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Data Analytics

Smart Transportation

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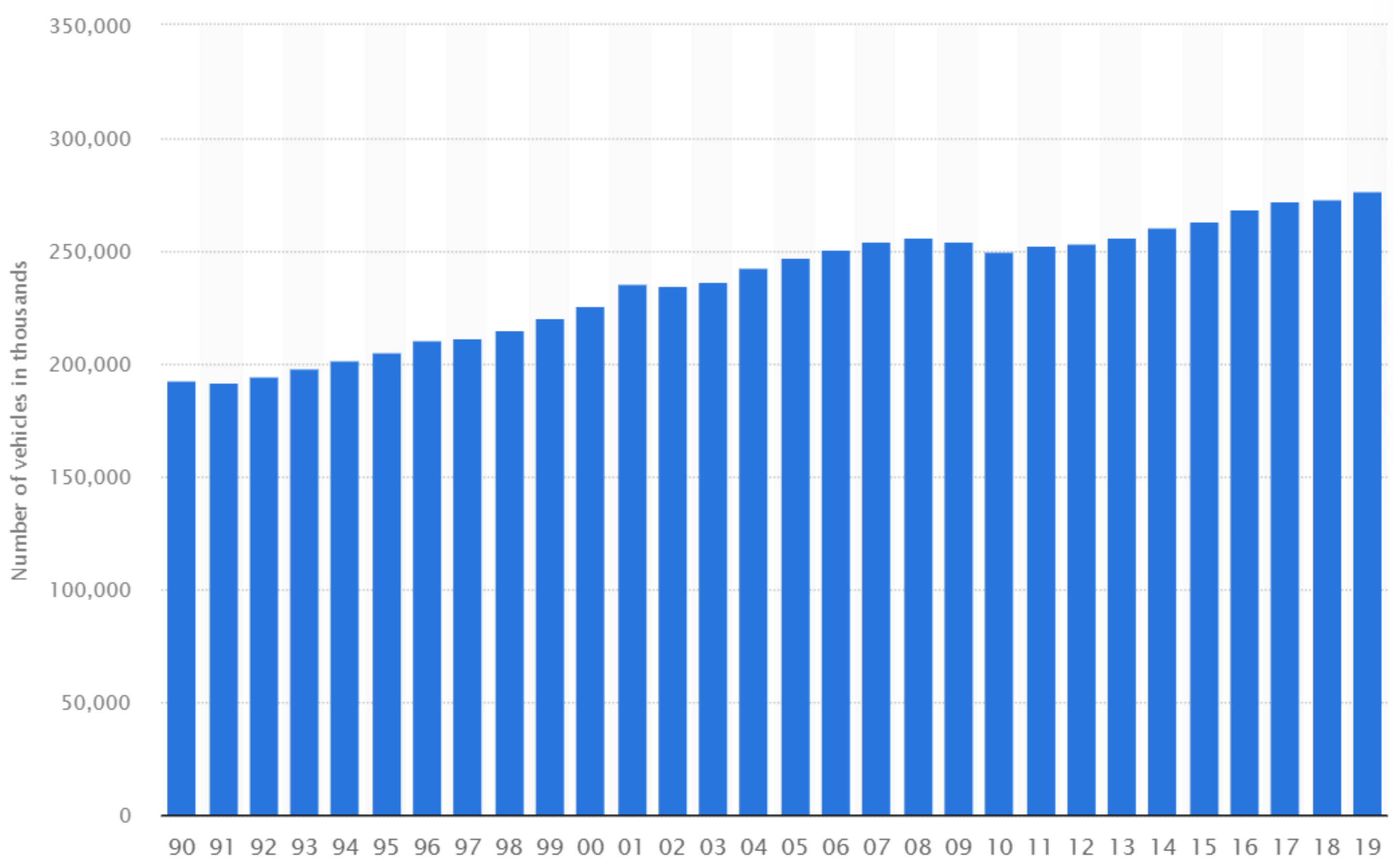
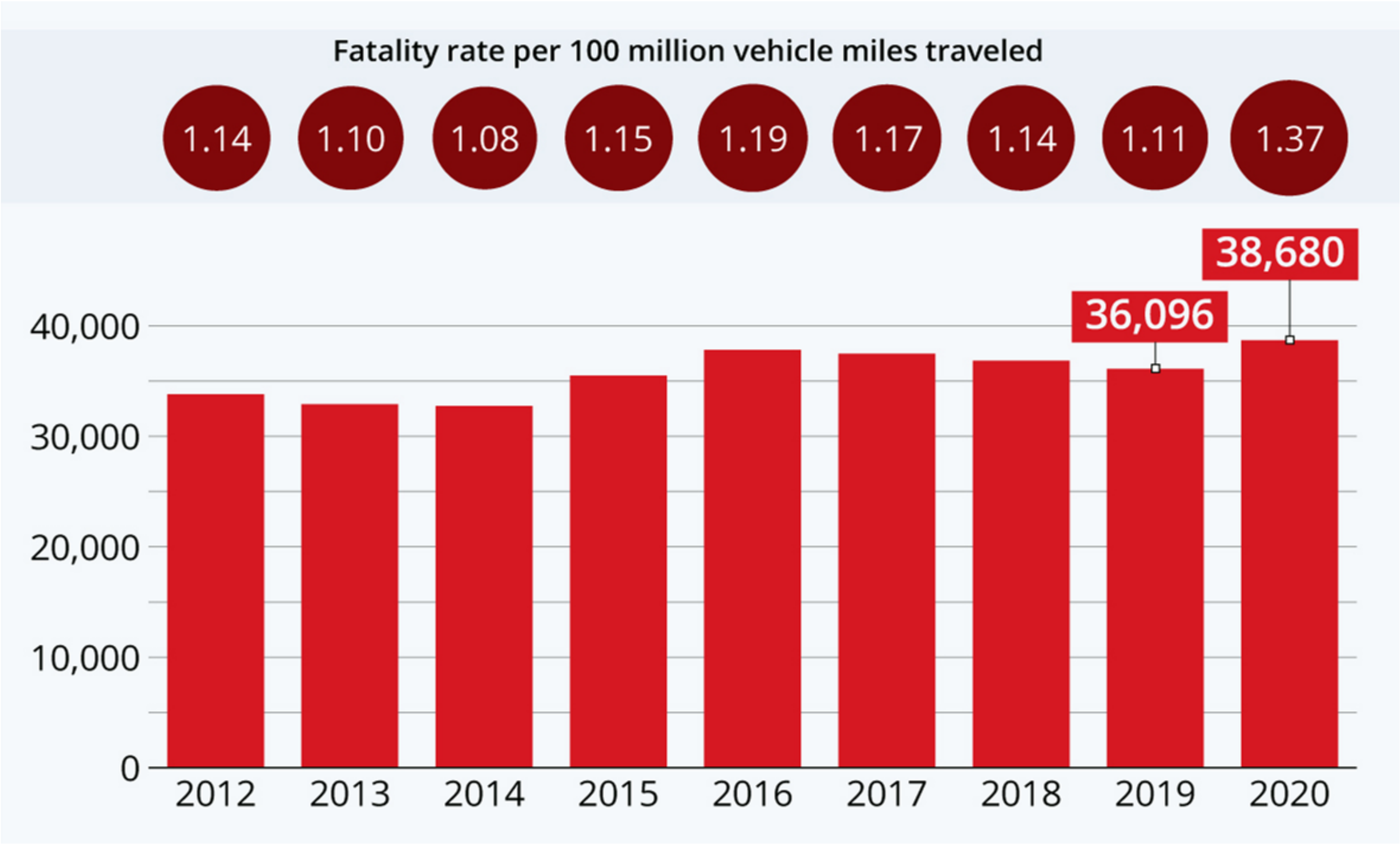
INTRODUCTION



Number of motor vehicles registered in the United States from 1990 to 2019

statista.com/statistics/183505/number-of-vehicles-in-the-united-states-since-1990/

INTRODUCTION



US Traffic Fatalities

www.statista.com/chart/25075/us-traffic-fatalities-by-year-and-fatality-rate/

INTRODUCTION

Systems in which information and communication technologies are applied in the field of road transport, including infrastructure, vehicles and users, and in traffic management and mobility management, as well as for interfaces with other modes of transport.

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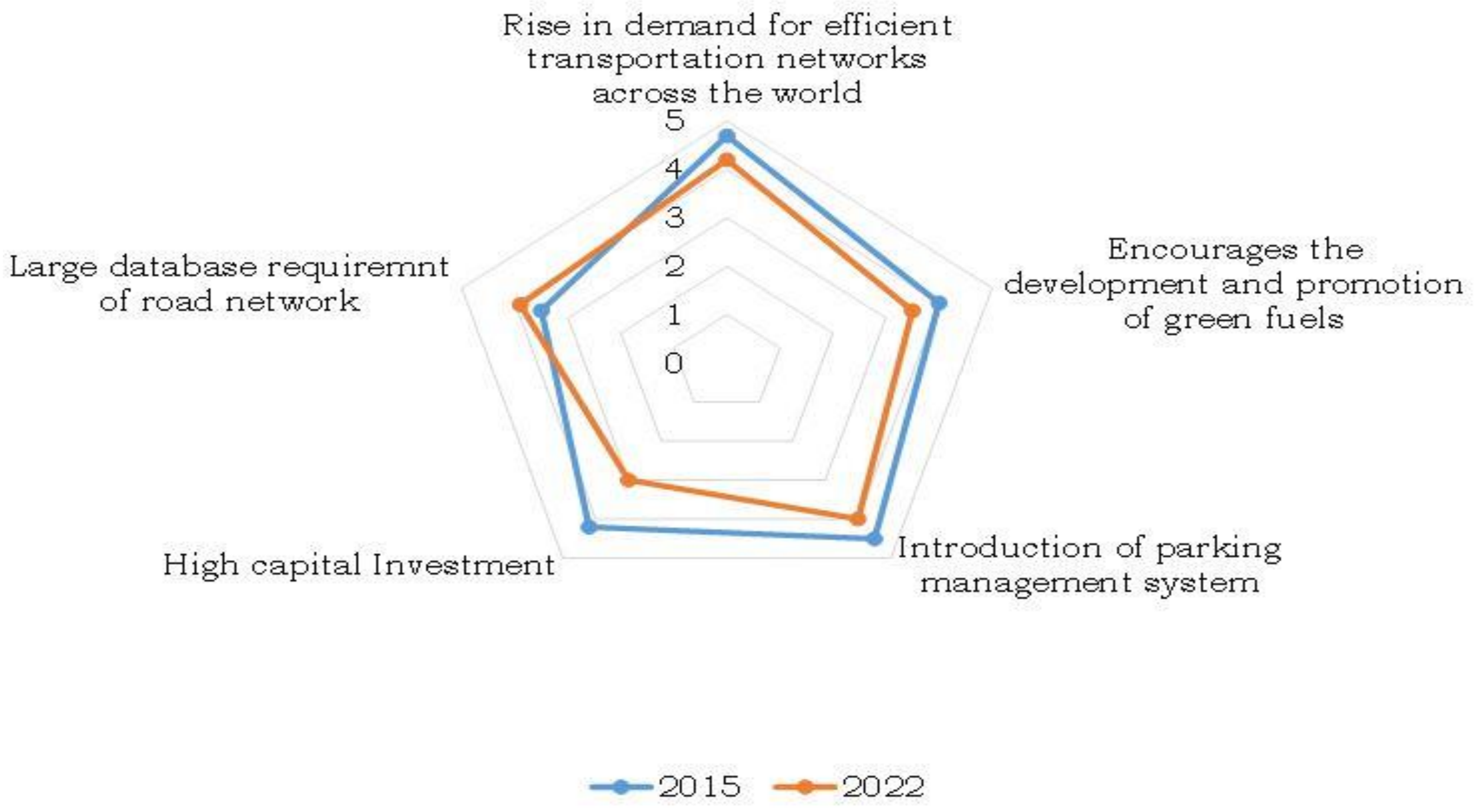


Top Factors Impacting the Global Smart Transportation Market

https://www.alliedmarketresearch.com/smart-transportation-market

INTRODUCTION

ECO SIGNAL

NUMBER PLATE RECOGNIZATION

PARKING MANAGEMENT

CAR NAVIGATION

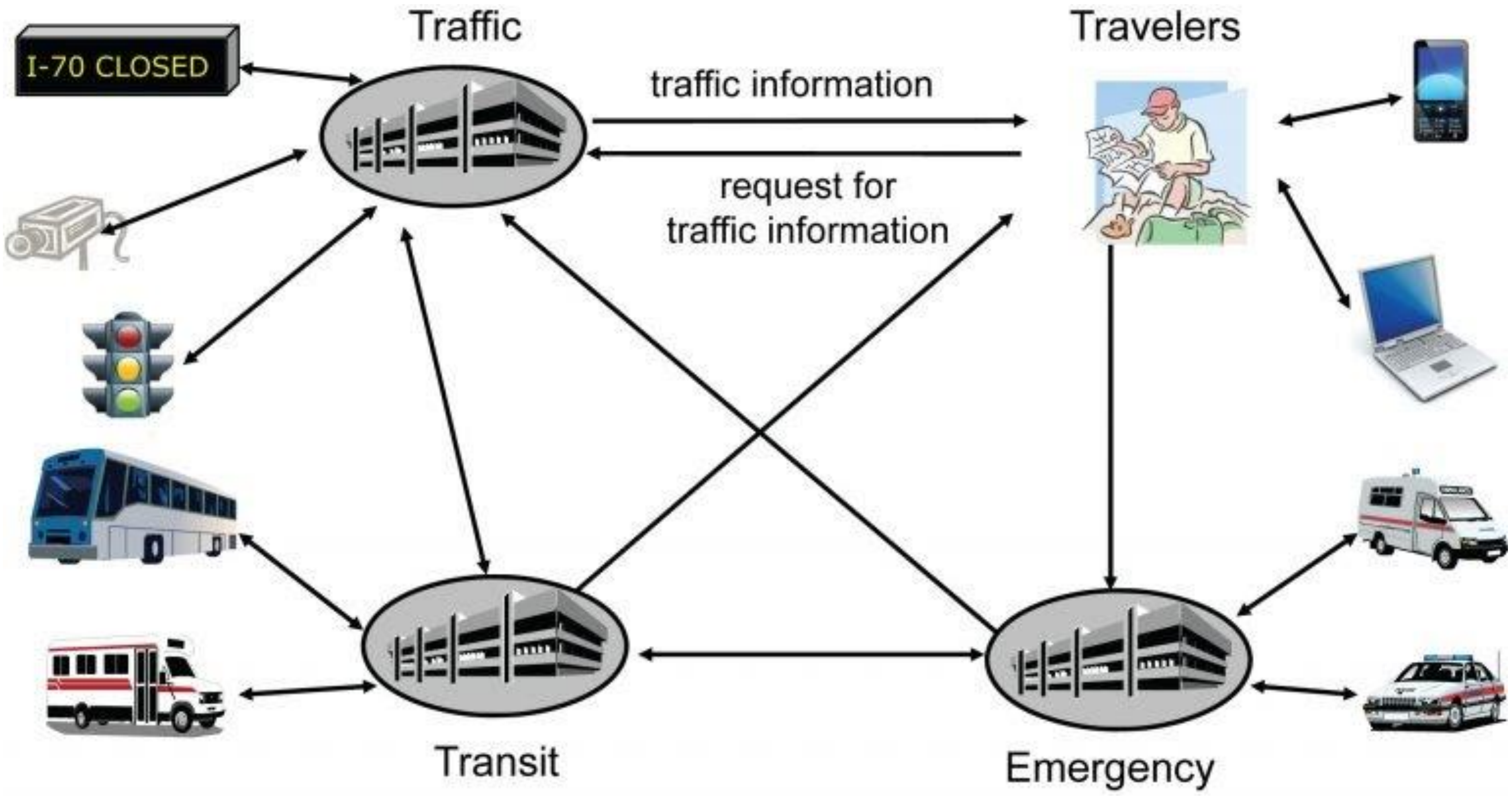
HIGH SPEED CAMERAS

TRAFFIC SIGNAL CONTROL SYSTEMS

ELECTRONIC TOLL COLLECTION

APPLICATION

INTRODUCTION



INTRODUCTION

Data collection

Hardware: sensors, cameras, GPS

Data type: traffic count, surveillance, speed and time, location, vehicle weight, delays etc

↓

Data Transmission

Rapid and real-time data transmission between the road and Traffic Management Center

↓

Data Analysis

Error rectification, data cleaning, data synthesis and adaptive logical analysis

↓

Data Transmission

Rapid and real-time data transmission between the Traffic Management Center and the traveller

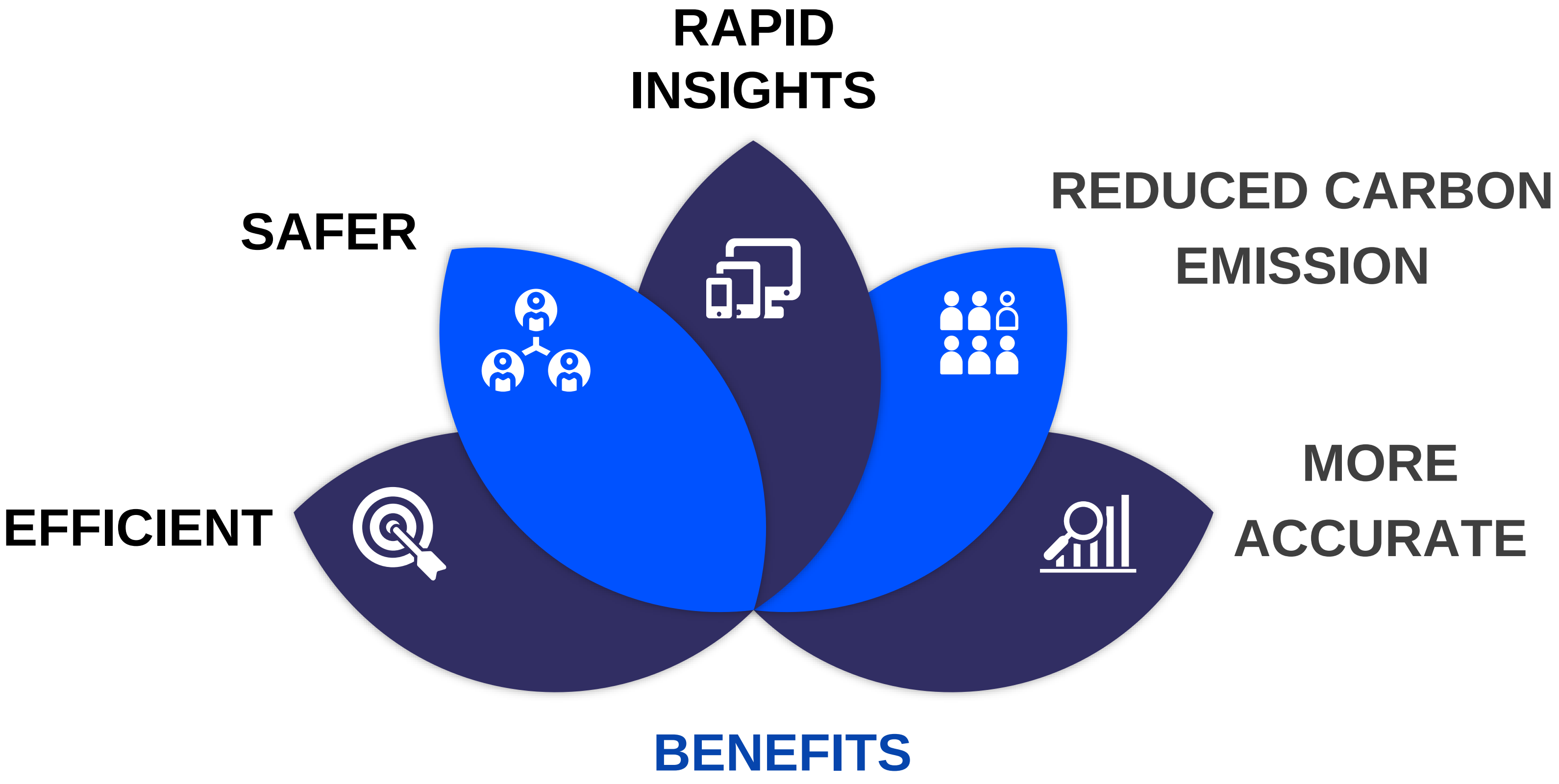
↓

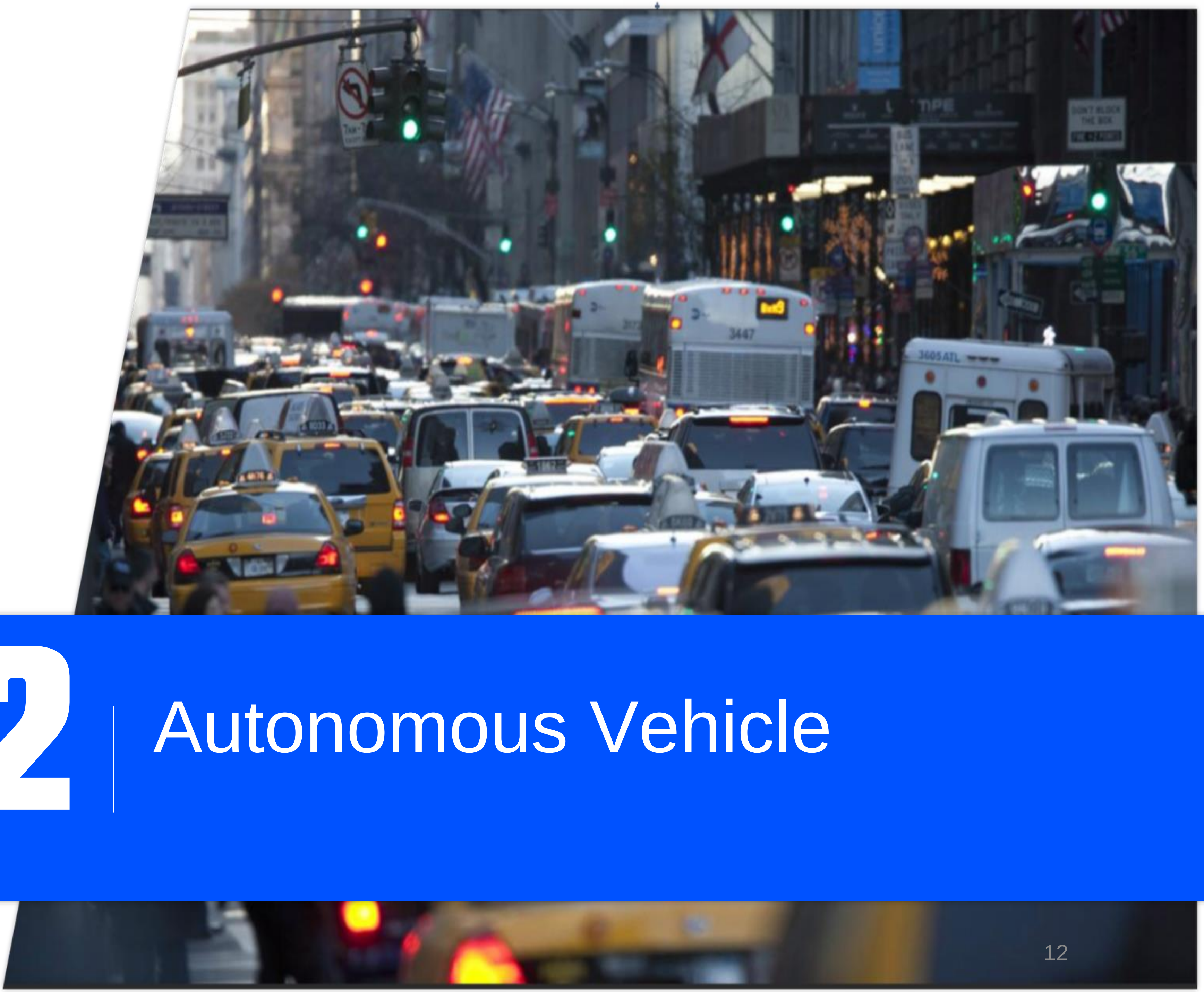
Intelligent Information

Real-time information like travel time, travel speed, delay, accidents on roads, change in route, diversions, work zone conditions etc.delivered by a wide range of electronic devices like variable message signs, highway advisory radio, internet, SMS, automated cell.

INTRODUCTION

The global smart parking market was valued at $6.05 billion in 2019, and is projected to reach $11.13 billion by 2027, registering a CAGR of 12.6% and has the following benefits:





02 | Autonomous Vehicle

Data Collection

Radar Sensor	Monitor the position of nearby vehicles
Video Camera	Detect traffic lights, read road signs, track other vehicles, and look for pedestrians
Lidar Sensor	Bounce pulses of light off the car’s surroundings to measure distances, detect road edges, and identify lane markings
Ultrasonic Sensor	Detect curbs and other vehicles when parking

Reference: What is an Autonomous Car? – How Self-Driving Cars Work | Synopsys

Challenges in Vehicle Testing

Infeasibility of complete testing (System Level)

Theory: Consider a hypothetical fleet of one million vehicles operated one hour per day (i.e., 106 operational hours per day). If the safety target is to have about one catastrophic computing failure in this fleet every 1,000 days, then the safety goal is a mean time between catastrophic failures of 109 hours, which is comparable to aircraft permissible failure rates.

Actual:In order to validate that the catastrophic failure rate of a vehicle fleet is in fact one per 109 hours, one must conduct at least 109 vehicle operational hours of testing (a billion hours) , and in fact must test several times longer, potentially repeating such tests multiple times to achieve statistical significance. Even this assumes that the testing environment is highly representative of real-world deployment, and that circumstances causing mishaps arrive in a random, independent manner.

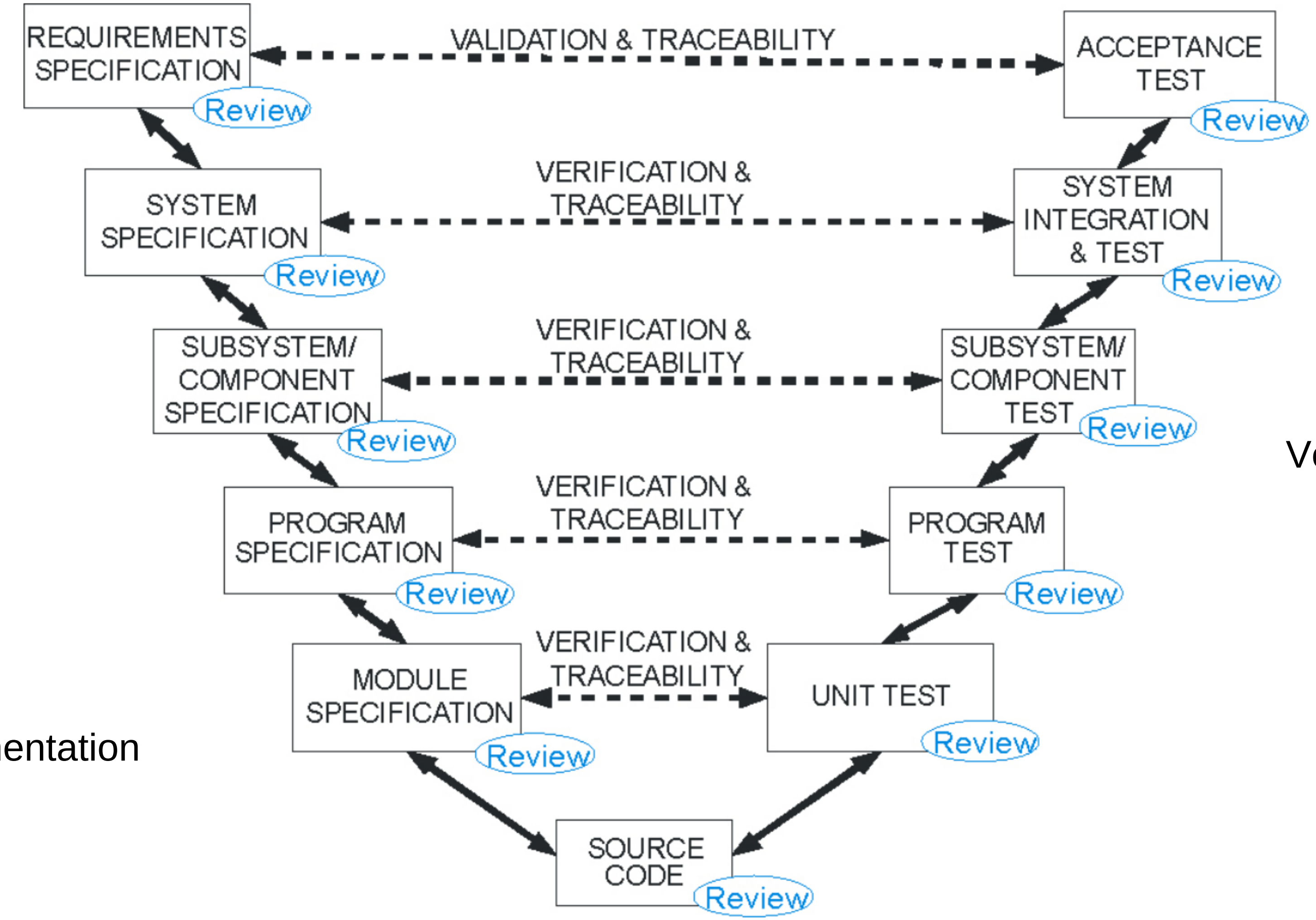
Reference: Philip, Michael. 2016. “Challenges in Autonomous Vehicle Testing and Validation”

V Model

Requirements

Design

Implementation



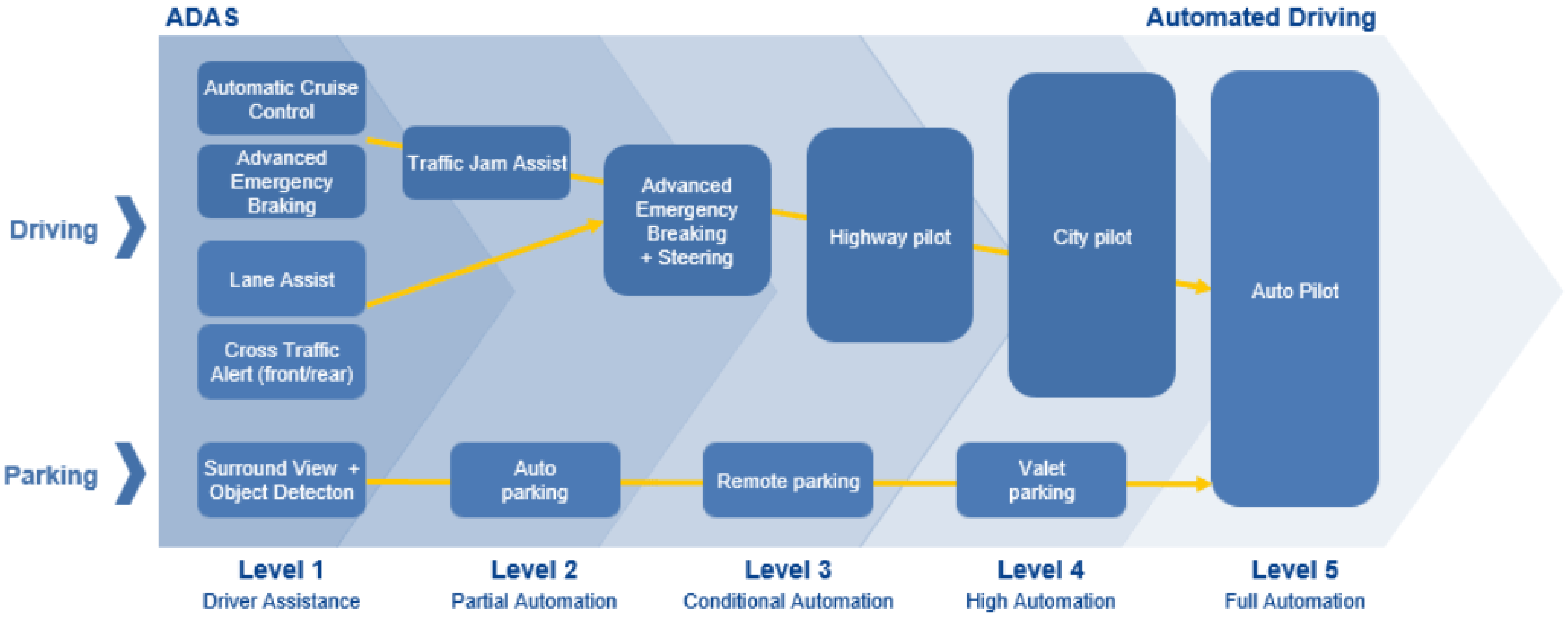
Verification and Validation

Reference: Philip, Michael. 2016. “Challenges in Autonomous Vehicle Testing and Validation”

Controllability Challenges

Advanced Driver Assistance System (ADAS) vs. Automotive Safety Integrity Level (ASIL)

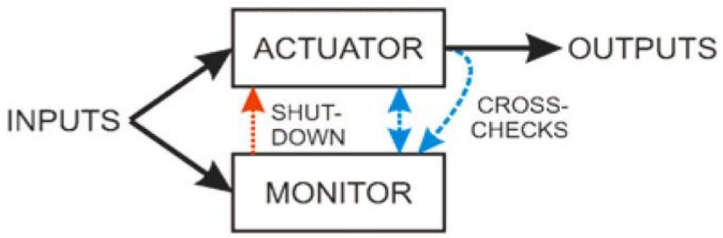
Human correction vs. Computer correction



Reference: Jeff. 2021. "MCUs for ADAS – what's the difference?"

Autonomy Architecture Approaches

One way to handle a potentially high-ASIL autonomy function is to use ASIL decomposition via a combination of a monitor/ actuator architecture and redundancy.



If the actuator misbehaves, the monitor shuts the entire function down (both modules), resulting in a fail-silent system

If the actuator pass the check of the monitor, the decision will be implemented

Providing fail operational behavior requires even more redundancy (more than one monitor/actuator pair), and very likely design diversity so that common-mode software design failures do not cause a systemic failure.

Reference: Philip, Michael. 2016. "Challenges in Autonomous Vehicle Testing and Validation"

Requirement Challenges

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An essential characteristic of the V model of development is that the right side of the V provides a traceable way to check how the left side turned out (verification and validation). However, this notion of checking is predicated on an assumption that **the requirements are actually known, are correct, complete, and unambiguously specified**. That assumption presents challenges for autonomous vehicles.

- Bad weather
  - Flooding
  - Fog
  - Snow
  - Smoke
  - Tornados
- Traffic rule violations
  - Wrong-direction cars on a divided highway
  - Other drivers running red lights
  - Stolen traffic signs
- Animal hazards
  - Deer
  - Armadillos
  - Occasional plague of locusts

Reference: Philip, Michael. 2016. “Challenges in Autonomous Vehicle Testing and Validation”

Operational Concept Approaches

One way to manage the complexity of requirements is to constrain operational concepts and engage in a phased expansion of requirements.

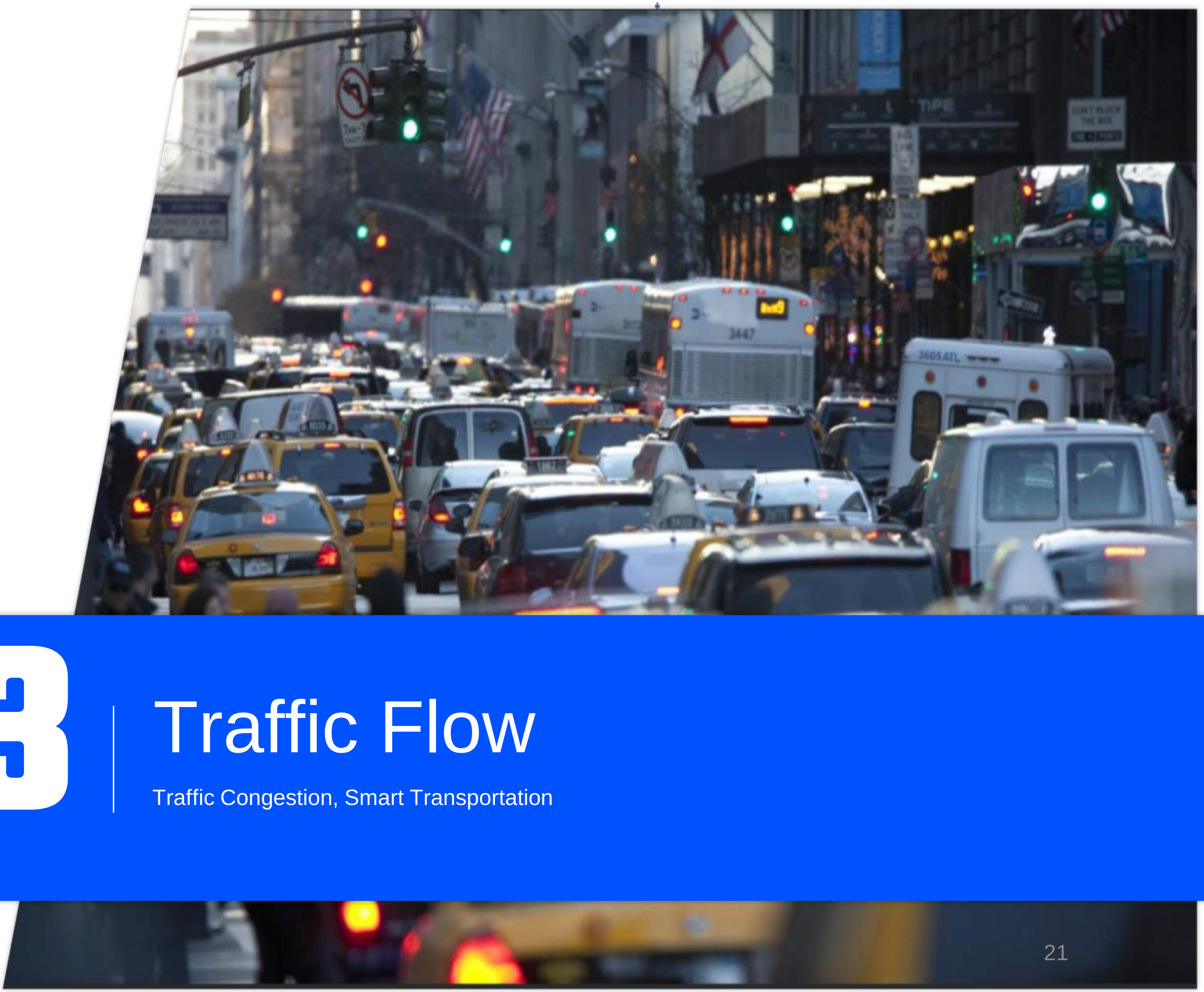
- Road access: limited access highways, HOV lanes, rural roads, suburbs, closed campuses, urban streets, etc.
- Visibility: day, night, fog, haze, smoke, rain, snow, etc.
- Vehicular environment: self-parking in a closed garage with no other cars moving, autonomous-only lanes, marker transponders on non-autonomous vehicles, etc.
- External environment: infrastructure support, pre-mapped roads, convoying with human-driven cars
- Speed: lower speeds potentially lead to lower consequences of a failure and larger recovery margin

Reference: Philip, Michael. 2016. “Challenges in Autonomous Vehicle Testing and Validation”

Benefits

- 90% reduction in traffic deaths
- 60% drop in harmful emissions
- Eliminate stop-and-go waves by 100%
- 10% improvement in fuel economy
- 500% increase in lane capacity
- 40% reduction in travel time
- Consumer savings

Reference: THALES. 2021. “7 benefits of autonomous cars”



03 Traffic Flow

Traffic Congestion, Smart Transportation

Traffic Congestion

City	Hours Lost in Congestion (2020)
New York City, NY	100
Philadelphia, PA	94
Chicago, IL	86
Boston, MA	48
Los Angeles, CA	45
San Francisco, CA	47
New Orleans, LA	42
Houston, TX	35
MIami, FL	35
Dallas, TX	34

Source: https://www.visualcapitalist.com/how-many-hours-do-americans-lose-to-traffic-congestion/

Intelligent Transport System (ITS)

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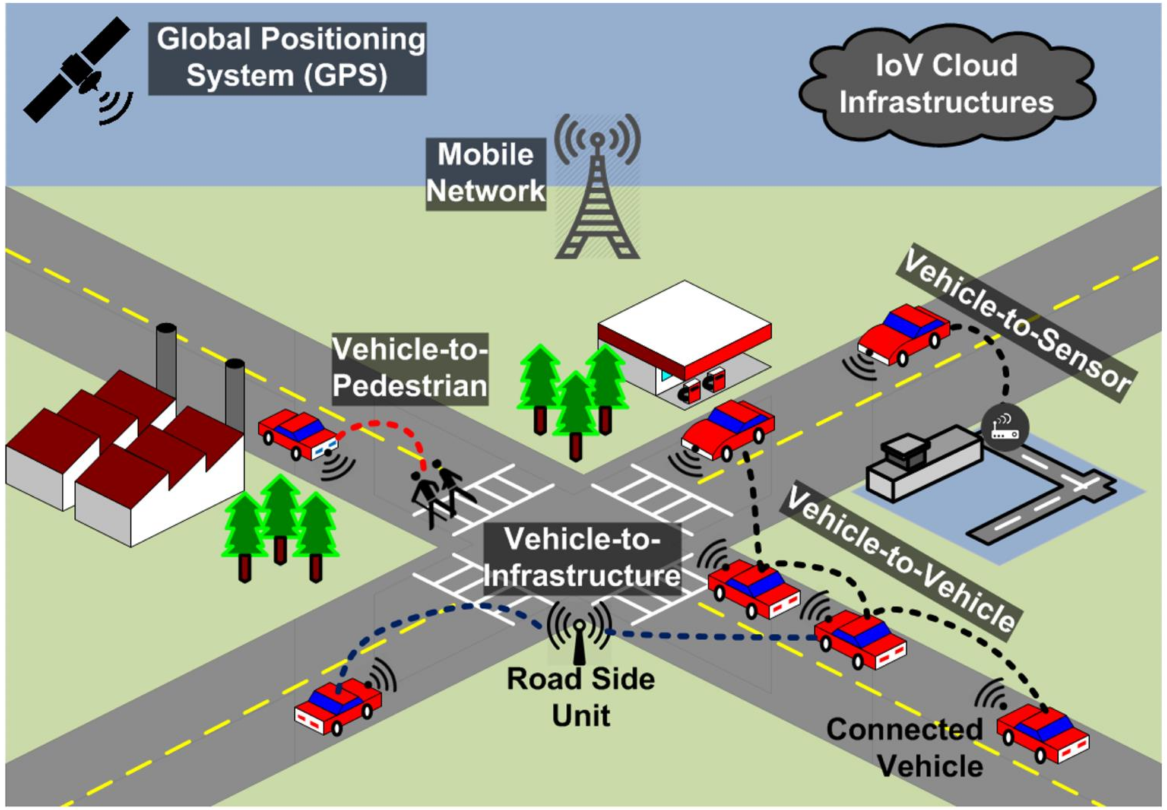
"Systems in which information and communication technologies are applied in the field of road transport, including infrastructure, vehicles and users, and in traffic management and mobility management, as well as for interfaces with other modes of transport."

European Union 2010/40/EU



Source: DIRECTIVE 2010/40/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 7 July 2010. eur-lex.europa.eu

How ITS works?

Data Collection

Automatic Vehicle Identifiers, GPS based automatic vehicle locators, sensors, camera

Data Transmission

Internet, SMS or onboard units of Vehicle

Data Analysis

Error rectification, data cleaning, data synthesis, and adaptive logical analysis

Traveller Information

Inform transportation updates to the traveling user

Video Detection

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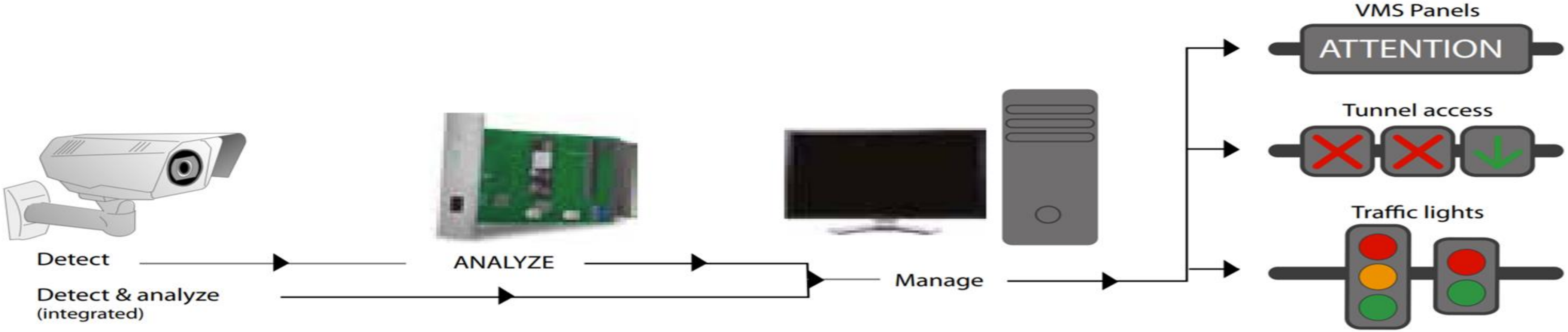
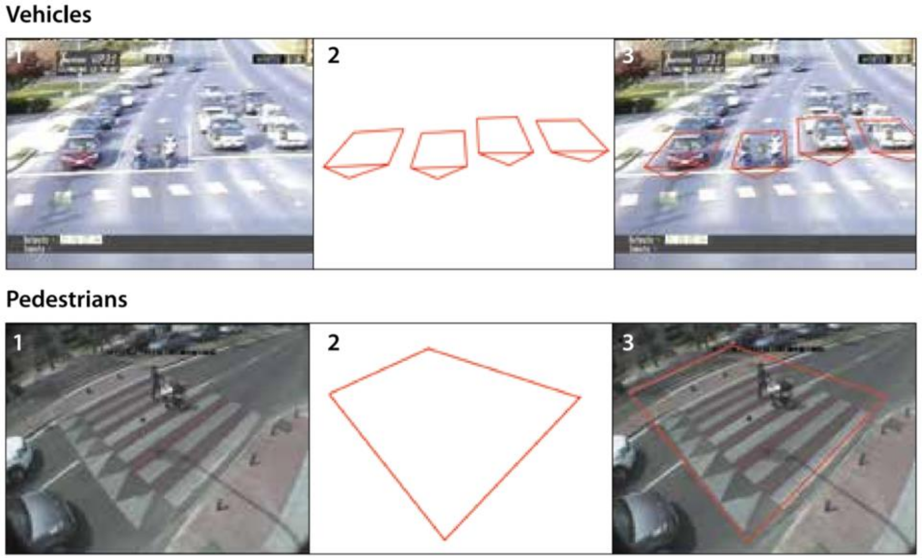


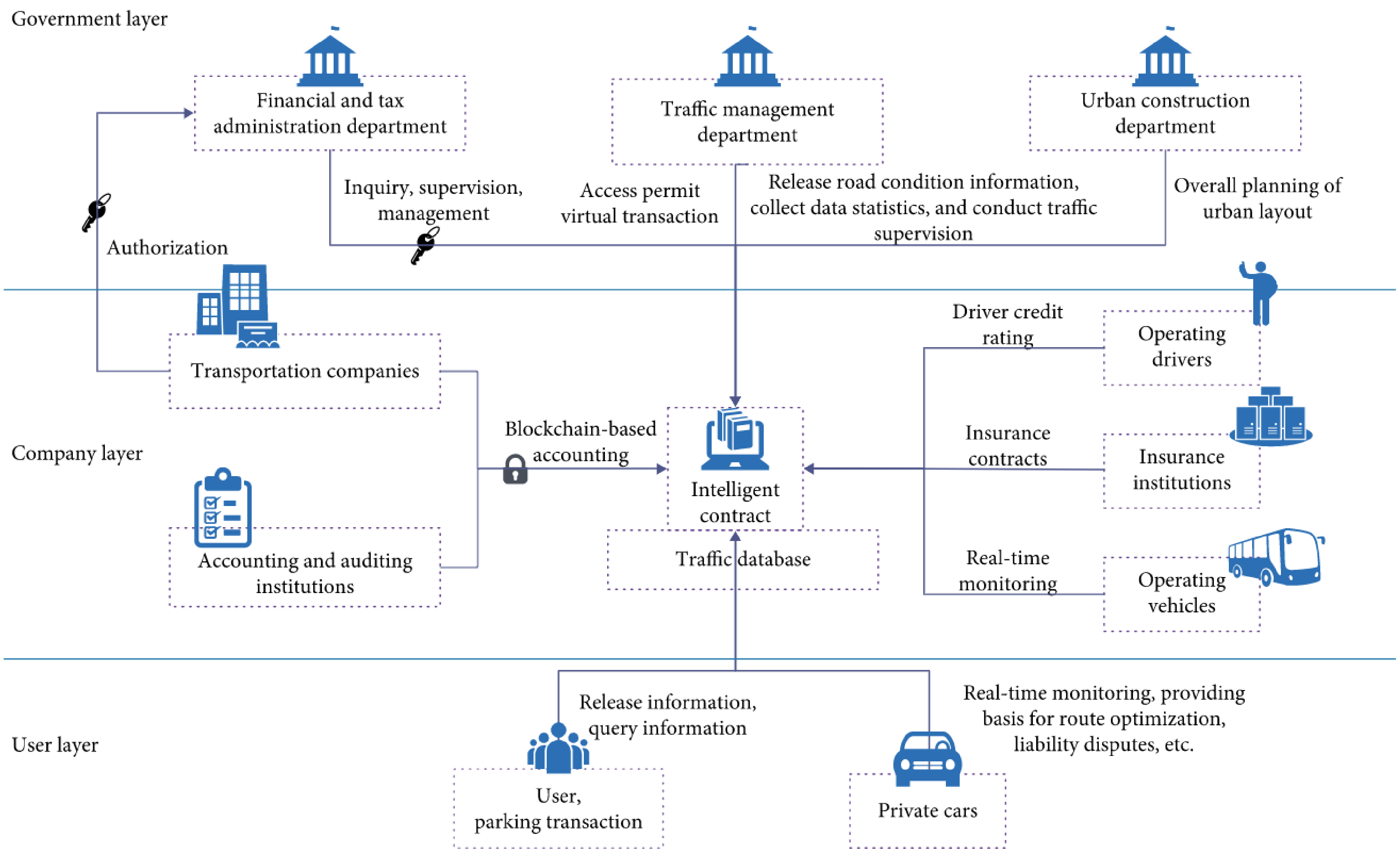


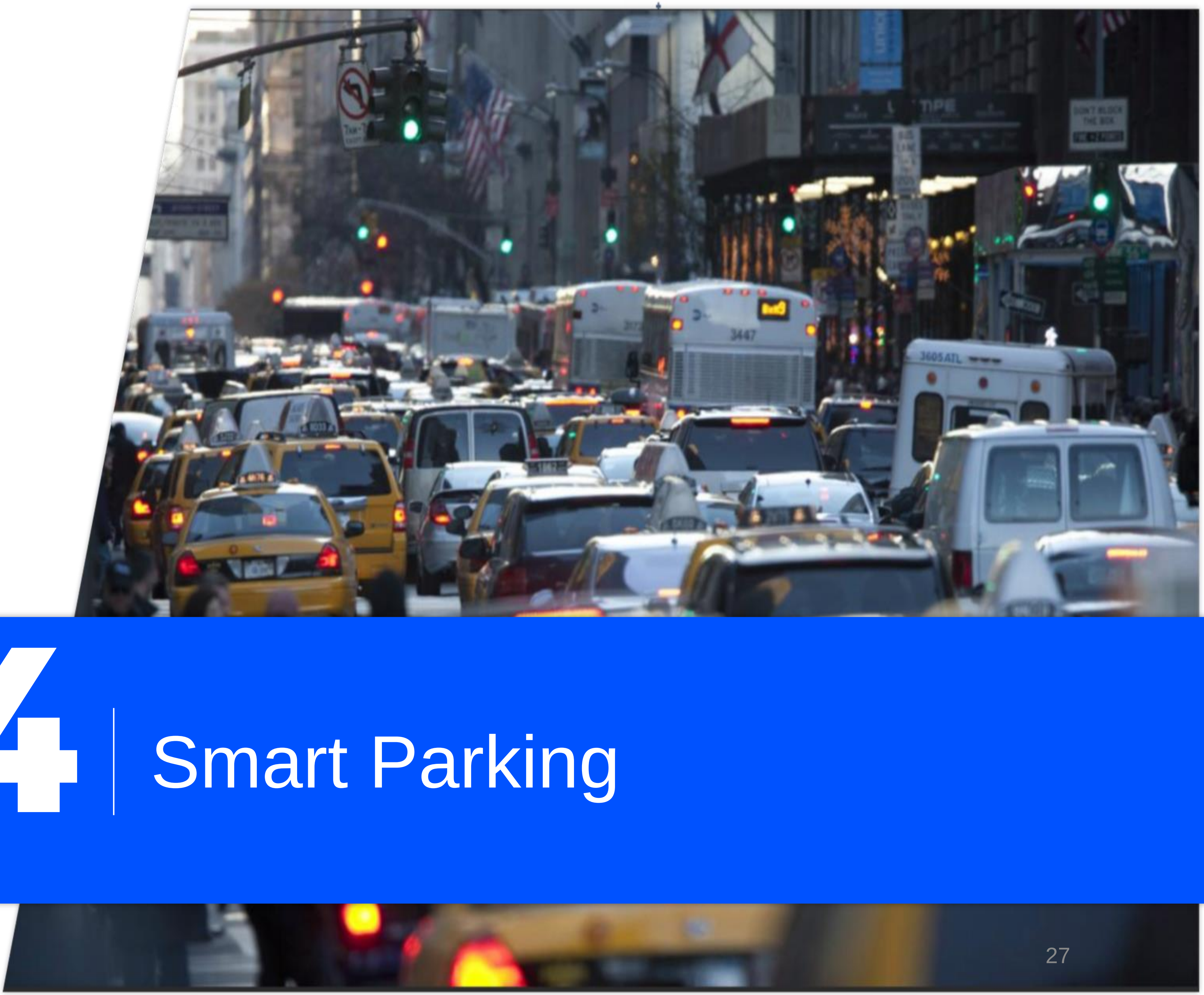
Identifies pedestrians and vehicles at intersections.

Video Detection controls intersection flow turning traffic lights into active management system

Source: https://www.flirmedia.com/MMC/CVS/Traffic/IT_0002_EN.pdf

Blockchain: Future of ITS?





04 | Smart Parking

Smart Parking

Parking Problems

According to a recent research, 30% of the traffic in urban areas is caused by drivers and motorists looking for parking spaces.

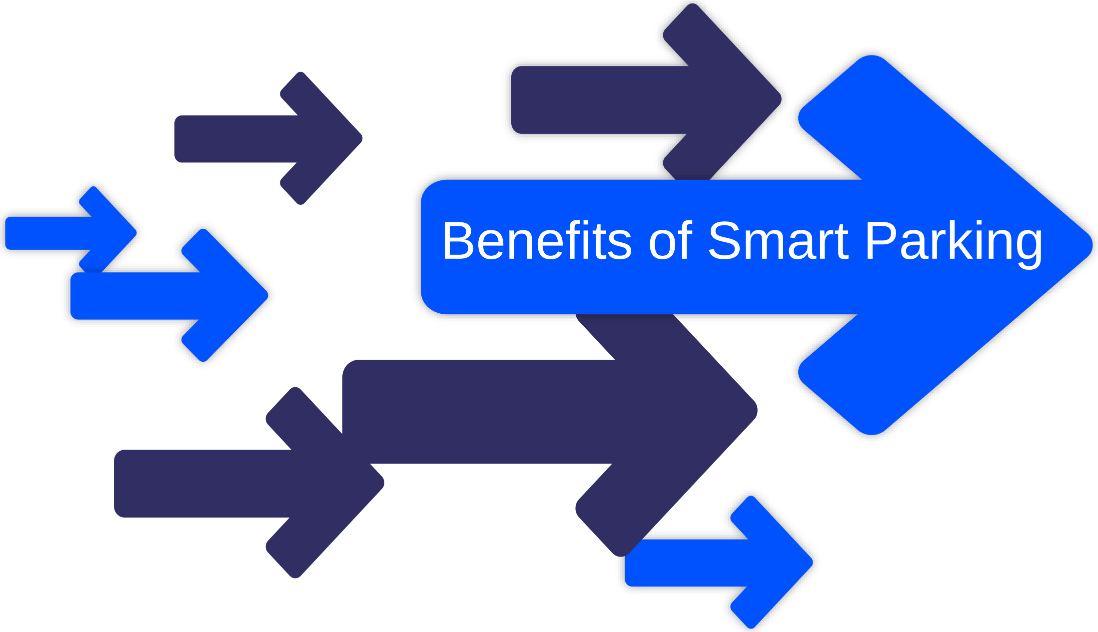
What is smart parking?

Smart Parking makes use of sensor technology, variable road message signs, flexible payment systems and smart navigation mobile map applications to direct the drivers and make them aware of parking options in an urban area.

How does it help?

This helps reduce the time spent in searching for parking spaces and also helps maximize the revenue gained by parking administrators and business owners. The unoccupied parking spaces can be utilized in a better way by using smart parking system.

Smart Parking



Optimized use of available space

Reduce traffic congestion

Improve drivers' experience

Improve parking management

Reduces pollution

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Case Study: Marlborough, Massachusetts

Marlborough is a medium-sized city located near the intersection of the Massachusetts Turnpike and Interstate 495. To accommodate its workforce and residential parking needs, Marlborough has enacted three zoning measures that promote a smart parking approach. The city has taken steps to decrease the oversupply of parking through provisions for shared parking, compact car spaces, and temporary reserve parking.

Smart Parking

The shared parking regulation has been effective in balancing the needs of new developments with existing businesses. Of note, Marlborough has encountered some conflicts in allowing residential parking to exist within the downtown structured facilities

- Businesses that want their parking to be as close as possible to their buildings are concerned with long-term residential parking taking up the nearby spaces.
- the Marlborough public works department requires that all parking lots be unoccupied overnight for purposes of snow removal, creating an obvious conflict with the needs of residential parking.

Smart Parking

- Compact car spaces is the second smart parking approach used in Marlborough. The compact car regulation is straightforward in its approach as it allows up to 33% of a site's required parking spaces to be reduced by 1 foot in width and 2 feet in length. This reduces the footprint needed to hold the same amount of cars.

- The temporary reserve parking regulation in Marlborough is primarily used within industrial park areas where the demand for parking on a daily basis falls significantly short of the required number of spaces. However, to accommodate increased parking demand on select occasions, it is important to provide a reserve supply of parking that can be left in a grassy or earthen state. This regulation allows developers to reduce the amount of on-site paved parking spaces, yet does not limit the total number of space available for temporary use. This helps reduce the City's total impervious surface coverage, thus improving on-site stormwater retention and surface water quality.

05 Smart Transportation & Carbon Emission

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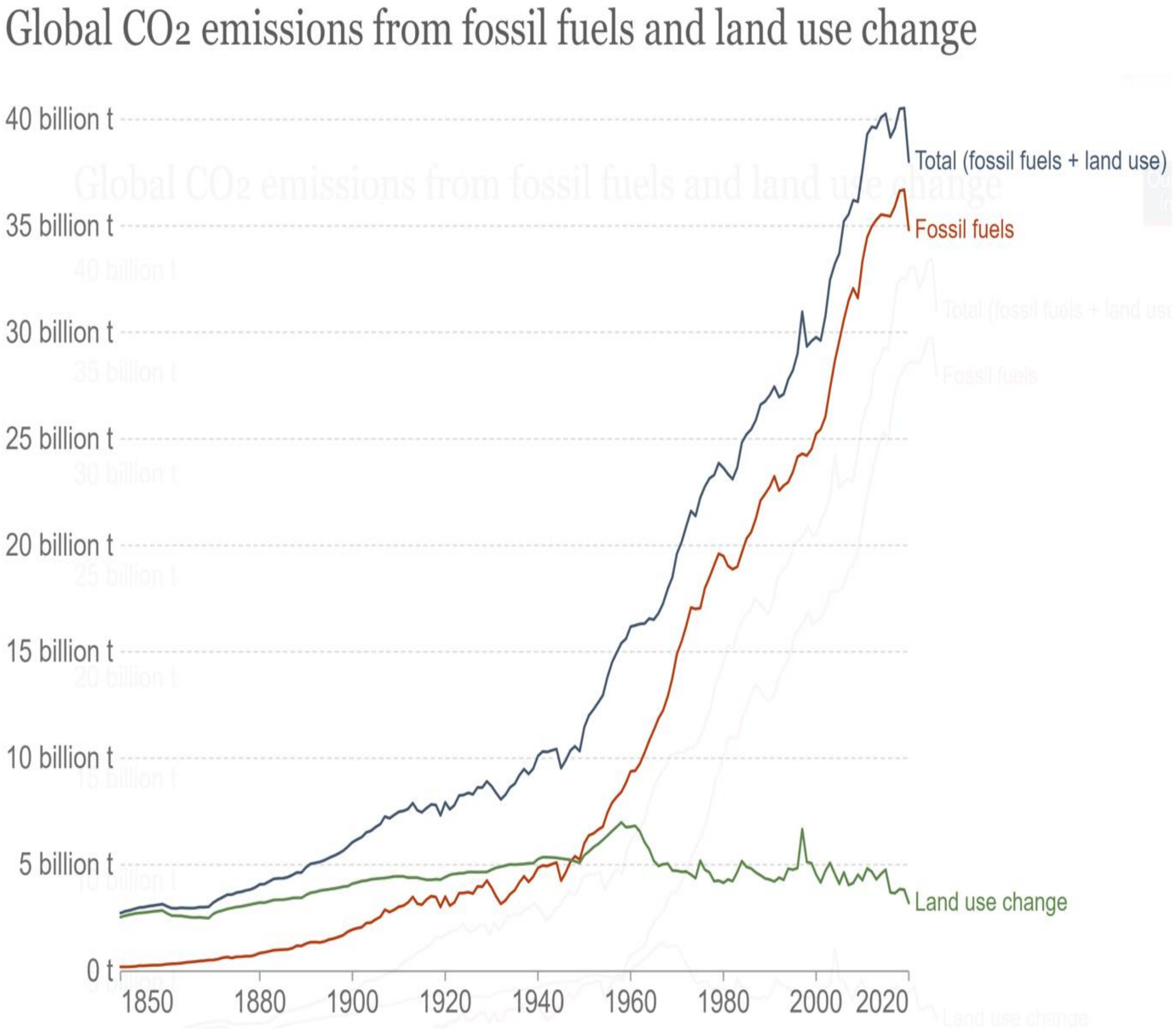
Background



Total carbon emissions is 38.2 million tons in 2020

Transport accounts for around 25% of global carbon dioxide (CO2) emissions

Global Carbon Project. (2021). Supplemental data of Global Carbon Budget 2021 (Version 1.0) [Data set]. Global Carbon Project

Minmize Carbon Emission from Transportation

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Build cleaner, more efficient vehicles

Decrease the total amount of driving

Develop and use alternative fuels

Improve transportation system efficiency

Smart Transportation

Auto Vehicle

Auto vehicle can applied in public transportation to make an more efficient transportation system

Minimize Traffic Congestion

To avoid traffic congestion, will reduce the congestion time, even eliminate congestion

Smart Parking

Reduce time on searching parking lot

Carbon Emission & Multi Strategy

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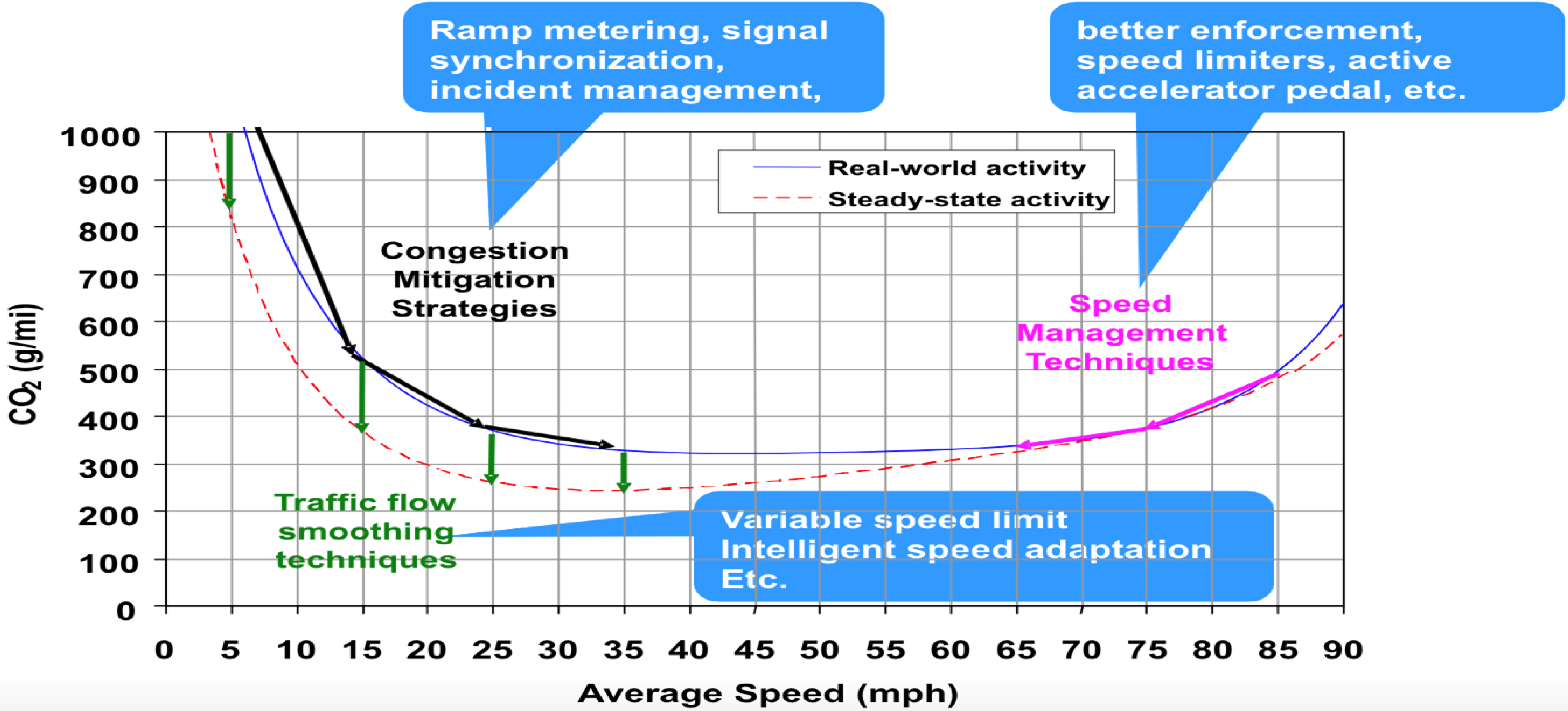
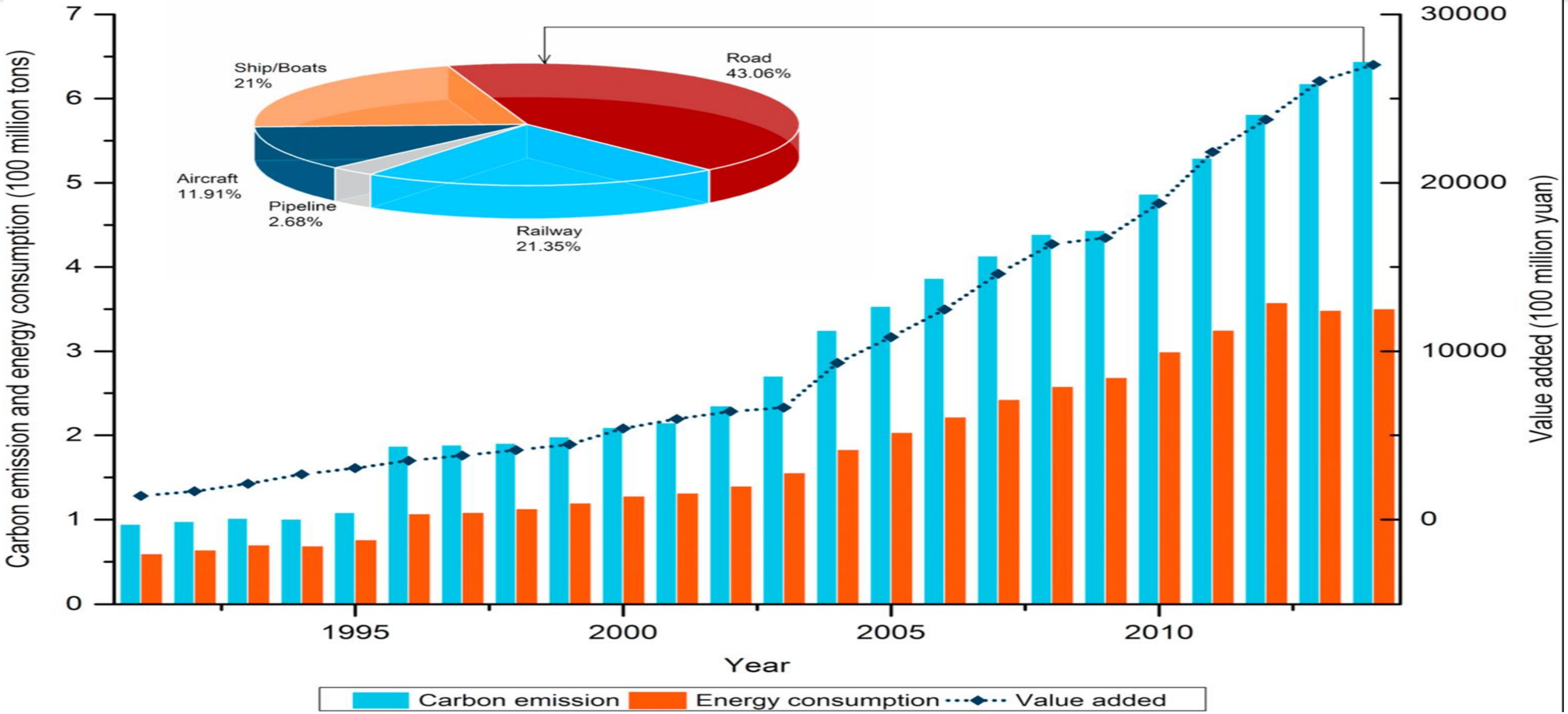
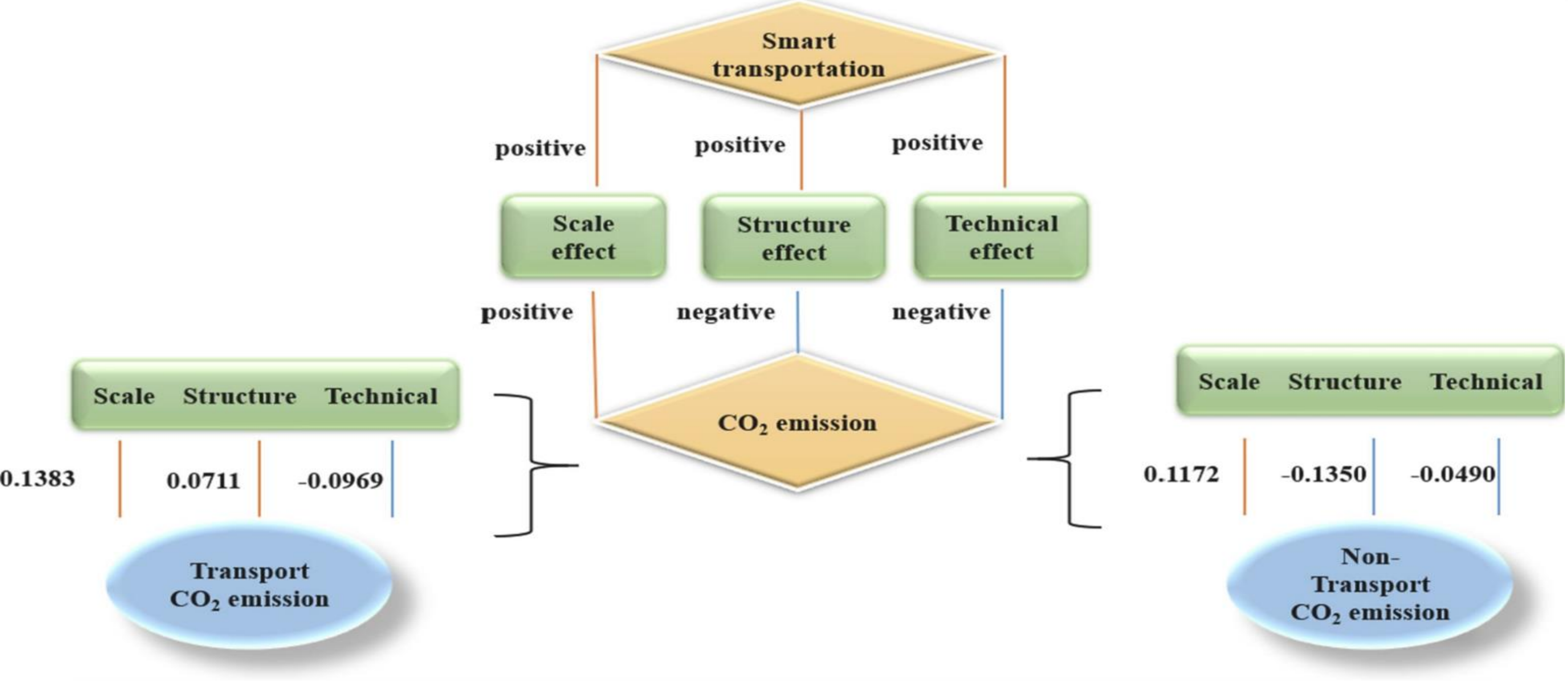


Reducing Greenhouse Gas Emissions through Intelligent Transportation System Solutions,https://ucdavis.app.box.com/v/event-20160601PPT

Case Study-China



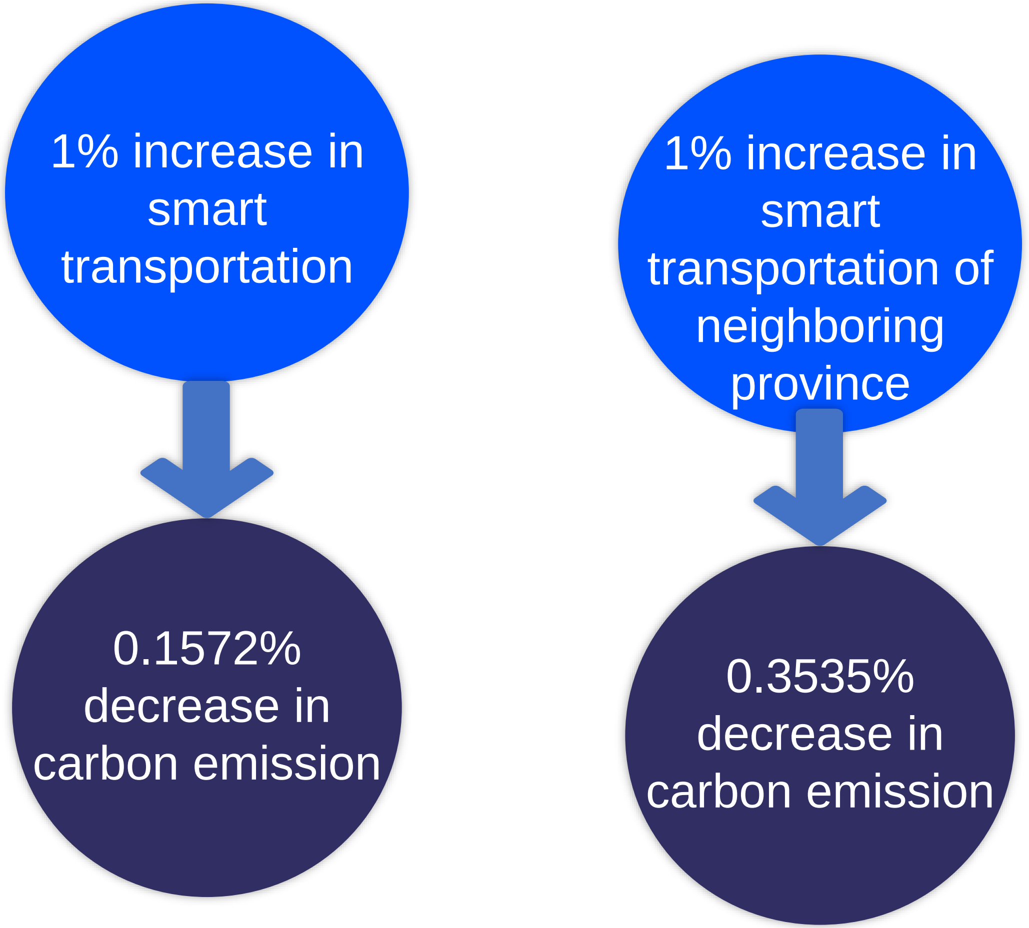
Case Study-China



Case Study-China

Variable	SDM model direct effects		SDM model indirect effects	
	Coefficient	*t* values	Coefficient	*t* values
LnST	-0.1572**	-2.1812	-0.3535**	-2.3691
LnPgdp	0.1260***	3.3473	-0.0858	-1.0311
LnInd	-0.3661***	-5.1603	0.4126**	2.6357
LnOpen	-0.1232***	-3.8387	0.1531**	2.3433
LnES	1.0198***	17.8118	0.2906***	2.8441

Notes: ***, **and* indicate statistical significance at the 1%, 5%, and 10% levels, respectively.



06 | SWOT Analysis

SWOT analysis

Strength

- Traffic and Traffic Light Control
- Vehicle Parking Administration

Weakness

- High Cost
- Security and Protection Concern

Oopportunity

- Blockage and Climate Alerts
- Obstruction Acknowledgment

Threats

- Organization Attacks and Threats
- Further Involvement of IoV (Internet of Vehicle)

Thanks