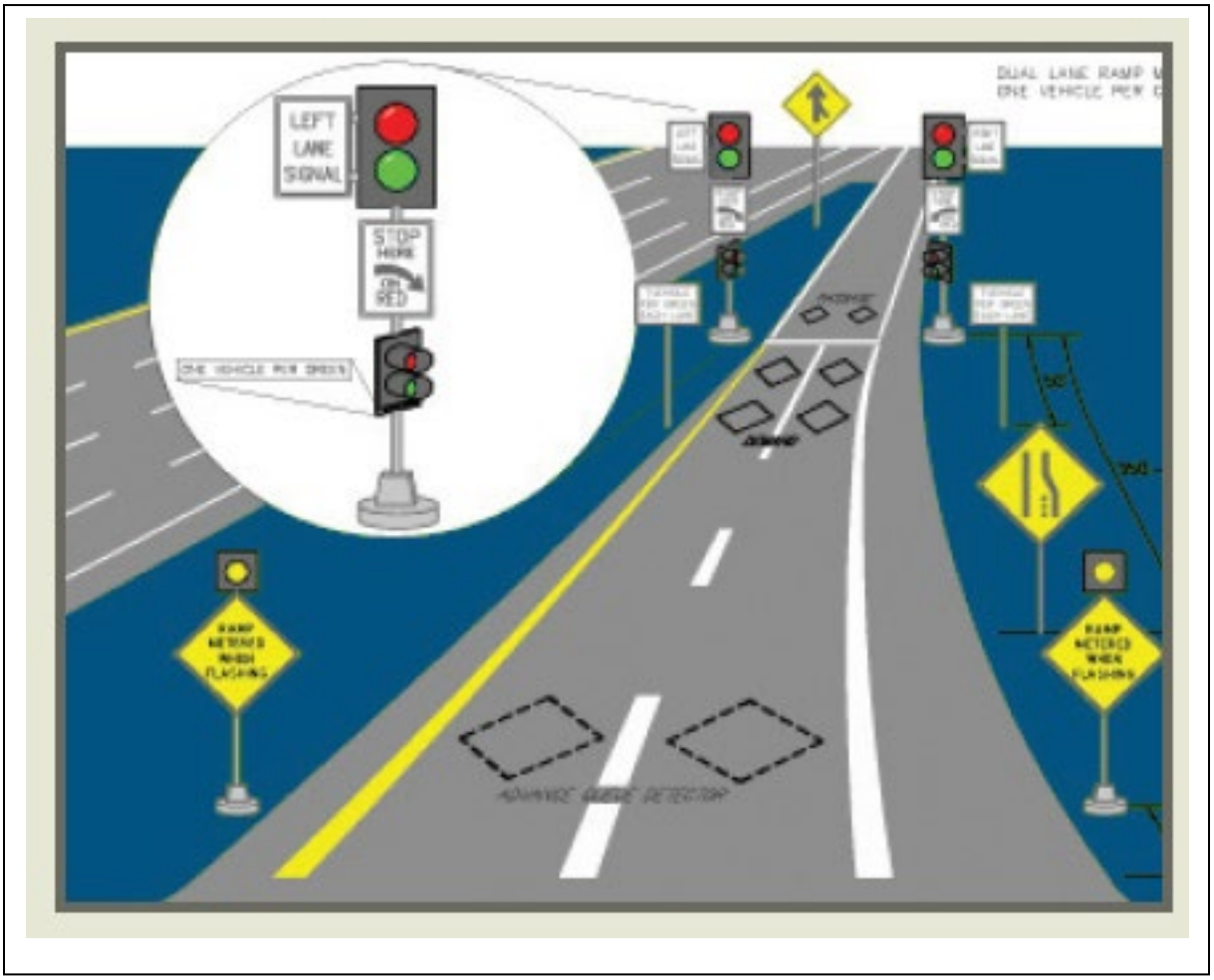
Freeway ITS applications include:

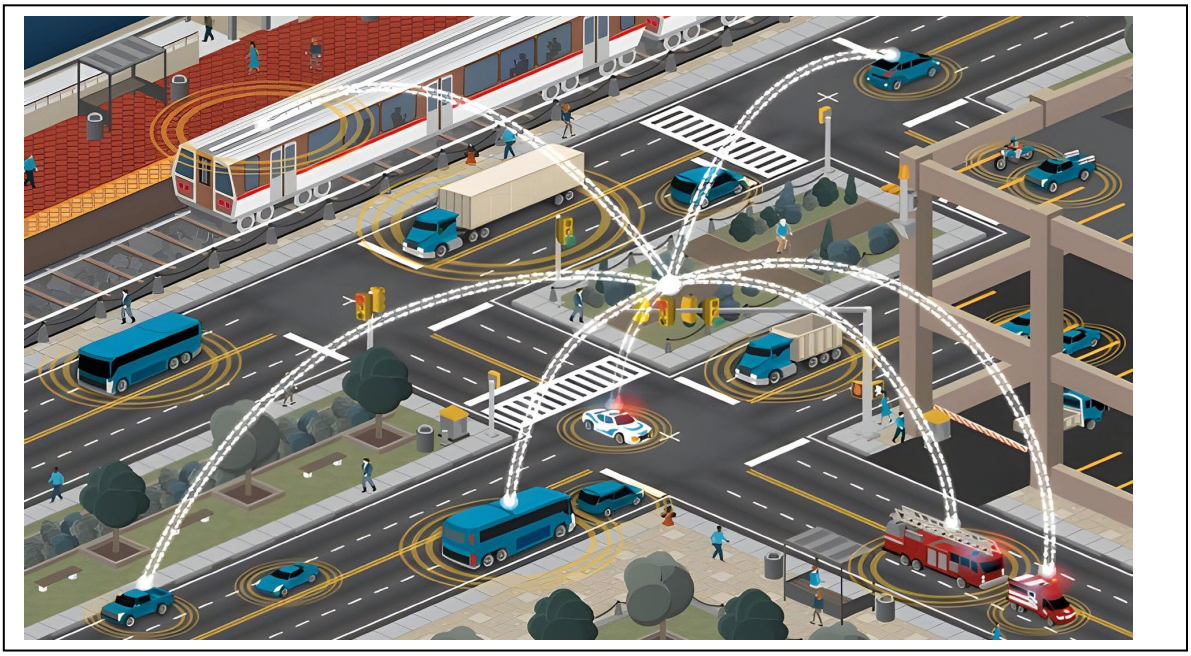
- Ramp metering
- Dynamic message signs
- Lane control signals
- Speed management systems

These systems improve:

- Traffic flow
- Safety
- Travel time reliability
- [**Figure 7 – Freeway management system layout**]





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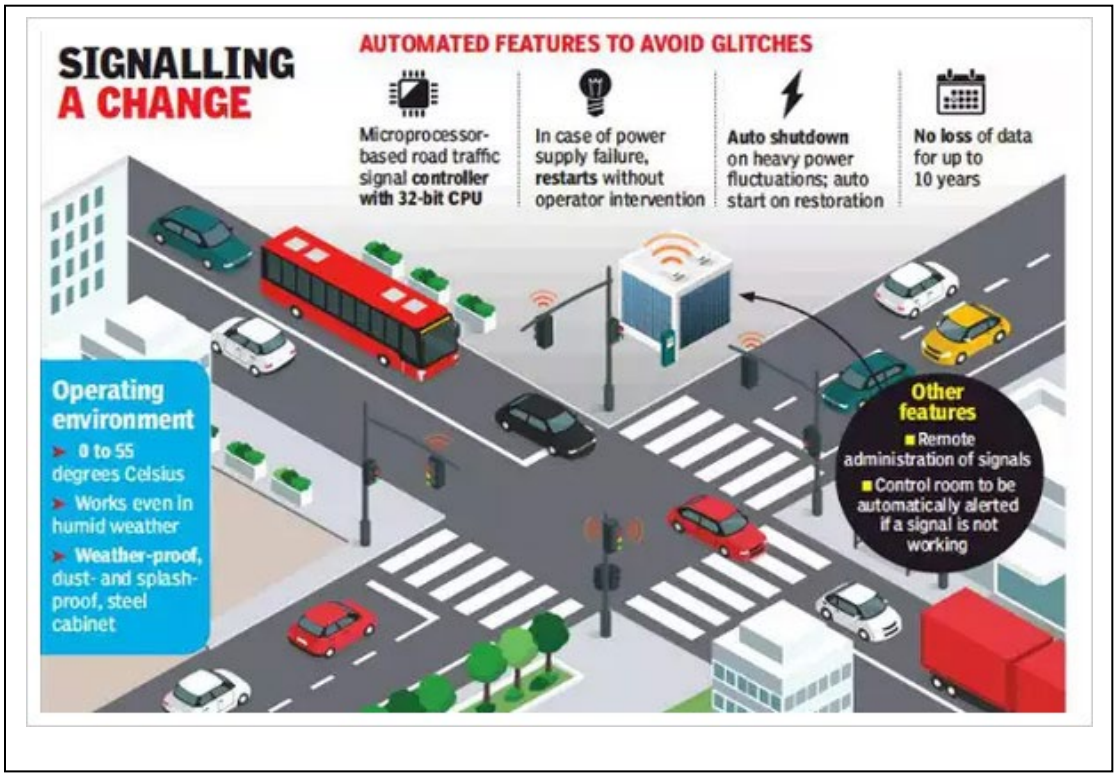
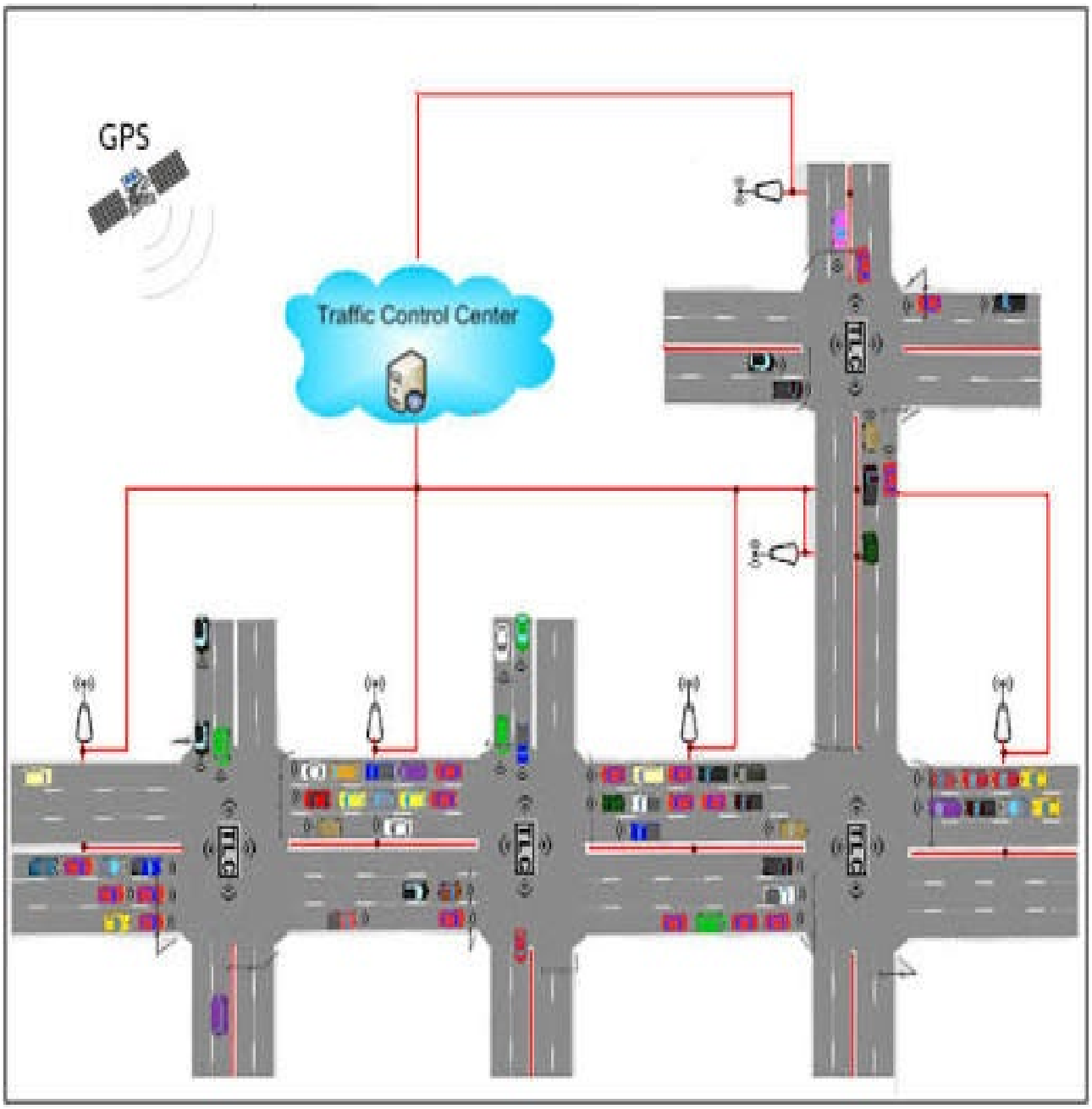
## 9. ARTERIAL MANAGEMENT SYSTEMS

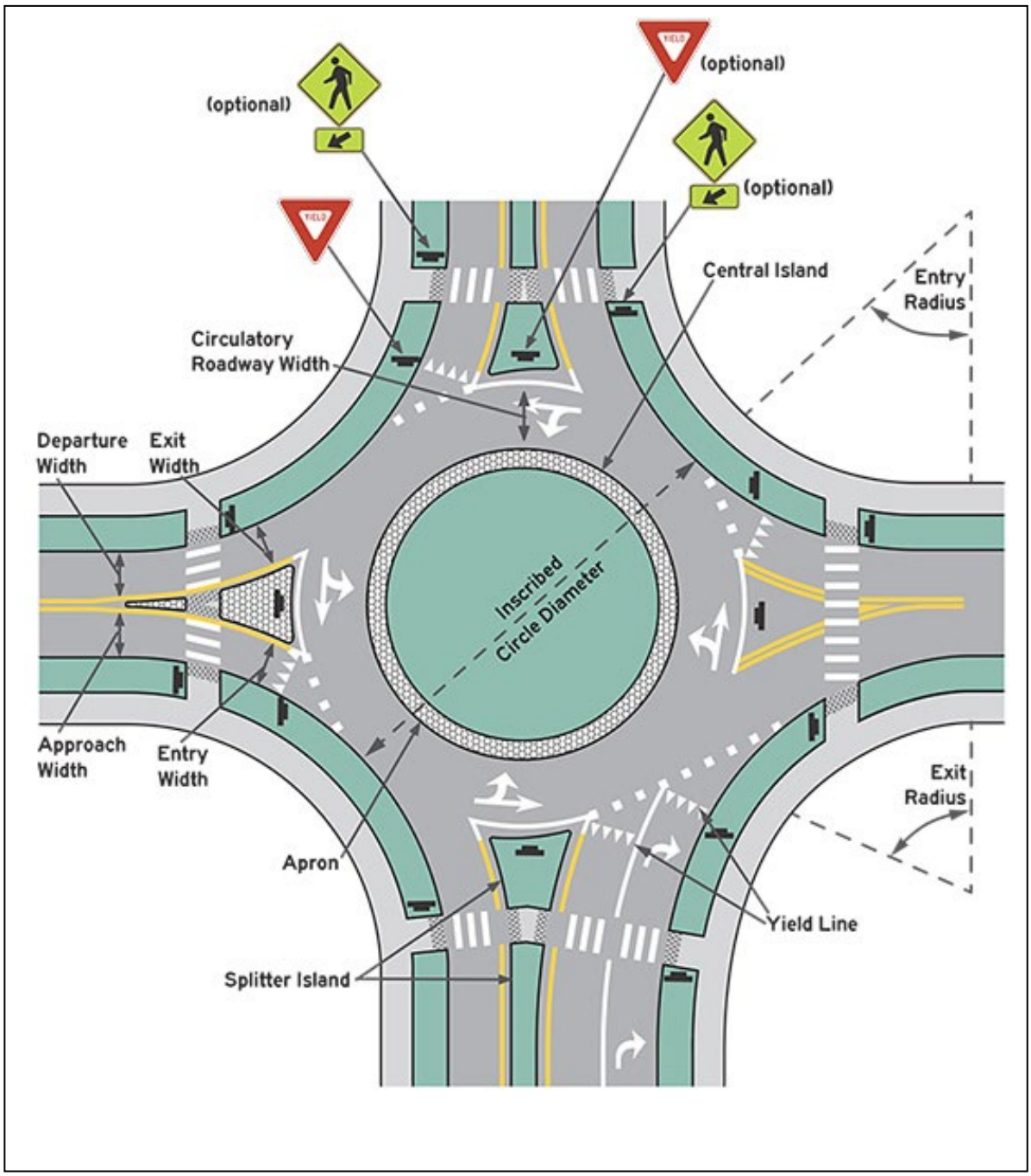
Arterial ITS strategies include:

- Adaptive signal control
- Transit signal priority
- Corridor coordination

[**Figure 8 – Smart signalized intersection system**]




GPS
Traffic Control Center

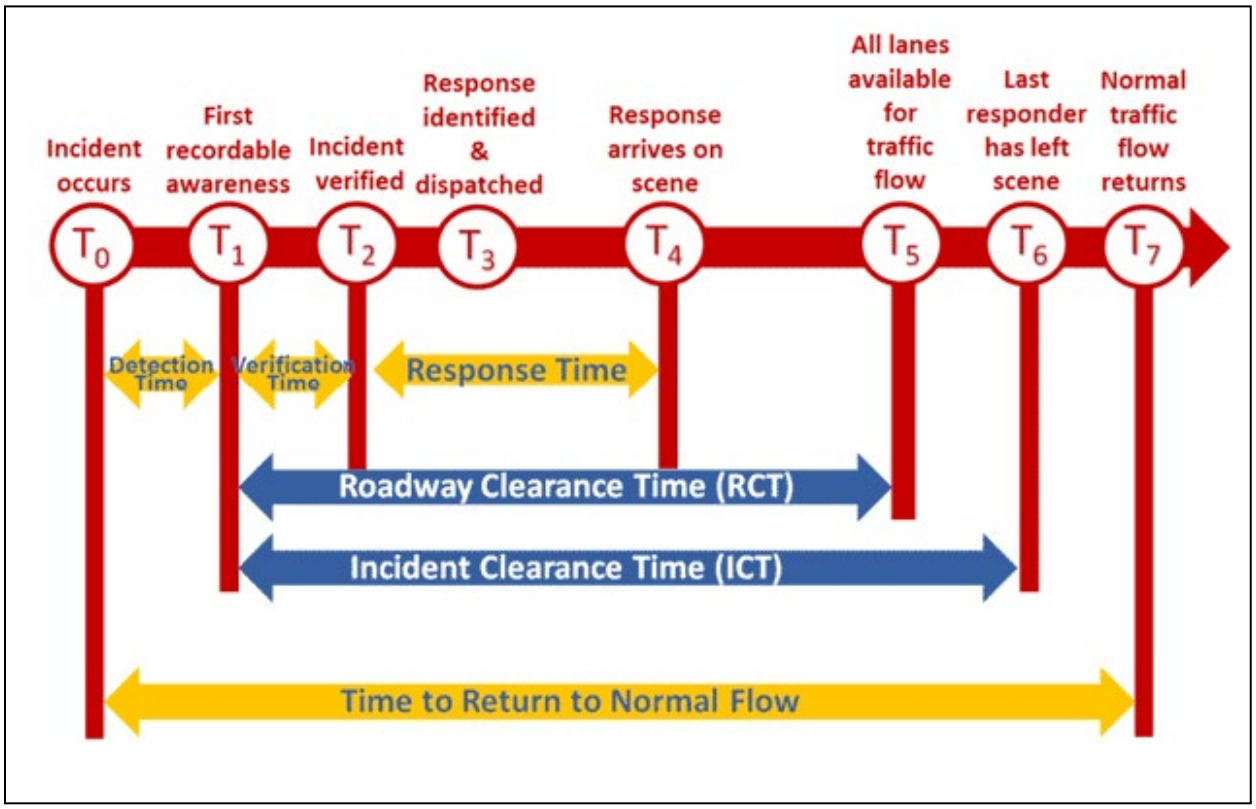

(optional)
(optional)
(optional)
Central Island
Entry Radius
Circulatory Roadway Width
Departure Width
Exit Width
Inscribed Circle Diameter
Approach Width
Entry Width
Apron
Exit Radius
Yield Line
Splitter Island

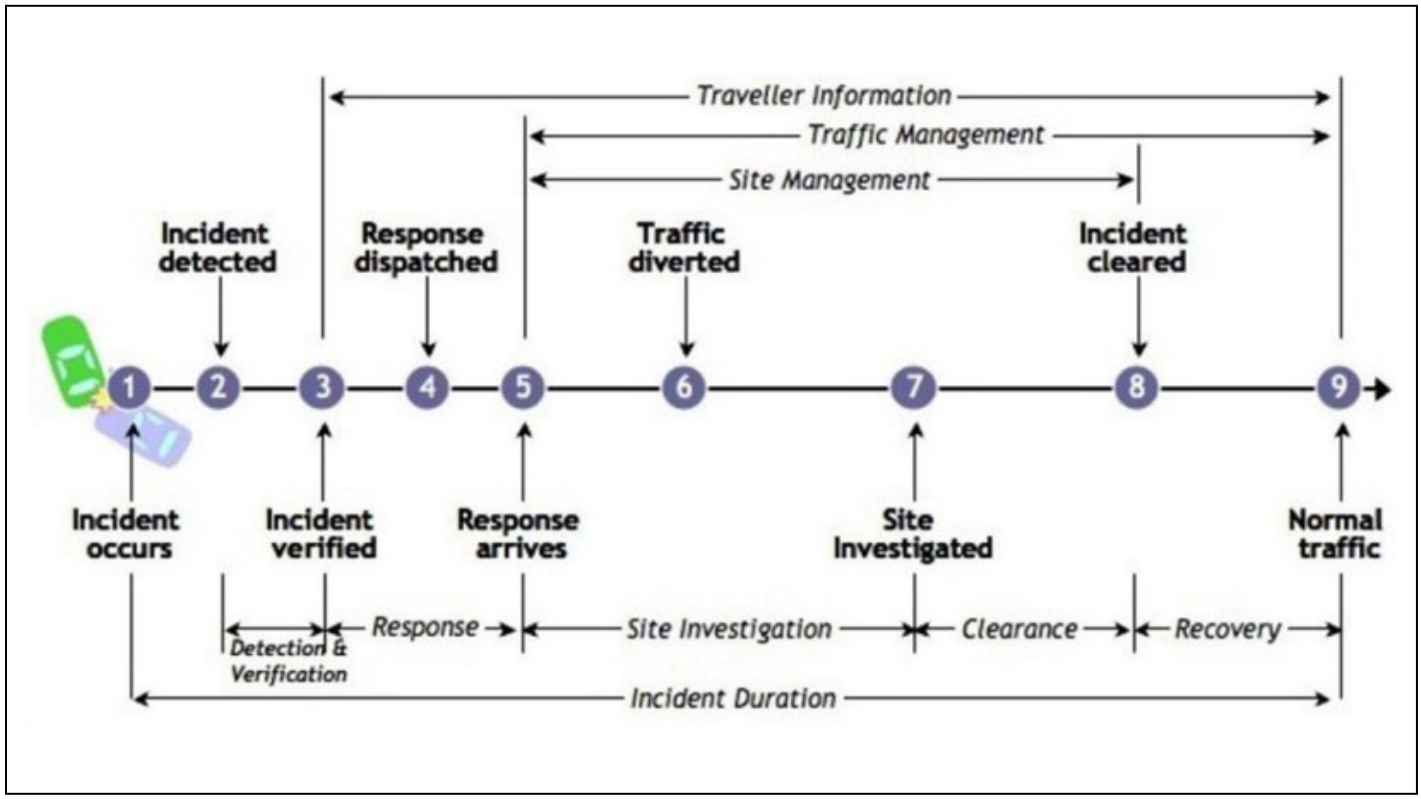
## 10. INCIDENT MANAGEMENT SYSTEMS

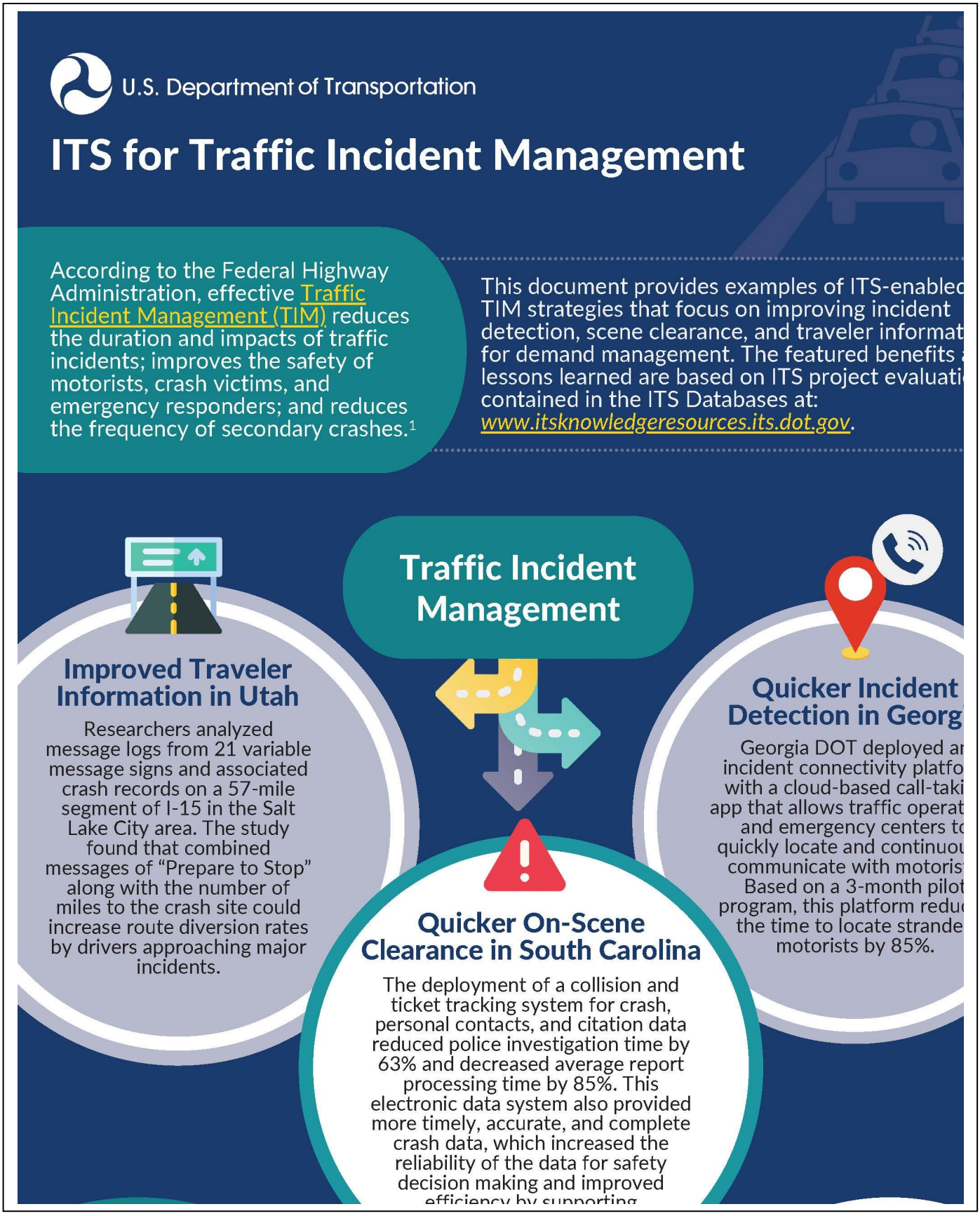
ITS improves incident response through:

- Automatic detection
- CCTV monitoring
- Dispatch coordination
- Real-time traveler alerts

[**Figure 9 – Incident detection and response workflow**]




Traveller Information
Traffic Management
Site Management
Incident detected
Response dispatched
Traffic diverted
Incident cleared
1
2
3
4
5
6
7
8
9
Incident occurs
Incident verified
Response arrives
Site Investigated
Normal traffic
Response
Site Investigation
Clearance
Recovery
Detection & Verification
Incident Duration


U.S. Department of Transportation
ITS for Traffic Incident Management
According to the Federal Highway Administration, effective Traffic Incident Management (TIM) reduces the duration and impacts of traffic incidents; improves the safety of motorists, crash victims, and emergency responders; and reduces the frequency of secondary crashes.[1]
This document provides examples of ITS-enabled TIM strategies that focus on improving incident detection, scene clearance, and traveler information for demand management. The featured benefits and lessons learned are based on ITS project evaluations contained in the ITS Databases at: www.itsknowledgeresources.its.dot.gov.
Traffic Incident Management
Improved Traveler Information in Utah
Researchers analyzed message logs from 21 variable message signs and associated crash records on a 57-mile segment of I-15 in the Salt Lake City area. The study found that combined messages of "Prepare to Stop" along with the number of miles to the crash site could increase route diversion rates by drivers approaching major incidents.
Quicker Incident Detection in Georg
Georgia DOT deployed an incident connectivity platfo with a cloud-based call-taki app that allows traffic operat and emergency centers to quickly locate and continuou communicate with motoris Based on a 3-month pilot program, this platform reduc the time to locate strande motorists by 85%.
Quicker On-Scene Clearance in South Carolina
The deployment of a collision and ticket tracking system for crash, personal contacts, and citation data reduced police investigation time by 63% and decreased average report processing time by 85%. This electronic data system also provided more timely, accurate, and complete crash data, which increased the reliability of the data for safety decision making and improved

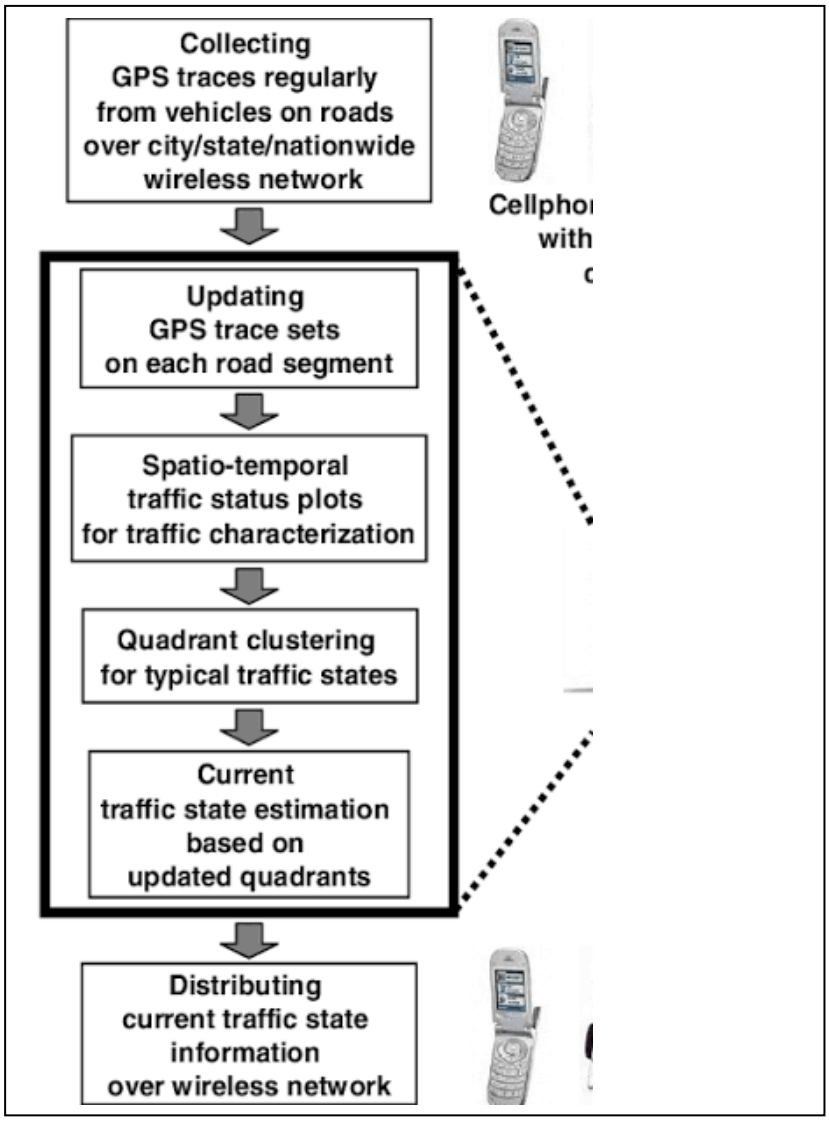
## 11. TRAVELER INFORMATION SYSTEMS

Information is provided through:

- Dynamic message signs
- Mobile applications
- Navigation systems
- Highway advisory radio

[**Figure 10 – Traveler information dissemination methods**]


SPEED
LIMIT
55
MINIMUM
45
CONSTRUCTION ZONE
NEXT 5 MILES
DRIVE WITH CAUTION
NORTH EAST
93
93
Concord
Portsmouth
SOUTH
93
Salem
Boston


Collecting
GPS traces regularly
from vehicles on roads
over city/state/nationwide
wireless network
Updating
GPS trace sets
on each road segment
Spatio-temporal
traffic status plots
for traffic characterization
Quadrant clustering
for typical traffic states
Current
traffic state estimation
based on
updated quadrants
Distributing
current traffic state
information
over wireless network

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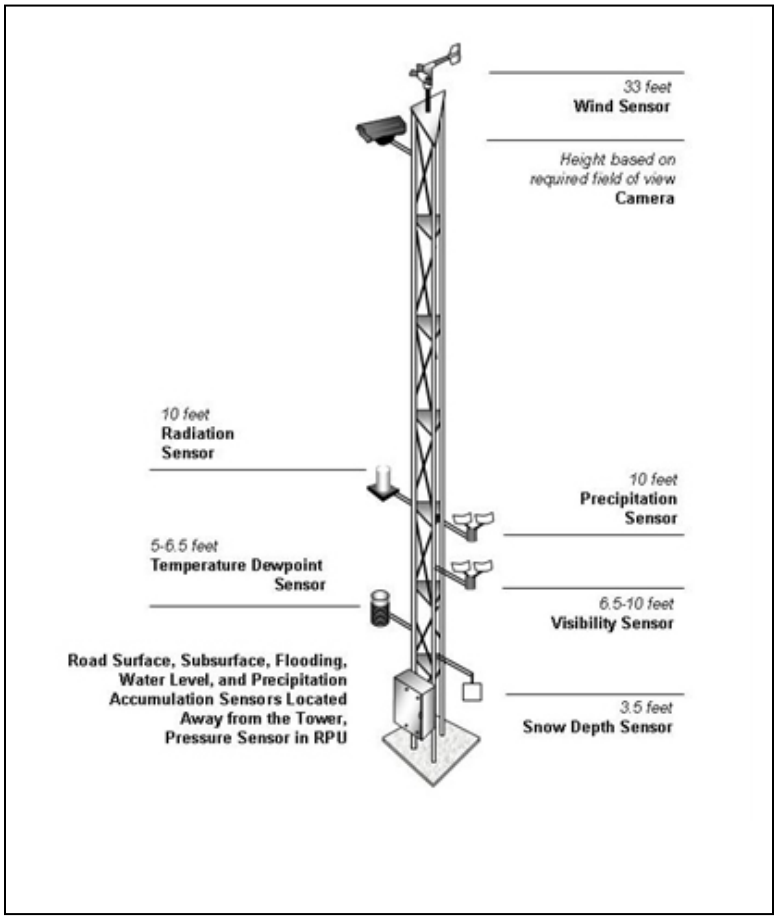
## 12. ROAD WEATHER MANAGEMENT SYSTEMS

These systems monitor:

- Pavement temperature
- Visibility
- Wind
- Precipitation

[**Figure 11 – Road weather information system station**]




Present Weather Sensor
Anemometer
Air Temperature and Humidity / Dewpoint
Web Cam
Optical Pavement Sensors

## 13. SMART WORK ZONES

Smart work zones improve safety through:

- Queue detection
- Speed warning systems
- Portable message signs

[**Figure 12 – Smart work zone ITS deployment**]


ROAD
WORK
AHEAD

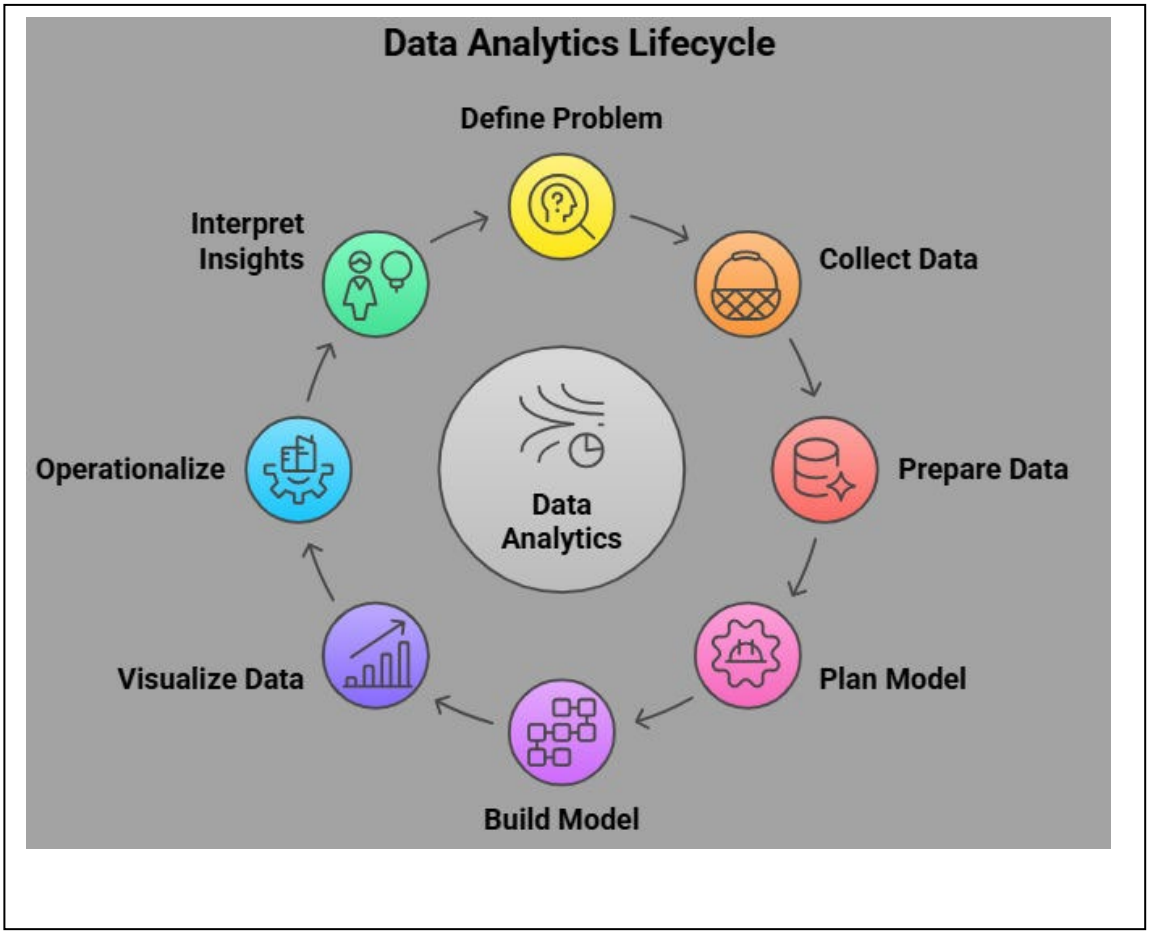

SLOW

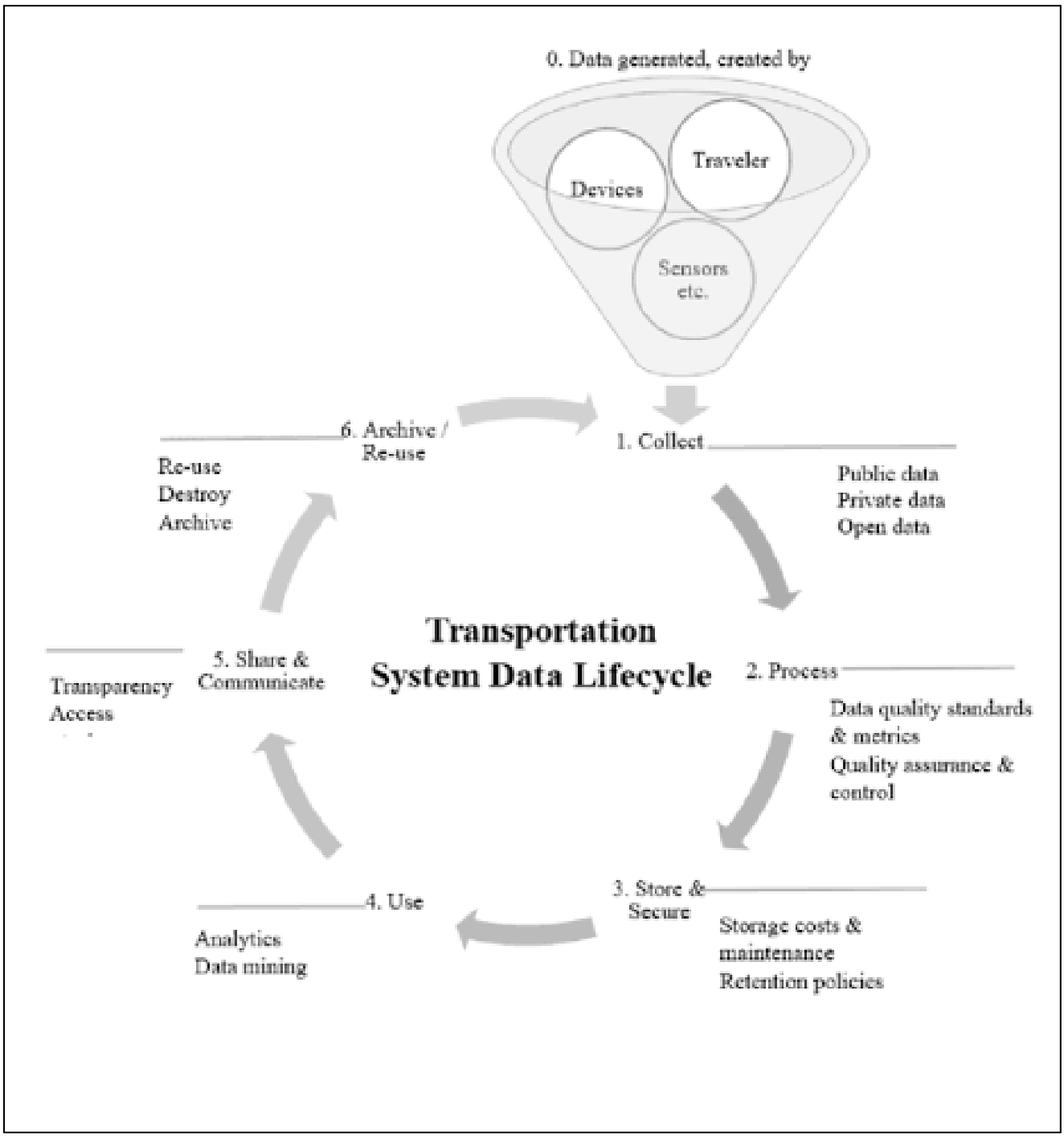
## 14. DATA COLLECTION AND TRANSPORTATION ANALYTICS

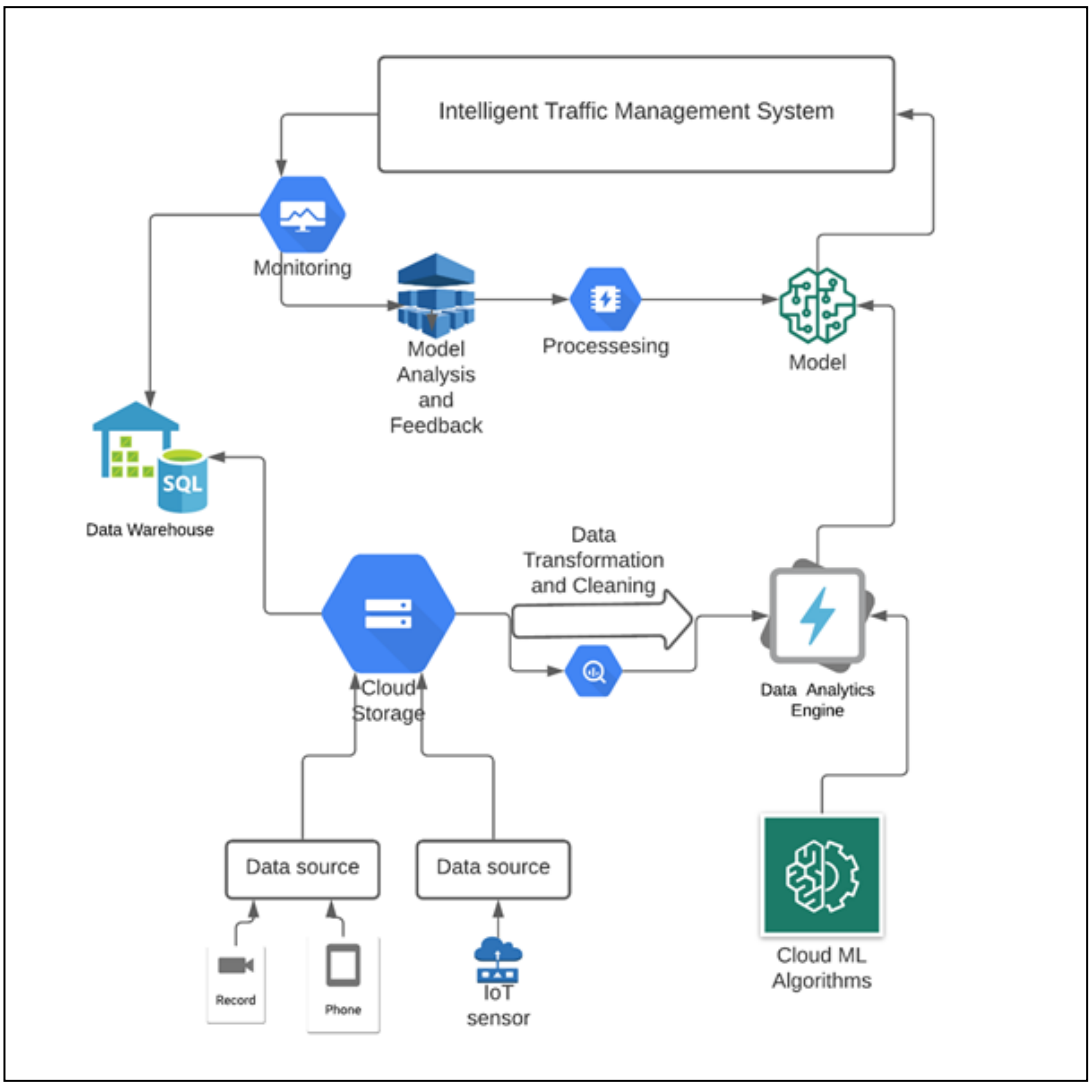
Data is used for:

- Performance monitoring
- Planning
- Predictive maintenance
- Congestion management

[**Figure 13 – Transportation data lifecycle**]




0. Data generated, created by
Traveler
Devices
Sensors
etc.
1. Collect
Public data
Private data
Open data
2. Process
Data quality standards
& metrics
Quality assurance &
control
3. Store &
Secure
Storage costs &
maintenance
Retention policies
4. Use
Analytics
Data mining
5. Share &
Communicate
Transparency
Access
6. Archive /
Re-use
Re-use
Destroy
Archive
Transportation
System Data Lifecycle

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**15. ROLE OF THE CIVIL ENGINEER IN ITS PROJECTS**

Civil engineers are involved in:

- Planning
- Design
- Infrastructure integration
- Construction coordination
- Operations support

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## 16. BENEFITS AND COST EFFECTIVENESS OF ITS

ITS provides:

- High benefit-to-cost ratios
- Improved safety
- Reduced fuel consumption
- Lower emissions

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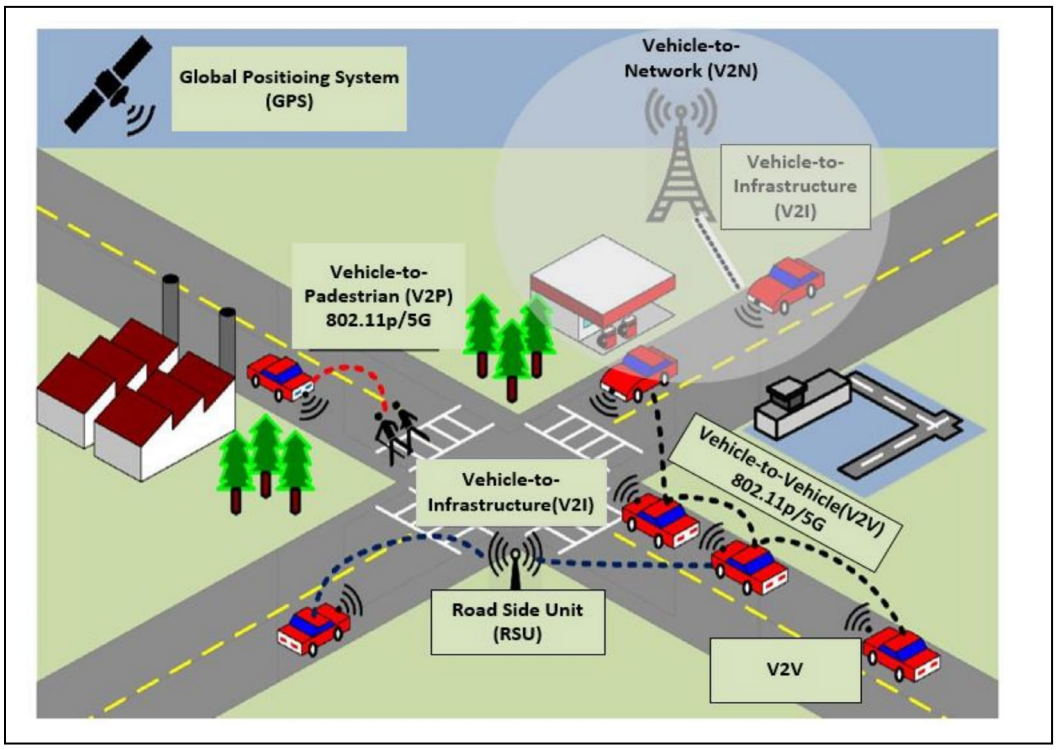
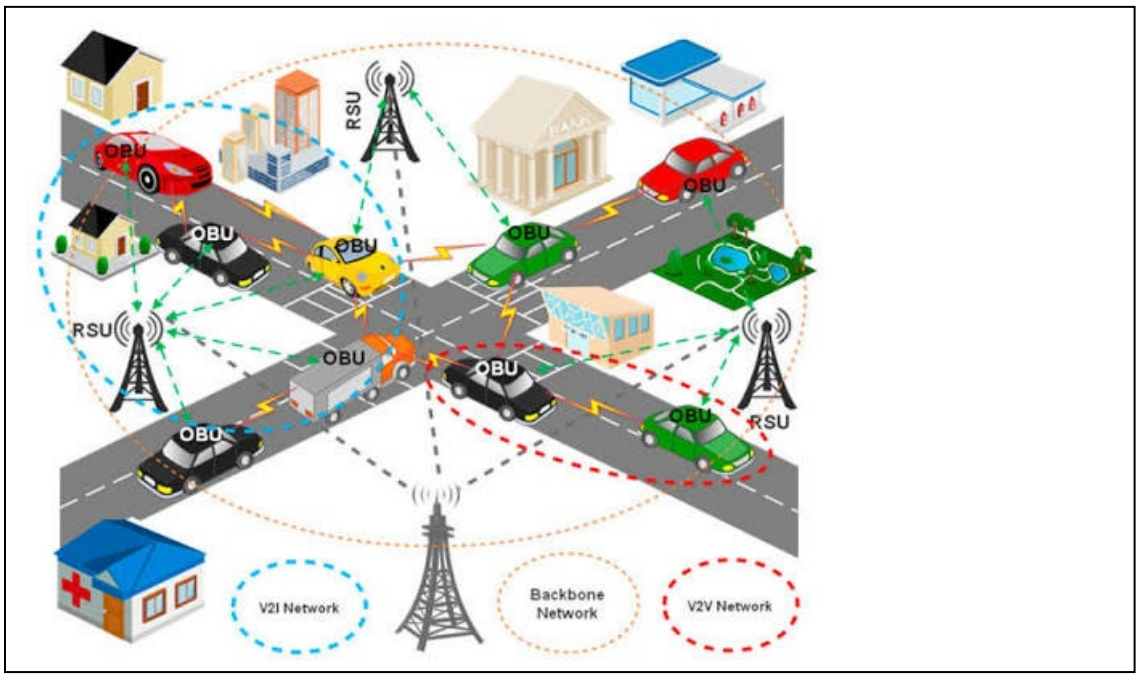
## 17. FUTURE OF INTELLIGENT TRANSPORTATION SYSTEMS

Future developments include:

- Connected vehicles
- Automated transportation
- Integrated corridor management
- Digital infrastructure

[**Figure 14 – Connected transportation ecosystem**]




RSU
OBU
OBU
OBU
OBU
OBU
OBU
RSU
OBU
OBU
OBU
RSU
OBU
V2I Network
Backbone Network
V2V Network


school
Integrated Transport Management Systems
Road Safety
Intelligent Fleet Management Systems
Big Data Analytics
SLOW
Vehicle-to-Vehicle Communications
Vehicle-to-Infrastructure Communications

## 18. SUMMARY

Intelligent Transportation Systems represent the transition from traditional infrastructure to a connected, data-driven transportation network that improves safety, efficiency, and reliability.