UNIT – IV: Smart Transportation Systems

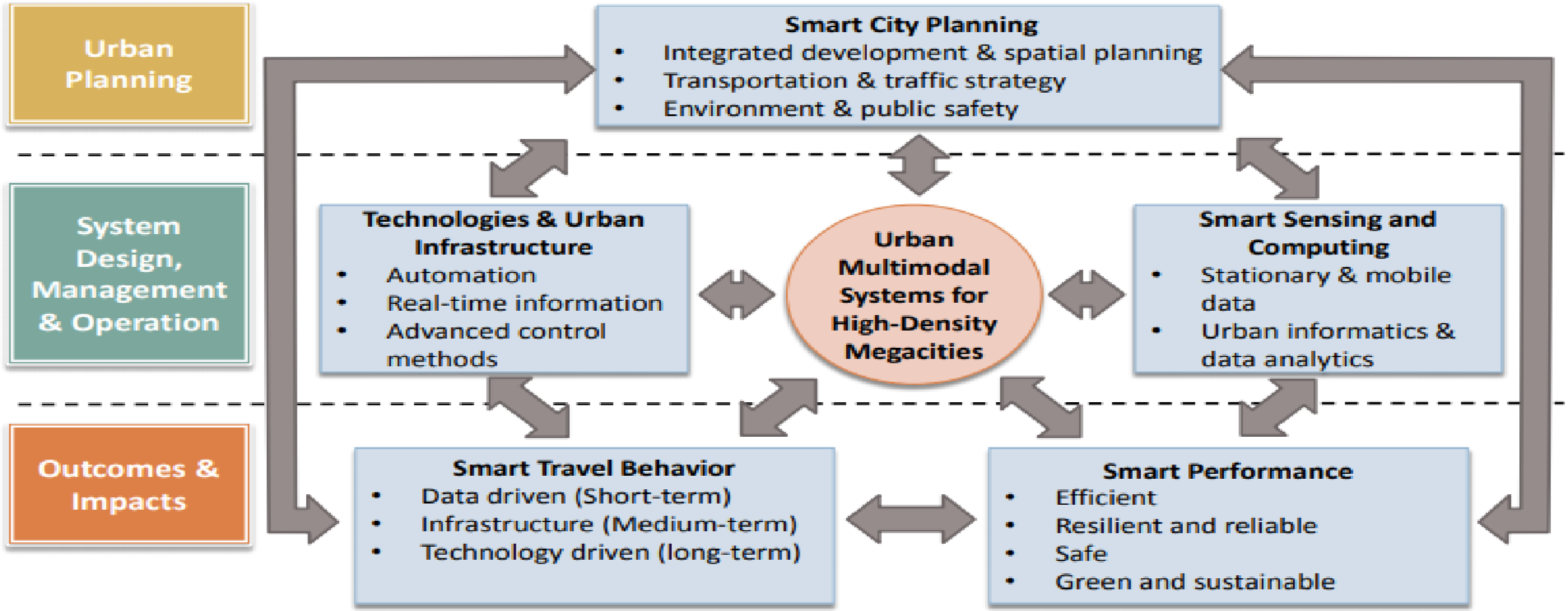
https://www.grantthornton.in/globalassets/1.-member-firms/india/assets/pdfs/smart-transportation-report.pdf
https://www.smartcity.press/intelligent-transportation-system-for-smart-cities/

- Smart Transportation Technologies
- Driverless and connected vehicles - ride sharing solutions
- The "improved" pathway
- The "shift" pathway
- Smart Roads and Pavement systems

Smart Transportation Technologies

https://coeut.iitm.ac.in/ITS_synthesis.pdf

Smart Transportation is About .....



Smart City Planning

Adaptive signal control

Bicycle sharing system

- **Is high-density development a solution to rapid urbanization?**
- **What are the enabling technologies and urban infrastructure to enhance sustainability, accessibility, mobility, and wellbeing?**

Automobile sharing

Walking/Cycling facilities

Technologies & Urban Infrastructure

- How would autonomous vehicles modify fundamental traffic flow properties, and impact infrastructure design and urban form?
- How would electric vehicles interface with the smart grid in terms of energy distribution and storage?

Autonomous self-driving vehicle

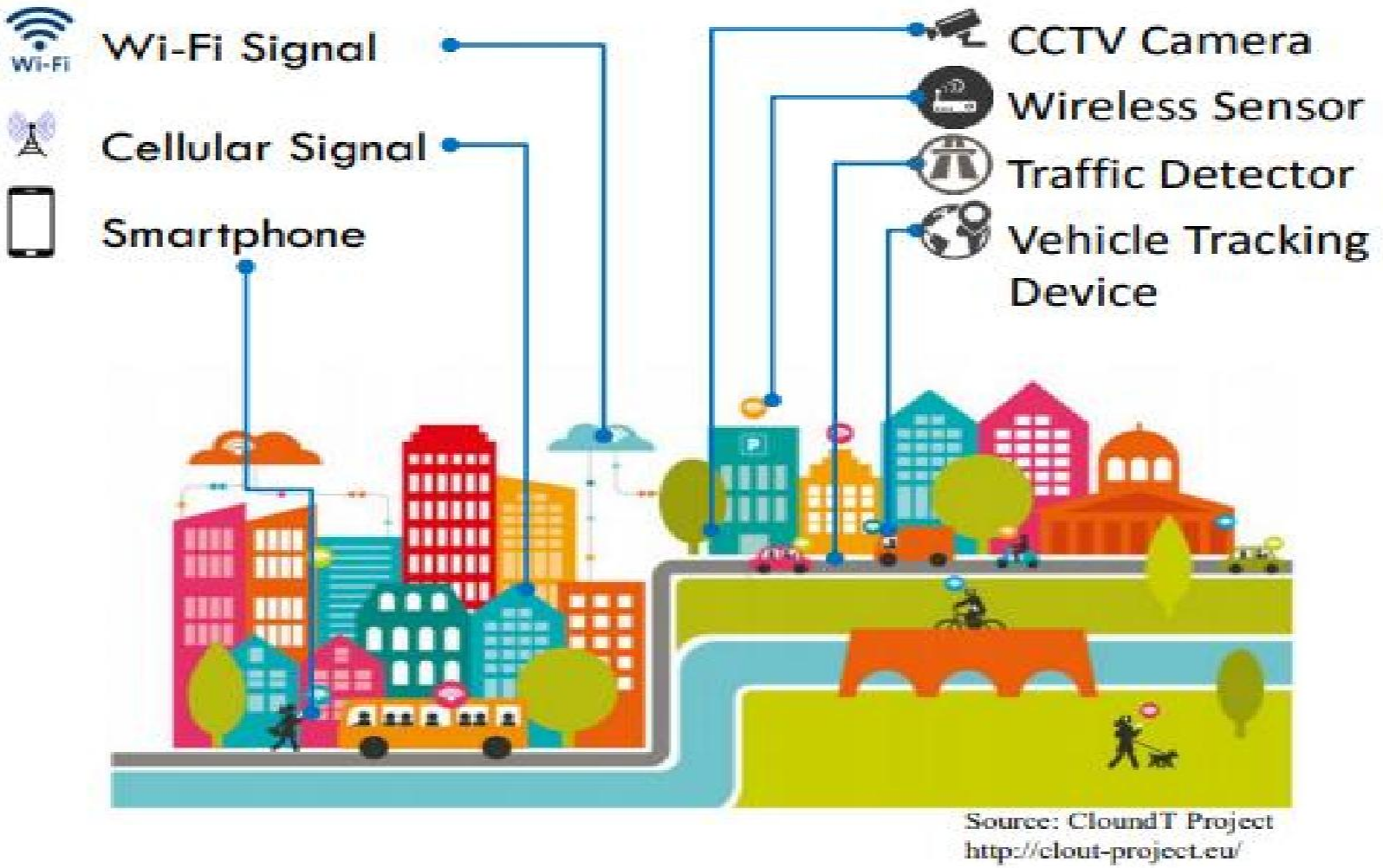
Speed Map Panel

Electric vehicle charging infrastructure

Real-time travel information

Journey Time Indicator

Smart Sensing



- What are the sensing strategies for collecting stationary and mobile sources of multi-modal traffic data and how are these data integrated and interpreted?
- What are the computing strategies for centralized and distributed data transmission, processing, interfacing, analysis, sharing, dissemination, and storage, in the context of big data arena?

Smart Travel Behavior

Data driven

Short-term

Medium-term

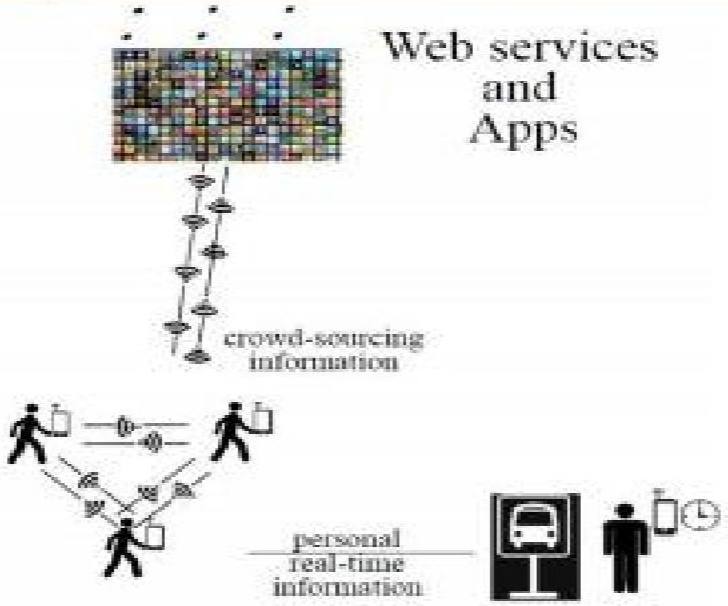
Long-term

Technology driven

Infrastructure driven

- How would accurate, reliable and timely multi-modal traffic information affect travelers' decision making processes?
- How would future technologies, such as autonomous self-driving vehicles, electric vehicles, multi-modal traffic information, massive and robust traffic control affect activity and mobility patterns?

Smart Performance



Better mobility and less congestion

V2V and V2I technologies

- **How to develop a cost-effective but highly resilient multi-modal transportation system in response to increasingly frequent and serious natural and manmade disruptions?**
- **How would the above smart developments help to maintain safe, healthy, rapid, reliable, comfortable, convenient, affordable, equitable, and environmentally compatible mobility of mankind?**

Uncertainties and disruptive conditions

Smart vehicles

Today's technology advancements shaping tomorrow's smart transportation

Technology advances in cellular communication have ushered an era of ubiquitous connectivity

Smart transportation is about disseminating information about the transportation network from an underlying network of sensors, infrastructure, and communication devices to build operating solutions and services for an intelligent transport system (ITS)

An ITS which is safe, efficient, inclusive, and serves the societal needs of modern living will need to reap the benefits of both the cellular and the transportation network

The ITS rubric is broad, and we at Qualcomm Technologies provide solutions across the board — from connectivity and telematics to in- vehicle compute, which are key to autonomous vehicles

Road owners and users alike benefit from unparalleled set of tools for personal mobility, safety, and environmentally-friendly transportation services, up to and including automated driving.

intelligent transport system

ITS empowers its users with meaningful information, facilitating a wide range of services from pre-trip planning and en route information, to advanced road safety services and paving the path to enhanced automated driving

While such applications bring obvious benefits to road users, they also provide actionable insight to private entities such as transportation planners working alongside government agencies on optimal operations strategies

Transportation planners can use the information to project travel demand

The demand information can help to determine optimal deployment of transportation infrastructure, advanced public transit services, and

placement of ITS-enabled transportation pricing and demand management systems such as electronic toll collection or variable parking fees

Planners can also benefit from insights into arterial road usage, traffic conditions, and congestion reports in shaping our neighborhoods and reducing greenhouse gas emissions

Intelligent transport technologies

Intelligent transport systems vary in technologies applied, from basic management systems such as car navigation; traffic signal control systems; container management systems; variable message signs; automatic number plate recognition or speed cameras to monitor applications, such as security CCTV systems; and to more advanced applications that integrate live data and feedback from a number of other sources, such as parking guidance and information systems; weather information; bridge deicing systems; and the like

Additionally, predictive techniques are being developed to allow advanced modeling and comparison with historical baseline data. Some of these technologies are described in the following sections

Floating car data/floating cellular data

- "Floating car" or "probe" data collection is a set of relatively low-cost methods for obtaining travel time and speed data for vehicles traveling along streets, highways, freeways, and other transportation routes
- Broadly speaking, three methods have been used to obtain the raw data
- Floating car data technology provides advantages over other methods of traffic measurement:
- Less expensive than sensors or cameras
- More coverage (potentially including all locations and streets)
- Faster to set up and less maintenance
- Works in all weather conditions, including heavy rain

GPS Based Methods

An increasing number of vehicles are equipped with in-vehicle GPS (satellite navigation) systems that have two-way communication with a traffic data provider

Position readings from these vehicles are used to compute vehicle speeds

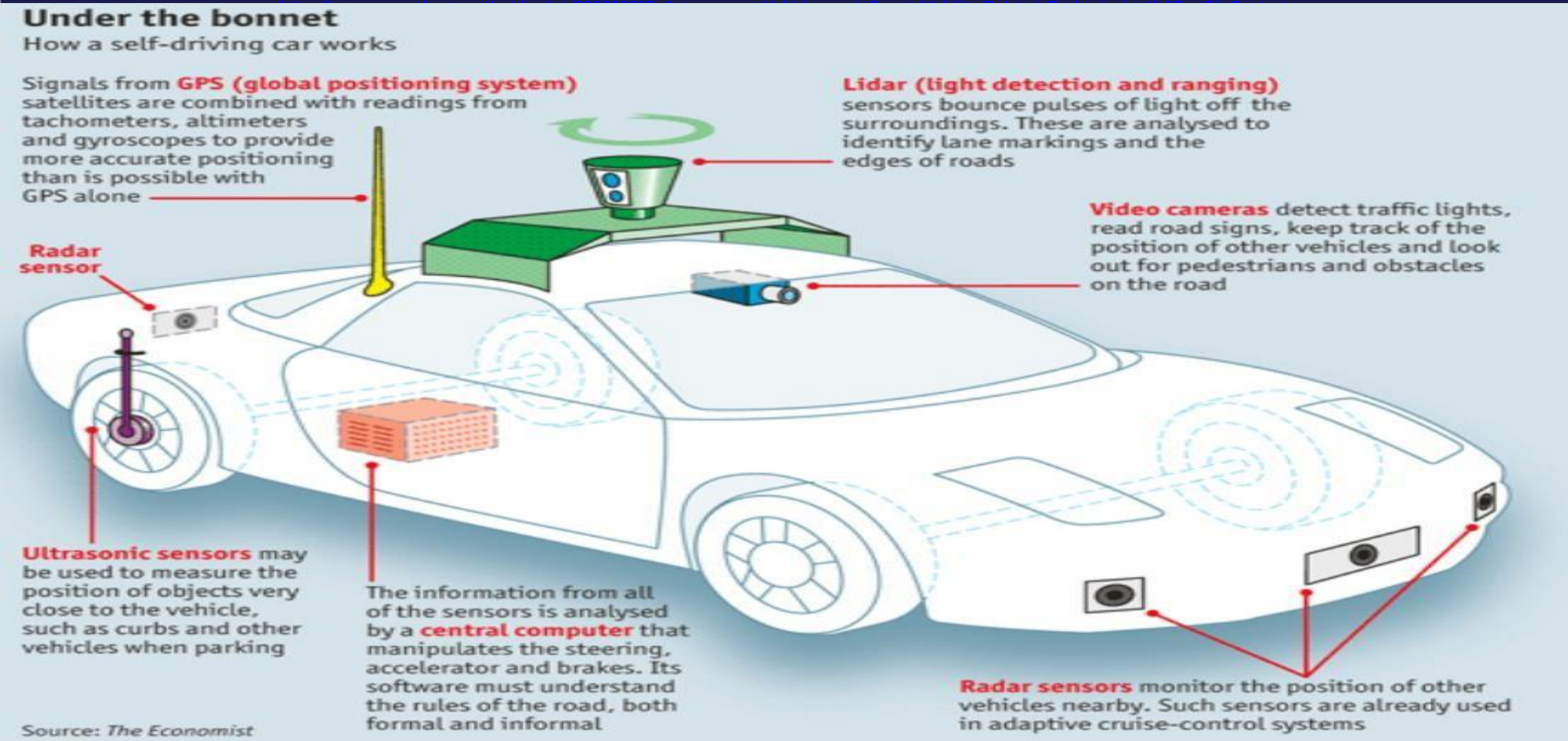
Basic Physical Ecosystem of an Autonomous Vehicle

- **Global Positioning System (GPS)**
- **Light Detection and Ranging (LIDAR)**
- **Cameras (Video)**
- **Ultrasonic Sensors**
- **Central Computer**
- **Radar Sensors**
- **Dedicated Short-Range Communications-Based Receiver (not pictured)**

Key Physical Components of Autonomous Vehicles

- Cameras – Provide real-time obstacle detection to facilitate lane departure and track roadway information (like road signs).
- Radar – Radio waves detect short & long-range depth.
- LIDAR – Measures distance by illuminating target with pulsed laser light and measuring reflected pulses with sensors to create 3-D map of area.
- GPS – Triangulates position of car using satellites. Current GPS technology is limited to a certain distance. Advanced GPS is in development.
- Ultrasonic Sensors – Uses high-frequency sound waves and bounce-back to calculate distance. Best in close range.
- Central Computer – "Brain" of the vehicle. Receives information from various components and helps direct vehicle overall.
- DRSC - Based Receiver – Communications device permitting vehicle to communicate with other vehicles (V2V) using DSRC, a wireless communication standard that enables reliable data transmission in active safety applications.

Driverless and connected vehicles - ride sharing solutions



The "improved" pathway

Information and Communication Technology (ICT)

- **User experience and safety**
- **Monitor urban transportation infrastructure**

•Automated driving systems Digitalization

- **Monitoring of urban transportation systems**
- **Equipped with data gathering devices such as**

➢ **Video cameras**

➢ **Speed cameras**

➢ **Sensors**

Improved Path way

Vehicles equipped with data processing and communication technologies

- **Vehicle to vehicle communication**
- **Vehicle to infrastructure communication**
- **Vehicle to pedestrian communication**

➢ **Speed limitations**

➢ **Road signs**

➢ **Traffic lights**

➢ **Warnings signs for hazardous conditions**

➢ **Automated traffic diversion signals**

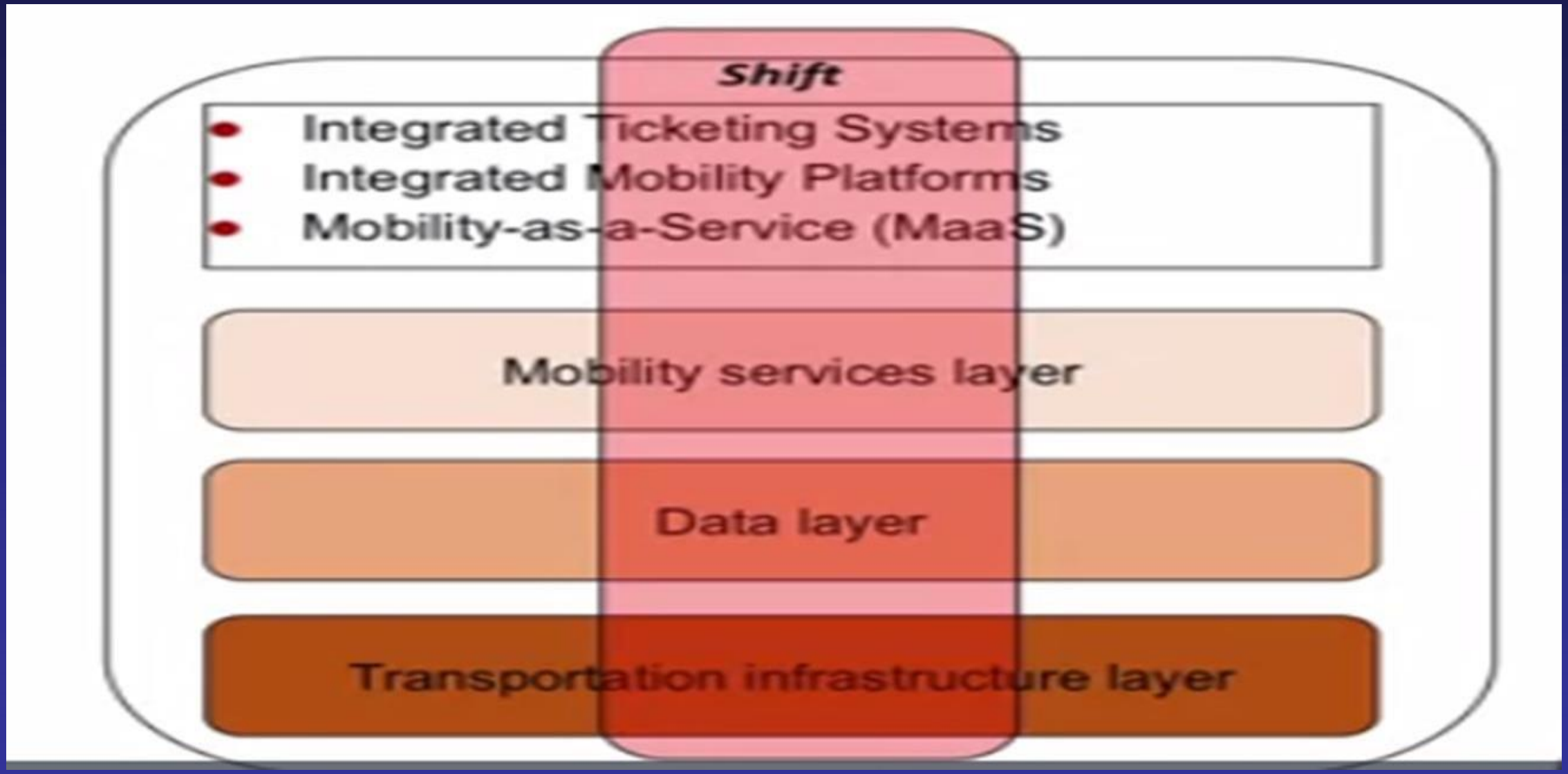
The "shift" pathway

https://www.coursera.org/lecture/smart-cities/the-shift-pathway-cP9vk

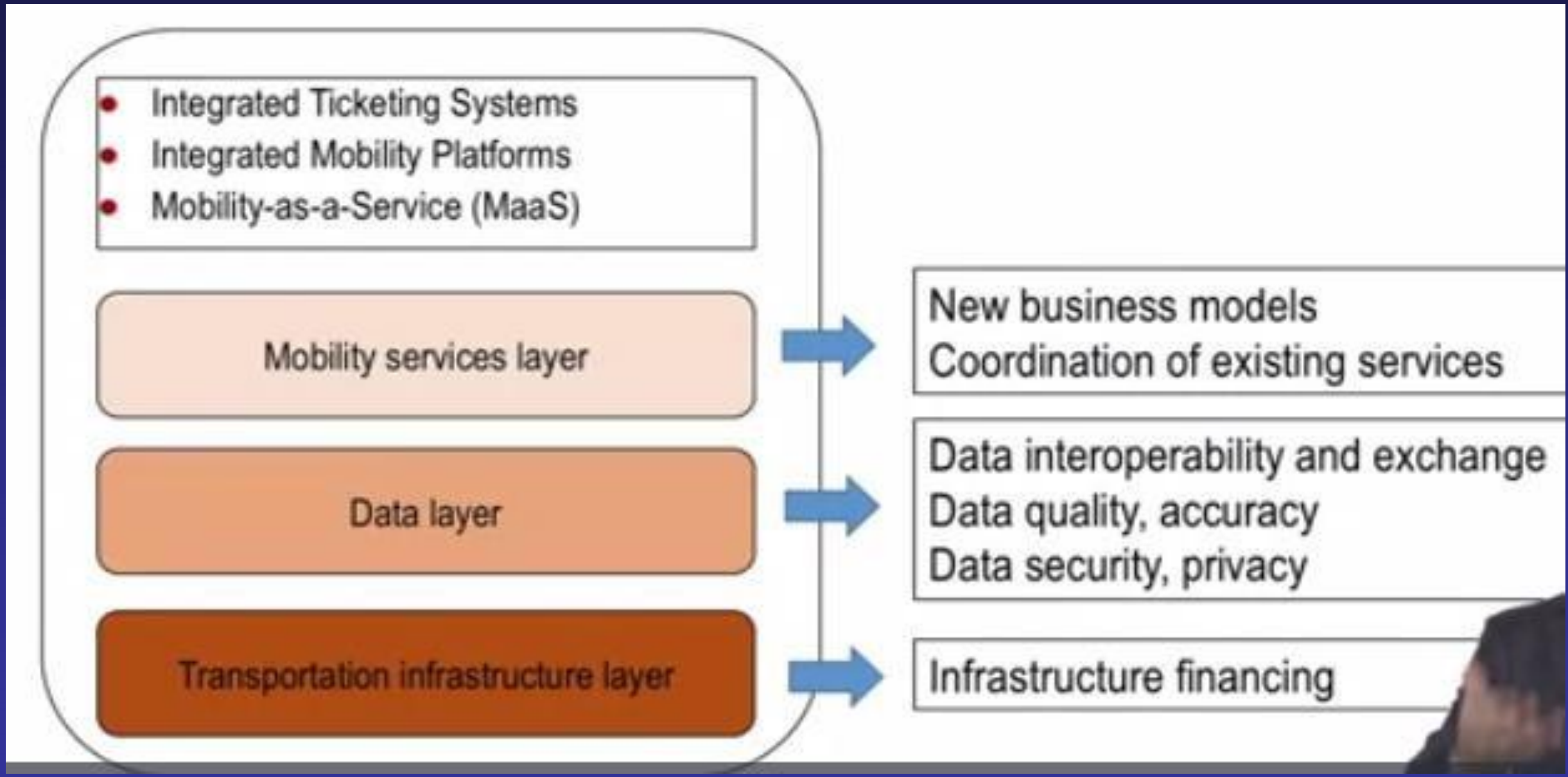
- New Mobility services

- Thanks to geo-localization, and ICT-based sharing mechanisms, new mobility services have emerged over the past 10 years:
  - Car sharing
  - Car pooling
  - E-hailing
  - ...
  - ultimately some of these services may well become driverless
- Paradigm ***shift*** will Impact private and public transportation
  - Affect the need to own a car thanks to the multiplication of mobility services
  - Affect public transportation
- Complexification of urban transportation systems, because of the multiplication of mobility offers

Services Integration



Implication



Smart Road Technology: Paving The Way To The Future
https://mobility.here.com/learn/smart-transportation/smart-road- technology-paving-way-future

- **The road is an often-overlooked part of the modern transport infrastructure**
- **We’ve all heard of self-driving cars, navigation apps, and ride-hailing services But as it turns out, the road itself can be a platform for an amazing array of innovations.**
- **Roads can be upgraded with communication, lighting and power transmission technologies that can support sustainability, improve safety, and transform the driving experience.**

What Is Smart Road Technology?

- Smart roads use Internet of Things (IoT) devices to make driving safer, more efficient, and greener
- Smart roads combine physical infrastructures such as sensors and solar panels with software infrastructure like AI and big data
- Smart road technologies are embedded in roads and can improve visibility, generate energy, communicate with autonomous vehicles, monitor road conditions, and more

Examples

- IoT connectivity: Cities can connect roads to IoT devices, and gather traffic and weather data. This type of connectivity can improve safety, traffic management, and energy efficiency.
- Traffic management networks: For improving safety and reducing congestion. The network uses speed cameras to provide warning signs for hazardous conditions, and sends automated traffic diversion signals that control traffic.
- Traffic lights optimization: Systems that use data from closed- circuit television (CCTV) cameras or smart vehicles to optimize traffic lights and update commuters on jams or bottlenecks
- Most transport-related smart tech focus on individual vehicles, although there have been major advances in technological solutions for smart infrastructure at scale. Worldwide experiments in Vehicle to Infrastructure (V2I), Vehicle to Vehicle (V2V) and Vehicle to Pedestrian (V2P) technologies are expected to make urban transport smarter

Smart Road Technologies

Solar powered roadways

- Photovoltaic cells are embedded within hexagonal panels made of tempered glass, which are used to pave roads
- These panels contain LEDs, microprocessors,

snow-melting heating charging devices and inductive electric capability for driving vehicles when

- Glass is renewable and can be engineered to be stronger than steel, and to allow cars to stop safely even when traveling at high speeds

Smart pavement

- Specially engineered roadways fitted with smart features, including sensors and that monitor report changing road conditions, and WiFi transmitters that provide broadband services to vehicles, homes and businesses.
- The smart pavement can also charge electric cars as they drive

Glow in the dark roads

- Glowing markers painted onto existing roadway surfaces use a photo-luminescent powder that absorbs and stores daylight
- The 500m long strips glow for 8 hours after dark
- This technology is still in the testing phase, and the glow is not yet consistent, but it could be more cost-effective than traditional road lighting

Interactive lights

- Road lights activated by motion sensors to illuminate a particular section of the road as a car approaches
- The lights dim once the car passes
- Suited for roads with less traffic, interactive lights provide night visibility as needed and reduce energy wastage when there are no cars

Electric priority lane for charging electric vehicles

- Embedded cables generate magnetic fields that charge electric vehicles while driving
- Inductive charging technology already exists for static cars, but future wireless technology could charge batteries while in motion

Weather detection

- Networks of AI-integrated sensors detect weather conditions that impact road safety
- Road Weather Information Systems (RWIS) in use today are limited because they only collect data from a small set of weather stations
- A larger future network could use automated weather stations to collect atmospheric and weather data and instantly upload it to the cloud

Traffic detection

- Data that helps travellers plan their routes
- Sensors lining highways monitor traffic flow and weight load, warn drivers of traffic jams, and automatically alert the authorities about accidents
- Fiber-optic cables embedded in the road detect wear and tear, and communication between vehicles and roads can improve traffic management
- For example, Rapid Flow Technologies uses artificial intelligence (AI) to manage traffic lights, which respond to each other and to cars