

1. public transport optimization:

Definition:

To optimize public transport routes, we use specialized transport models that reflect current or projected transport demand. Existing passenger flows are primarily used for model calibration, not as the main data source for optimization.

Project objectives:

Public transit can ensure mobility of the entire population, including the poor and handicapped; permits commuter to reach city centers and assure their viability; contributes to quality of life; and conserves scarce resources such as land and energy.

Platform development:

Internet of Things will enable companies to create new data driven services, cloud data processing, and predictive analytics. IoT development platform is like an Integrated Development Environment (IDE) which provides a powerful toolkit for IoT development and complete end to end solution to develop, deploy and manage IoT applications.

An IoT platform connects devices, smart sensors and IoT gateways to the cloud. Since [IoT](#) operates in many areas, IoT platform should be able to handle huge amount of data from devices, sensors, websites, and applications efficiently. It has a real-time analytics option to monitor network activities.

1. Amazon Web Services (AWS)

2. Amazon Web Services IoT is a managed cloud platform designed for Internet of Things applications, it allows unlimited number of devices and sensors to interact with cloud applications securely. Moreover, AWS supports all the popular software development kits (SDKs) like Embedded C, JavaScript, Python, Java and iOs for applications development.
3. AWS offers super charged dedicated servers for any complex applications and it has the capability to handle millions of devices and huge data rate.

2. Microsoft Azure IoT

Microsoft offers Azure IoT Suite and Azure IoT Hub for developers to create applications, manage devices remotely and analyze data in real-time. It has the flexibility to operate with multiple operating systems and platforms.

Azure cloud platform uses Microsoft Visual Studio SDK which is familiar to millions of developers. In addition, integration with other cloud solutions and web applications make Azure on the top IoT platform list.

3. Google Cloud IoT

Google Cloud IoT platform is another powerful managed and integrated service which offers complete solution for development and management of millions of connected devices across the globe. Sophisticated analytics tool lets companies to get an insight in real-time manner.

End-to-end security, integrated services with cloud, advanced data analytics, business process optimization and fully managed infrastructure are the core features of Google Cloud IoT platform

Raeal time application:

Public transport (also known as **public transportation**, **public transit**, **mass transit**, or simply **transit**) is a system of [transport](#) for [passengers](#) by group travel systems available for use by the general public unlike [private transport](#), typically managed on a schedule, operated on established routes, and that charge a posted fee for each trip.^{[1][2]} There is no rigid definition of which kinds of transport are included, and air travel is often not thought of when discussing public transport—dictionaries use wording like "buses, trains, etc."^[3] Examples of public transport include [city buses](#), [trolleybuses](#), [trams](#) (or [light rail](#)) and [passenger trains](#), [rapid transit](#) (metro/subway/underground, etc.) and [ferries](#). Public transport between cities is dominated by [airlines](#), [coaches](#), and [intercity rail](#). [High-speed rail](#) networks are being developed in many parts of the world.



Examples of types of public transport. Clockwise from top left: A [rapid transit system](#) in [Taiwan](#), a [ferry](#) in the [United States](#), a [bus](#) in [England](#), and a [commuter rail](#) in [Japan](#).

Most public transport systems run along fixed routes with set embarkation/disembarkation points to a prearranged timetable, with the most frequent services running to a [headway](#) (e.g.: "every 15 minutes" as opposed to being scheduled for any specific time of the day). However, most public transport trips include other modes of travel, such as passengers walking or catching bus services to access train stations.^[4] [Share taxis](#) offer on-demand services in many parts of the world, which may compete with fixed public transport lines, or complement them, by bringing passengers to interchanges. [Paratransit](#) is sometimes used in areas of low demand and for people who need a door-to-door service.^[5]

Urban public transit differs distinctly among Asia, North America, and Europe. In Asia, profit-driven, privately owned and publicly traded mass transit and [real estate](#) conglomerates predominantly operate public transit systems.^{[6][7]} In North America, municipal [transit authorities](#) most commonly run mass transit operations. In Europe, both state-owned and private companies predominantly operate mass transit systems.

For geographical, historical and economic reasons, differences exist internationally regarding the use and extent of public transport. While countries in the [Old World](#) tend to have extensive and frequent systems serving their old and dense cities, many cities of the [New World](#) have more [sprawl](#) and much less comprehensive public transport.^[citation needed] The [International Association of Public Transport](#) (UITP) is the international network for public transport authorities and operators, policy decision-makers, scientific institutes and the public transport supply and service industry. It has 3,400 members from 92 countries from all over the globe.

4. Sensor used in IoT:

Transportation systems have become a fundamental base for the economic growth of all nations. Nevertheless, many cities around the world are facing an uncontrolled growth in traffic volume, causing serious problems such as delays, traffic jams, higher fuel prices, increase of CO₂ emissions, accidents, emergencies, and the degradation of quality of life in modern society. According to a report by the Texas Transportation Institute, in the United States, commuters spend approximately 42 h a year stuck in traffic, drivers waste more than 3 billion gallons of fuel per year, having a total nationwide price tag of \$160 billion, equivalent to \$960 per commuter [\[1\]](#). Such problems will worsen in the future because of population growth and the increasing migration to urban areas in many countries around the world as reported by the United Nations Population Fund [\[2\]](#) and the Population Reference Bureau [\[3\]](#). Hence, there is a strong need to improve the safety and efficiency of transportation.

Advances in Information and Communication Technologies (ICT) in areas such as hardware, software, and communications have created new opportunities for developing a sustainable, intelligent transportation system. The integration of ICT with the transportation infrastructure will enable a better, safer traveling experience and migration to Intelligent Transportation Systems (ITS) which focus on four fundamental principles: sustainability, integration, safety, and responsiveness. These principles will play a fundamental role in achieving the main objectives of the Intelligent Transportation Systems

which include access and mobility, environmental sustainability, and economic development [4].

The success of ITS largely depends on the platform used to access, collect, and process accurate data from the environment. Sensing platforms are broadly classified into two categories. The first category is the intra-vehicular sensing platform which collects data about a vehicle's conditions. The second category, urban sensing platforms, are used to collect information about traffic conditions. Sensor technology is a vital component used for data collection during Vehicle-to-Vehicle (V2V) and Vehicle to Infrastructure (V2I) communications. This data is then provided to transportation management systems for further processing and analysis and subsequent decisions/actions. Smart and intelligent ITS promise to address issues such as high fuel prices, high levels of CO₂ emissions, high levels of traffic congestions, and improved roads [5,6].

[Go to:](#)

2. Sensor Technology

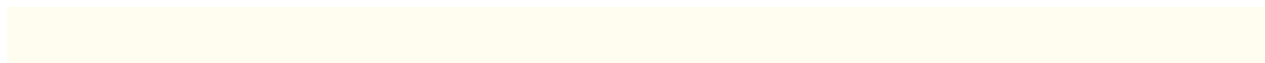
Over the last decade, sensor technology has become ubiquitous and has attracted a lot of attention. Sensors have been deployed in many areas such as healthcare [7,8], agriculture [9,10], and forest [11,12], vehicle and marine [13,14] monitoring. In transportation, sensor technology supports the design and development of a wide range of applications for traffic control, safety, and entertainment. In recent years, sensors, and actuators such as tire pressure sensor and rear-view visibility systems have become mandatory (due to federal regulation in the United States [15]) in the manufacturing of vehicles and the implementation of intelligent transportation systems, aimed at providing services to increase drivers' and passengers' satisfaction, improve road safety and

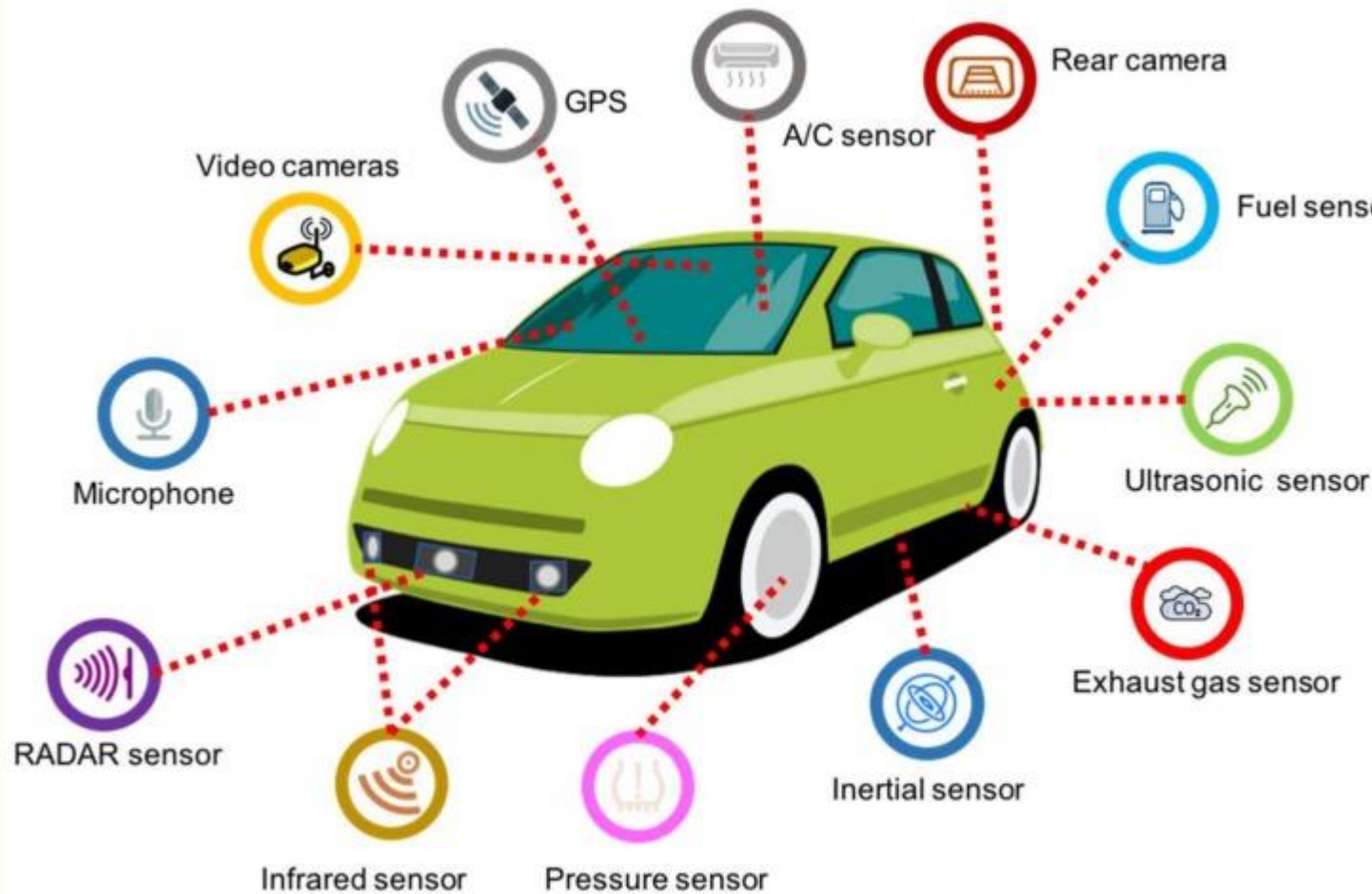
reduce traffic congestion. Other sensors are optionally installed by manufacturers to monitor the performance and status of the vehicle, provide higher efficiency and assistance for drivers. Currently, the average number of sensors in a vehicle is around 60–100, but as vehicles become “smarter”, the number of sensors might reach as many as 200 sensors per vehicle [16].

In [17], the author presents a classification of three categories of sensors based on the place of deployment in the vehicle: powertrain, chassis, and body. Another work classifies sensors in a vehicle based on the type of application the sensor is intended to support, and four categories of sensors are identified: sensors for safety, sensors for diagnostics, sensors for convenience and sensors for environment monitoring [18]. We extend the classification (four categories) proposed in [18] to include two additional categories of sensors, namely sensors for driving monitoring and traffic monitoring, as shown in Table 1.

2.1. In-Vehicle Sensors

In ITS, identifying the type of sensors to develop applications that contribute to address problems such as: (1) traffic congestion and parking difficulties, (2) longer commuting times, (3) higher levels of CO₂ emissions, and (4) increase in the number of road accidents, among others is of critical importance for improving a vehicle’s performance as well enhancing the driving experience. Figure 1 depicts some of the most widely used sensors in vehicles today.





[Figure 1](#)

Different types of in-vehicle sensors.

Applications for In-Vehicle Sensors

Tire-pressure monitoring is an application that is required for the National Highway Traffic Administration of the U.S. to alert drivers using acoustic, light or vibration warning if the tire air pressure is low [19].

Proximity, ultrasonic and electromagnetic sensors are used in parking assistance and reverse warning applications. Proximity sensors can detect when a vehicle gets close to an object. Ultrasonic sensors use a

type of sonar to identify how far the vehicle is from an object, alerting the driver when the vehicle gets closer than a set threshold.

Conclusion:

Mathematical Optimization can help public transportation systems, especially in large cities, overcome their existing challenges and unlock next-level business growth