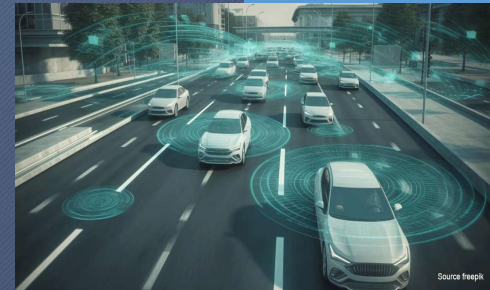


INTELLIGENT TRANSPORTATION SYSTEM

BCV714A



MODULE 1



- Basic elements of intelligent transportation systems (ITS), focusing on technological, systems and institutional aspects. Benefits of ITS -ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection



INTRODUCTION



- It refers to the integration of advanced technologies, such as sensors, communication, data analytics, and control systems, into transportation infrastructure and vehicles.
- The goal of ITS is to improve the safety, efficiency, and sustainability of transportation networks.
- These systems provide real-time information, enable more effective traffic management, reduce congestion, enhance travel experience, and support autonomous vehicle development.
- It encompasses a wide range of applications and solutions aimed at addressing the challenges associated with transportation in urban and rural areas.

Basic elements of intelligent transportation



- Technological aspect
- System aspect
- Institutional aspect

Technological aspect

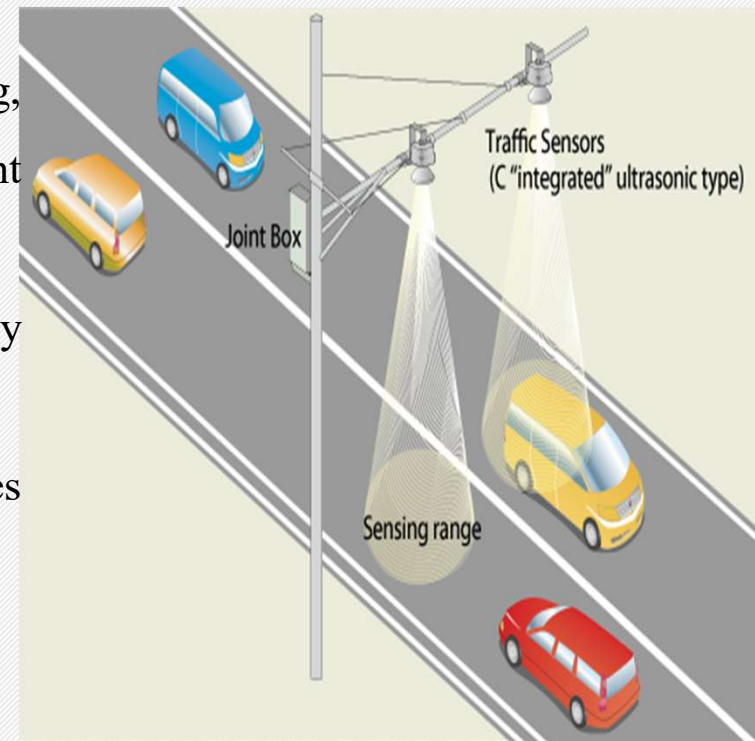


- Sensing and Detection Technologies
- Communication Systems
- Data Processing and Management
- Control Systems
- User Interfaces and Information Systems
- Safety and Security Systems
- Autonomous and Connected Vehicles
- Sustainable Transport Technologies

Sensing and Detection Technologies



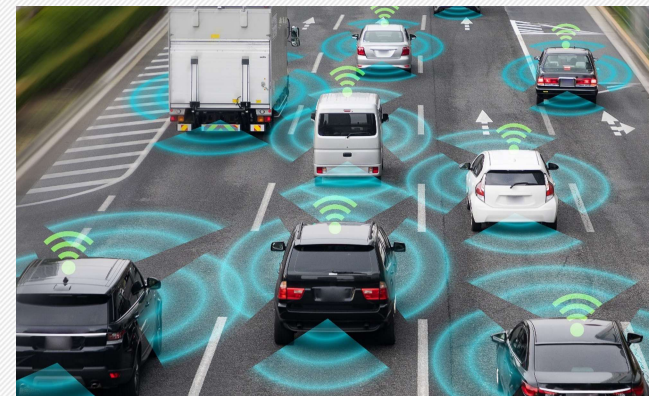
- **Traffic Sensors:** Measure real-time traffic data, including vehicle speed, density, and flow. Examples include inductive loops, radar, and infrared sensors.
- **Environmental Sensors:** Monitor weather conditions (rain, fog, etc.) and road surface conditions to inform traffic management systems.
- **Surveillance Cameras:** Monitor traffic flow, incidents, and security concerns.
- **Vehicle Detection Systems (VDS):** Detect the presence of vehicles to optimize signal timing and traffic flow.



Communication Systems



- **Vehicle-to-Vehicle (V2V) Communication:** Enables vehicles to exchange information (like speed, location, and direction) to prevent collisions and improve traffic flow.
- **Vehicle-to-Infrastructure (V2I) Communication:** Vehicles communicate with road infrastructure (e.g., traffic signals, toll booths) for smoother operations and safety enhancements.
- **Dedicated Short Range Communication (DSRC):** A key wireless technology used for V2V and V2I communications.
- **5G and Cellular Networks:** High-speed data transmission for real-time communication between vehicles and control centers.



Data Processing and Management



- **Traffic Management Centers (TMCs):** Centralized systems that gather, analyze, and manage real-time traffic data to optimize traffic flow and incident response.
- **Big Data Analytics:** Analyzes large amounts of traffic data to predict patterns, optimize routes, and reduce congestion.
- **Cloud Computing:** Provides scalable data storage and processing for real-time transportation management

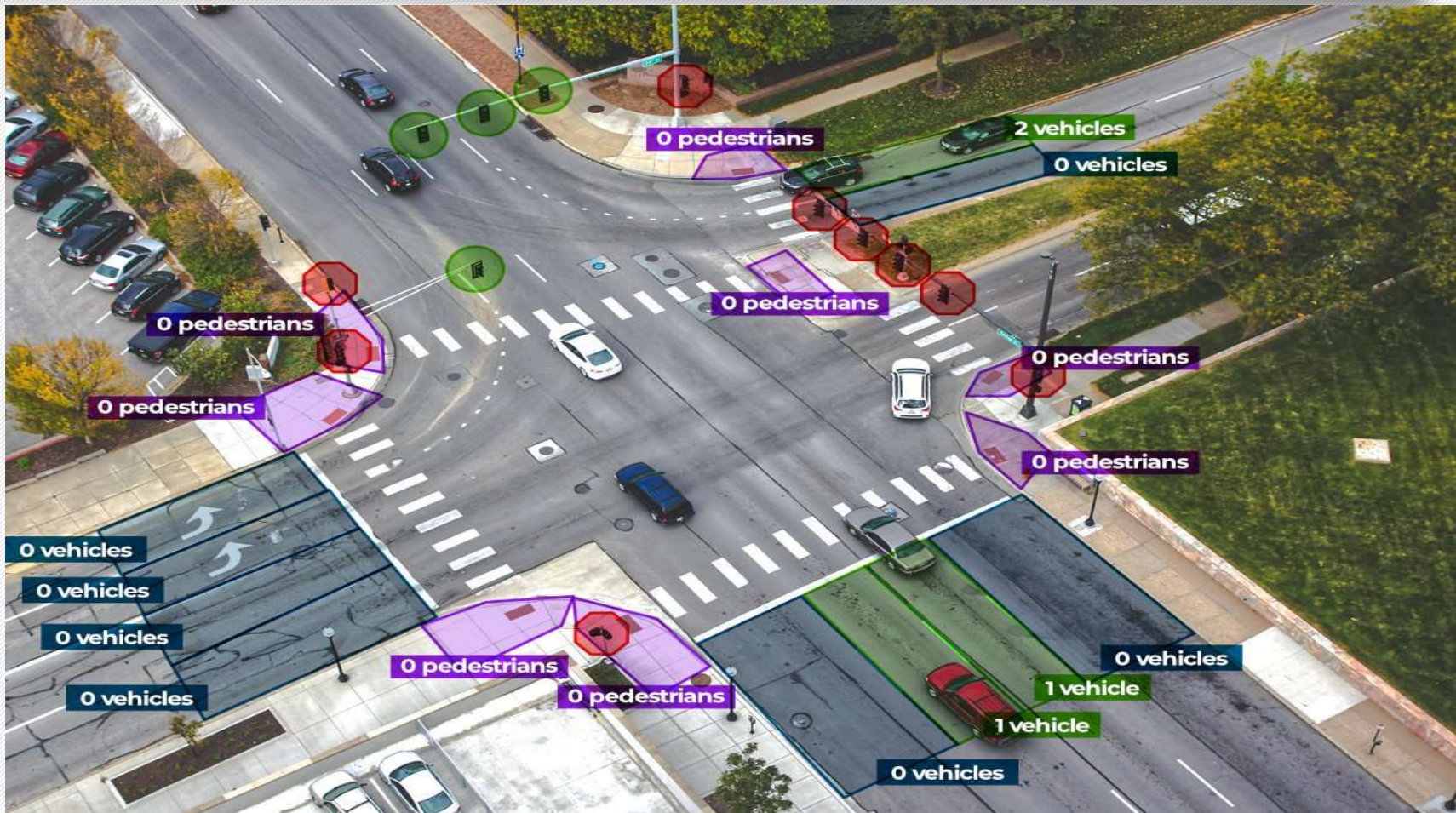


Control Systems



- **Adaptive Traffic Signals:** Adjust signal timing based on real-time traffic conditions to reduce congestion and improve traffic flow.
- **Ramp Metering:** Controls the rate of vehicles entering highways to prevent bottlenecks.
- **Dynamic Message Signs (DMS):** Display real-time information such as traffic conditions, accidents, and weather warnings to drivers.
- **Autonomous Vehicle Systems:** Uses AI, sensors, and control systems to allow vehicles to navigate without human intervention.

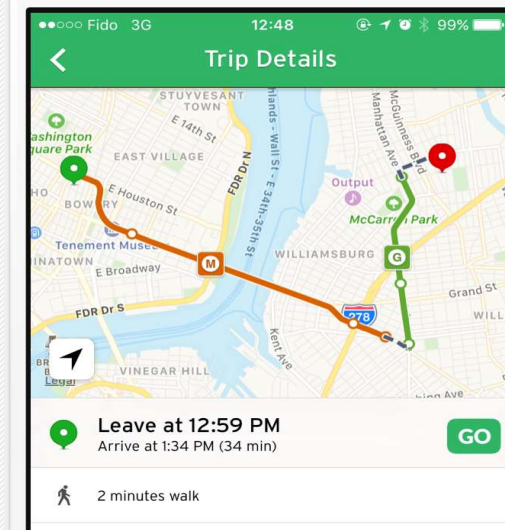
Control Systems



User Interfaces and Information Systems



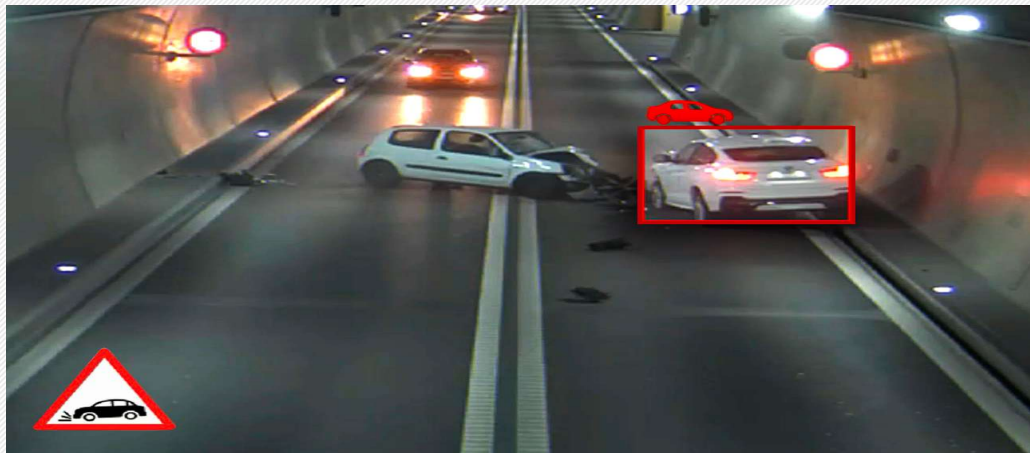
- **Traveller Information Systems:** Provide real-time information to drivers via apps, websites, or onboard systems (e.g., GPS navigation) about traffic conditions, road incidents, and optimal routes.
- **Smartphone Applications:** Integrated apps for real-time navigation, public transit tracking, and shared mobility options.
- **Automated Toll Collection:** Uses RFID or other sensors to automatically charge tolls without stopping.



Safety and Security Systems



- **Incident Detection and Management Systems:** Automatically detect accidents or other road incidents and dispatch emergency services while informing other drivers.
- **Collision Avoidance Systems:** Uses sensors and V2V communication to warn or prevent vehicles from colliding.
- **Emergency Notification Systems:** Provide quick response capabilities by alerting authorities during crashes or breakdowns



Autonomous and Connected Vehicles



- **Advanced Driver Assistance Systems (ADAS):** Technologies like adaptive cruise control, lane departure warning, and automatic emergency braking improve vehicle safety.
- **Self-driving Vehicles:** Autonomous cars use sensors, AI, and communication systems to navigate without human drivers, integrating with ITS for traffic optimization.



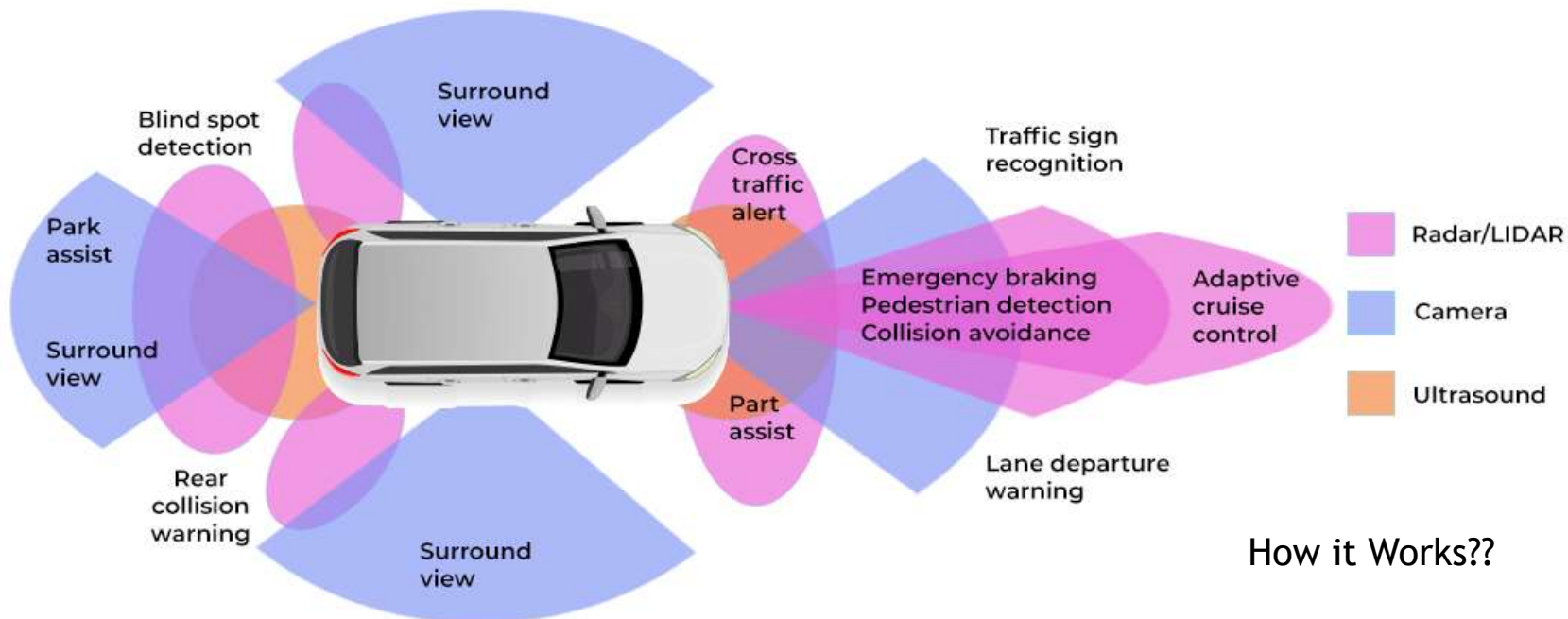
<https://www.youtube.com/watch?v=Zl3YSPiIT-w>



Autonomous and Connected Vehicles



HOW ADAS WORKS



How it Works??

Sustainable Transport Technologies



Electric Vehicle (EV) Charging Stations: Integrated into transportation networks, often with real-time data available on availability and location.

Eco-Driving Assistance: Systems that help drivers optimize fuel efficiency through real-time feedback on driving habits.

SYSTEM ASPECT

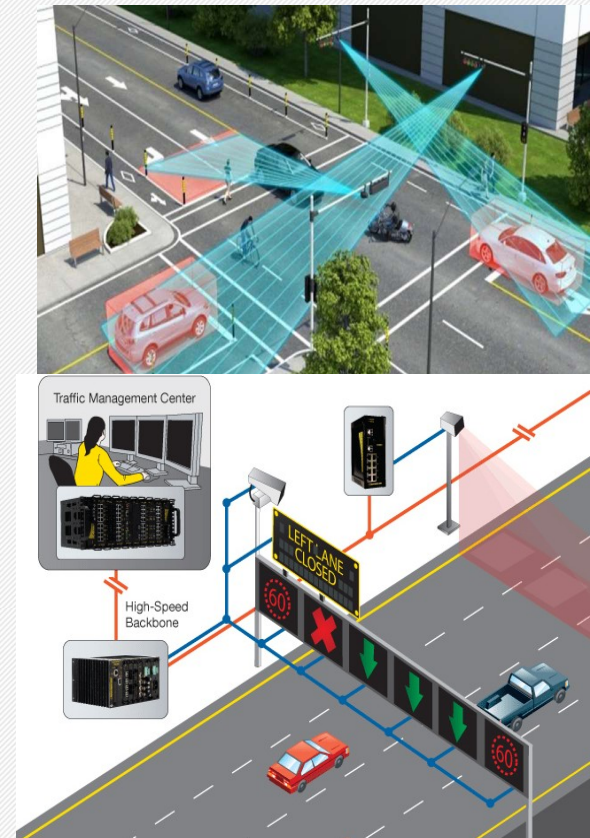


- The **system aspects** of Intelligent Transportation Systems (ITS) focus on structure and organization of how the technologies are integrated, interact, and provide comprehensive transportation solutions.
- These systems work together to manage traffic, enhance safety, and improve the overall efficiency of transportation networks.

Traffic Management Systems



- **Integrated Traffic Control:** Centralized or distributed systems that monitor and control the flow of traffic in real-time. They coordinate traffic signals, freeway ramp meters, and dynamic message signs based on real-time data.
- **Incident Management Systems:** Detect accidents or breakdowns and coordinate the appropriate emergency response, while updating other drivers to reduce secondary incidents.
- **Congestion Management:** Systems that monitor traffic density and implement congestion-reduction strategies such as dynamic lane management, congestion pricing, and alternative routing.



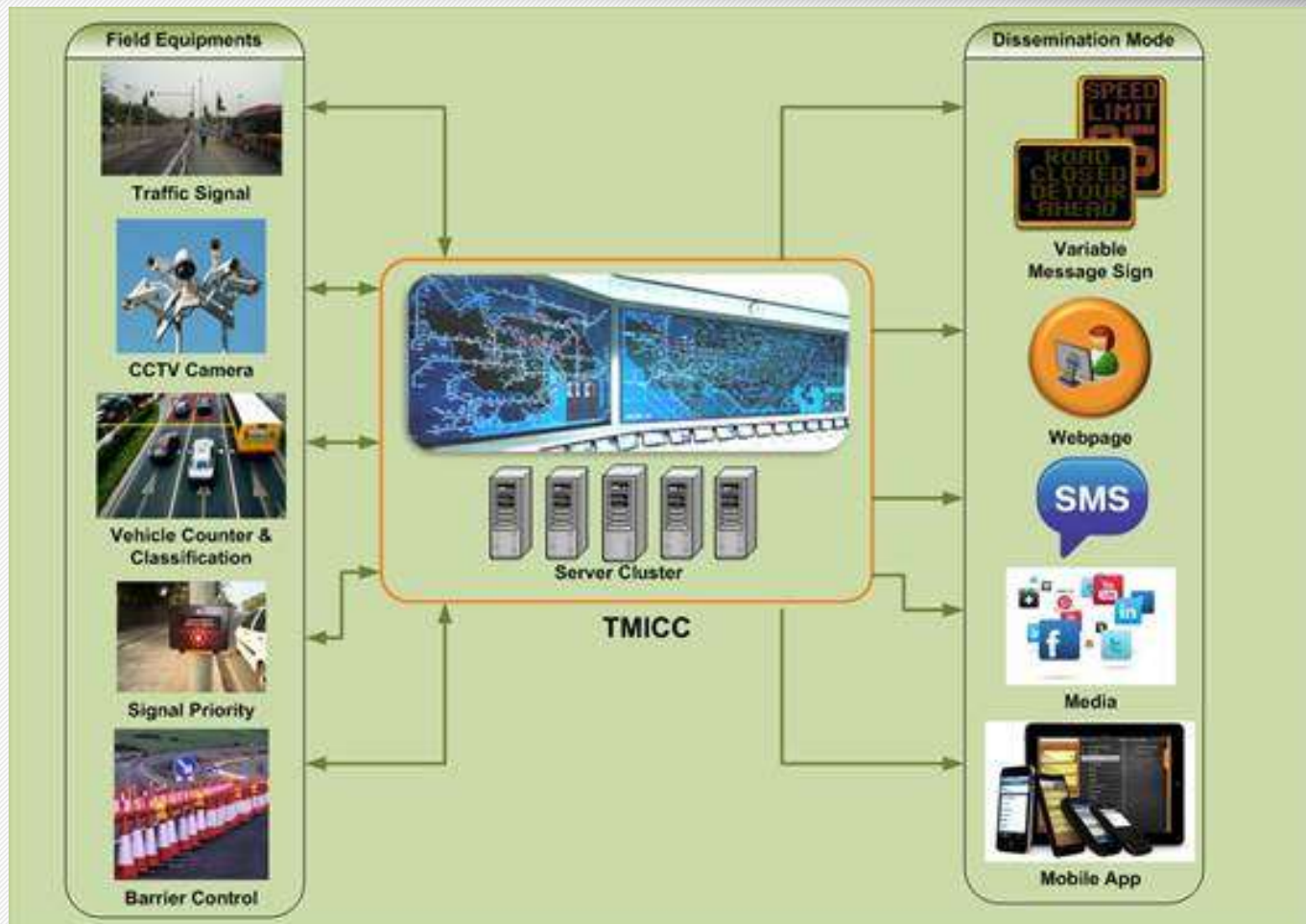
Traveller Information Systems



- **Real-time Information Dissemination:** Provides current traffic, road, and weather conditions to travelers through apps, websites, message boards, and radio systems.
- **Route Guidance:** Offers dynamic navigation that adapts to changing traffic conditions, giving users optimized routes.
- **Multimodal Travel Information:** Displays integrated travel options across multiple modes (cars, buses, trains, bikes), supporting seamless transitions between them.



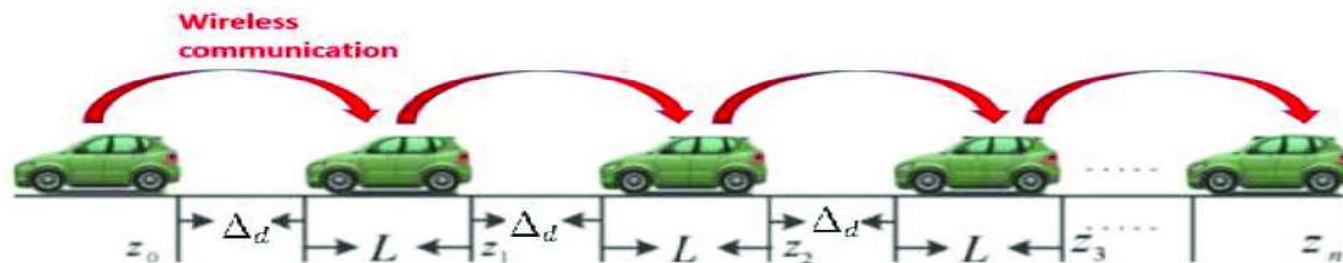
Traveller Information Systems



Advanced Vehicle Control Systems



- **Autonomous Vehicle Support:** Infrastructure systems to support autonomous driving, including vehicle-to-infrastructure (V2I) communication and dedicated lanes for autonomous vehicles.
- **Vehicle Platooning:** A system where groups of vehicles travel together in a convoy, closely spaced to reduce drag and improve road capacity, with minimal driver intervention.
- **Driver Assistance Systems (ADAS):** Vehicle systems integrated with ITS for functions like automated braking, lane keeping, and collision avoidance, improving driver safety and efficiency

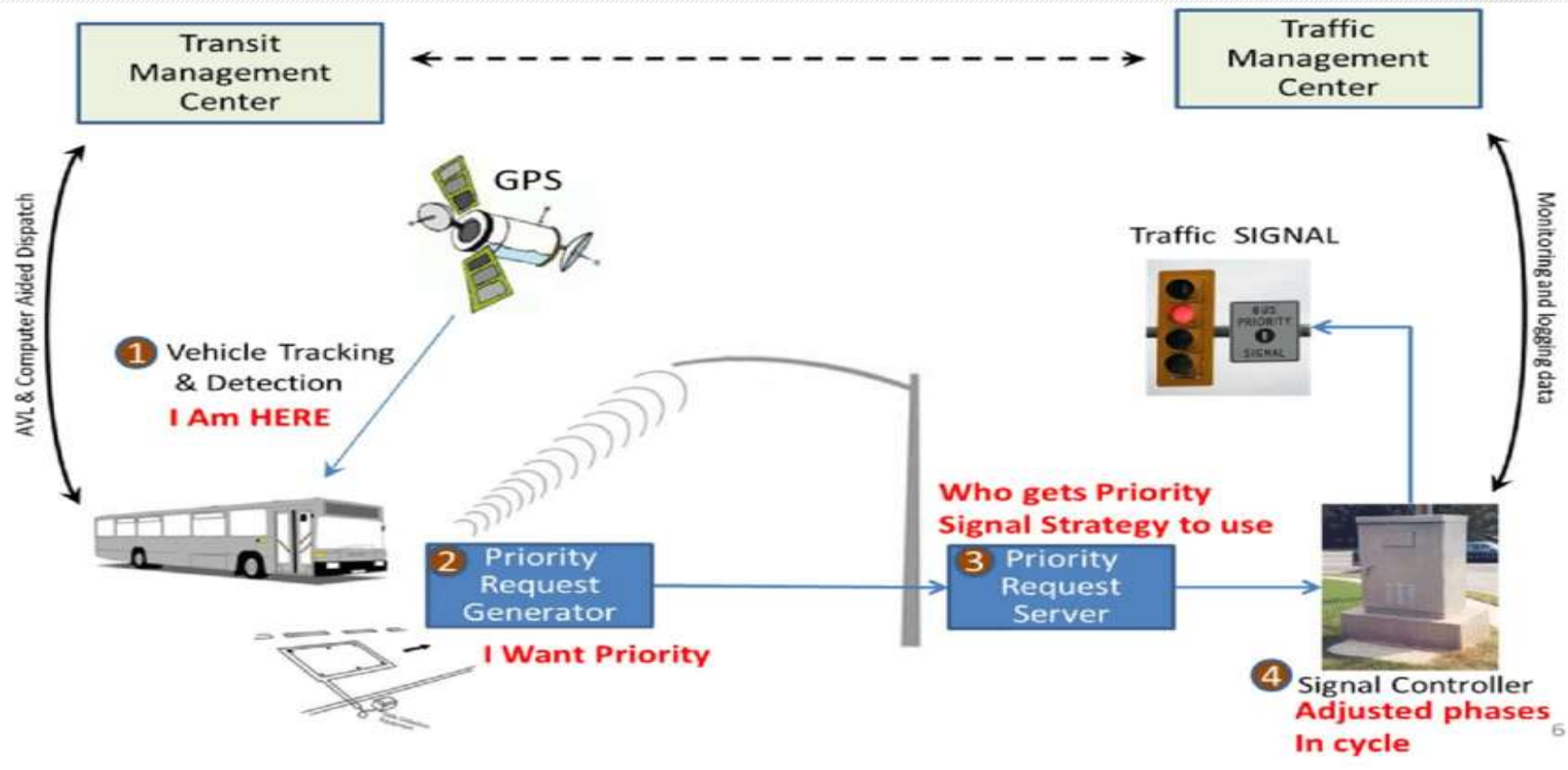


Public Transportation Systems



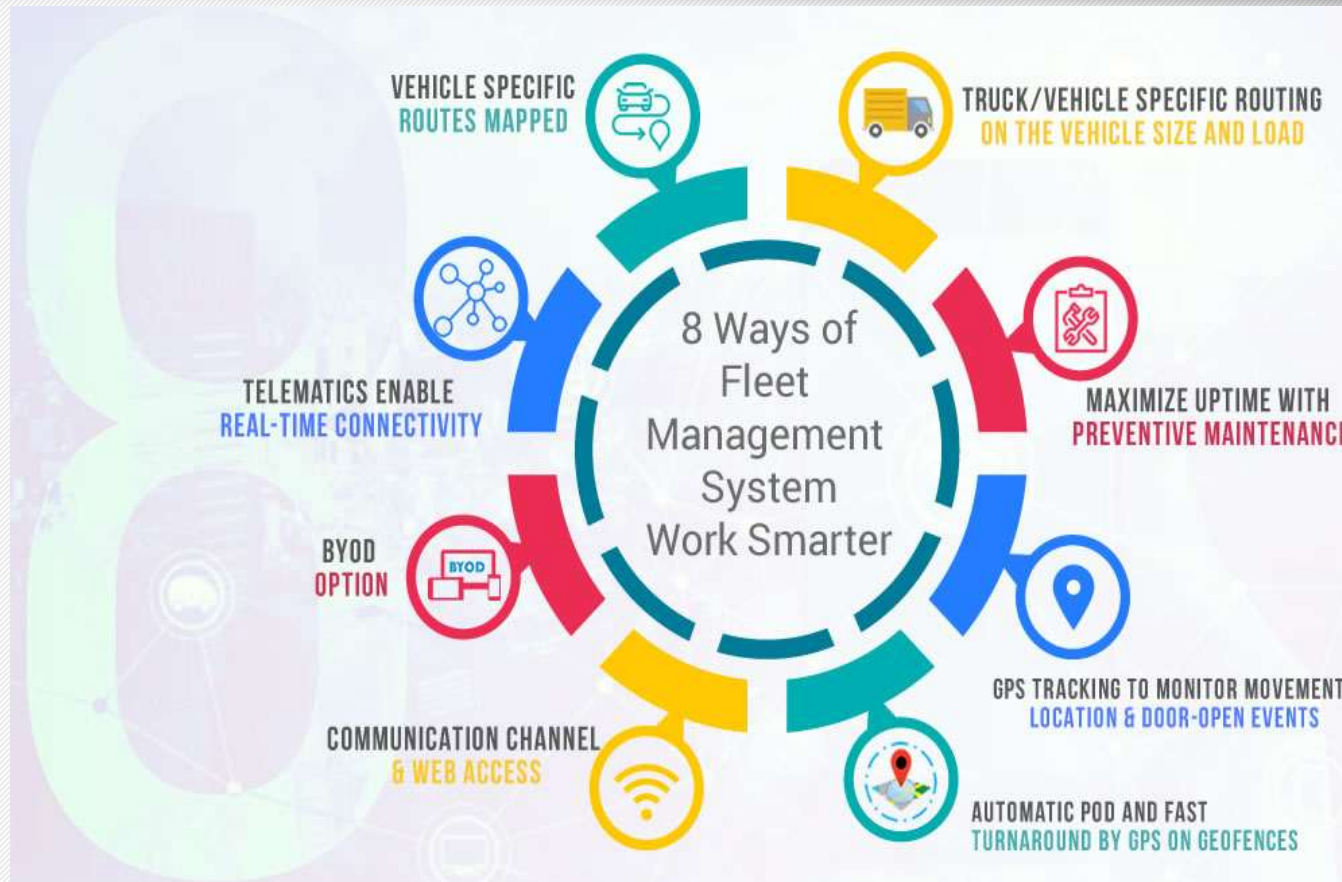
- **Real-Time Transit Monitoring:** Provides real-time updates on bus or train locations, expected arrival times, and any delays, making public transportation more reliable and efficient.
- **Transit Signal Priority (TSP):** Gives buses or trains priority at traffic signals to improve transit times and service reliability.
- **Fleet Management:** Systems that manage public transportation fleets, optimizing vehicle assignments, routes, and schedules based on real-time data.

Public Transportation Systems



Transit Signal Priority (TSP)

Public Transportation Systems



Fleet Management

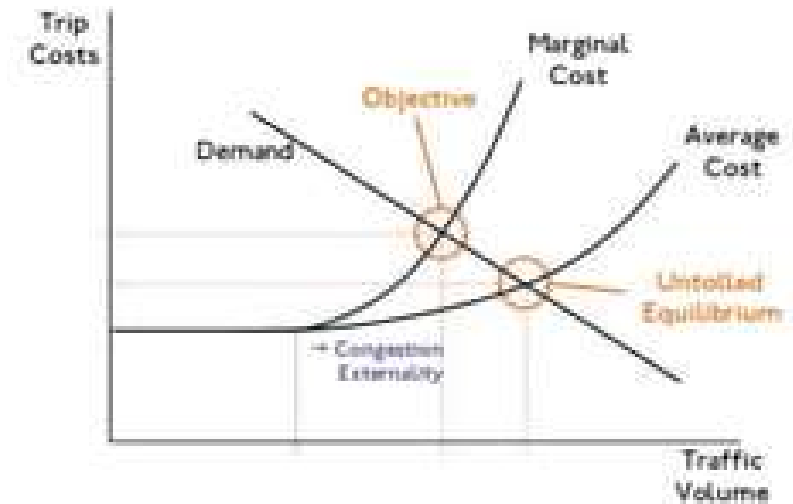
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Electronic Payment and Toll Systems



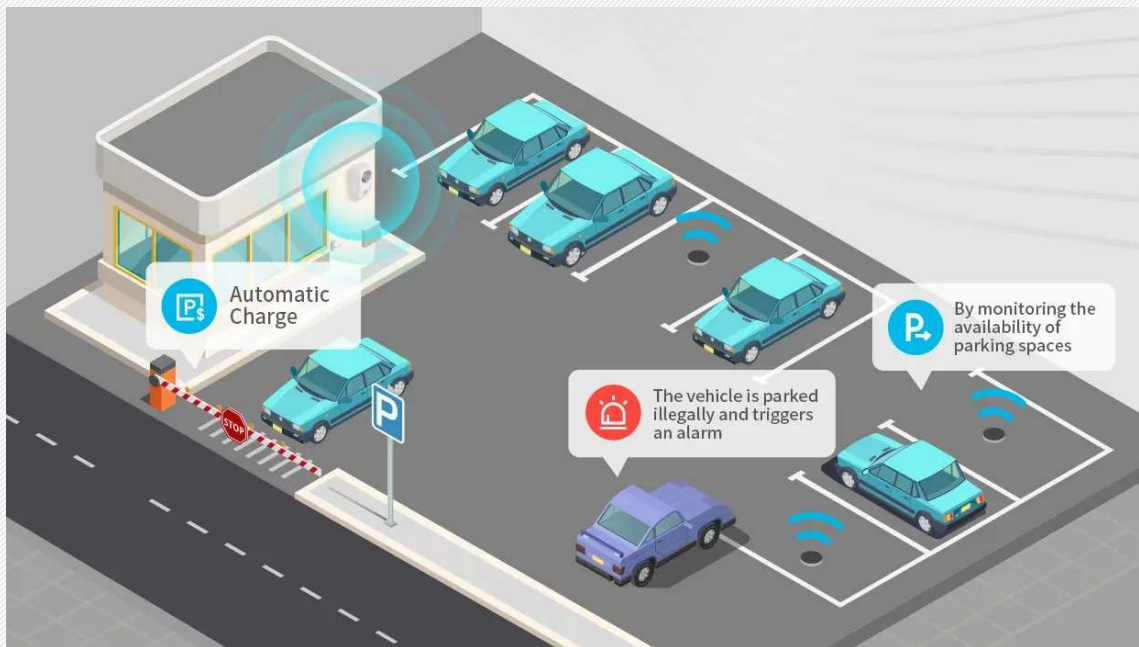
- **Congestion Pricing Systems:** Dynamically charge tolls based on the time of day or the level of traffic congestion, encouraging off-peak travel and reducing congestion.



Electronic Payment and Toll Systems



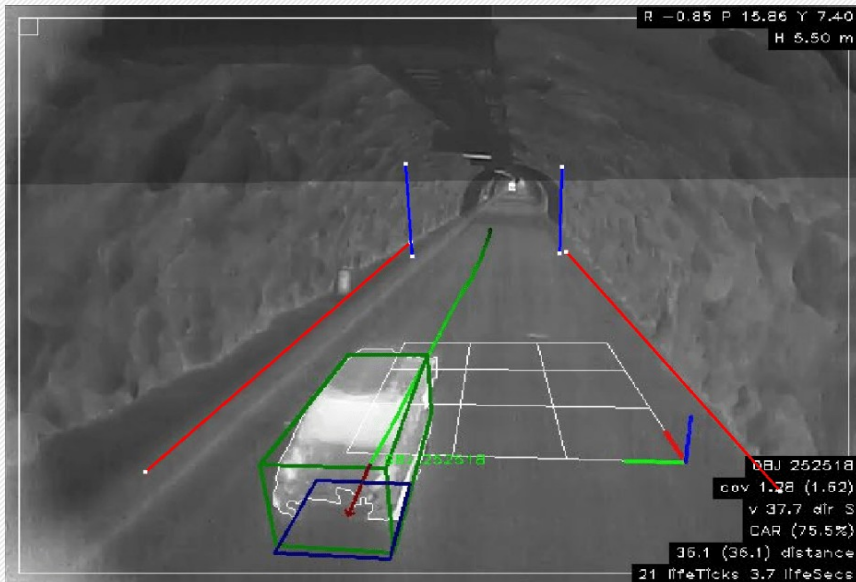
- **Smart Parking Systems:** Monitor parking availability and allow for automatic fee payment, reducing the need for manual intervention and improving space utilization.



Safety and Emergency Systems



- **Automated Incident Detection (AID):** Systems that detect traffic incidents, stalled vehicles, or accidents automatically, triggering an immediate response.



<https://www.youtube.com/watch?v=13id-BKfd1Q>



https://www.youtube.com/watch?v=zA_SIC6nmdM

Safety and Emergency Systems



- **Emergency Vehicle Presumption:** Traffic signals that can detect approaching emergency vehicles and give them priority at intersections, speeding up response times.

Ambulance	Fire Service	Police	Normal Vechile
Priority : 1	Priority : 2	Priority : 3	Priority : 4
			

Safety and Emergency Systems



- **Road Weather Management Systems:** Monitor and predict road conditions due to weather (ice, snow, fog) and automatically alert drivers, reroute traffic, or activate safety measures like reduced speed limits.



<https://www.youtube.com/watch?v=tK-w9w2ZmZY>

Data Management and Analytics



- **Traffic Data Collection:** Real-time collection of data from road sensors, vehicles, and cameras to monitor traffic conditions and make informed decisions.
- **Data Processing and Analysis:** Use of big data analytics and machine learning to predict traffic patterns, optimize route planning, and enhance decision-making in traffic management centers (TMCs).
- **Historical Data Analysis:** Use past data to analyze trends, improve traffic models, and forecast future demands on the transportation system.

Infrastructure Monitoring and Maintenance Systems



- **Structural Health Monitoring (SHM):** Continuous monitoring of critical infrastructure such as bridges, tunnels, and roadways for maintenance needs and early detection of potential failures.
- **Asset Management Systems:** Keep track of infrastructure health, maintenance schedules, and lifecycle management for roads, bridges, and other transportation infrastructure.
- **Roadway Condition Monitoring:** Detects surface degradation, potholes, and other infrastructure issues, allowing for timely repairs

Communication Networks and Integration



- **Dedicated Communication Networks:** Robust and reliable networks that allow seamless data exchange between vehicles, infrastructure, traffic management centers, and users. These often use a combination of wired and wireless technologies like fiber optics, 5G, and DSRC (Dedicated Short-Range Communications).
- **System Interoperability:** Ensures that different subsystems (e.g., traffic control, public transport management, toll collection) can communicate and operate together effectively.
- **Cloud-Based and Edge Computing Systems:** For handling the massive amount of data in real time, leveraging both centralized (cloud) and decentralized (edge) systems to reduce latency and improve responsiveness.

Sustainable and Environmental Systems



- **Eco-Traffic Management:** Adjusts traffic signals and controls to reduce stops and starts, optimizing traffic flow and reducing vehicle emissions.
- **Green Vehicle Integration:** Integrates electric vehicle (EV) charging networks and promotes the use of zero-emission vehicles by providing infrastructure support.
- **Intelligent Parking Solutions:** Guides drivers to available parking spots efficiently, reducing emissions from cars driving around looking for parking

Regulatory and Governance Systems



- **Policy and Regulation Systems:** Provides a framework for the safe, legal, and ethical operation of ITS technologies. This includes data privacy laws, autonomous vehicle regulation, and tolling policies.
- **Interagency Coordination Systems:** ITS typically involves coordination between multiple agencies (traffic control, law enforcement, public transport authorities), requiring strong systems to share information and collaborate in real-time

INSTITUTIONAL ASPECT



The **institutional aspects** of **Intelligent Transportation Systems (ITS)** focus on the organizational, regulatory, and collaborative frameworks required to implement, operate, and manage ITS effectively.

Regulatory and Policy Framework



- **Legislation and Policy Development:** Establishes the legal framework for the deployment of ITS. This includes regulations related to privacy, data sharing, autonomous vehicles, communication standards, and environmental impact.
- **Standards and Protocols:** Ensures interoperability between systems and devices, promoting uniformity across different jurisdictions and vendors. Standardization is key for seamless communication between systems (e.g., V2V, V2I).
- **Safety and Security Regulations:** Develops policies related to public safety and cybersecurity for ITS, including standards for protecting transportation infrastructure from cyber threats.
- **Data Privacy and Management:** Creates laws and policies that protect the privacy of personal and travel data collected through ITS systems, balancing data usage with privacy concerns.



Interagency Coordination



Collaboration Among Agencies: ITS requires cooperation between multiple government entities such as transportation departments, public safety agencies, city planners, law enforcement, and emergency services. A clear governance structure facilitates decision-making and resource sharing.

Cross-Border Collaboration: For regional or national ITS systems to function, coordination between different jurisdictions (e.g., neighboring states or countries) is essential. For example, toll systems, traffic management, and emergency response should be aligned across borders.

Public-Private Partnerships (PPP): Encourages collaboration between government agencies and private entities (such as technology companies, vehicle manufacturers, and infrastructure providers) to leverage resources, expertise, and innovations.

Funding and Financial Models



Government Funding: National, regional, and local governments often provide the financial backbone for ITS projects. This includes investments in infrastructure, research and development, and operational support.

Private Investment: Through public-private partnerships or private initiatives, private companies may contribute financially, especially in areas such as toll collection systems, autonomous vehicle development, or infrastructure technologies.

Grants and Incentives: Governments may offer grants, tax incentives, or subsidies to foster innovation, research, and development in the ITS field, and to encourage the adoption of ITS solutions by municipalities and businesses.

User-Pay Models: Implementing revenue models such as congestion pricing, electronic toll collection, or smart parking fees to fund ITS projects, ensuring sustainable financial resources over time.



Stakeholder Engagement



- **Public Engagement and Awareness:** Institutional efforts must include public outreach programs to inform and educate the public on the benefits and implications of ITS. This helps build public trust and ensures that users understand how to interact with new systems, such as autonomous vehicles or electronic tolling.
- **Private Sector Collaboration:** Key players in the private sector, including automakers, technology companies, telecommunications providers, and infrastructure firms, must be engaged to ensure that the technology is implemented effectively and evolves with market needs.
- **Academic and Research Institutions:** Collaboration with universities and research bodies helps to foster innovation, pilot new technologies, and provide objective analyses for government and industry stakeholders.

Governance Structures



- **Centralized or Distributed Governance Models:** ITS can be governed either through a centralized authority (e.g., a national ITS body) or a decentralized structure where different agencies and local governments take responsibility for their regions. This includes establishing decision-making protocols and defining roles and responsibilities.
- **Data Governance:** Since ITS relies heavily on real-time data, there must be clear policies on data ownership, access, sharing, and security. An institutional framework ensures that data is used responsibly and transparently.
- **Accountability and Oversight:** Clear governance structures help to ensure accountability for ITS project implementation and operation. Oversight mechanisms ensure that systems are effective, safe, and serving public interests.

Capacity Building and Training

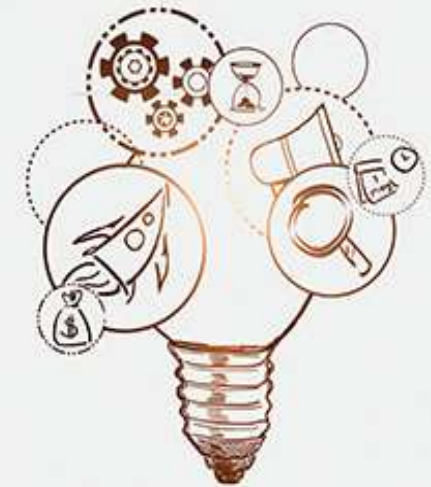


- **Technical Expertise Development:** Establishing training programs for government employees, private sector partners, and transportation professionals is essential for the successful deployment and maintenance of ITS technologies.
- **Workforce Development:** ITS implementation requires the development of a skilled workforce with expertise in transportation engineering, data analytics, cybersecurity, and system integration.
- **Public Training:** For technologies like autonomous vehicles or electronic tolling to succeed, there is a need for public education and training on how to safely use these systems.

Research and Development (R&D)



- **Innovation Support:** Governments and institutions often fund or support R&D initiatives that aim to advance ITS technologies, such as autonomous driving, smart infrastructure, or advanced traffic management systems.
- **Pilot Projects and Testing:** Before wide-scale implementation, governments or institutions run pilot projects and field tests to assess the feasibility and effectiveness of new ITS technologies.
- **Collaboration with Academia:** Continuous collaboration with academic institutions ensures that R&D is evidence-based and that there is a flow of new ideas into the ITS space.



Legal Liability and Risk Management

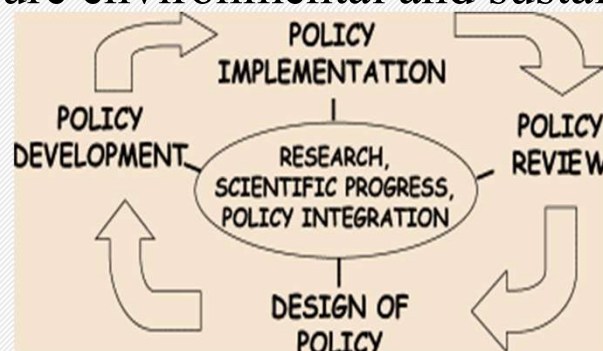


- **Liability in Autonomous Systems:** As technologies like autonomous vehicles become integrated into ITS, institutions need to clarify legal responsibilities in the event of accidents, failures, or misuse of systems.
- **Insurance and Risk Management:** Creating policies around insurance for technologies like connected vehicles or autonomous driving, to manage risks and liabilities.
- **Crisis and Incident Management:** Developing legal and institutional frameworks to respond effectively to traffic incidents, cybersecurity attacks, and other emergencies within the ITS framework

Sustainability and Environmental Goals



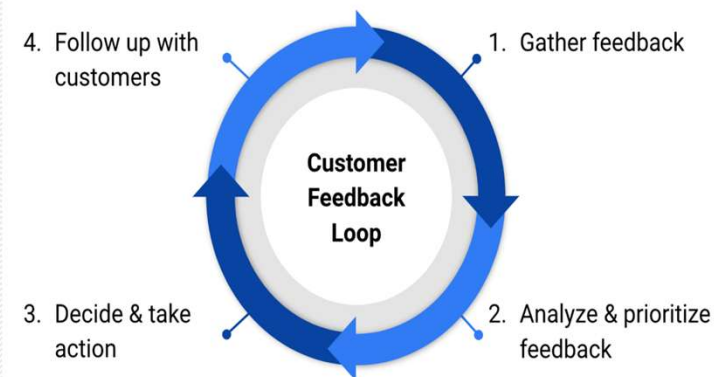
- **Sustainability Policy Integration:** ITS projects often aim to reduce carbon emissions and encourage the use of electric vehicles, public transport, and sustainable modes of travel. Institutions play a role in aligning ITS with broader environmental policies.
- **Eco-Friendly Incentives:** Encouraging the adoption of eco-driving, electric vehicles, and reduced emissions through policy incentives like tax breaks, rebates, or infrastructure investments.
- **Long-Term Urban Planning:** ITS is integrated into broader urban planning initiatives to ensure the system meets future environmental and sustainability goals.



Monitoring, Evaluation, and Feedback



- **Performance Monitoring:** Institutions establish mechanisms to continuously monitor the performance and effectiveness of ITS systems, including traffic flow, safety improvements, and public satisfaction.
- **Evaluation Frameworks:** Regular assessments and audits of ITS projects are conducted to evaluate the economic, social, and environmental impact of the technologies. This allows for adjustments and improvements in policies.
- **Public Feedback Mechanisms:** Institutions must create channels for public feedback, allowing citizens to report issues, suggest improvements, or evaluate the success of ITS implementations.



International Collaboration and Standards



- **Global Standards Alignment:** As transportation systems become more global, ITS must adhere to international standards for communication, data transfer, and infrastructure.
- **International Research and Best Practices:** Learning from global ITS deployments helps nations and cities implement systems based on proven success stories and avoid common pitfalls



BENEFITS OF INTELLIGENT TRANSPORT SYSTEM



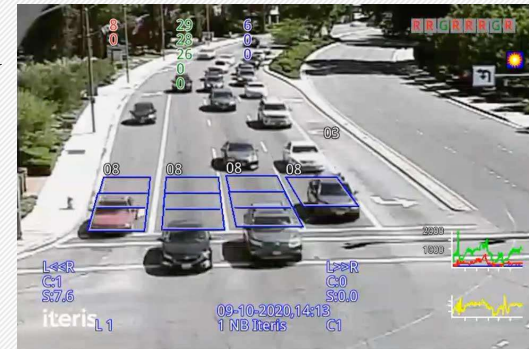
1. Enhanced Traffic Flow
2. Improved Road Safety
3. Reduced Environmental Impact
4. Increased Efficiency in Public Transportation
5. Better Incident Management
6. Cost Savings
7. Enhanced Travel Experience
8. Support for Autonomous Vehicles
9. Improved Freight and Logistics
10. Data Collection and Analytics

BENEFITS OF INTELLIGENT TRANSPORT SYSTEM



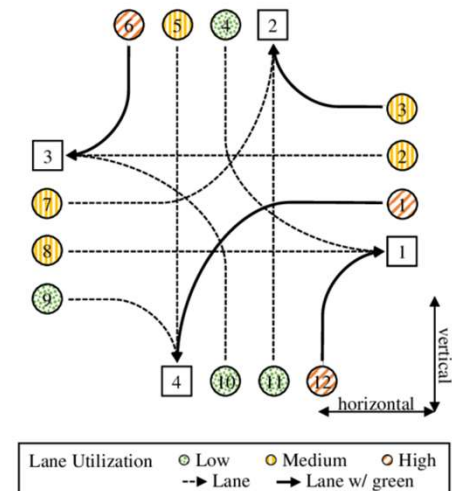
1. Enhanced Traffic Flow

- ITS uses real-time data to optimize traffic signals, improve road usage, and reduce congestion.
- Dynamic traffic management systems can respond to real-time conditions, reducing bottlenecks.



2. Improved Road Safety

- Collision avoidance systems and early warning alerts help drivers react faster, reducing accidents.
- Technologies such as smart traffic signals and real-time hazard warnings contribute to safer driving environments.

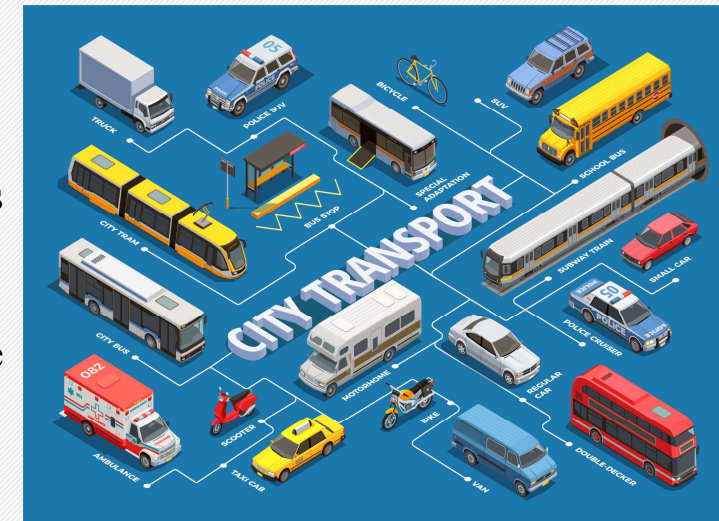


BENEFITS OF INTELLIGENT TRANSPORT SYSTEM

3. Reduced Environmental Impact



4. Increased Efficiency in Public Transportation



BENEFITS OF INTELLIGENT TRANSPORT SYSTEM



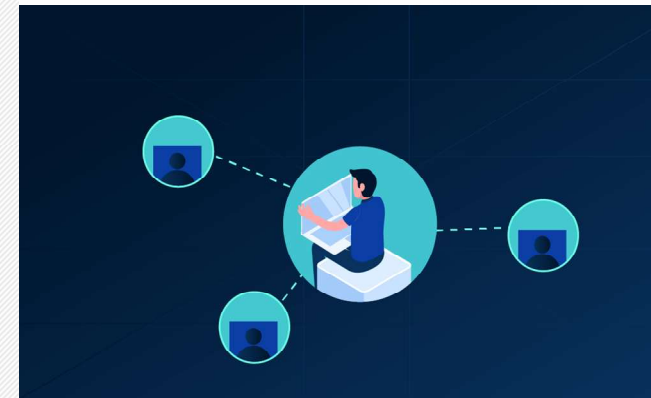
5. Better Incident Management

- Real-time monitoring of traffic conditions enables quick detection and management of incidents, such as accidents or breakdowns.
- Emergency services can be dispatched faster and more effectively, reducing response times.



6. Cost Savings

- Reduced fuel consumption and optimized traffic flows lead to lower vehicle operating costs for drivers and transportation agencies.
- Reduced congestion also translates to lower infrastructure maintenance costs.



BENEFITS OF INTELLIGENT TRANSPORT SYSTEM



9. Improved Freight and Logistics

- ITS helps in tracking and managing the movement of goods, making logistics more efficient by reducing delays and improving route planning.

10. Data Collection and Analytics

- ITS generates valuable data that can be analyzed to improve future transportation planning, policy-making, and system optimization.



DATA COLLECTION TECHNIQUES



Intelligent transportation systems (ITS) use a variety of data collection techniques, including

- Vehicle detection
- Inductive loops
- Video cameras
- Radio-frequency id (rfid) sensors
- Acoustic sensors
- Other Sensors

Vehicle detection



- **Floating car data:** This method uses information and communication technology to provide traffic data.
- **Multi sensor data fusion:** This technique combines data from multiple sources to create a better understanding of the situation.
- **Traffic condition prediction:** This is a key component of ITS, and can be done using neural networks.
- **Real-time data collection:** ITS collects data from roads in real-time, processes it, and then transmits it to decision-making systems.

Vehicle detection



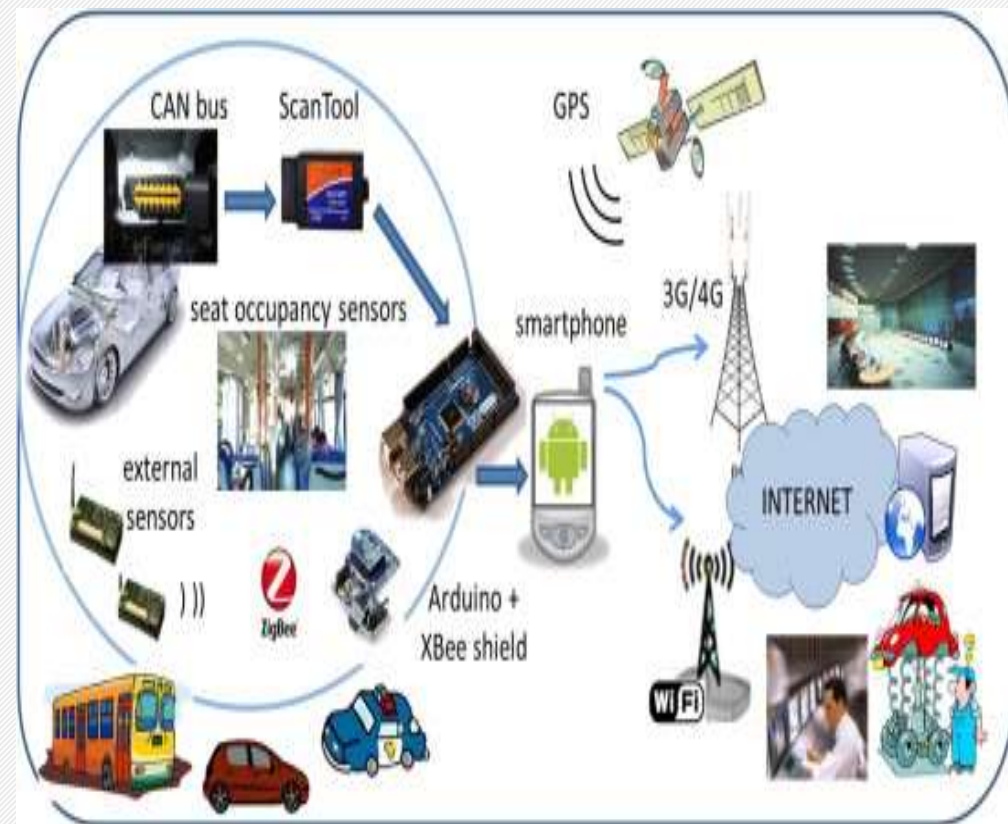
Floating car data:

- An observer drives a test vehicle through a pre-selected route at a speed similar to the average traffic speed. The test vehicle driver attempts to pass as many vehicles as they pass, and the time it takes to complete the section is recorded.
- The floating car method is used to determine traffic speed, identify congestion, calculate travel times, and generate traffic reports.
- The floating car method uses moving vehicles to collect data, while other methods use stationary devices like traffic cameras or induction loops.
- The participating vehicles act as moving sensors, using GPS receivers or cellular phones to collect timestamped geo-localization and speed data.
- A third observer records the number of vehicles that overtake and are overtaken by the test vehicle, while a fourth observer records the number of vehicles traveling in the opposite direction.

Vehicle detection

Floating car data:

In this method the driver tries to float in the traffic stream passing as many vehicles as pass the test car. If the test vehicle overtakes as many vehicles as the test vehicle is passed by, the test vehicles should, with sufficient number of runs, approach the median speed of the traffic movement on the route. In such a test vehicle, one passenger acts as observer while another records duration of delays and the actual elapsed time of passing control points along the route from start to finish of the run.



Traffic condition prediction



Traffic condition prediction is the process of using data analysis and artificial intelligence (AI) to forecast future traffic conditions and patterns. It involves predicting travel time, traffic density, and speed.

Traffic condition prediction is important for:

- Transportation systems: Improving transportation systems and reducing traffic congestion
- Public transportation: Planning public transportation and new infrastructure projects
- Logistics and transportation: Estimating times of arrival (ETAs) for fleet management and customer delivery
- Mobility as a service (MaaS): Planning multi-modal transportation routes



Traffic condition prediction



Traffic condition prediction uses a combination of real-time and historical data points, including traffic volumes, weather conditions, and travel patterns. Some techniques used in traffic condition prediction include:

- Machine learning and computer vision**

Analyzing traffic camera footage to extract real-time information about traffic conditions

- GM(1,1) model**

Using a combination of intelligent trapezoidal and variable weights to improve prediction accuracy

- Logistic regression**

Immune to data noise and multi-collinearity, but unsuitable for nonlinear problems

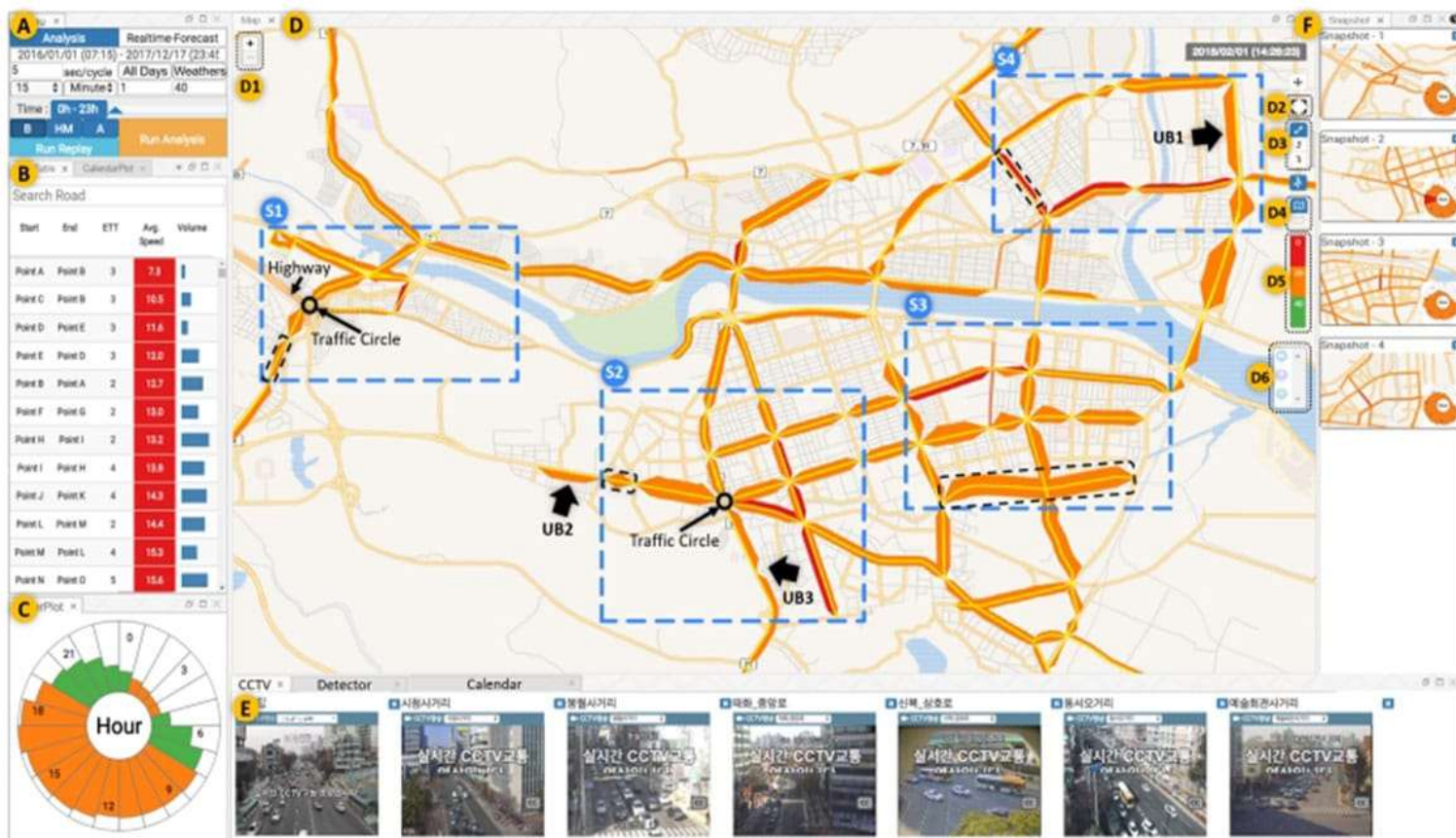
- Linear regression**

Can achieve the best prediction accuracy if the training data is prepared correctly

Google Maps and TomTom are examples of modern traffic prediction systems that can estimate traffic congestion in seconds and suggest alternative routes to drivers



Traffic condition prediction



Real-time data collection



Real-time data collection for road transport can be done through a variety of methods, including:

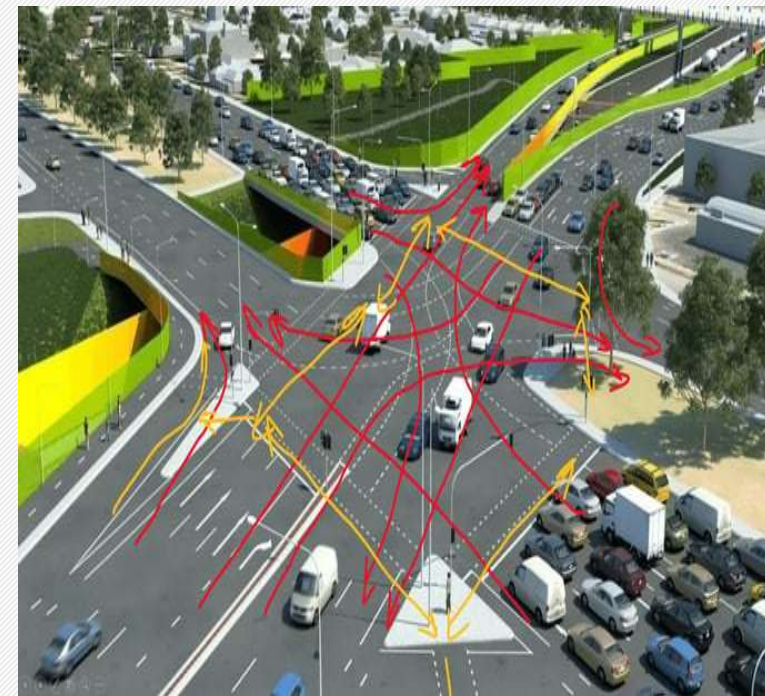
- **Fixed detectors:** These are placed along the road at strategic points to collect information such as traffic flow and vehicle speed.
- **Mobile phones and In-Vehicle GPS:** These can provide accurate real-time information over a large road network.
- **Sensors:** These can be embedded in the roadway or mounted beside or above it. Intrusive sensors, such as inductive loop detectors, are embedded into the roadway. Nonintrusive sensors, such as radar, infrared, and ultrasonic, are mounted beside or above the roadway.



Real-time data collection



- **Closed-circuit television (CCTV) cameras:** These can be used to collect real-time traffic data.
- **Traffic management centers:** These can be used to collect real-time traffic data.
- **Mobile apps:** These can be used to collect real-time traffic data.
- **Third-party data providers:** These can be used to collect real-time traffic data.
- **Pneumatic tubes:** These are placed across the roadway and release a burst of air when a vehicle passes over them. This air pressure activates a data logger or sends an electrical signal to traffic counting software



Inductive loops

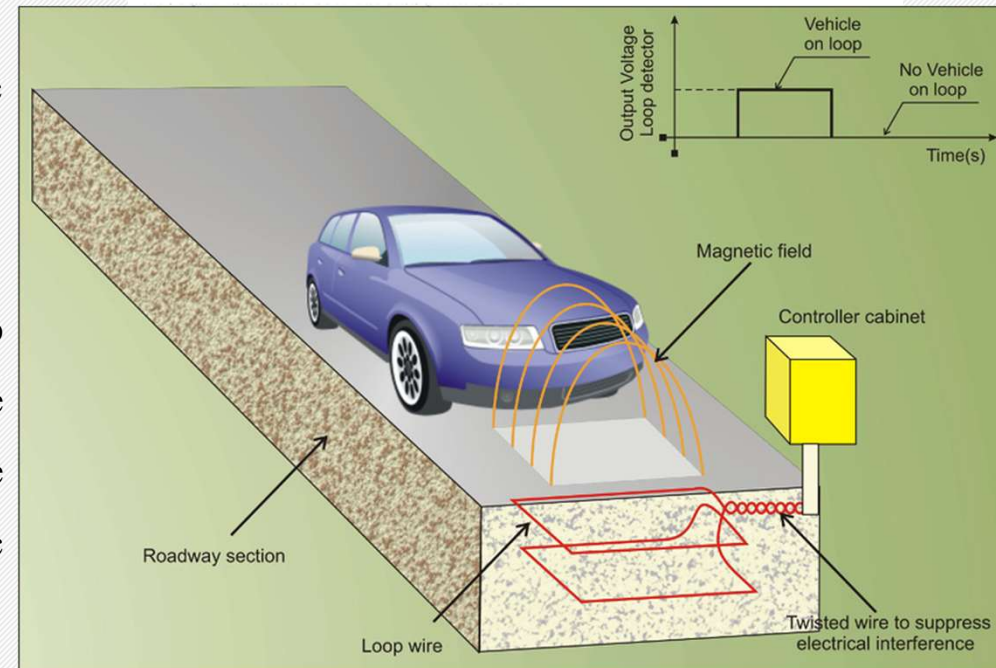
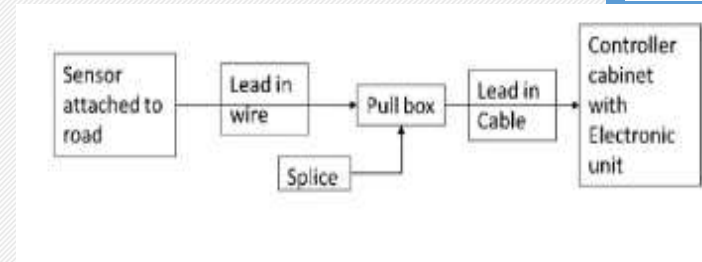


- These sensors are embedded in the roadbed and detect vehicles as they pass over them. They can count the number of vehicles, and more sophisticated loops can also estimate the speed, length, and class of vehicles.
- Inductive loop detectors are one kind of traffic sensor used to identify the different vehicle classes using the induced current from the loop of a wire which is fixed to the pavement. These are extensively used in highways as they possess very high accuracy and are economical as well.
- There are various types of detectors available based on their functionality and usage. They are Pressure type, Push button type, Magnetic, Magnetometer, Inductive loop, radar type, sonic type, radiofrequency type and light emission detectors. Out of all these Inductive loop and magnetometer types are widely used for various purposes

Inductive Loop Mechanism



- Inductive loop detectors consist of one or more turns of wire in a saw cut slot in the road surface at the area where vehicles will pass and need to be detected.
- The ends of the loop are connected by a cable to an electronic amplifier which is usually placed in the controller cabinet.
- When the vehicle moves over the loop and disturbs the loop magnetic field, this, in turn, is sensed by the amplifier because the loop detector can detect either the presence or passage of the vehicle and it will introduce a new dimension to the traffic control.



Radio-frequency id (rfid) sensors

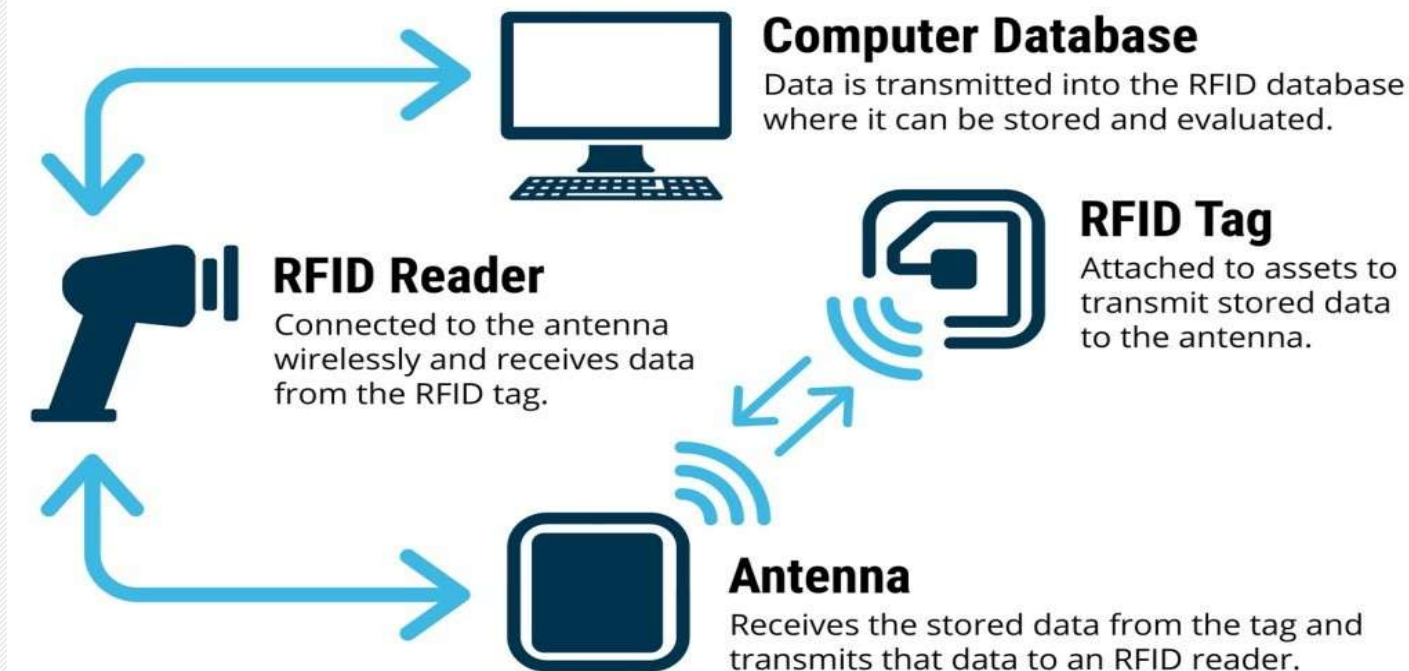


- RFID (radio frequency identification) is a form of wireless communication that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency portion of the electromagnetic spectrum to uniquely identify an object, animal or person. These sensors can automatically identify vehicles and collect their data. They can also be used for smart parking.
- Radio-Frequency Identification (RFID), a technology that enables data to be transmitted from a micro silicon chip at very fast speeds and without the need for line of sight, as required by barcodes, is an established data-carrying and automatic identification technology used throughout industry

Radio-frequency id (rfid) sensors



Basic RFID System

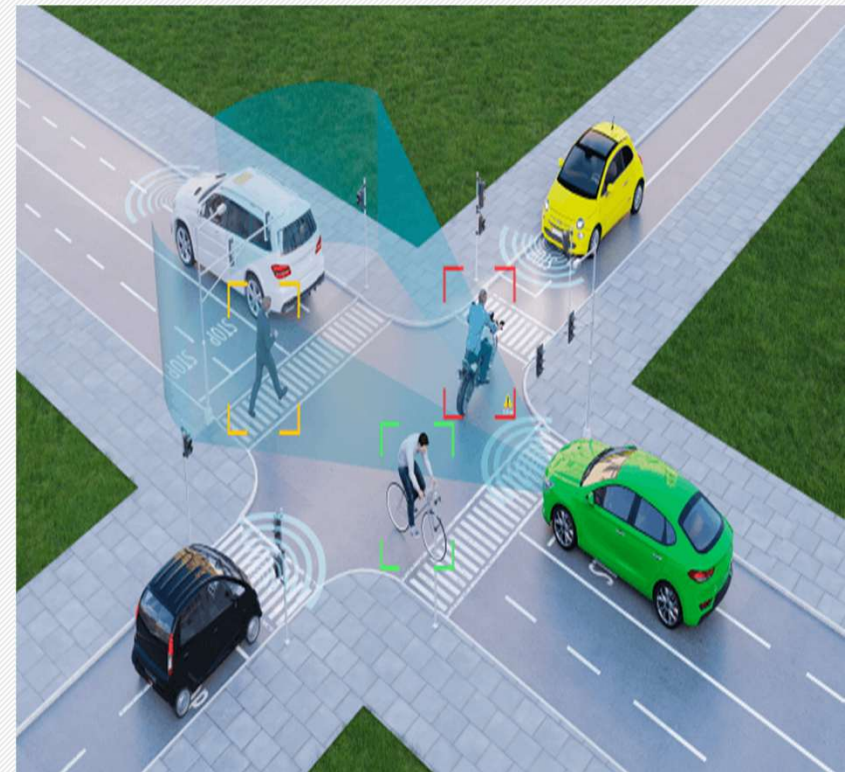


Acoustic sensors

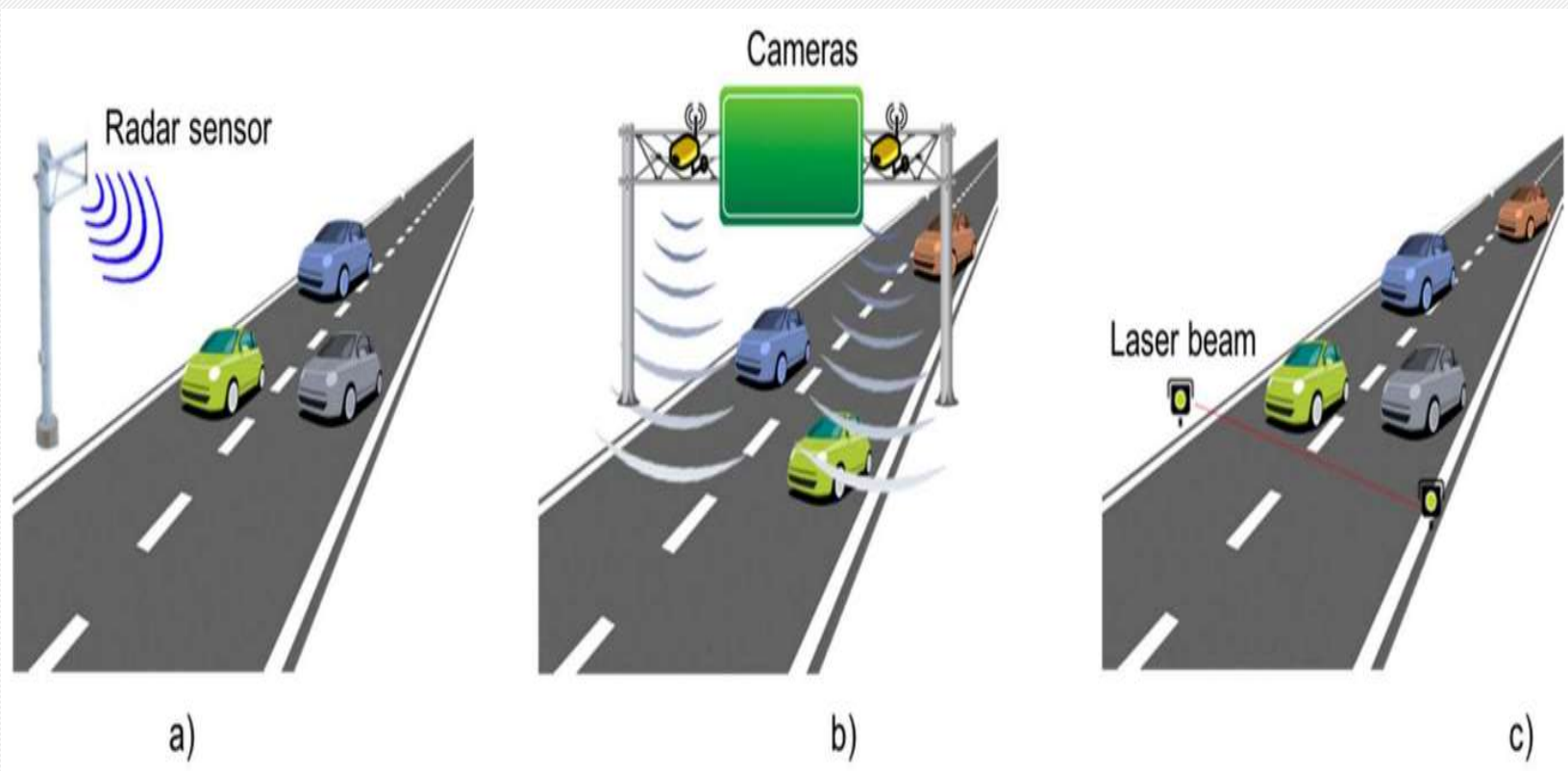


These sensors can be used to calculate traffic volume, occupancy, and average vehicle speed.

- Acoustic sensors are used in intelligent transportation systems (ITS) to monitor traffic by analyzing sound waves emitted from vehicles. Here are some ways acoustic sensors are used in ITS:
- Traffic volume, occupancy, and speed: Acoustic sensors can replace magnetic induction loops to calculate these metrics.
- Vehicle classification: Acoustic sensors can be used to classify vehicles.
- Occupancy detection: Acoustic sensors can be used to detect the number of passengers in a vehicle.



Acoustic sensors



PRESSURE SENSORS



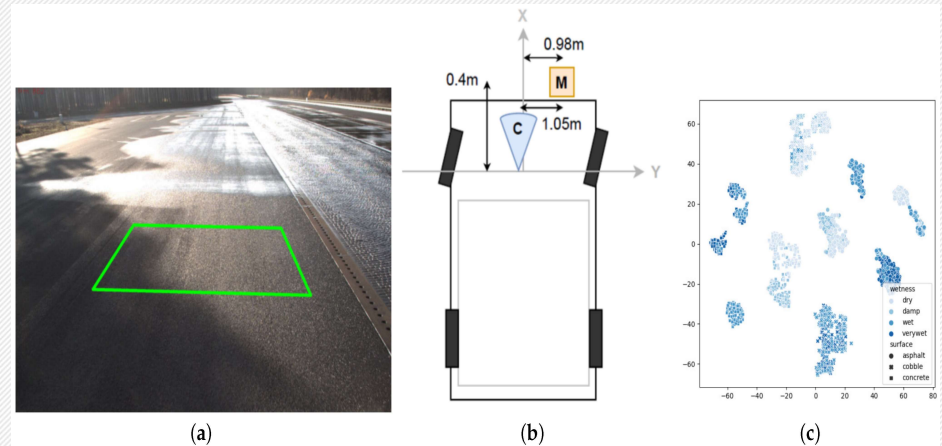
- Pressure sensors are composed of two screw elements, which are separated by some distance.
- Once the transport front wheels crossed the first push element, the receiver gives the signal of start of timer.
- Once the front wheels reached the second transport screw element, the receiver command is ending the countdown.
- At the time and known a certain distance between sensors it is simply to calculate the values of a passing transport.
- It may be the speed, quantity and direction



ROAD SURFACE CONDITION SENSORS



- These sensors use laser and infrared technologies to read road conditions, such as temperature and grip.
- Sensors are a key component of ITS, providing the data needed to operate the system. They are used to collect information about traffic conditions, which can then be used to improve transportation conditions



Automatic Vehicle Location (AVL)



- Automatic vehicle location is a means for determining the geographic location of a vehicle and transmitting this information to a point where it can be used.
- Most commonly, the location is determined using GPS and the transmission mechanism is a satellite, terrestrial radio or cellular connection from the vehicle to a radio receiver, satellite or nearby cell tower.
- The tracking data is then transmitted using any one of a variety of telemetry systems. GSM and EVDO are the most common technologies used for telemetry because of the low data rate needed for AVL. The low bandwidth requirements also allow for satellite technology to receive telemetry data at a moderately higher cost, but across a global coverage area and into very remote locations not well-covered by terrestrial radio or public carriers

TYPES OF AVL SYSTEMS



- DIRECTION FINDING
- SIGN POST SYSTEMS
- GPS BASED

DIRECTION FINDING



Amateur radio and some cellular or PCS wireless systems use direction finding or triangulation of transmitter signals radiated by the mobile. This is sometimes called radio direction finding, or RDF. The simplest forms of these systems calculate the bearing from two fixed sites to the mobile. This creates a triangle with endpoints at the two fixed points and the mobile. Trigonometry tells you roughly where the mobile transmitter is located. In wireless telephone systems, the phones transmit continually when off-hook, making continual tracking.

SIGN POST SYSTEMS



To track and locate vehicles along fixed routes, a technology called sign post transmitters was employed. This is used on transit routes and rail lines where the vehicles to be tracked continually operated on the same linear route. A transponder or RFID chip along the vehicle route would be polled as the train or bus traverses its route. As each transponder was passed, the moving vehicle would query and receive an ark, or handshake, from the signpost transmitter. A transmitter on the mobile would report passing the signpost to a system controller. These systems are an alternative inside tunnels or other conveyances where GPS signals are blocked by terrain.

GPS BASED



The low price and ubiquity of Global Positioning System or GPS equipment has lent itself to more accurate and reliable tele location systems. GPS signals are impervious to most electrical noise sources and don't require the user to install an entire system. Only a receiver to collect signals from the satellite segment is installed in each vehicle and a radio to communicate the collected location data with a dispatch point are typically used

Automatic Vehicle Identification (AVI)

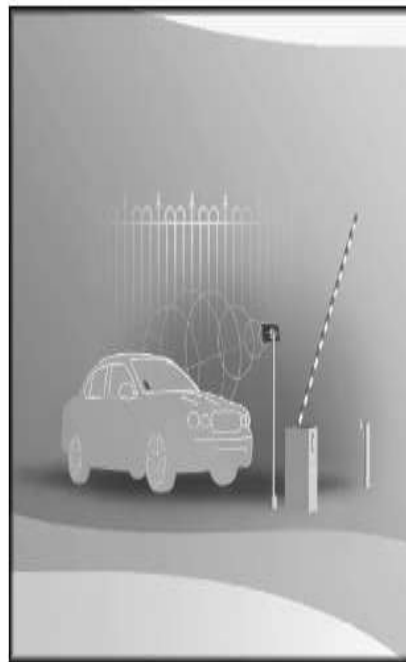
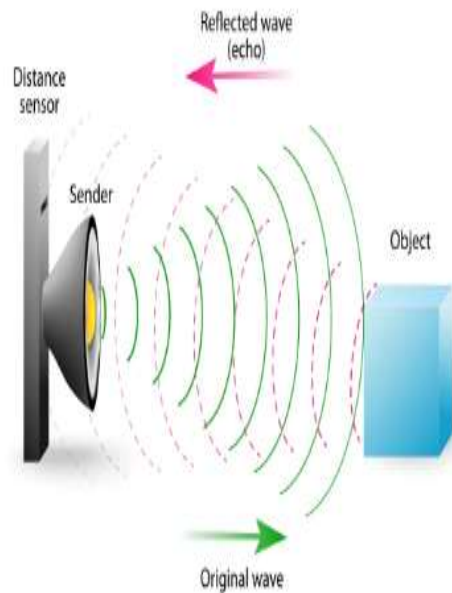


Automatic Vehicle Identification (AVI) offers the opportunity to identify vehicles in various traffic situations in a secure, reliable and cost-efficient way. Different applications like electronic toll collection, access control and speed control, can benefit from AVI. A corresponding RFID tag in the license plate secures it as a government-issued document, protecting them from forgery and duplication. RFID readers could also determine which vehicles had a stolen license plate.

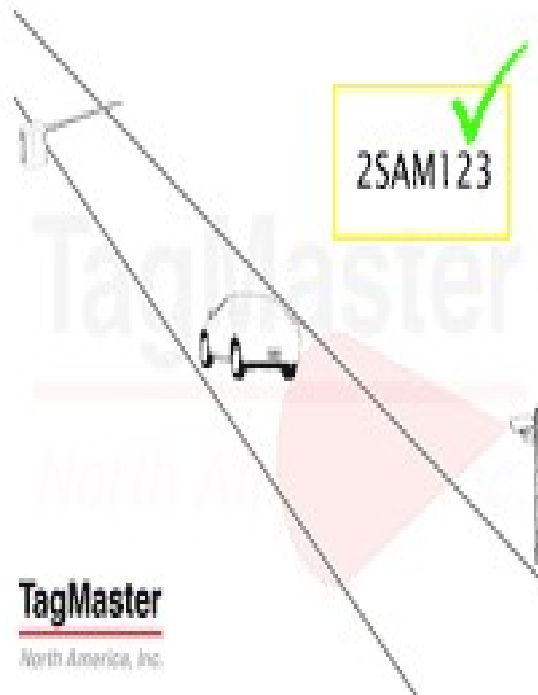
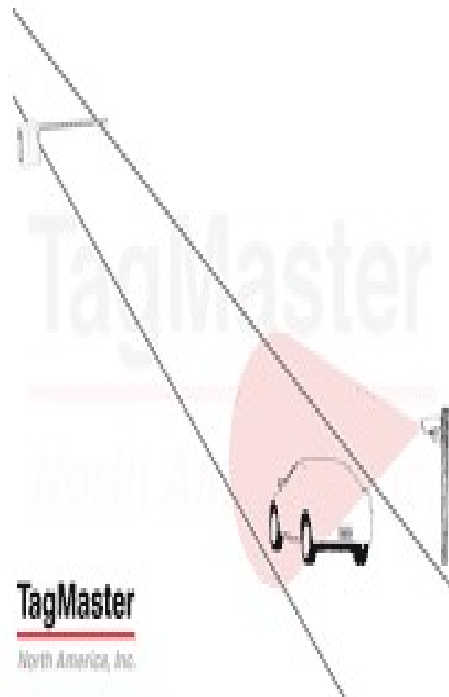
There are two main technologies that are used in AVI applications:

- Radiofrequency identification (RFID) and
- License plate recognition (LPR).

Radiofrequency identification (RFID)



License plate recognition (LPR)



Geographic Information Systems (GIS)



Transportation is a crucial component of society that plays a crucial role in the movement of people, goods, and services from one place to another. It significantly impacts economic growth, social development, and environmental sustainability. GIS technology has immensely impacted transportation by refining practically every aspect of the transportation system. Authorities in many developed countries now actively use GIS for highways and transport management, mainly due to the benefits of sinking operational costs and growing ease

Uses of GIS in Transportation



- **Point of Interest Data Creation:** GIS can collect information and identify points of interest within the transportation network. This is done by geocoding the collected addresses to obtain accurate latitude and longitude coordinates. Geocoding can convert addresses into spatial coordinates that can be represented on maps and put to specific uses.
- **Digitization of road and street data:** Roads and streets information can be collected through survey. This data and related attributes can be stored in GIS and can be used as per requirement. Classification of roads and streets is one such use.
- **3D Building Landmark Data Creation (3DLM):** 3DLM is an exclusive combination of GIS and multimedia technologies that creates geocoded real time 3D models of the landmarks such as schools, religious places, establishments etc. GIS enables the incorporation of these models into maps for better visualization and navigation.
- **3D City Model:** GIS can perform accurate georeferencing of various features of a city. This data can be linked with attributes at various levels to provide an in-depth estimation of potentials of numerous buildings, landmarks, roads etc..

Uses of GIS in Transportation



- **Route planning:** GIS enables the calculation and comparison of multiple routes based on various factors like distance, traffic patterns, road conditions, and speed limits. By integrating real-time data, such as traffic flow and congestion, GIS helps identify the most efficient routes, reducing travel time and fuel consumption.
- **Environmental Impact Assessment:** GIS enables the integration of various geospatial data layers, including topography, land cover, vegetation, hydrology, and sensitive ecological areas. By overlaying these layers, GIS helps visualize the potential environmental impacts of roads and other transportation infrastructure on the adjacent environment.
- **Asset Mapping:** GIS facilitates the inventory and management of transportation assets, including landmarks, crossings, streets, building conditions etc. By mapping and monitoring these assets, transportation agencies can prioritize maintenance and repairs based on their condition, ensuring the safety and longevity of the infrastructure.
- **Geospatial Data Integration:** GIS enables the integration of various geospatial data sources, such as satellite imagery, aerial photographs, drone images and GPS data. This integration improves the accuracy of transportation planning and related activities

Video Data Collection



- Video based sensor systems can play a key role in delivering data for better road planning and traffic management. Smart road technologies will largely depend on data quality and quantity in the future.
- Video based detection systems, being an indispensable part of intelligent traffic systems (ITS), show huge potentials as they do not only offer a flexible way of data acquisition but are also being developed at a huge pace due to recent evolutions in hardware and software technology.
- In order to give a better understanding on the methods and potentials of this technology, a structured review is presented which not only includes current applications but also shows future use cases by analyzing the techniques of image processing and extrapolating their results to the future requirements of traffic engineering

Benefits of Video Cameras



- **Incident detection**

Cameras can automatically detect incidents like congestion, stopped vehicles, and wrong-way drivers.

- **Alerts**

Cameras can send real-time alerts to traffic management centers, which can then notify drivers on the road.

- **Data collection**

Cameras can collect data on traffic patterns and congestion points, which can help with data-driven decision making.

- **Traffic management**

Cameras can help manage traffic signals by detecting congestion and providing data on vehicle movements.

- **Road planning**

Video-based sensor systems can provide data for better road planning.