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REMOBILISE

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Part 2
Achieving smart mobility

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Associação Porto Business School (PBS) - U. Porto

Urban mobility is…

?

Urban mobility is…

Urban mobility is…

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Urban mobility is…

A very complex, sometimes chaotic, vital **urban service**

- Each city has its challenges
- Efficient mobility is being "handled" in different ways

Where are we now?

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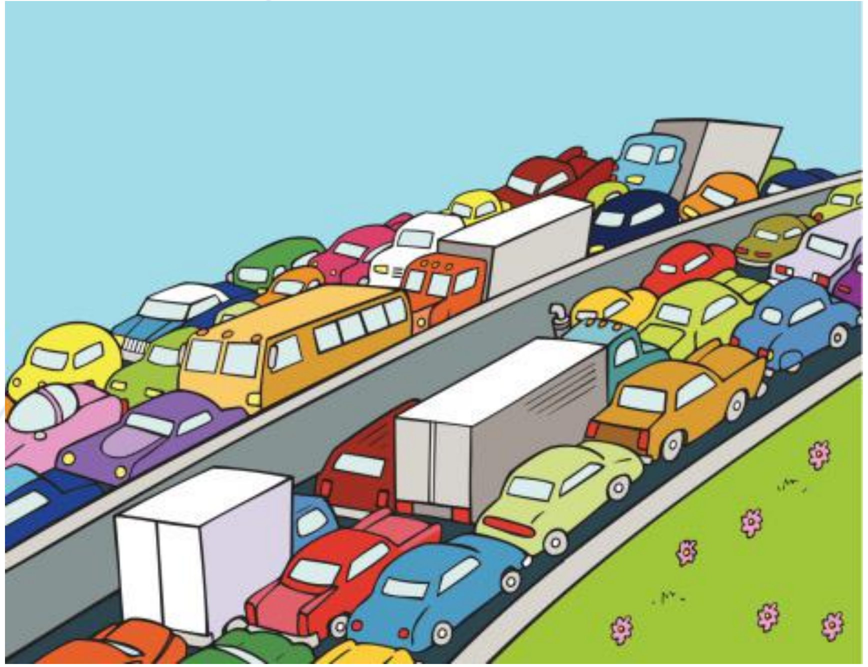
In USA, a total of 3.4 billion hours were wasted in 2021 due to mobility traffic

- Americans lose more than $100B every year in lost labor and gas due to traffic jams

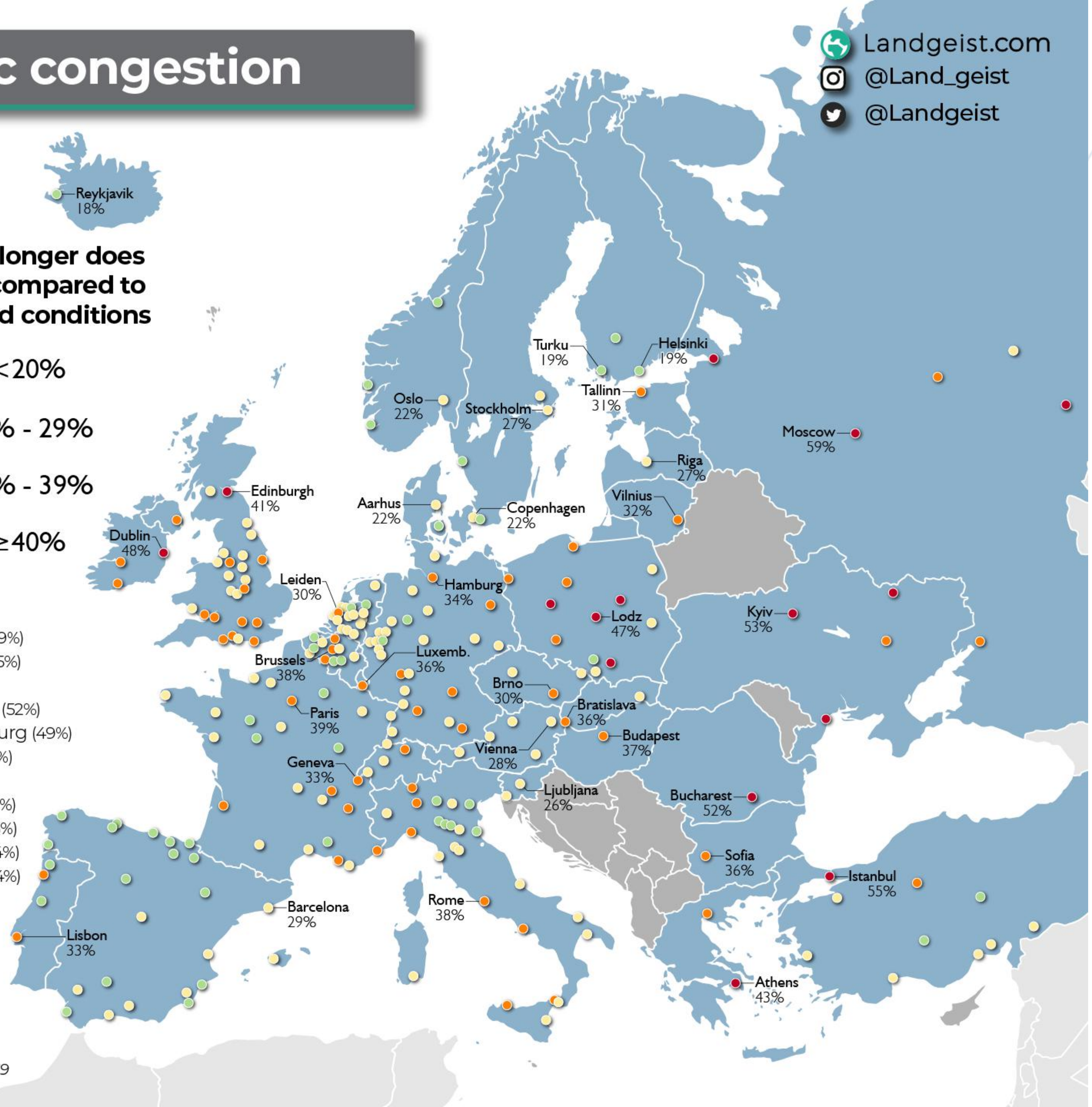
Congestion accounts for 25% of car greenhouse gas emissions

More than 40% of traffic accidents occur in intersections

Sustainable urban mobility is still a major challenge



Traffic congestion



How much longer does a trip take compared to uncongested conditions

- <20%
- 20% - 29%
- 30% - 39%
- ≥40%

Highest

1. Moscow (59%)
2. Istanbul (55%)
3. Kyiv (53%)
4. Bucharest (52%)
5. St Petersburg (49%)
6. Dublin (48%)
7. Lodz (47%)
- Odessa (47%)
9. Krakow (45%)
10. Poznan (44%)
- Samara (44%)

Source: TomTom, 2019

Smart mobility services

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- Smart mobility
  - Parking
  - Traffic control
  - Transportation
  - Smart vehicles

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Smart mobility services

Smart mobility

- **Parking**
- Traffic control
- Transportation
- Smart vehicles

The parking issue

We are still dependent on **private** mobility

- Gives flexibility concerning schedule and routes

Parking is then a big problem, specially in large cities

1. Lacking of sufficient spaces (*cities centres are more challenging*)
2. High costs (*inefficient use of space*)
3. Acessibility

Most first **smart parking** solutions targeted efficient parking

We want to reduce the time to find free space

The parking issue

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1/3 of urban land in the USA is used as parking (on- and off-street)

- The size of West Virginia state

An average of 17 hours are spent yearly due to parking in the USA

There are many laws that demand parking space

- Vehicle-centric culture

The parking issue

For the existing parking infrastructure, what are the biggest problems?

- **Time:** Accounts for the travel time
- **Traffic:** Searching free parking spaces increase traffic
- **Pollution:** Both due to driving and stoped time with engine on
- **Accidents:** Sudden stops or illegal turns

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Smart parking

Use of tehcnology to reduce the negative impacts of parking in urban areas

- Sensors
- Cameras
- Smarthpone apps
- Data from other urban systems

Primary goal: reduce searching time

Smart parking

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Sensors-based solutions

- Count the number of vehicles, identify free spots

Camera-based solutions

- Automatic detection of car plates

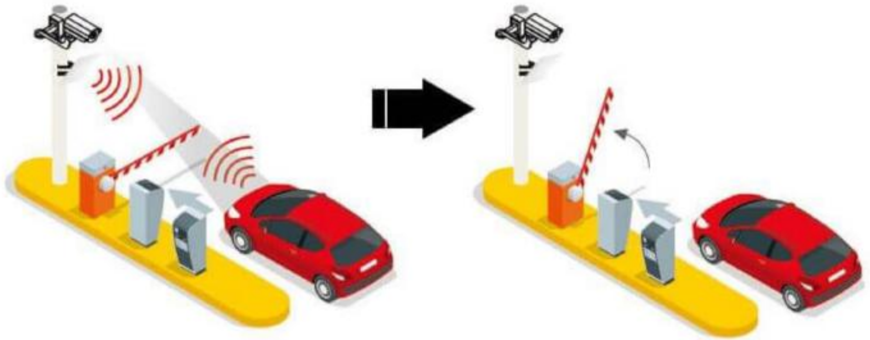
Apps for better parking

- Pre-reserve spots
- Schedule routes based on parking availability

Driving assitance / Automatic parking

Smart city integration

- The parking infrastructure REACT



Smart parking... research

It is important to identify **centralized-assisted** smart parking e **distributed-assisted** smart parking

Different uses of data

Different levels of integration

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Sustainable Cities and Society

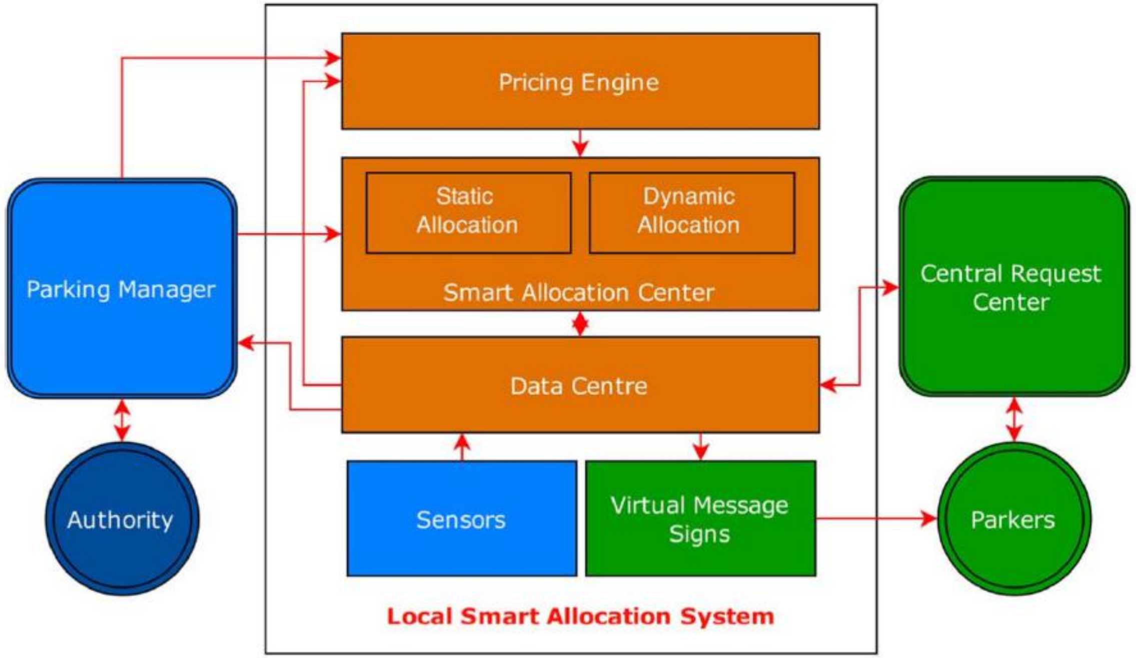
Volume 49, August 2019, 101608

Smart parking in IoT-enabled cities: A survey

Fadi Al-Turjman [a], Arman Malekloo [b]

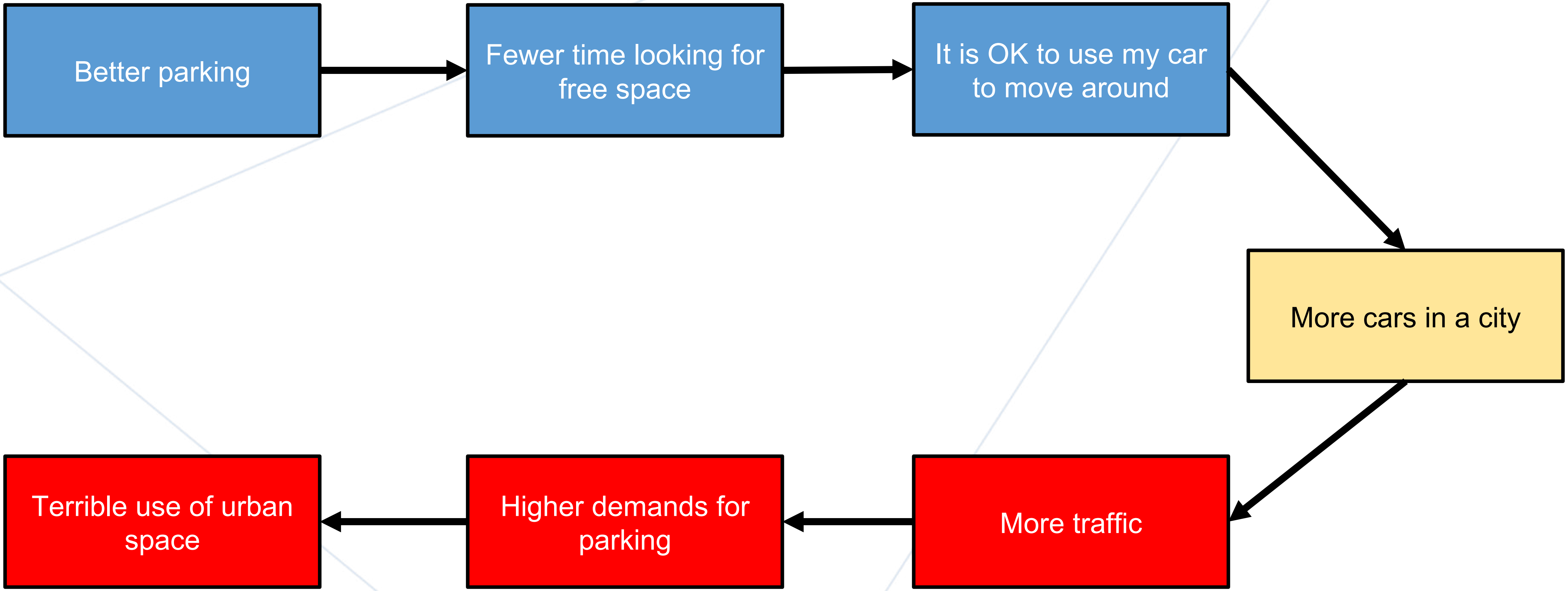
Smart parking… research

- Guaranteed parking reservations with the lowest possible cost and searching time for drivers and the highest revenue and resource utilization for parking managers



O. Kotb, Y. -C. Shen, X. Zhu and Y. Huang, "iParker—A New Smart Car-Parking System Based on Dynamic Resource Allocation and Pricing," in *IEEE Transactions on Intelligent Transportation Systems*, vol. 17, no. 9, pp. 2637-2647, Sept. 2016.

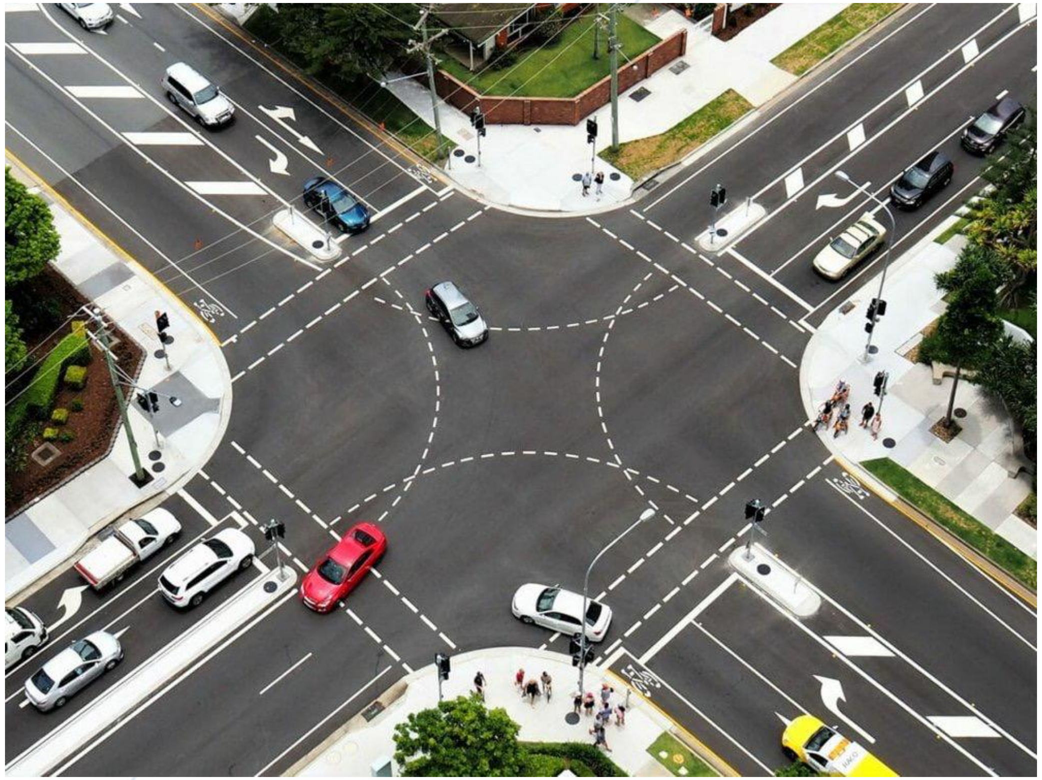
Is smart parking the best solution?



Smart mobility services

Smart mobility

- Parking
- **Traffic control**
- Transportation
- Smart vehicles



Urban congestion

Sao Paulo: car rotation based on zone and plate numbers

Top 10 most congested cities in the world in 2021

Rank	City	Congestion Rate (in 2021)
1	Istanbul, Turkey	62%
2	Moscow, Russia	54%
3	Kyiv, Ukraine	56%
4	Bogota, Colombia	55%
5	Mumbai, India	53%
6	Odessa, Ukraine	51%
7	Saint Petersburg, Russia	50%
8	Bucharest, Romania	50%
9	Novosibirsk, Russia	48%
10	Bengaluru, India	48%

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Goals of (smart) traffic control

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1) Optimize traffic flows to reduce the travel time

- Keep traffic moving quickly
- Avoid congestion and accidents – *Urban streets are different than highways*

2) Respond to eventual accidents

- Relieving critical situations to avoid further complications

3) Promote sustainable and resilient cities (*desired*)

- Interacting with other services (e.g. parking)
- Priotizating critical vehicles

Smart traffic lights (and other road signals)

It is the *easiest* way to perform traffic control

Traditional traffic lights may be improved:

- 1) Follow a “schedule” for rush hours
- 2) Use sensors to detect moving vehicles
- 3) Use cameras to detect the type of vehicles
- 4) Interact with other systems (*desired*): smartphones (people), (intelligent) vehicles and even the city as a whole (*macro-system perception*)

Smart traffic lights – the *desired* goal

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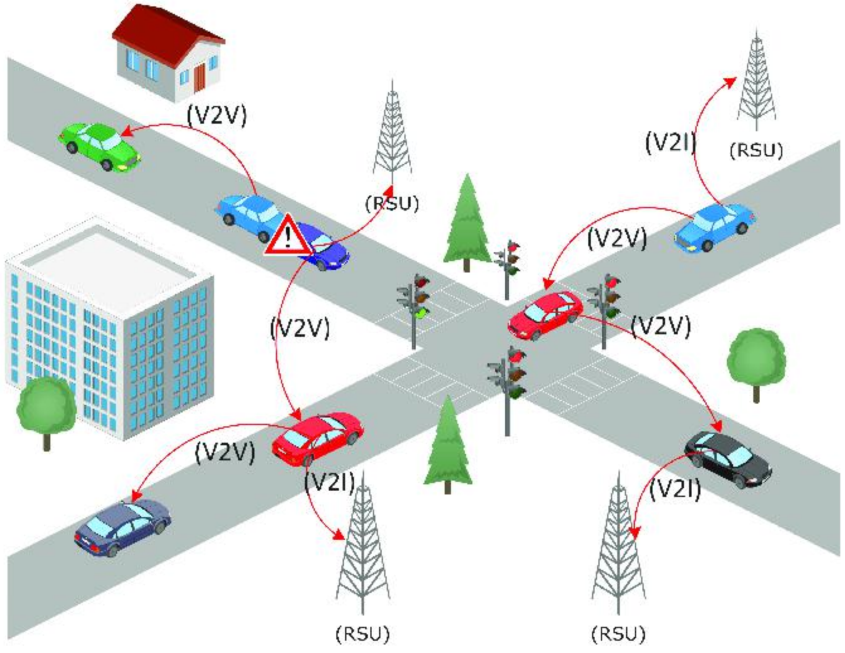
A) Get data to support its operation

- Adjust time for green, yellow and red
- Manage the number of vehicles at junctions, dynamically
- Coordinate different traffic lights as a **chain**

B) Provide data to guide the operation of vehicles

- Vehicles may anticipate actions, transmitting data



But there are more than traffic lights…

Crowndsensing emerged as a promising approach

- Google maps and Waze apps help drivers to avoid traffic
- Congestions tend to achieve a plateau (heavy traffic desencourages additional drivers)

Congestion taxes / rotations may have good impact

- Zero delay is not a reasonable expectation at busy times
- Who should pay for traffic congestions? (*how much*?)

Better use of data to reschedule our way of living

- Why everybody work and study at the same time?

Traffic dynamics and decisions may be “removed” from humans

- Self-driving vehicles

Smart traffic... research

- Maximize the number of vehicles crossing an intersection
- AI is used to make predictions

Computer Communications 154 (2020) 324–330

Contents lists available at ScienceDirect

Computer Communications

journal homepage: www.elsevier.com/locate/comcom

Traffic signal control for smart cities using reinforcement learning ☆

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ARTICLE INFO

Keywords:
Smart city
Q-learning
Traffic signal control
Traffic congestion

ABSTRACT

Traffic congestion is increasing globally, and this problem needs to be addressed by the traffic management system. Traffic signal control (TSC) is an effective method among various traffic management systems. In a dynamically changing and interconnected traffic environment, the currently model-based TSCs are not adaptive. In addition, with the rise of smart cities and IoT, there is a need for efficient TSCs that can handle large and complex data. To address this issue, this study proposes a TSC system to maximize the number of vehicles crossing an intersection and balances the signals between roads by using Q-learning (QL). The proposed system has a flexible structure that can be modified to suit the changes in the original structure of the intersection.

Smart mobility services

Smart mobility

- Parking
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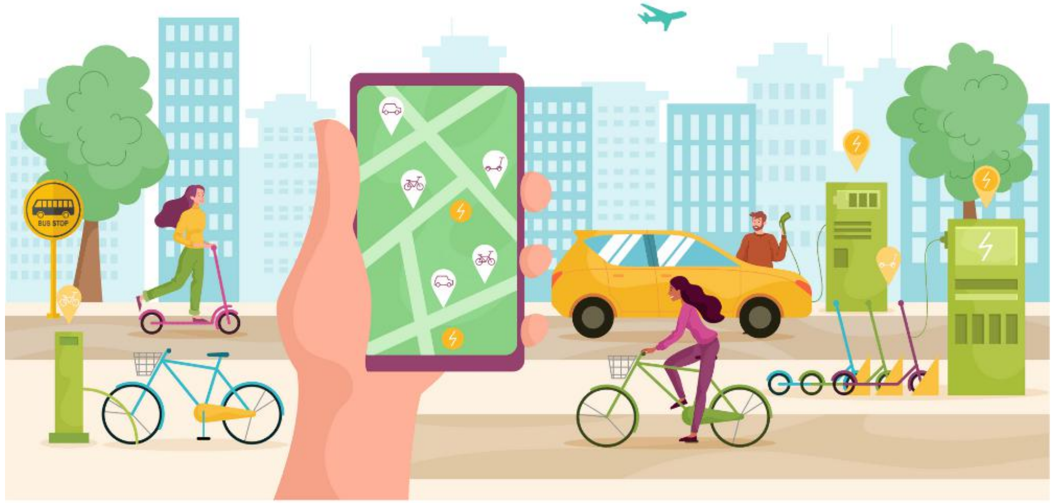
- **Transportation**
- Smart vehicles



S M A R T

Service: good coverage, availability and affordability

Mobility: to move quickly and smoothly

Accessibility: easy to access

Responsiveness: flexible to handle changes

Technology: take advantage of new solutions

Existing transportation modals

Private transportation

- Cars/motorcycles

Public transportation

- Subway and metro systems
- VLT (Light Rail Vehicle) / BRT (Bus Rapid Transit)
- Buses

Personal transportation

- Bicycles
- Scooters

Existing transportation modals

On-demand transportation

- Taxi / Uber
- Ride sharing

Ownership may be temporary

- Rentals
- Vehicle sharing

Reduce average commuting

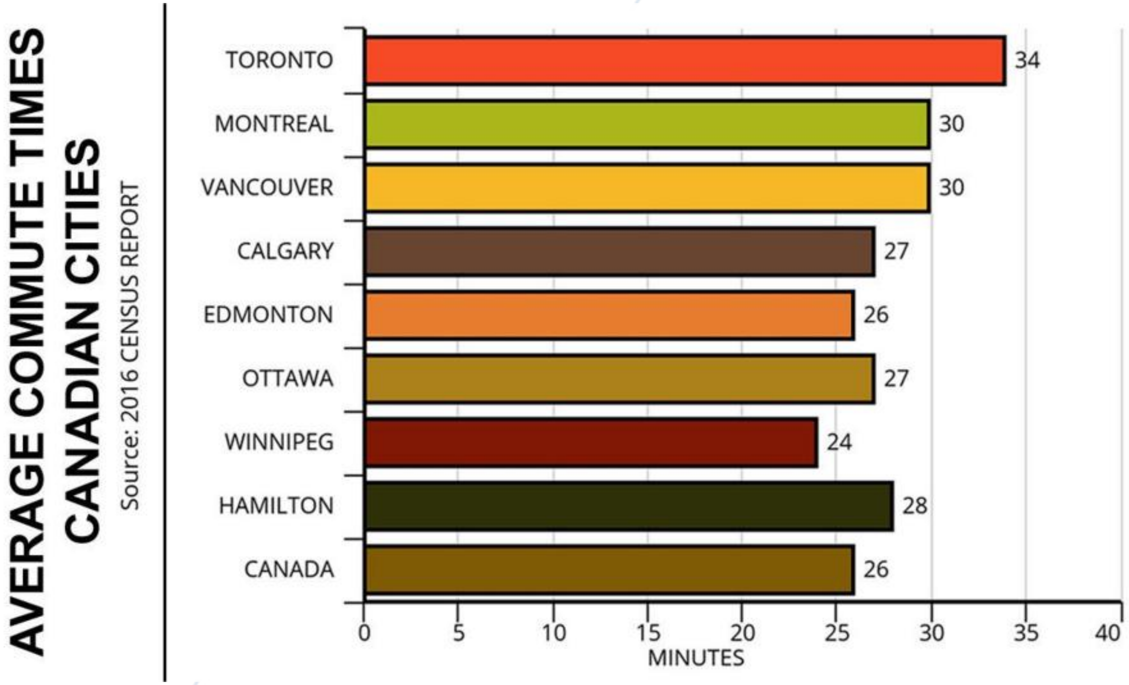
Marchetti’s constant

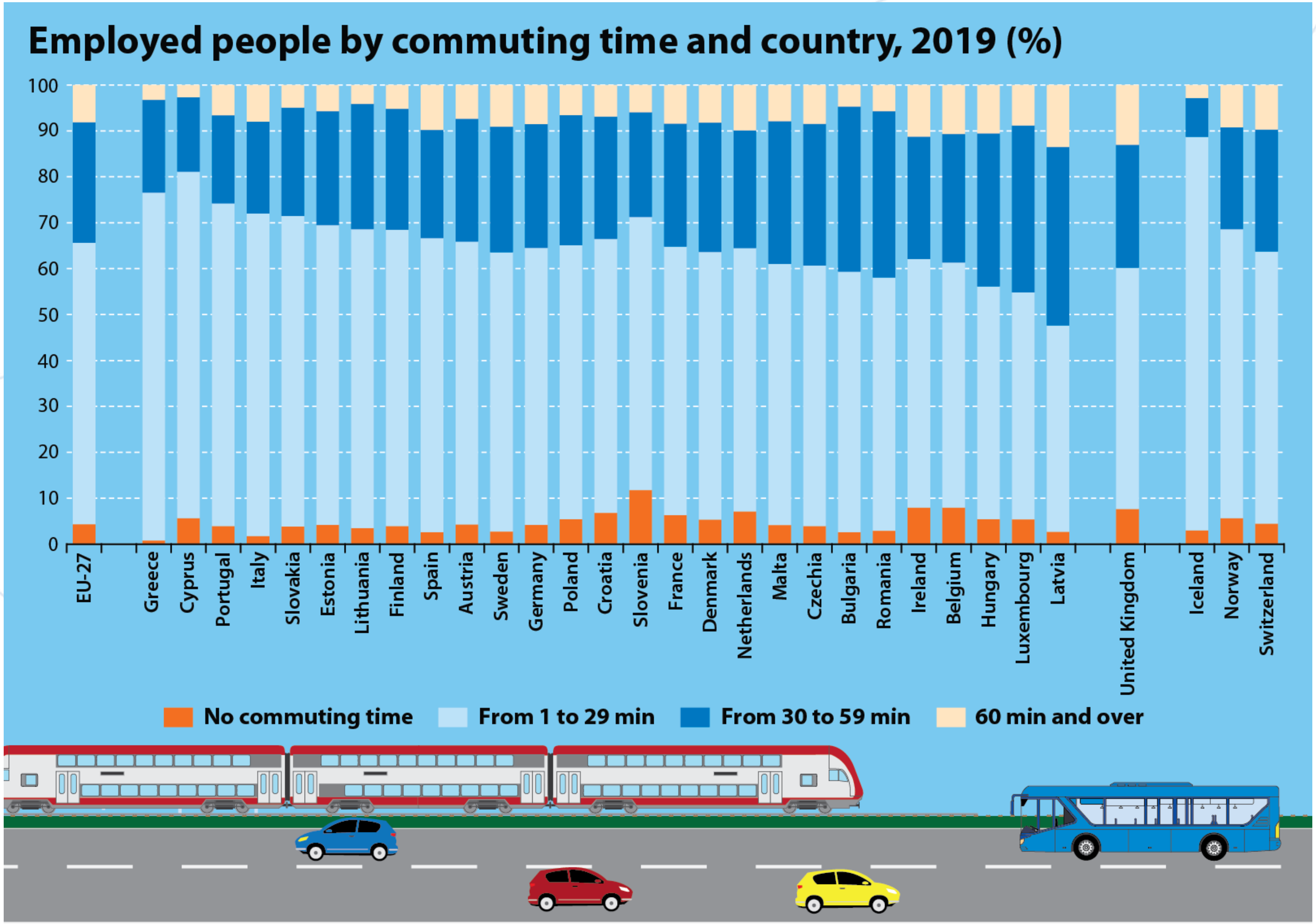
In average, a person (wish to) spend **1 hour** commuting every day

- Half an hour for a one-way trip

Although transport may change, people gradually adjust their lives

- Private vehicles allowed us to live farther, not to save time





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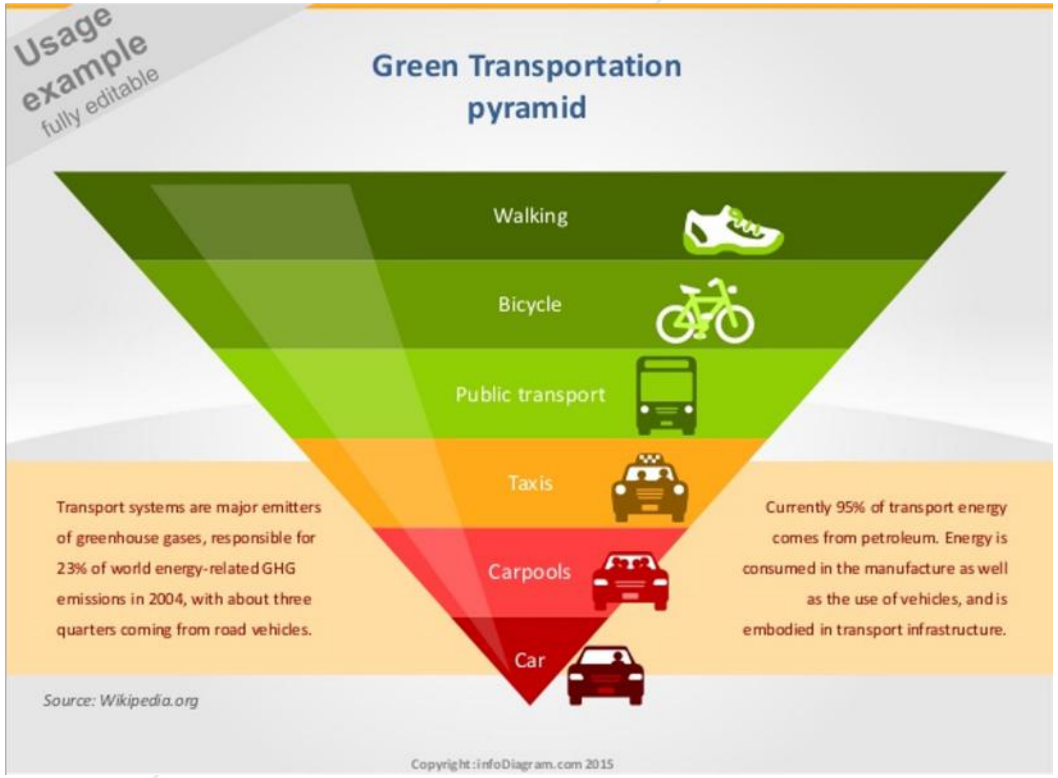
Smart commuting

We need to provide efficient transportation means

- Well-connected networks
- Affordable options
- As “clean” as possible

What can we do?

- Understand the mobility demands
- Adopt smarter solutions



Smart commuting

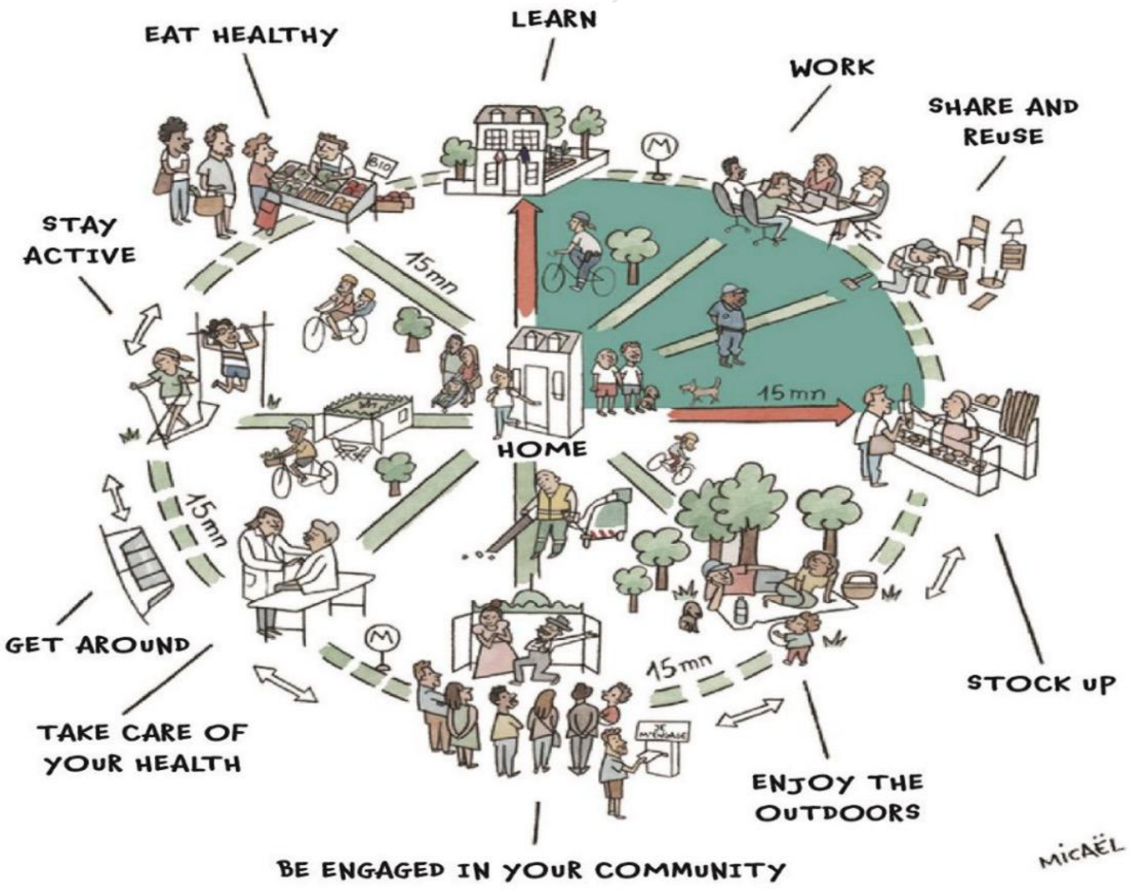
Sustainable idea: the 15-minutes cities

- Prioritise more efficient modals
- Reduce dependence of cars

Reality: on-hour mobility in large cities

Technology is an important ally

- For users: better data to support travel planning
- For cities: better scheduling according to (dynamic) demands



Smart commuting… research

Inefficient parts of multimodal transportation are identified

Different metrics are exploited for that

Contents lists available at ScienceDirect

Physica A

journal homepage: www.elsevier.com/locate/physa

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Identification of critical nodes in multimodal transportation network

Check for updates

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ARTICLE INFO

Article history:
Received 25 November 2020
Received in revised form 11 May 2021
Available online 5 June 2021

Keywords:
Complex networks
Multimodal transportation
Critical nodes
Comprehensive transportation network
Topology model

ABSTRACT

A transportation network is an essential lifeline engineering system, and its reliability is critical when faced with natural or man-made disasters. The reliability of the transportation network will affect the decision-making process of the managers of a country or province during disasters. When a disaster strikes, one or more critical nodes in the transportation network may completely lose their basic function, which may greatly reduce the reliability of the transportation network. Therefore, identifying critical nodes in the transportation network is of utmost importance in the analysis of the reliability of the transportation network. The complex network theory provides a powerful tool to identify critical nodes. In this study, we propose an improved weighted k-shell (IWKS) model to identify the critical nodes based on the complex networks theory. This model comprehensively considers the diversity of the transportation modes, independent transportation ability, and connectivity of the node. Additionally, the comprehensive transportation network in Zhejiang (China) was used to illustrate the effectiveness of the proposed method. The results show that the proposed method can effectively identify

Smart mobility services

Smart mobility

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- **Smart vehicles**

Smart vechiles

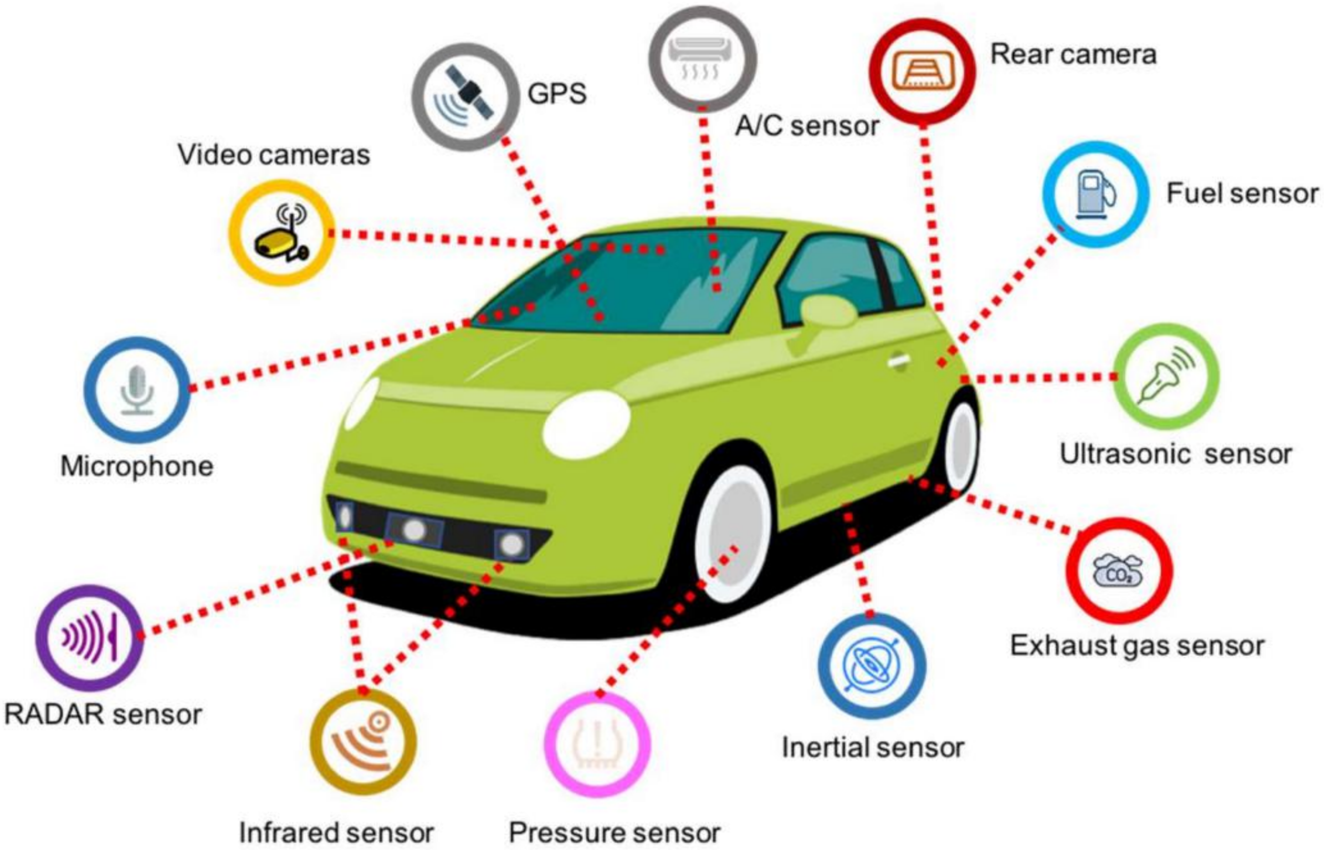
Urban mobility will benefit from a new generation of smart vehicles

Smart cities will communicate with such vehicles

- Relieve mobility problems

Technology is evolving

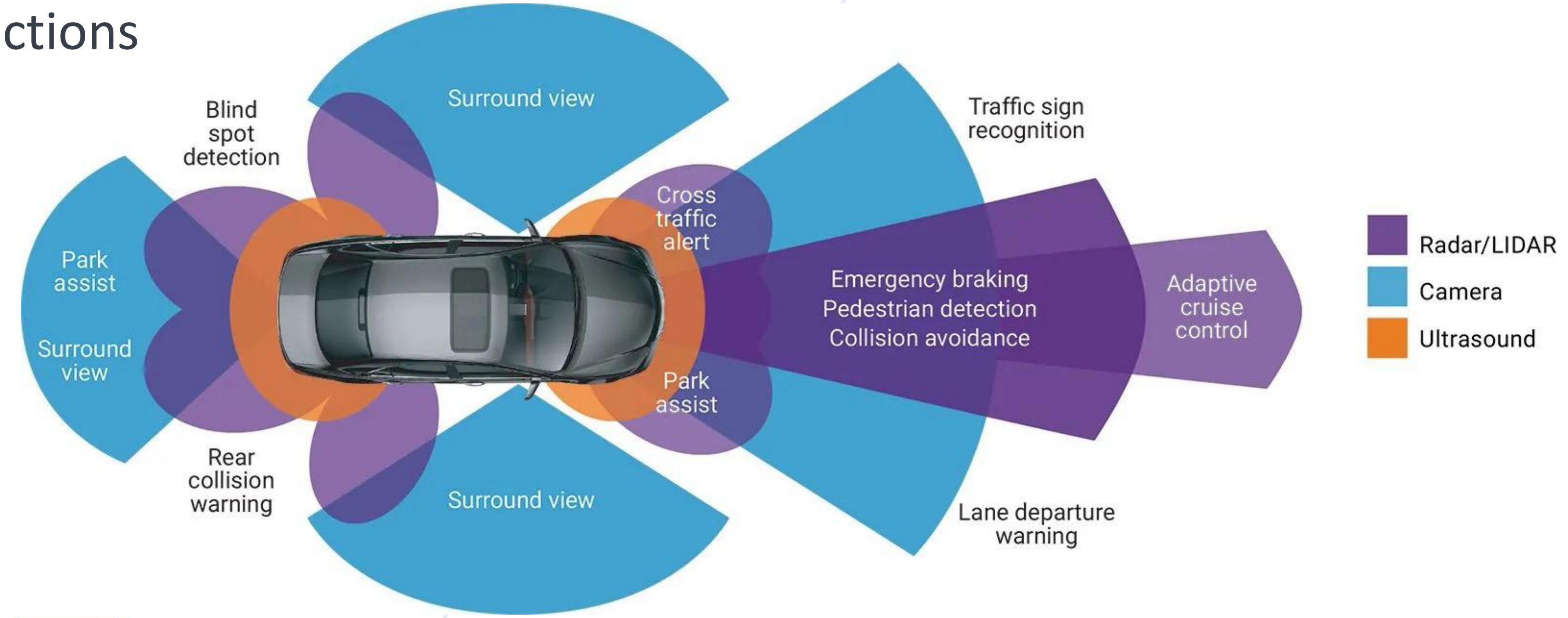
- VANETs
- V2X communications

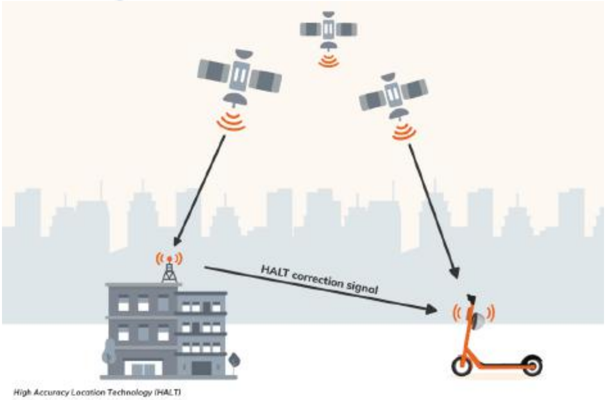


Smart vehicles

What are the key elements in this area?

- Sensors and cameras
- On-board artificial intelligence
- Communication capabilities
- Users- and city-level interactions
- Electrification





Smart vehicles… research

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Use of low-cost computing resources to support better driving

Data from other vehicles are considered

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Contents lists available at ScienceDirect

Microprocessors and Microsystems

journal homepage: www.elsevier.com/locate/micpro

Smart driver assistance system using raspberry pi and sensor networks

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ARTICLE INFO

Keywords:
Computer vision
Embedded system
Image processing
Sensor networks
Surveillance systems

ABSTRACT

With the evolution of science and technology, monitoring human reactions and activities have become really easy and smooth. These new technologies have the potential to revolutionize the domain of safety and security in different realms of the society. Surveillance being the key factor of security measures has been elevated to a whole new level with the advancement in signal processing techniques. This paper basically focuses on the implementation of a smart surveillance system using signal processing and embedded tools which is applied in automobiles to ultimately develop the holistic driver assistance system. Earlier methods were based on physiological and analog data, but the present day scenario demands a smarter and digitalized working system so as to employ integrity and compatibility with other smart sub-systems like mobile phones and tablets. Transportation as we all know is one of the key sectors in the society. But the safety and security measures which people implement for their homes is not being employed for their vehicles. Apart from the vehicular anti-theft burglar systems, driver monitoring systems are also crucial to the lives of the driver and the passengers. Hence, this paper consists of three inter-linked modules which are the driver fatigue detection, alcohol content detection and vehicular crash detection along with control to monitor the driver's physiological state that can affect the vehicular control. A variety of input extraction hardware tools and software algorithms have been utilized in a collaborative way to implement this process.

GOAL: Inteligent Transportation Systems (ITS)

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What is a better mobility?

- Lower traffic?
- Less polution?
- More safety?
- Less fuel consumption?
- Prioritization of pedestrians?

How to get there?

- Better planning
- Better infrastructure
- Data acquisition and processing
- Active tehnologies
- Ubiquituous solutions

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