

Internet of Vehicles(IoV) and VANET

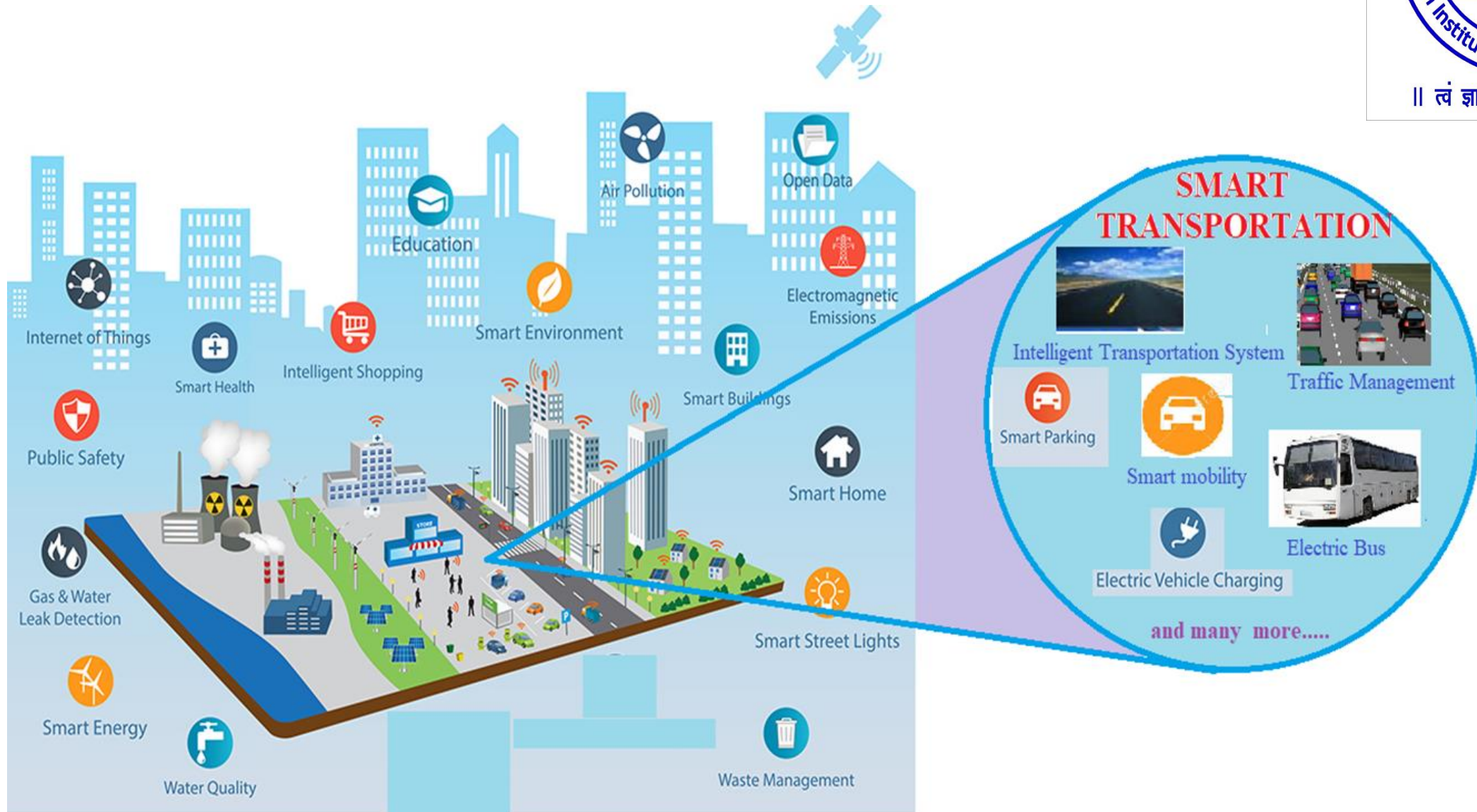
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Smart Cities



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Smart Transportation

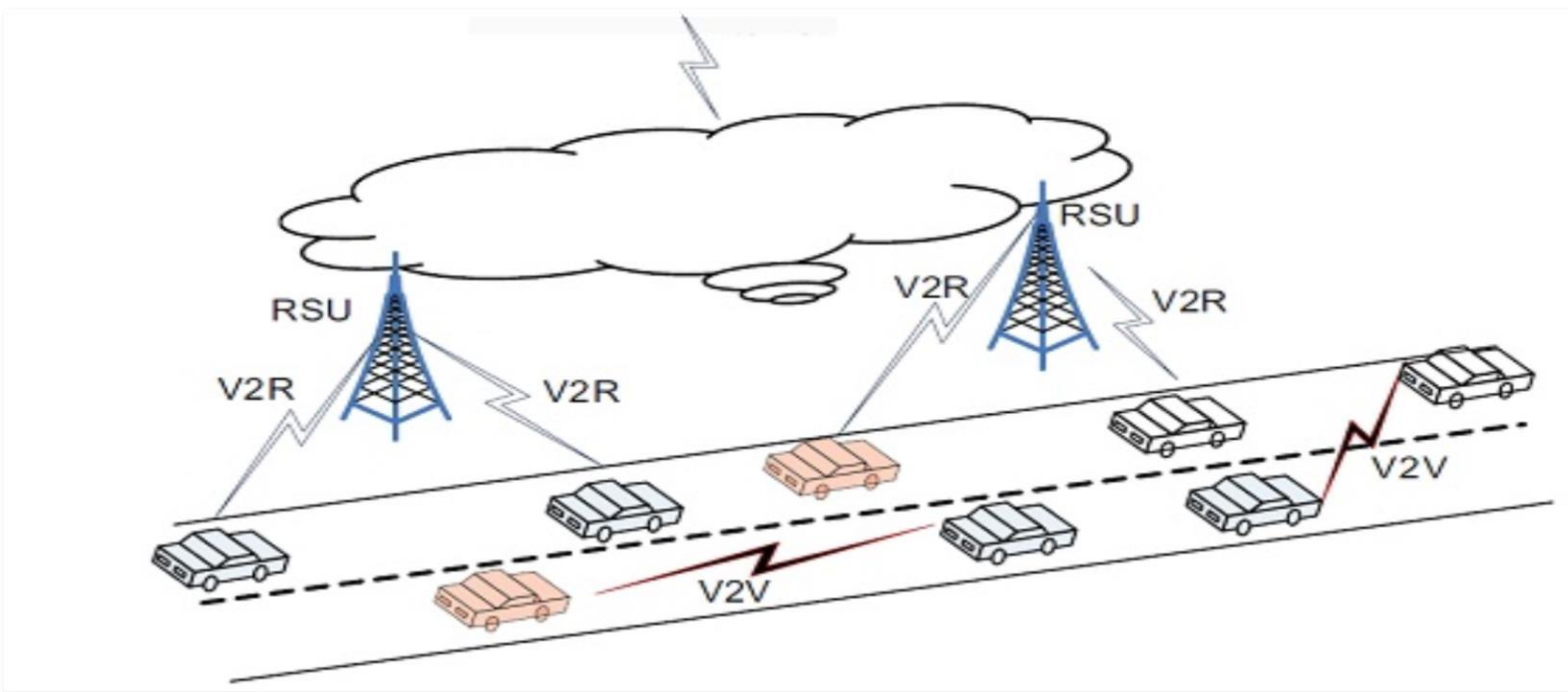


- There is a **serious mismatch** between **the growing traffic volume and the availability of resources to support the traffic.**
- Some of the important reasons for this mismatch are **rapid development of our economy, increased affordability of our society, multiple vehicles per family, and so on.**
- We believe that the **mismatch will continue to grow and adversely affect our traffic infrastructure** unless **efficient traffic management solutions that includes security are developed and deployed**

Vehicular Ad Hoc Network (VANET)

:A vehicular ad hoc network (VANET) uses cars as mobile nodes

- Vehicle-to-Vehicle (V2V) and
- Vehicle-to-Road Side Units(V2R).



VANET Architecture

Intelligent Transport System (ITS)

- Advanced vehicles and associated transportation infrastructures that use IT&C technology to make driving safer, efficient and comfortable
- Operation of vehicles, manage vehicle traffic, assist drivers with safety and other information, provisioning of convenience applications for passengers
- ITS
 - high interest for companies, operators, government, academia, research; many countries have public and private sector bodies working on ITS
 - Important technologies - implementing many applications related to vehicles, vehicle traffic, drivers, passengers and pedestrians
- **Typical use cases and services/applications**
 - **Active road safety** applications
 - Warnings, notifications, assistance
 - **Traffic efficiency** and management applications
 - **Infotainment** applications

Intelligent Transport System (ITS)

- **Typical use cases and services/applications**
 - **Active road safety applications**
 - Collision warning: Intersection, Risk, Head on, Rear end, Co-operative forward, Pre-crash
 - Warning on: Overtaking vehicle, Wrong way driving, Stationary vehicle, Traffic condition, Signal violation, Control Loss, Emergency vehicle proximity, etc.
 - Lane change assistance
 - Emergency electronic brake lights
 - Hazardous location notification
 - Co-operative merging assistance
 - **Message types for safety apps:** time-triggered position messages and event-driven hazard warnings
- **Traffic efficiency and management applications**
 - Speed management and Co-operative navigation
- **Infotainment applications**
 - Co-operative local services
 - Global Internet services

Vehicular Ad-Hoc Networks(VANETs)

- Recent advances in **hardware, software, and communication** technologies are enabling the **design and implementation** of a whole range of different types of networks that are being deployed in various environments.
- One such network that has received a lot of interest in the last couple of years is the **Vehicular Ad-Hoc Network (VANET)**.
- VANET has become an active area of research, standardization, and development because it has tremendous potential to **improve vehicle and road safety, traffic efficiency, and convenience as well as comfort to both drivers and passengers.**

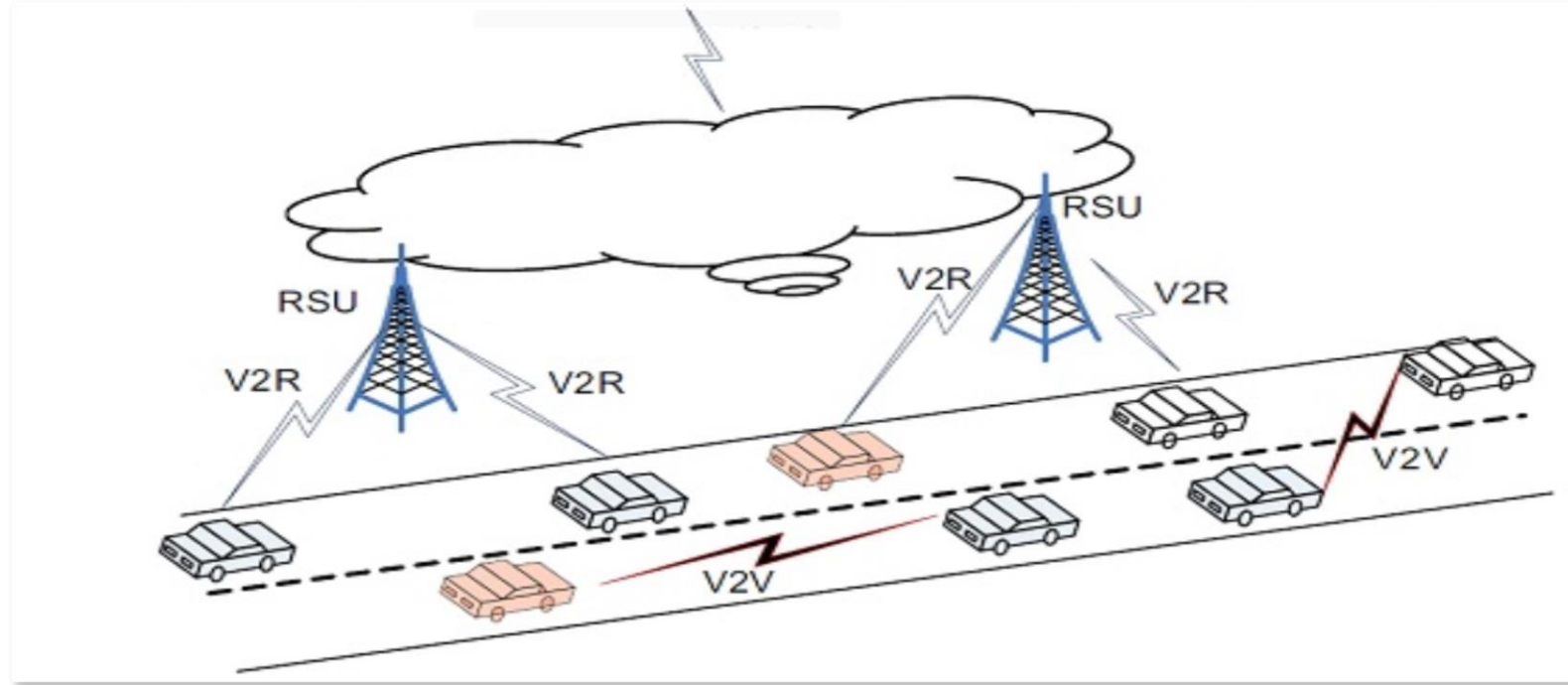
Introduction

- Vehicular communications are used in various safety and business applications in today's technology world for user benefits.
- In this, vehicle-to-vehicle (V2V) and V2R communication enables users to exchange meaningful information with nearby vehicles directly.
- In general, **vehicles move faster on the highway rather than the intersection road environment**, and thus, a robust system is required to communicate efficiently and securely.

Vehicular Ad Hoc Network (VANET)

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VANET Architecture

Vehicular Cloud Computing(VCC)

- **The Vehicular Cloud Computing(VCC)** provides a storage facility for OBU or RSU,
- It is essential to provide **VC resources to both (OBU and RSU)** because OBUs are installed in an individual vehicle and hence, vehicle users may have an opportunity to bogus data to the VC.
- Thus, we need reliable communication protocols for the new VCC system.

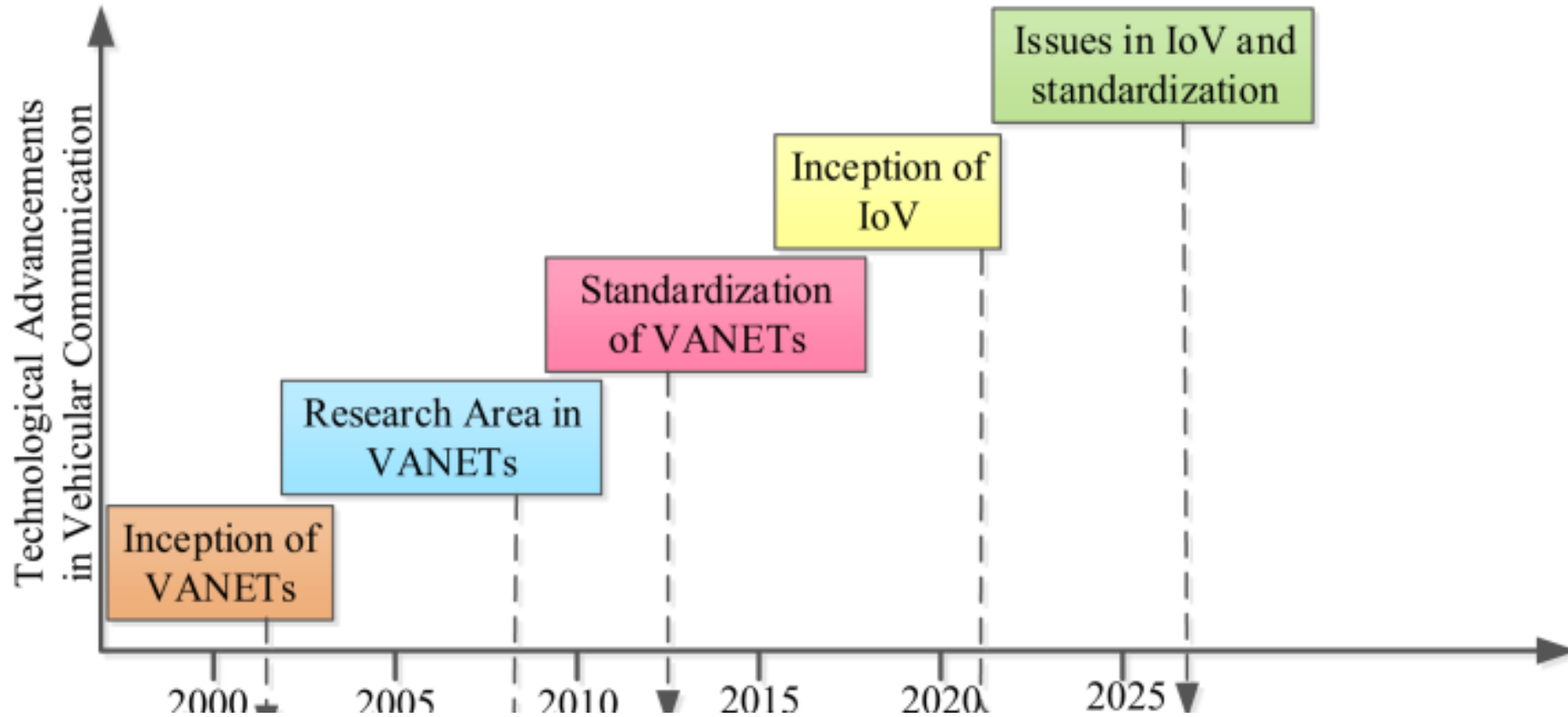


Motivation



- ❖ The traditional **Intelligent Transport System (ITS)** has significantly evolved, including **vehicular communication**
 - Main communications: V2V, V2R, V2I → Vehicular ad-hoc Networks (VANET)
 - VANET – is an important part of the ITS
- ❖ VANET (special class of Mobile ad-hoc Network - MANET)
 - has both **technical and business-related limitations**
 - still - **not very large scale deployment in the world**

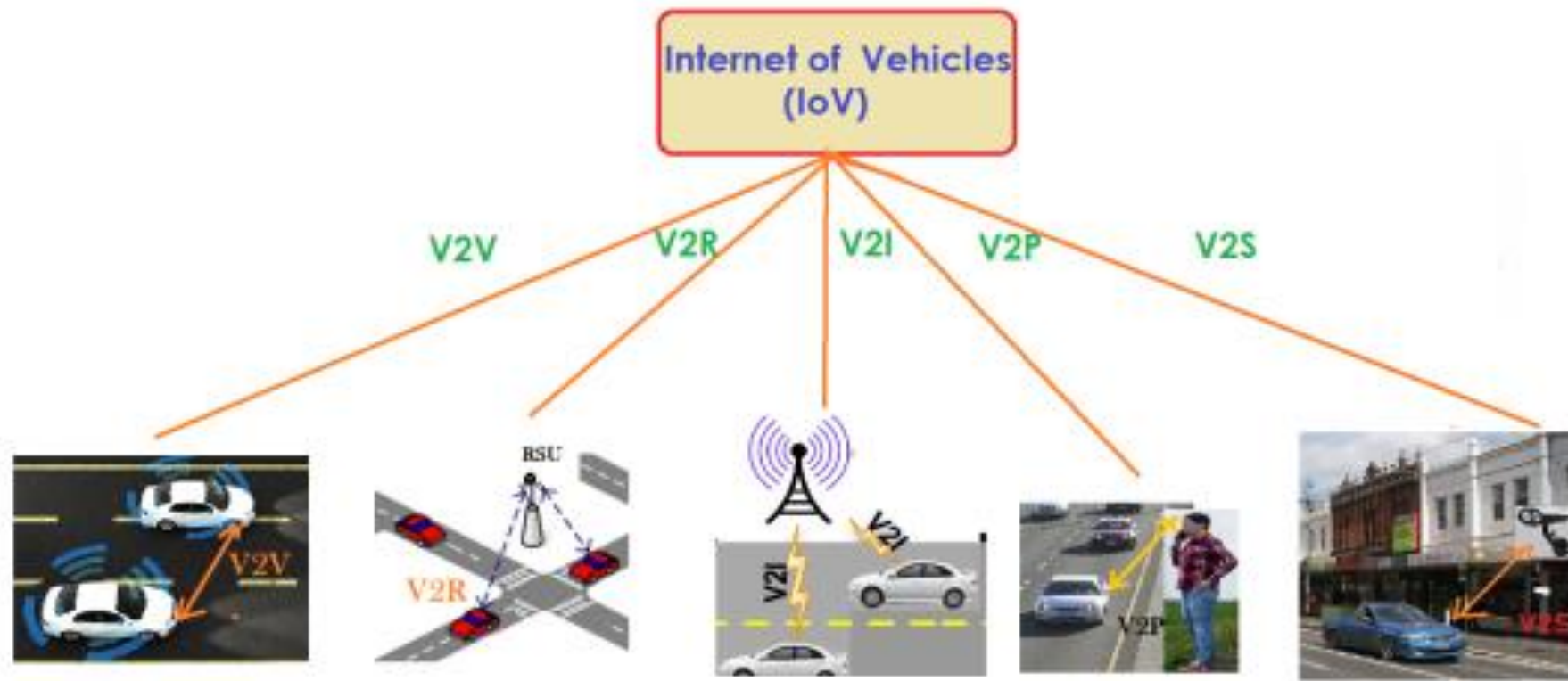
Evolution of vehicular communication from VANETs towards IoV



Internet of Vehicles(IoV)

- ❖ The Internet of Vehicles (IoV) is a typical application of it in the field of transportation, which aims at achieving an integrated intelligent **transportation system to enhance traffics, to avoid accidents, to ensure road safety, and to improve driving experiences.**
- ❖ **Internet of Vehicles(IoV) = Vehicular Ad-Hoc Networks (VANETs) + Internet of Things(IoT)**

Internet of Vehicles(IoV) [VANETs + IoT]



Vehicular Ad-hoc Networks to Internet of Vehicles

- **Motivation of this talk**
- The traditional ***Intelligent Transport System (ITS)*** has significantly evolved, including vehicular communication
 - Main communications: V2V, V2R, V2I → *Vehicular ad-hoc Networks (VANET)*
 - VANET – is an important part of the ITS
- **VANET** (special class of ***Mobile ad-hoc Network - MANET***)
 - **has both technical and business-related limitations**
 - **still - not very large scale deployment in the world**
- **Recent approach: IoV – significant extension of the VANET capabilities**
 - global network of vehicles – enabled by *Wireless Access Technologies (WAT)*
 - involving Internet and including heterogeneous access networks
 - IoV – special case of ***Internet of Things (IoT)***
 - **IoV Target domains:**
 - vehicles driving and safety (basic function – in VANET) and additionally:
 - urban traffic management, automobile production
 - repair and vehicle insurance, road infrastructure construction and repair, logistics and transportation, etc.

Why from VANET to IoV ?

- **Commercial, objectives, architecture**
 - **VANET:** **architecture** supports **specific apps. only** (safety, traffic efficiency)
 - Internet access is not fully available (due to specific architecture)
 - **IoV:** business oriented architecture → high opportunities for various apps. (safety, traffic optimization and efficiency, infotainment, etc.)
- **Collaboration capabilities:**
 - **VANET:** **specific architecture, non-collaborative** (i.e., Internet-wide)
 - **IoV:** collaboration between heterogeneous nets, reliable Internet service
- **Communication types:**
 - **VANET:** basically - **V2V, V2R, only partially V2I**
 - **(IoV) includes different types of communications:**
 - vehicle-to-vehicle (V2V), roadside (V2R)
 - and additionally :
 - infrastructure of cellular networks and Internet (V2I)
 - personal devices (human) (V2D/V2P)
 - sensors (V2S)

Why from VANET to IoV ?

- **Processing power and decision capabilities:**
 - **VANET:** **limited** (local simple decisions), low volume data
 - **IoV:** high capabilities – (cloud based), big data, data mining, ..
- **Compatibility with personal devices:** VANET: **limited**; IoV : any PD
- **Scalability:**
 - **VANET:** **non-scalable** (consequence of its architecture)
 - **IoV:** scalable (and it integrates various access types: VANET, WiFi, 4G/LTE, ..)
- **Connectivity:**
 - **VANET:** vehicles can experience **connection/disconnection**- depending on network current availability
 - **IoV:** “always-connected” is possible, one can use the best network type
- **Network/environment awareness:**
 - **VANET:** **limited** (basically on neighborhood of the vehicle)
 - **IoV:** global network awareness is possible (cloud-assisted)
- **Cloud Computing (CC) compatibility:**
 - **VANET:** **limited** (possible, but currently not supported)
 - **IoV:** the main operations can be based on CC services

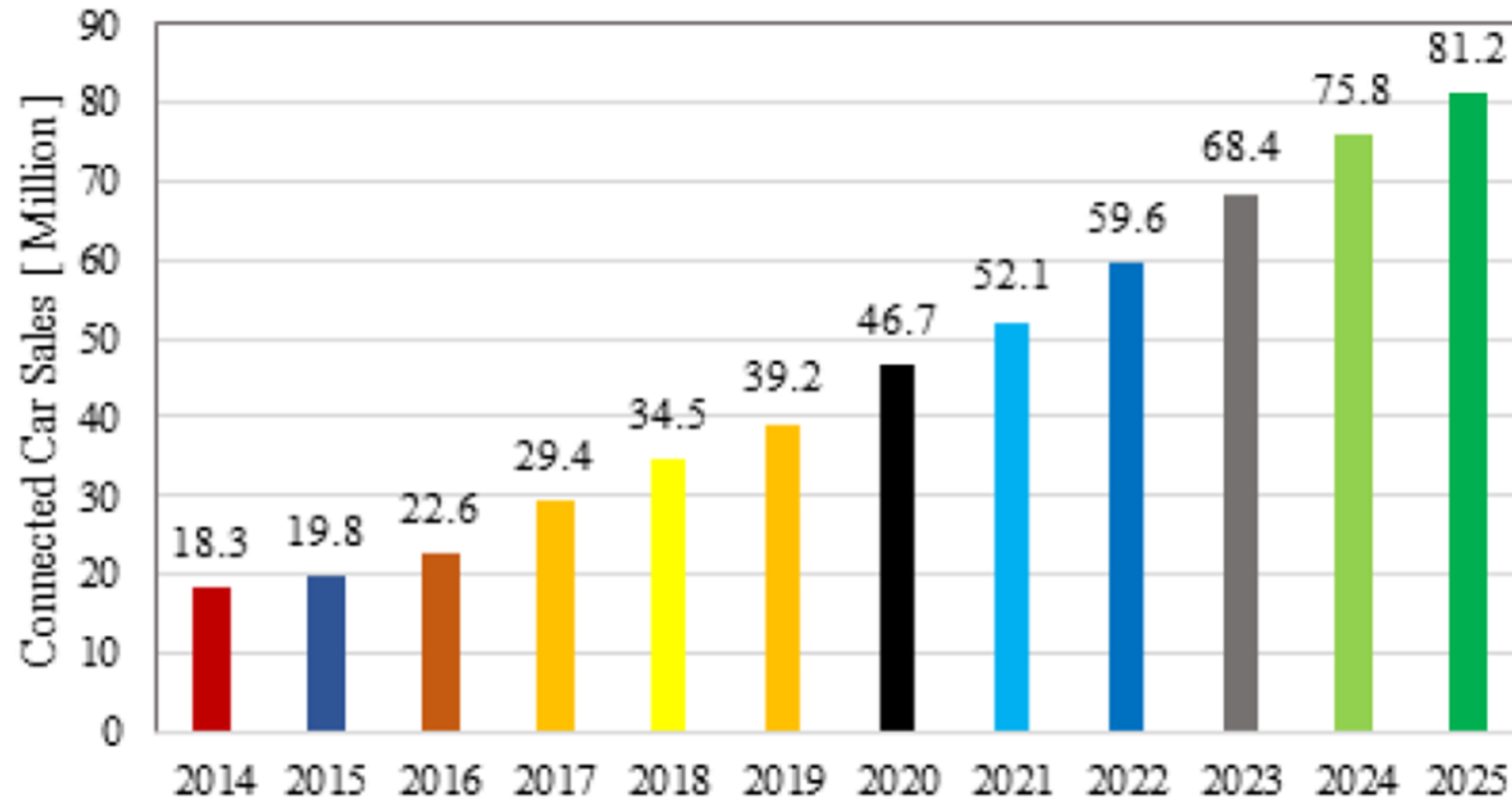
Objectives

- IoV – **distributed transport fabric** capable of making its own decisions about driving customers to their destinations
- IoV should have **communications, processing, storage, intelligence, learning and strong security** capabilities
- To be **integrated in IoT** framework and smart cities technologies
- To **cooperate with and support advanced ITS systems**
- **Extended business models and the range of applications** (including media-oriented) w.r.t current vehicular networks
- Incorporate **heterogeneous networking access** technologies to provide universal Internet access (integrate multiple users, multiple vehicles, multiple things and multiple networks)

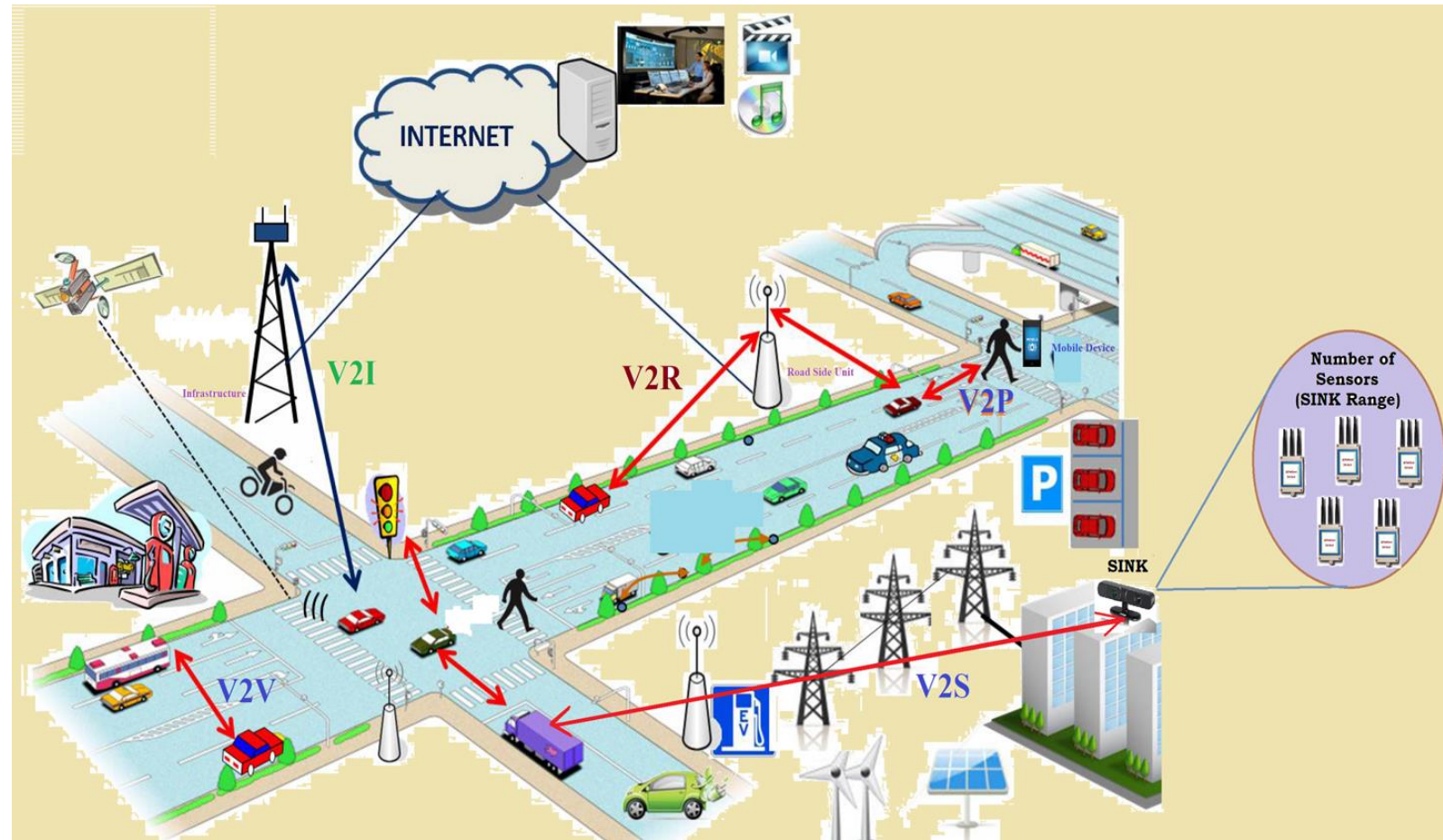
Objective

- IoV should make profit of recent technologies and approaches
 - Cloud Computing
 - Vehicular Cloud Computing
 - Mobile Edge computing and Fog Computing
 - Big Data technologies
 - Virtualization technologies
 - Complex Cyber-Physical Systems (CPS) technologies
- Interaction with humans (pedestrians and drivers) and with infrastructure (built or self-organizing) should be supported
- Allow, large-scale and seamless deployments/approaches

The prediction of car sales with some form of connectivity till 2025



Internet of Vehicles(IoV) communication environment



Introduction



- In the near future, one of the promising concepts which are going to change undoubtedly the whole **automobile industry, vehicular networking, software industry, IT manufacturing industry, Industry, transportation sector, service provider, etc.** is the Internet of Vehicles (IoV).
- It can have the capability to boost innovation in smart city applications (like intelligent transportation, smart health-care, smart environment etc).

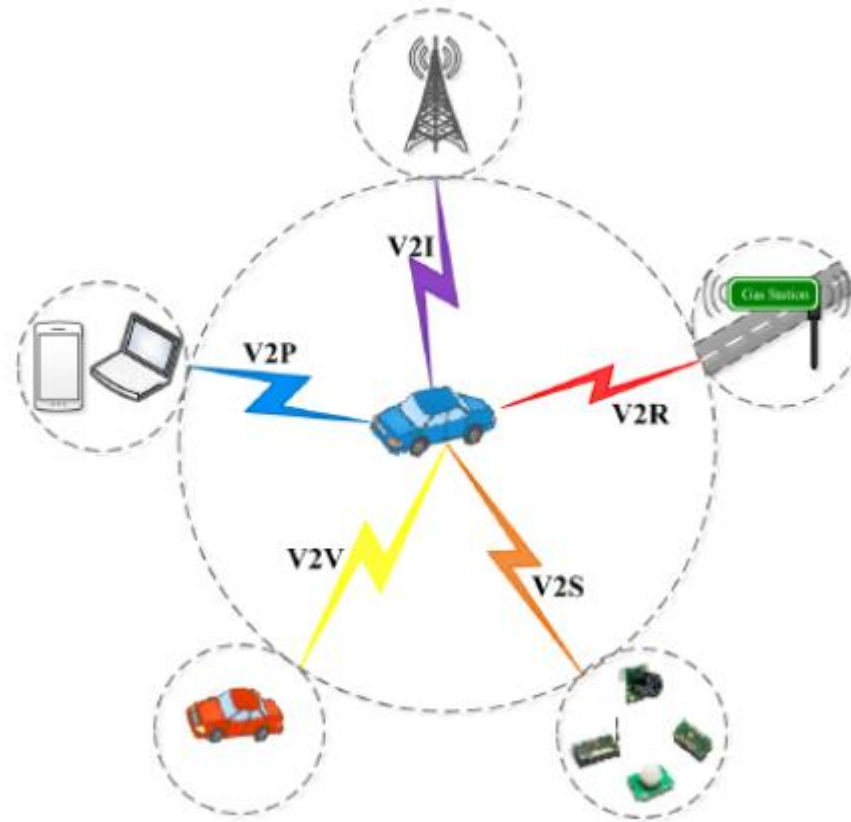
Internet of Vehicles(IoV)



- **IoV= VANET + IoT**
- **The IoV is a dynamic network system which allows data sharing between different entities like vehicles, their surrounding RSUs (Roadside Units), infrastructures, sensors, mobile devices, clouds, etc.**
- **IoV opened new opportunities in different services and applications to enhance road conditions, driver/passenger safety, transportation issues, non-safety applications, etc.**
- **However, ensuring Efficiency and security is one of the main challenges in an IoV scenario.**

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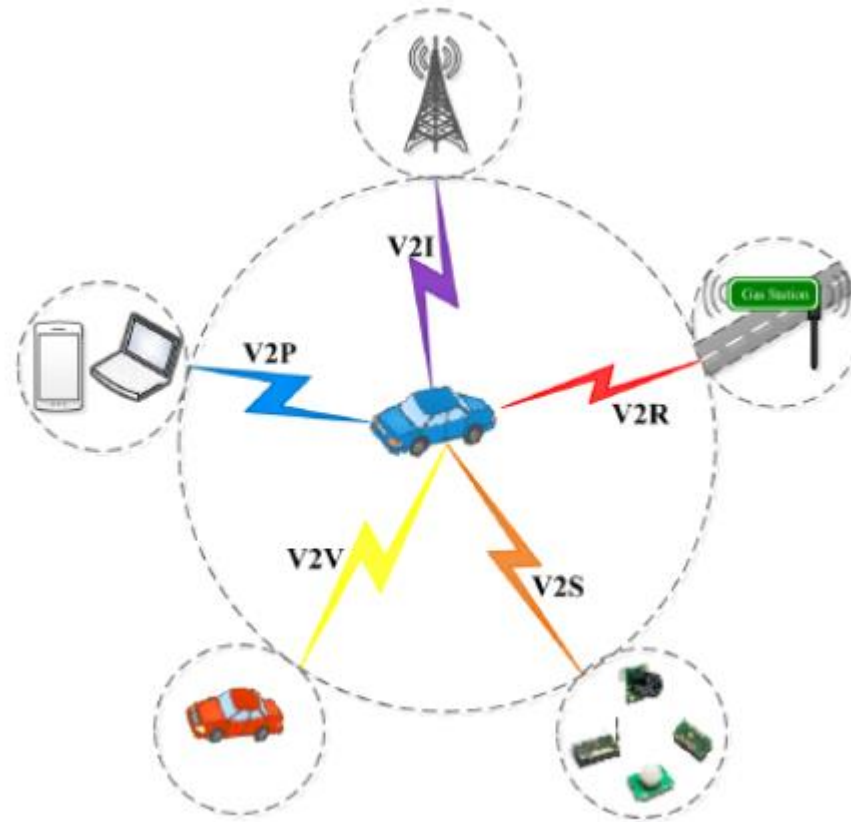
Internet of Vehicles



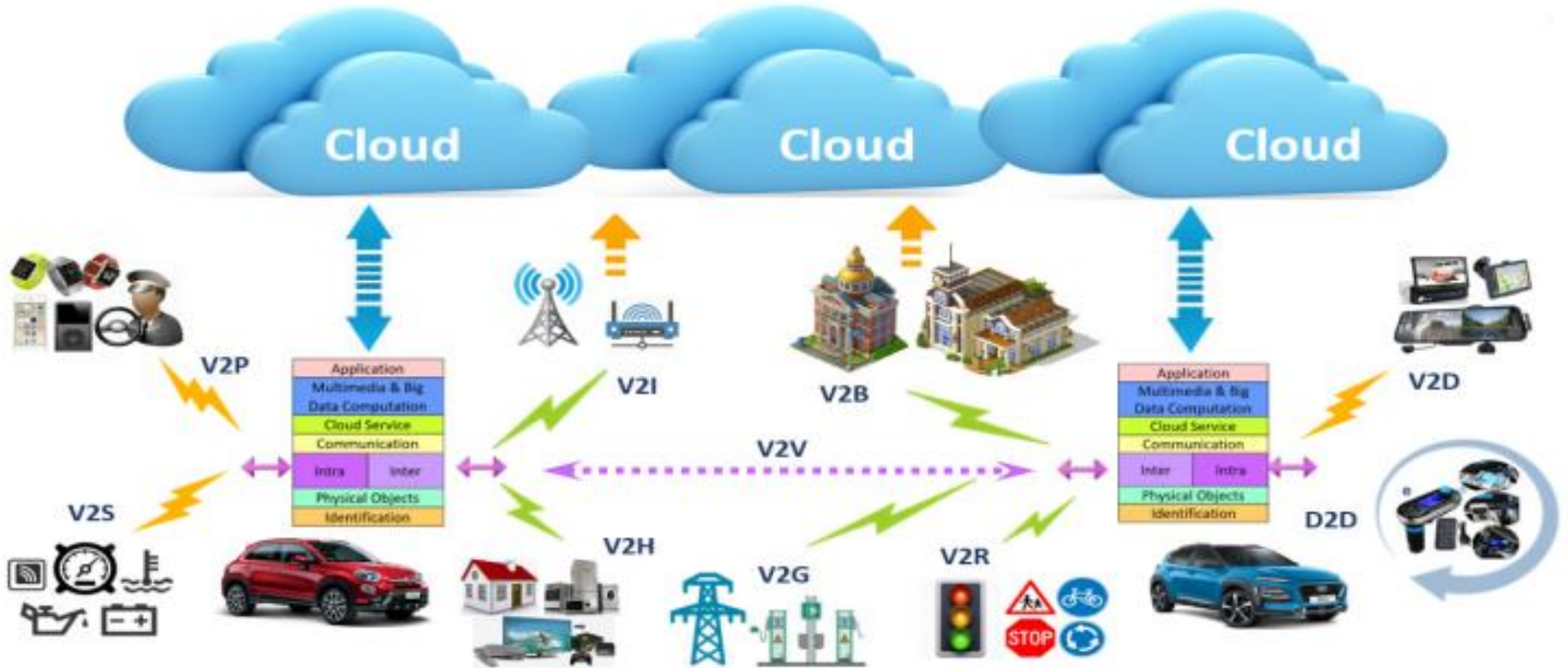
Why Universal VANETs(or IoV)

- The number of on-road vehicles has been predicted to increase significantly in the world.
- **Due to the higher motorization rate, congestion would result in longer on-road travelling time in coming years.**
- Even if 5 minutes of the time wasted in travelling globally is monetized then it is expected to generate Euro 25 billion revenue per year by 2030.
- Automobile industry is expected to increase the profit margin of Euro 54 billion in 2012 to Euro 79 billion by 2020.

Internet of Vehicles



Universal IoV



Universal IoV



- Building a highly efficient vehicle is recently a trend worldwide for the automobile industry since vehicles are **familiar to everyone**, and people are **not only satisfied with the basic function** of a vehicle, namely the movement, they are looking for the most comfortable way to drive a car and even the car can drive themselves (driverless cars).
- **They focus on comfort and cheap traveling**; on the meanwhile, they do not want to abandon the trip with a vehicle.

Universal IoV

- Due to these reasons, a new and modern concept with communication ability is under consideration.
- So many researches have been done and going on in this area.
- We proposed the use of mobile FAPs in a city scenario to fulfill the performance constraints of VANET/IoV applications without incurring high cost.

The realization of IoV with heterogeneous vehicular networks

