# Smart Cities and Nations in one Cooperative World

## The Network point of view and Smart Mobility Issues

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## Who we are?

T.Net is a key IT partner in the Digital Enabling process that assists businesses and Public Administration in digitizing and digital transformation. **We make possible what others think difficult or impossible**.

## BUSINESS SUMMARY

- T.net owns its Data Center is in the heart of Italian Telecommunication Centre (Caldera, Milan)
- Strong cloud computing expertise in complex Data Centers and articulated infrastructures
- Engineering Team with deep skills in cognite software and developing complex IT infrastructure
- High prestige customers all over the country with a deep knowledge of Italian Public Tenders.
- Some of the realized projects have become Case Study of the partners
- Strong international relations with leading industry players (Huawei, Extreme, NetApp, Fortinet, Kapsch)
- Very active in the Regulamentary and Technical International Community (ETSI, IEEE, IOT Forum, etc)

## ACHIEVED SO FAR

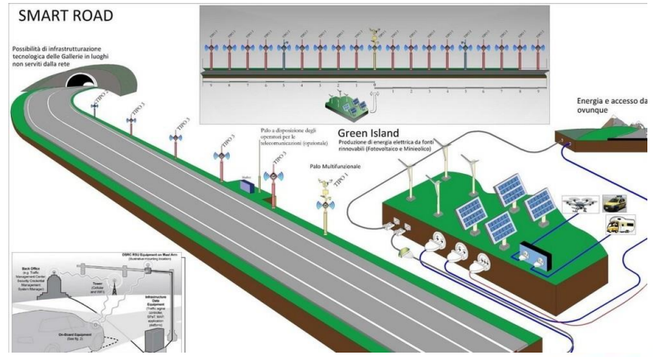
- ✓ July 13th 2017, chosen as Technical Partner by Consorzio Valori for the ITS System of Anas (+160 mln tenders, in 14 lots, 4 already proclaimed)
- ✓ Feb 5th 2018, Singapore IEEE IOT Smart Cities and Nations, Distinguished Speakers, , https://goo.gl/YJC7SD
- ✓ June 4th 2018, T.net Registered in the Chamber of Commerce of Milan as Innovation Company (Infobroker patent)
- ✓ Sept 5th 2018, T.net entered EIT Digital Accelerator, the biggest Scaleup Accelerator in Europe, a body of the European Union Commission under H2020 program, https://goo.gl/W3cznq
- ✓ Oct 5th, official winner with IGGroup of one of the Anas Smart Road Lot (10 mln, 4.5 mln T.net part)

# Done 2017-2018

- •Registerd Office in Milan, 26.05.2017
- IoT Week, **Geneva**, 6-9 June 2017
- Smart Mobility Forum, **Torino**, 10-11 October 2017
- World Forum on IOT, **London**, 16-17 November
- IEEE IOT Word Forum, Singapore, 05-08 February 2018
- IEEE Vertical on Smart Agriculture – Siena, 08-09 May 2018
- T.Net won one the Smart Road Tender in Italy (10 mln)
- T.Net enters EIT Digital 05.09.2018
- The Future of Transportation, Cologne. Germany 19-20 June 2018

the FUTURE of TRANSPORTATION World Conference

eit Digital




IEEE World Forum on Internet of Things

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# EIT Digital is responding to this challenge → Driving Europe's Digital Transformation


- The mission of EIT Digital is to drive European leadership in ICT innovation for economic growth and quality of life.
- Bringing together education, research and business
- More than 130 partners
  - Leading universities
  - ICT companies
  - Research institutes
- Co-location Centres in 9 countries

# Certifications


**Quality Certifications UNI EN ISO 9001:2018**

Design and provision of internet service provider, hosting and housing and certified e-mail. Design and creation of websites. Design, development, supply, assistance and maintenance of software and integrated hardware and software systems. Design, installation, operation and maintenance of data networks. Reselling of hardware and software products


**Public Certified Authorized Body**

Certification for public works OS 19 - III Level and OS 30 Level I Telecommunications networks and transmission and processing Electrical, telephone, radiotelephonic and television systems


**Information technology -- Security techniques -- Information security management systems Certification**

**Design, management, commissioning and start-up of data centers, infrastructures and Information Technology services of data centers, cloud services and service centers for Network Operations Center and Security Operations Center, also in virtual mode. Start-up and management of applications, platforms and information technology infrastructures even in managed mode**

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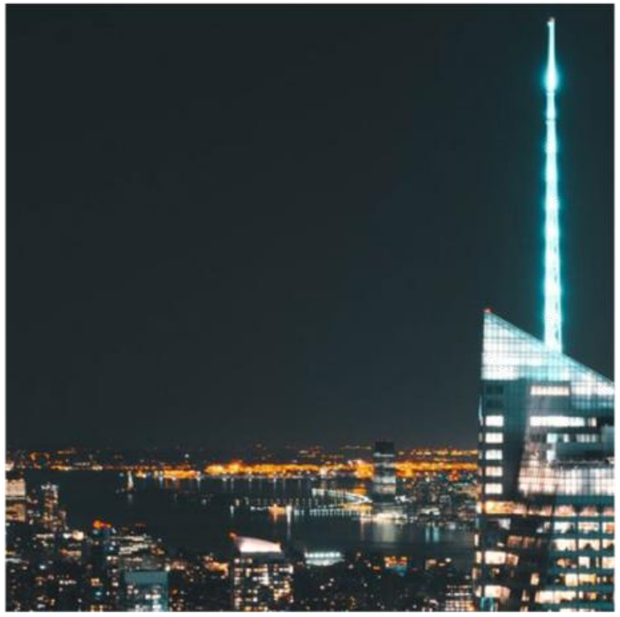
# ENGINEERING & IOT

## Shaping the Future

### SMART CITY

An Internet of Cooperative things



To be really “**smart**” it is essential that cities equip themselves with enabling infrastructures that help the development of **intermodal services**, support new ways of interacting with customers, citizens and service providers.

### SMART ROAD

IoT Infrastructure in a C-ITS context

On **vehicles**, power and speed control should be **managed** in conjunction with vehicle-to-vehicle communications, particularly in traffic scenarios with a very high traffic density, e.g. in situations of traffic jam.

### SMART AGRICULTURE

To produce more with less

**Precision Agriculture** can help Farmers to produce more with less, obtaining important advantages in livestock breeding. We tested the solution taking into consideration the dairy area in the southernmost part of Italy, in Sicily.

# ENGINEERING & IOT

## SECURITY

An holystic approach to Data Protection and Cyber Security

Data Protection EU Regulation (GDPR, 679/2016/UE) changed the approach to secure and protect data introducing new concepts like “Data Protection Impact Assessment”, “Accountability” and “Privacy by Design”.

## CLOUD SERVICES

A reliable approach to IT services outsourced on the Cloud System

If you’re looking for computer power, data storage, file sharing, e-mails, virtual pbx, unified communication and advanced wireless solution, T.net has the services to assist you to build complex application.

## CONNECTIVITY

A Pure Fiber connection to deliver successful and powerful projects

Business Internet Access to Organizations that want to connect fast to the Cloud. DDOS and WAF protection for attack mitigation and a reliable multi tenant infrastructure deliver customers services with no compromise.

# ENGINEERING & IOT

## DATACENTER AND NETWORK INFRASTRUCTURE DESIGNERS AND BUILDERS

We interpret your needs and using competency and technology deliver successful projects. We're the ones of the **Impossible Missions**.

Grazie ad un team qualificato e certificato, disegnamo, implementiamo, sviluppiamo e ottimizziamo infrastrutture complesse. Data Center, Soluzioni Desktop Virtuali, Sistemi di Comunicazione integrata, Soluzioni Avanzate di Wireless (Wi-fi in movimento, Wi-fi di prossimità, ecc.)

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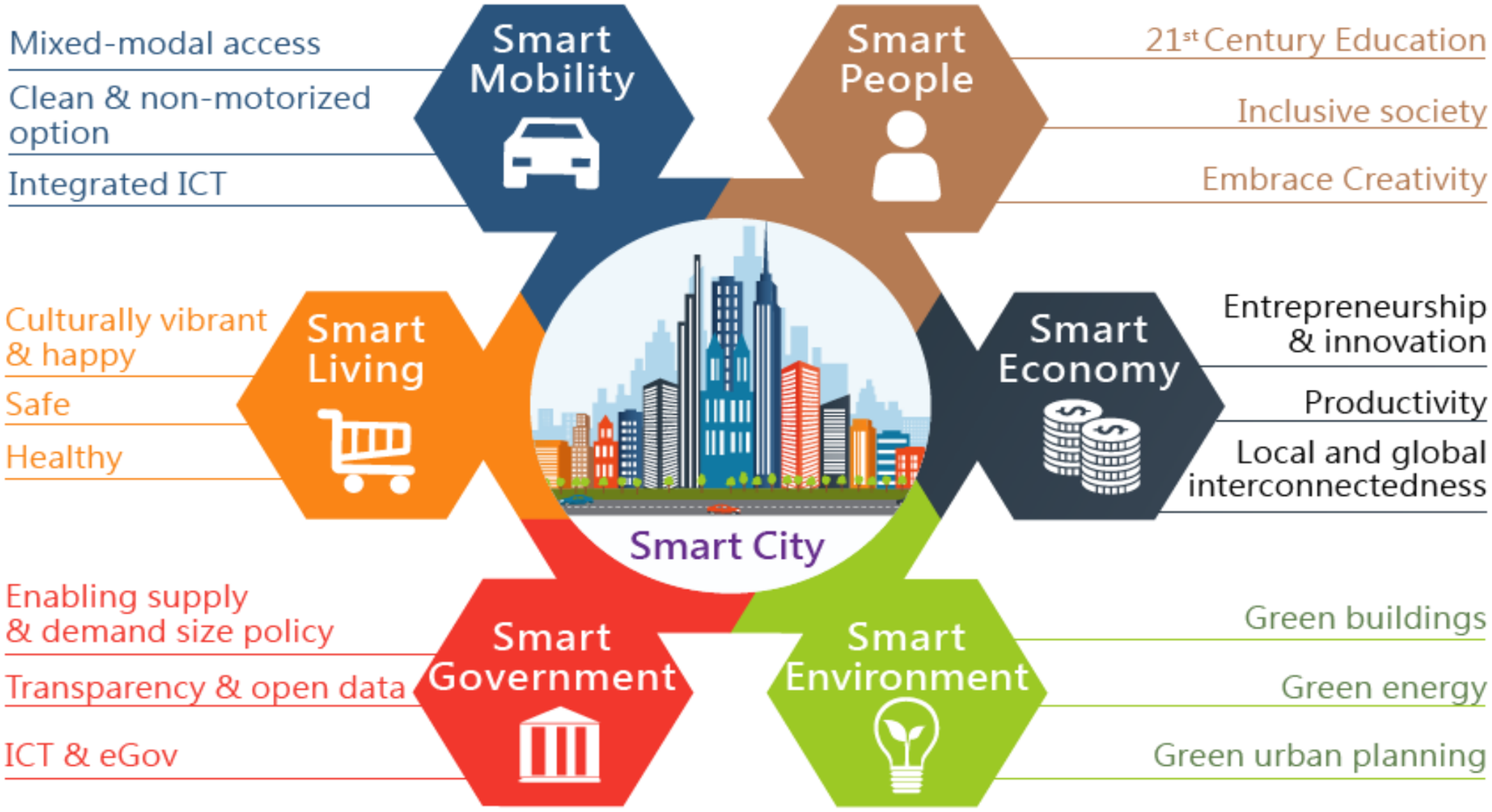
# Agenda

- **Smart City & Nations**
  - Introduction
  - Requirements
  - Standards
  - Framework
  - Nations Architecture
- **Smart Mobility**
  - IOT Network Infrastructure
  - IOT Sensors
  - WiFi DSRC ITS
  - WIFi in motion
  - InfoBroker
  - Mobility Cloud Microservices

# What's a Smart City ?

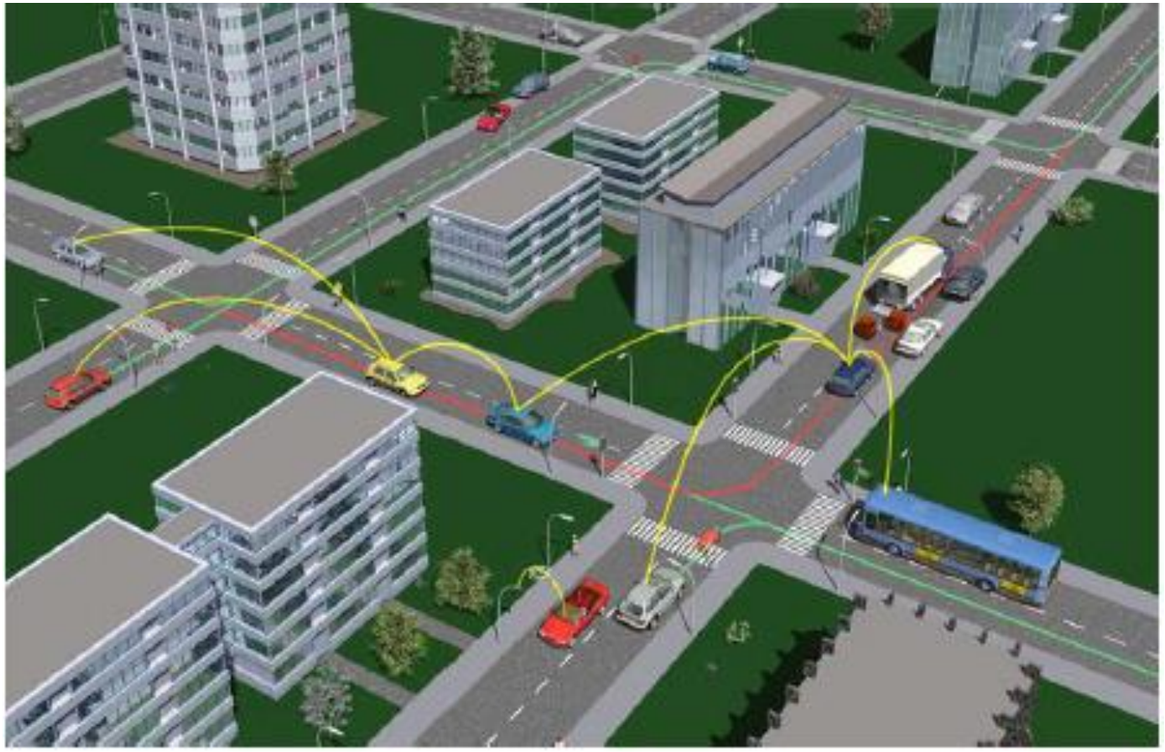


# Smart City Requirements

- Traffic management
- Road safety and security
- Freight management
- Public transport
- Automotive telematics
- Parking management
- Autonomous/Express Drive La
- Environment protection
- Intelligent Lighting
- Waste Handling
- Smart Metering

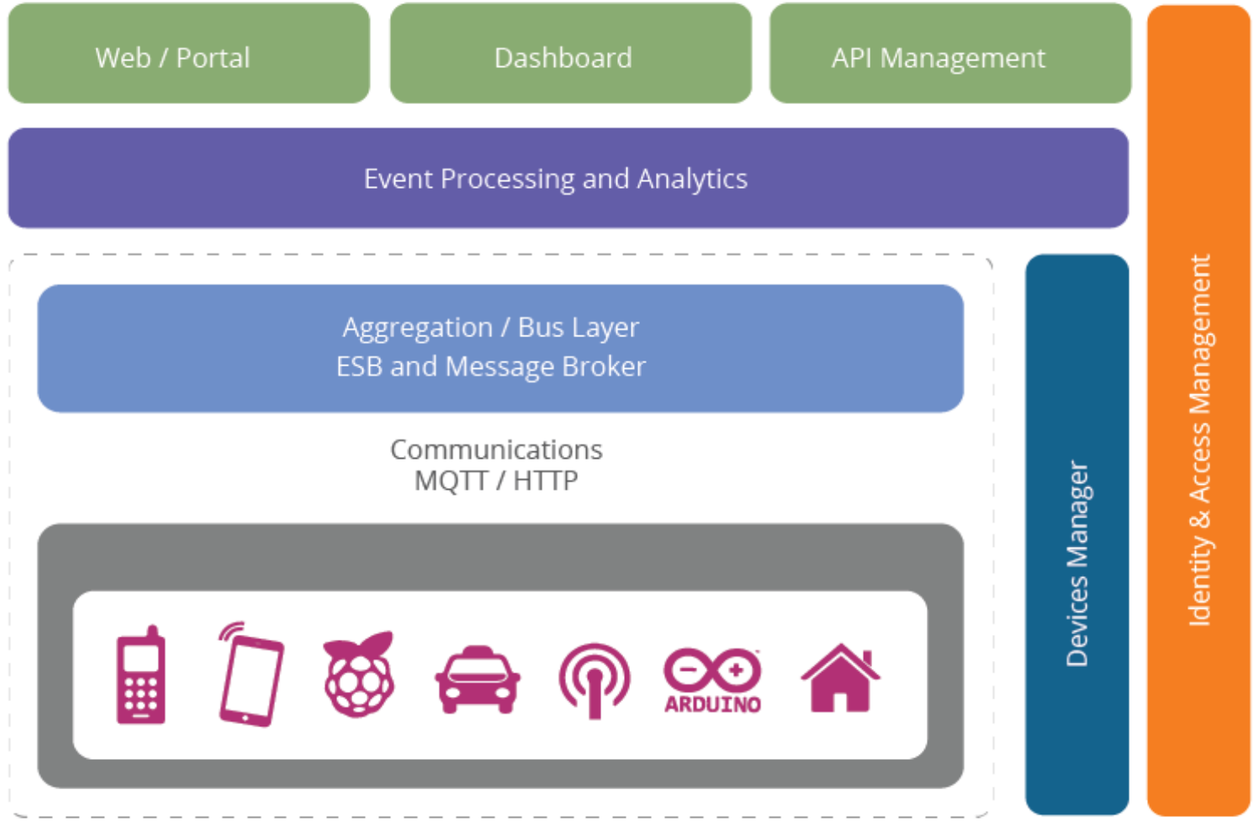
# Standards for Being Smart

- IEEE P2413, Standard for an Architectural Framework for the Internet of Things (IoT)
- IEEE P1451-99, Standard for Harmonization of Internet of Things (IoT) Devices and Systems
- IEEE P1931.1, Standard for an Architectural Framework for Real-time Onsite Operations Facilitation (ROOF) for the Internet of Things
- IEEE P2510 – Standard for Establishing Quality of Data Sensor Parameters in the Internet of Things Environment

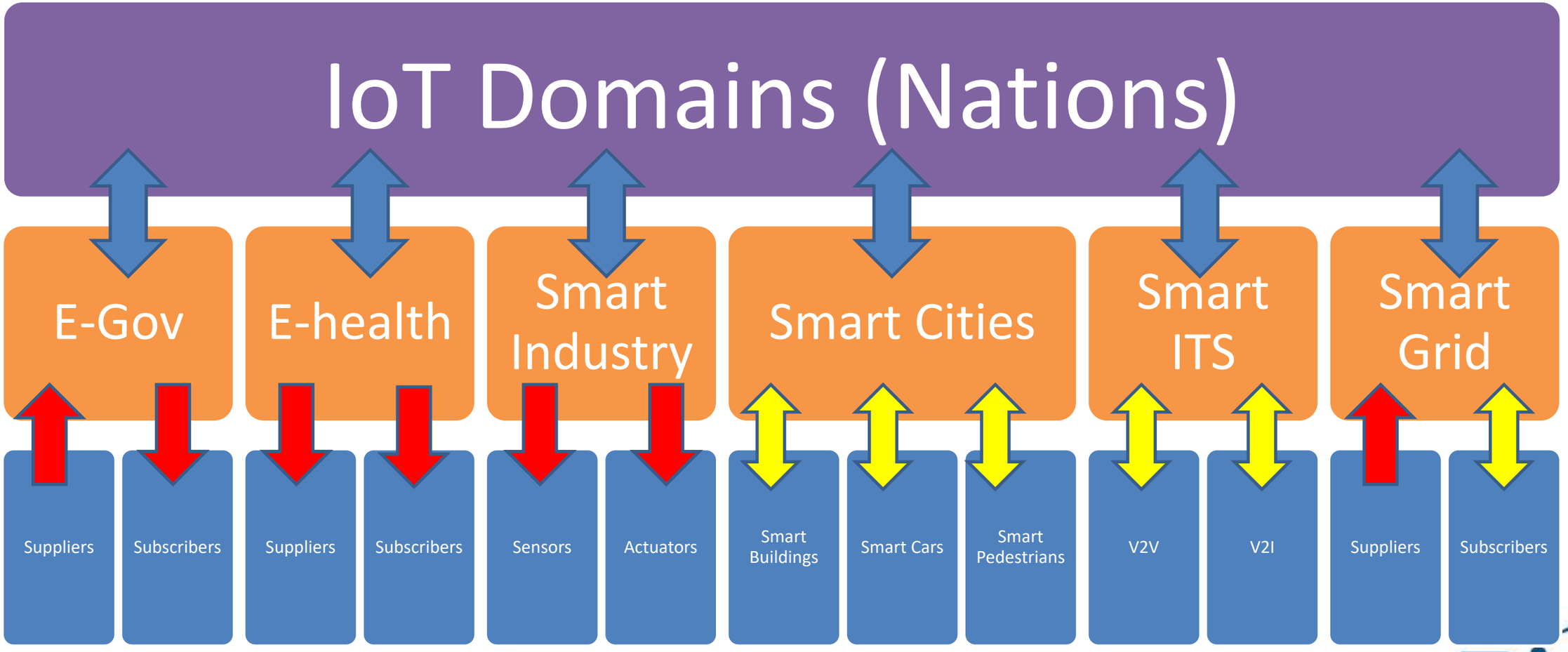


# Smart City & Nations – The Framework

- ✓ Creating an integrated network between the various components of the systems
- ✓ Set up a storage and an harvesting system on the Cloud
- ✓ Manage the flow of Information from sensors (IOT) to different domains
- ✓ Develop environmental models for pollution control and event based driving
- ✓ Design and implement a series of "cloud based" microservices for the selection and provision of data collected at a superior "business application" level



# Cloud Microservices
# Cross-domain interactions for Nations



# SMART MOBILITY SERVICES

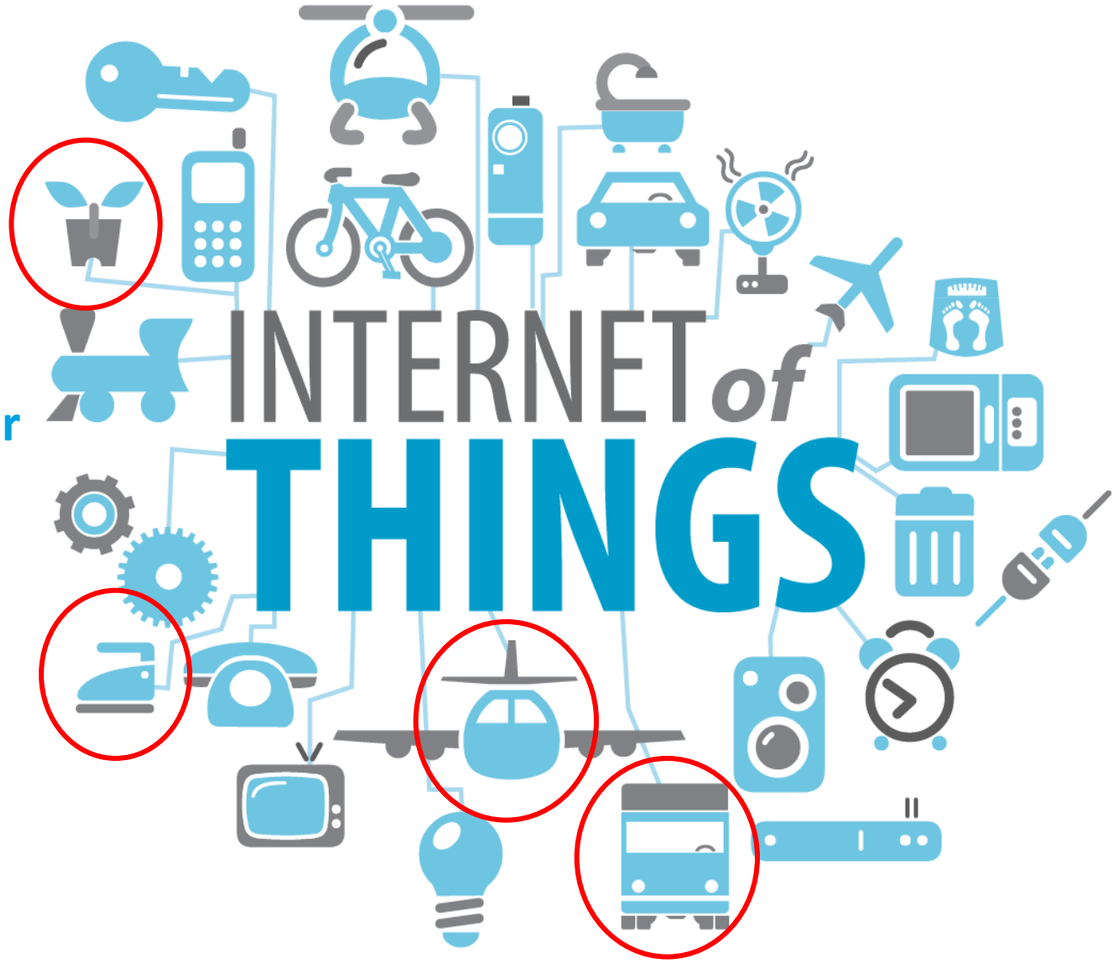
## MaaS microservices delivered in a Smart Mobility Context

# Smart Mobility Systems

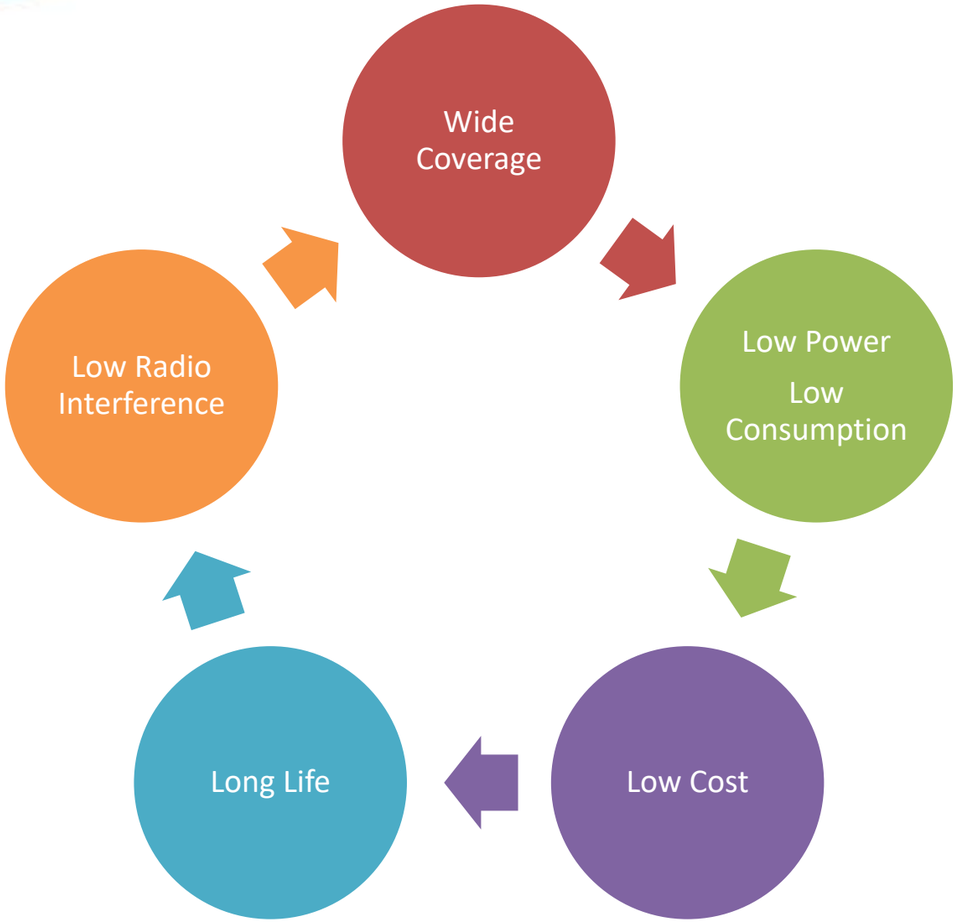
- **Stakeholders Goals**
  - Enhance Road Safety and Traffic Flow
  - Incidents Reduction
  - UE/UI
  - Enviroment Protection and Monitoring
  - Congestion avoidance
- **Set of Technological Infrastructure**
  - IOT Sensors
  - 6LoPWAN
  - 802.11p for ITS
- **Secure Platform Development:**
  - Enabling and Network Agnostic
  - Open and Non proprietary
  - Robust and not redundant
- **Standards and Directives compliant**
  - C-ITS (ETSI TR 102 638), Directive 2010/40/UE

# IOT Networks – The Issues

- Which Objects?
  - Fixed
  - In movement
- What purpose?
  - What band do I need?
  - What energy do I need?
  - Which frequency should I use?
  - Where do I have to put it?
- How much do I have to scale (Sensors per Square KM)?
  - 1-> 100
  - 100-> 10,000
  - 10,000> 100,000
  - > 100,000
- What coverage do I have to provide?
  - Interior (Buildings)
  - Open (City)
  - Open (Highway)
  - Open (Countryside)



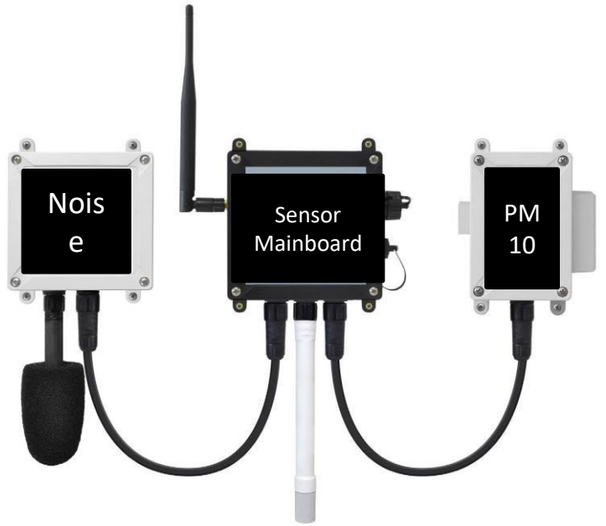
# IOT Networks– The Requirements



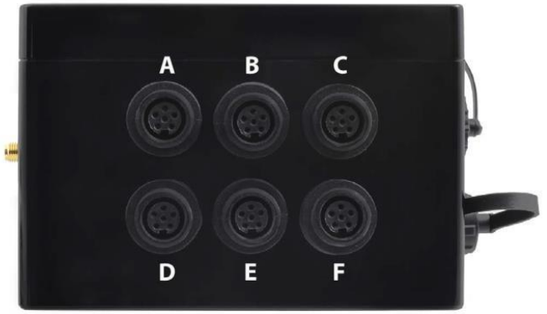


# IOT Sensors

- Possibility of connecting different probes;
- GPS antenna
- Cover for outdoor harsh environment;
- Multiple radio modules:
  - 802.15.4;
  - 868 MHz (EU);
  - 900 MHz (US);
  - Wifi;
  - 4G;
  - SigFox;
  - LoRaWAN

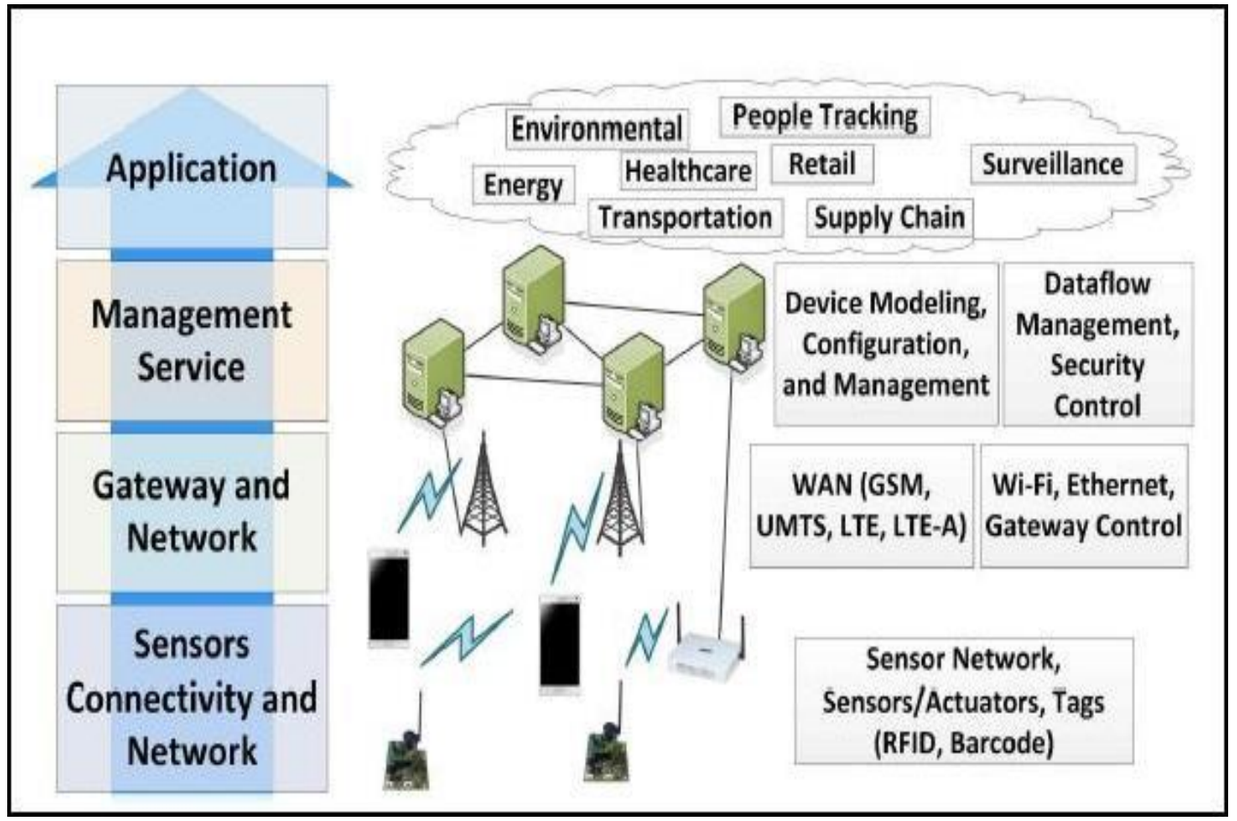



| Sensor probe type | Lifetime |
|---|---|
| Gas sensors | 3 months – 2 years |
| Humidity and Temperature (Sensirion) | 6 months – 2 years |
| Solar radiation | 1 year – 2 years |
| Soil moisture | 1 year – 2 years |



# IOT - Network Infrastructure

- IPv6
- Extensive sensors available
- Robust and Scalable Network
- Different types of networks
- Large unstructured amount of data



# Non-Cellular Networks for Smart Cities Cooperation

- Latest generation IoT technologies for environmental monitoring
- Wide-ranging communication protocols
- Low consumption and environment friendly technologies
- Low-cost systems and reduced maintenance
- Use of non-licensed bands

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# IOT Networks
# NB-IOT (LTE Cat NB1) vs LoRa vs Sigfox

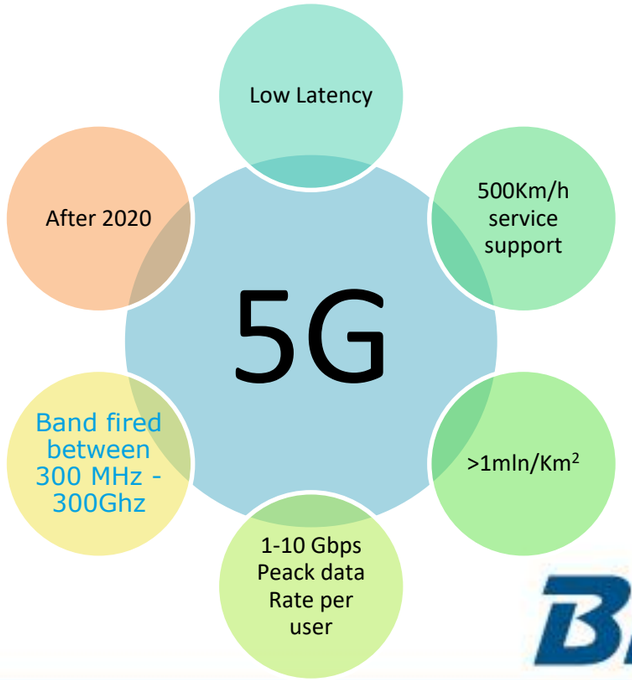
- NB-IOT (later -> LTE-Cat-M1), belongs to the group that developed the standards for mobile phones (3GPP) and uses licensed bands
  - In Band LTE
  - Less risk of interference
  - Need to resort to a mobile operator
  - 250 Kbits / sec
  - Latency 1.6s-10s
  - BW 180 kHz
- LoRa uses non-licensed frequencies
  - 900 Mhz (868 Mhz EU, 902 Mhz US)
  - Risk of interference in the case of simultaneous presence of several networks
  - No need to rely on mobile operators
  - Bidirectional
- SigFox uses non-licensed frequencies
  - 900 Mhz (868 Mhz EU, 902 Mhz US)
  - Low cost of the single receiving device
  - Monodirectional (substantially) Uplink
  - Need to contact the SigFox operator
  - No collision limitation system

| | SigFox | LoRA™ |
|---|---|---|
| Modulation | UNB | DSS-like (constant enveloppe) |
| Throughput | 100bps | [300bps - 50Kbps] |
| Payload | 10 bytes | 50 bytes |
| Link Adaptation | NO (BPSK) | VSF [SF7 - SF12] |
| BW | 100Hz | 125KHz |
| LBT | NO | NO |
| Duty Cycle Limited | YES | YES |
| Frequency accuracy | compensated in UL in BS, BUT problem with DL | low (10ppm) |
| Channel Hopping | Yes (imposed by Terminal) | Yes |
| Best Sensitivity (dBm) | -142 | -142 |
| Bi-Directional | NO* | YES |
| Battery Life | 10years | 10years |
| Localization | NO | YES |
| Roaming | Yes (SNO) | To Build (Alliance) |
| Encryption | AES-128 | AES-128* |

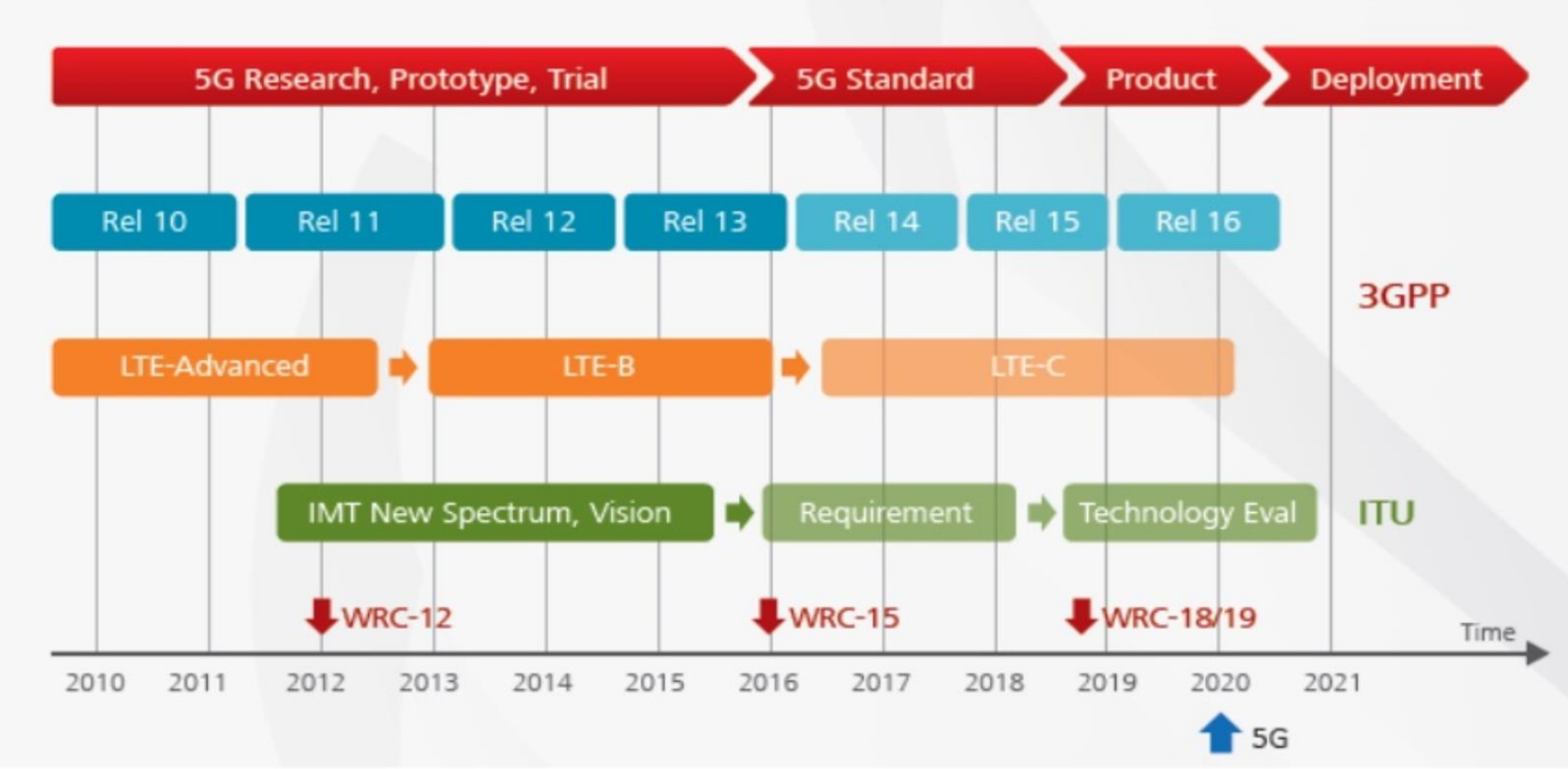
# IOT Networks - NB-IOT vs LTE-M vs 5G

- Cellular networks consume too much battery, especially 4G and LTE
- Data to be transmitted by IOT sensors do not require large amounts of data to be transmitted but small quantities (100 bytes with a variable frequency between 1Hz or 10 Hz)
- It was necessary to develop variants of cellular protocols to optimize the objectives of reducing consumption (Low Power) and extend the coverage with a reduced number of Base Stations.
- EC-GSM-IOT, Extended Coverage for IOT Optimized Network and is compatible with existing GSM networks
- Cat-M1 / Cat-M / LTE-M, is the second generation of the LTE protocol project for the IOT and compatible with existing LTE networks
- 5 G native < 1 Ghz sub-band
  - Latest generation networks under construction and available after 2020
  - Up to 1 Gbs available on Km2
  - Support for moving objects up to 500 km / h

| | Sigfox | LoRa | EC-GSM-IoT | NB-IoT | LTE Cat-M1 | RPMA |
|---|---|---|---|---|---|---|
| **Bandwidth** | 100Hz | 125kHz | 600kHz | 180kHz | 1.08MHz | 1MHz |
| **Coverage** | 149dB | 157dB | 164dB | 164dB | 160dB | 177dB |
| **Capacity** | 50,000/cell | 40,000/cell | 190,000/cell | 200,000/cell | 1M/cell | 500,000/cell |
| **Battery Life** | 10 years + | 10 years + | 10 years + | 10 years + | 10 years + | 10 years + |
| **Throughput** | 100bps | 290bps - 50kbps | 473kbps | 250kbps | 1Mbps | 624kbps |
| **2-Way Data** | No | Class dependent | Yes | Yes | Yes | Yes |
| **Security** | 16bit | 32bit | 3GPP (128-256bit) | 3GPP (128-256bit) | 3GPP (128-256bit) | AES 128bit |
| **Scalability** | Low | Medium | High | High | High | High |
| **Mobility Support** | No | Yes | Idle Mode | Idle Mode | Connected+Idle Mode | Yes |
| **Location Support** | No | Yes | Needs GPS | Needs GPS | Needs GPS | Needs GPS |



# 5 G Roadmap

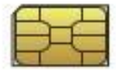



Source: Huawei

# 5 G Lights and Shadows

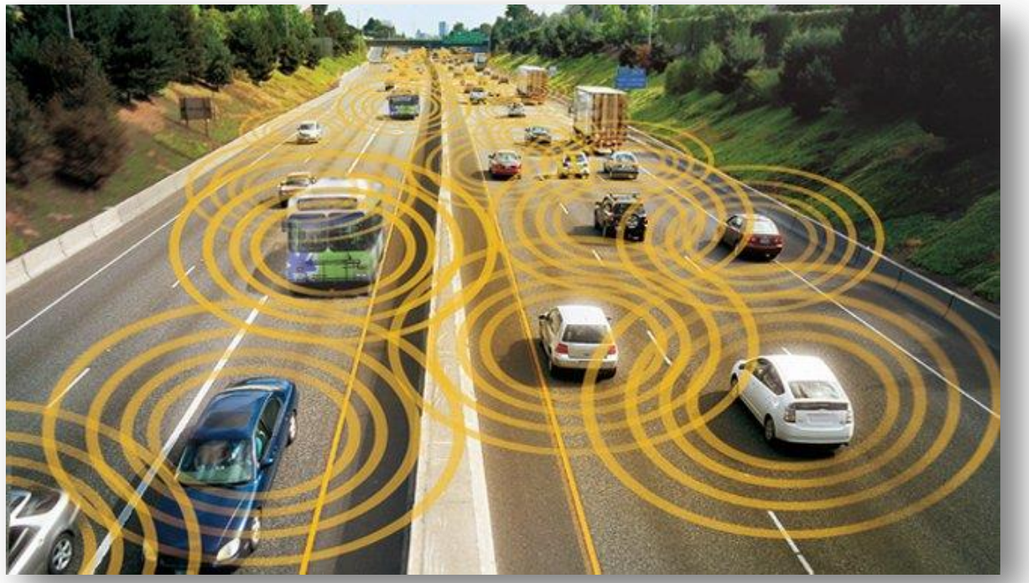
- Available only from 2020 in three specific frequency ranges:
  - Sub 1 GHz for IOT and large coverage (vs. Lora / ZigBee / SigFox)
  - 1-6 GHz (3.3-3.8 GHz) for mobile services as they are known & Beyond (vs DSRC: 5.9Ghz)
  - > 6 Ghz for new services requiring UHB (vs 4G & Wi-Fi in Motion) in the 24.25-27.5 GHz, 31.8-33.4 GHz, 37-43.5 GHz, 45.5-50.2 GHz, 50.4-52.6 GHz, 66 bands -76 GHz and 81-86 GHz
- Today only known experiments at 15 GHz for UHB (Ericsson with At & T), 3.4-3.8 GHz in Italy
- In the availability only of Mobile Operators
- Which Back-Bones and for how many Users?
- Which coverage?
- What investments?
- What quality compared to the increase in speed?
- Short Distance vs. Long Distance?
- Low Power vs High power
- Security, Data Protection & Privacy (eSIM with SE)
- 4k Video vs Mobility vs M2M

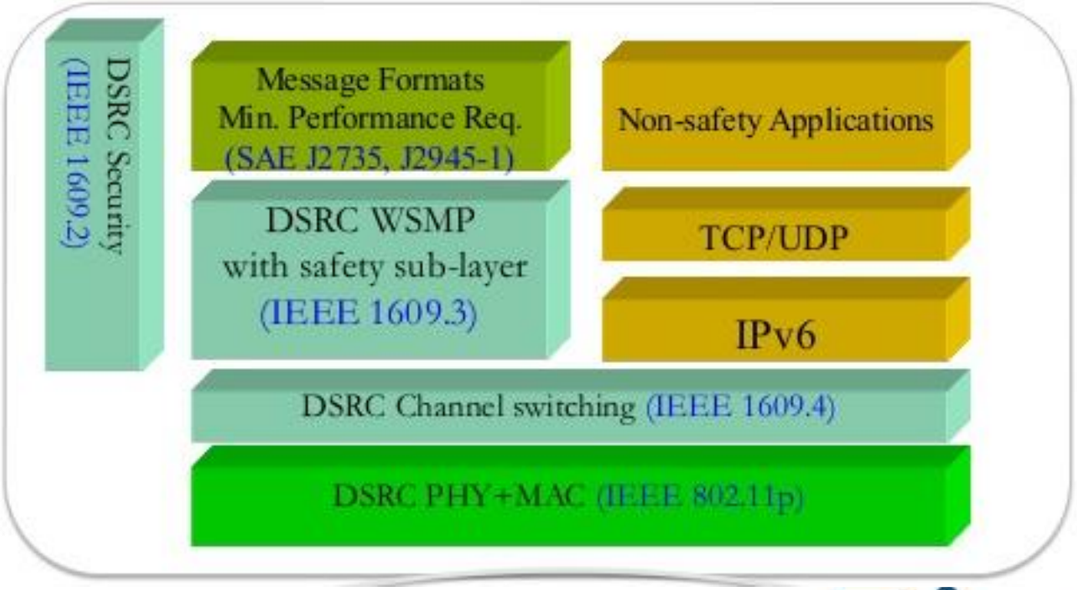





# WIFI-DSRC ITS for V2X

- Based on the IEEE 802.11 p Wireless Access in Vehicular Enviroments (WAVE) for lower layer specifications
- IEEE 1609.x for higher layer specifications
  - Exchange Info between OBUs and RSU
  - Exachange Info in a V2V context
- The family of IEEE 1609 standards as of its publication includes IEEE Std 1609.2™, IEEE Standard Security Services for Applications and Management Messages, IEEE Std 1609.3™ Networking Services, IEEE Std 1609.4™ Multi-Channel Operation, IEEE Std 1609.11™ Over-the-Air Electronic Payment Data Exchange Protocol for Intelligent Transportation Systems (ITS), IEEE Std 1609.12™ Identifier Allocations, and IEEE Std 802.11™ in operation outside the context of a basic service set.

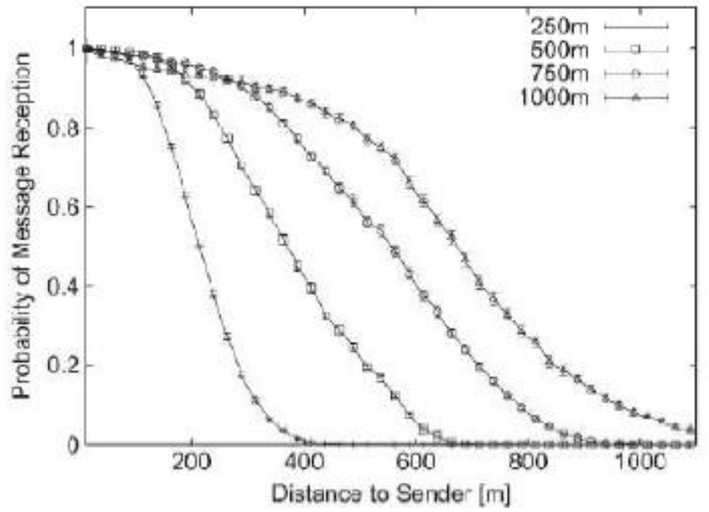




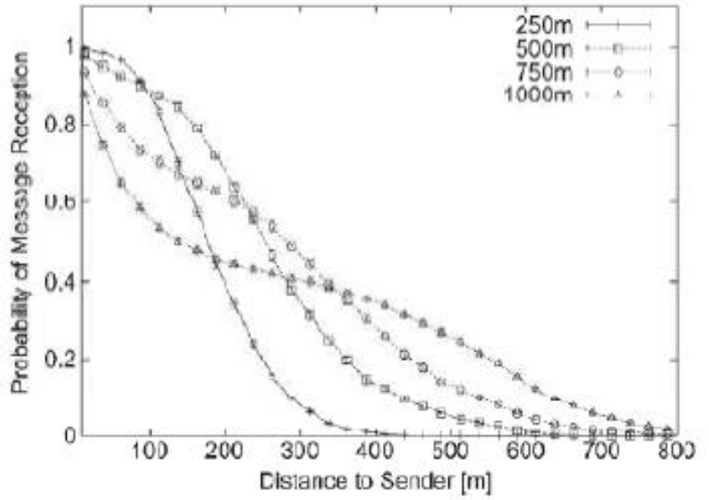
# WiFi - DSRC ITS – The Issues

- Context Challenges
  - Urban Context
  - Motorways and Expressways
  - Vehicles Density
  - Vehicles Speed

- How to optimize:
  - Beaconing
  - Antennas
  - Geobroadcast
  - Power of transmission
  - Unicast
  - Fast Response




36 vehicles/km6




6 vehicles/km

M. Torrent-Moreno, J. Mittag, P. Santi, H. Hartenstein: Vehicle-to-Vehicle Communication: “Fair Transmit Power Control for Safety-Critical Information” , IEEE Tr. on Vehicular Technology, Sept. 2009, pp 3684-3703

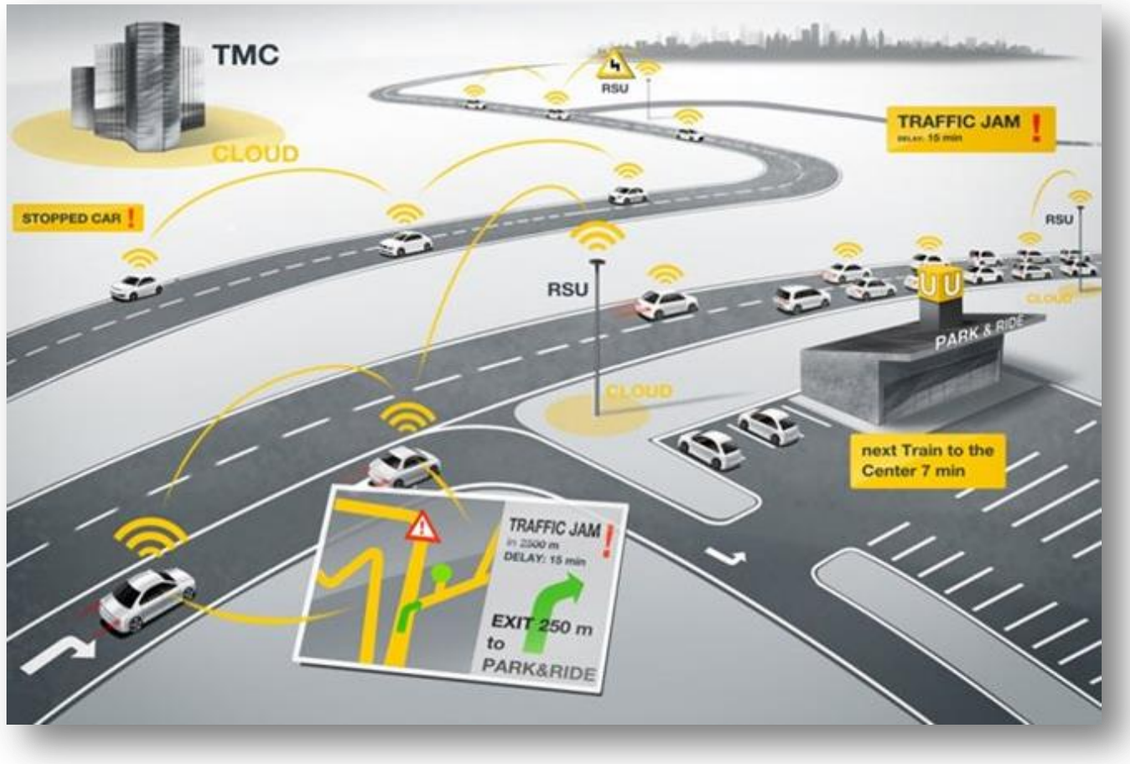
# WiFi -DSRC ITS – The levels

- Software Integration between the different component
- Middleware Reaction Time
- OBU «intelligent» through SDN
- Software Switching and Routing components
- OBU talking with Car Driving Systems (Future releases)

| Protocols | Standard document | Purpose of the standard | OSI model layer numbers |
|---|---|---|---|
| WAVE PHY and MAC | IEEE 802.11p | Specifies the PHY and MAC functions required of an IEEE 802.11 device to work in the rapidly varying vehicular environment | 1 and 2 |
| Multichannel operation | IEEE 1601.4 | Provides enhancements to the IEEE 802.11p MAC to support multichannel operation | 2 |
| WAVE networking services | IEEE 1609.3 | Provides addressing and routing services within a WAVE system | 2, 3, and 4 |
| WAVE resource manager | IEEE 1609.1 | Describes an application that allows the interaction of OBUs with limited computing resources and complex processes running outside the OBUs in order to give the impression that the processes are running in the OBUs | N/A |
| WAVE security services | IEEE 1609.2 | Covers the format of secure messages and their processing | N/A |

# WiFi - DSRC  ITS – Smart Mobility

- Transmission and processing of information to control centers to deliver results for intermodal efficiency between different mobility subsystems (Railway, Underground, Cars, etc.
- Distribution of information processed to vehicles for Weather Conditions to detect asphalt slippery so avoiding hydroplaning and wheelspin.
- Pollutants and Metereological Models
- Strong Partner

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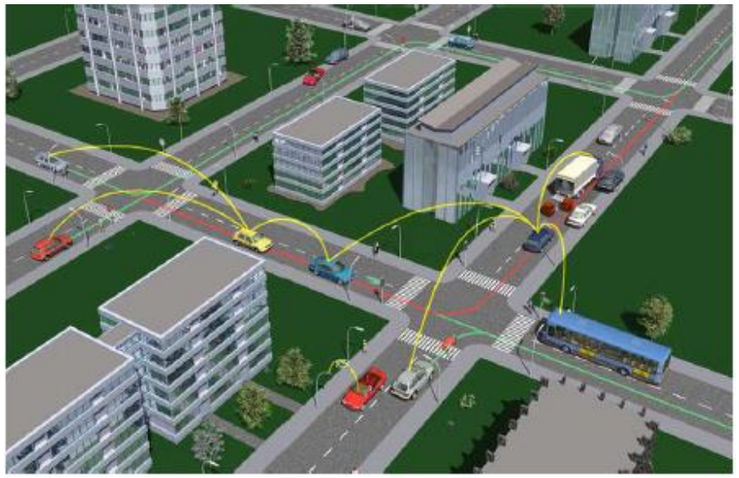
# WiFi in Motion– Smart Mobility

- Reliable network coverage even in complex environments with variable weather condition.
- Ability to manage a large number of vehicles simultaneously in transit.
- Voice and data communications managed with proper Quality of Service (QoS):
  - WIPS (Wireless Intrusion Prevention System) support
  - Firewalling
  - Encryption (WPA2 + WPA + AES)
  - CAPWAP tunnel support
  - and-Over and stable Roaming (10-130km/h)
- Site Survey
- Strong Partner Support



ekahau WIRELESS DESIGN

Extreme networks

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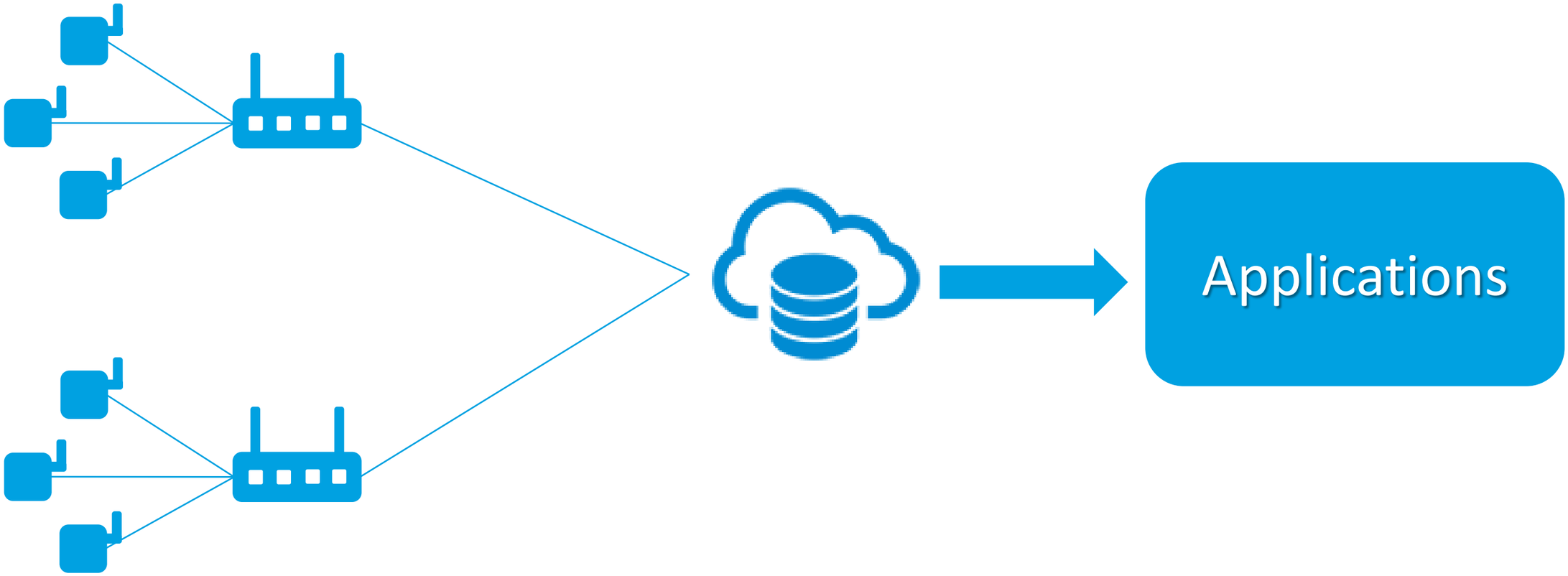
# WiFi in Motion– Field Results

Field tests have shown that an accurate network design, through advanced simulations, allows to establish and maintain an excellent level of communication on moving vehicles even under maximum speed conditions (130 km/h).

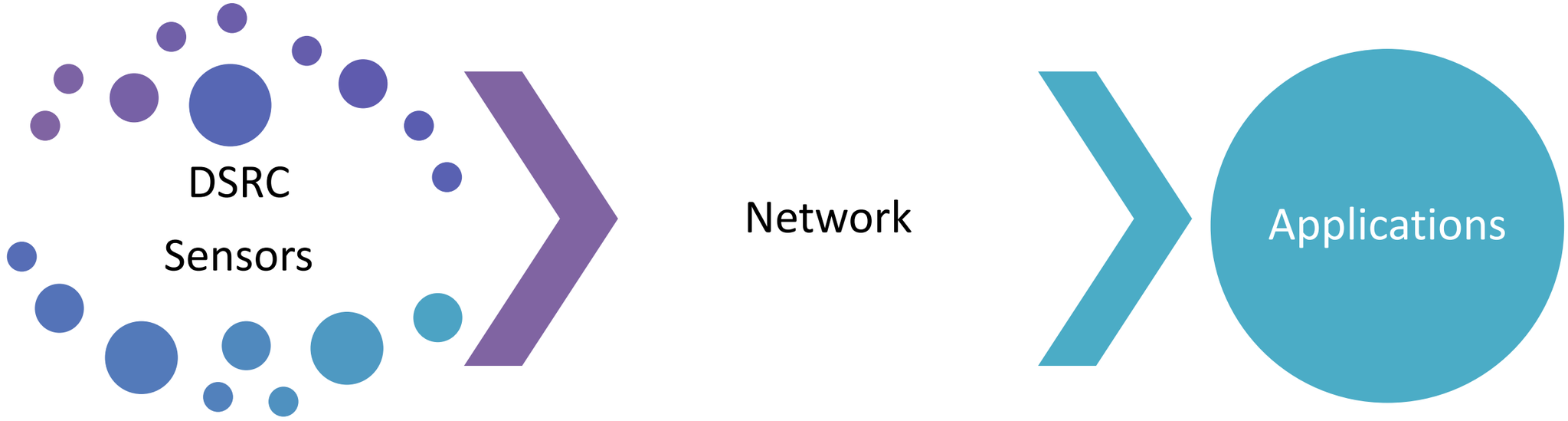
## Which Goals?

- Voice and data communications with a relevant level of quality and performances.
- Very reliable and stable communications towards vehicles and people moving on motorways

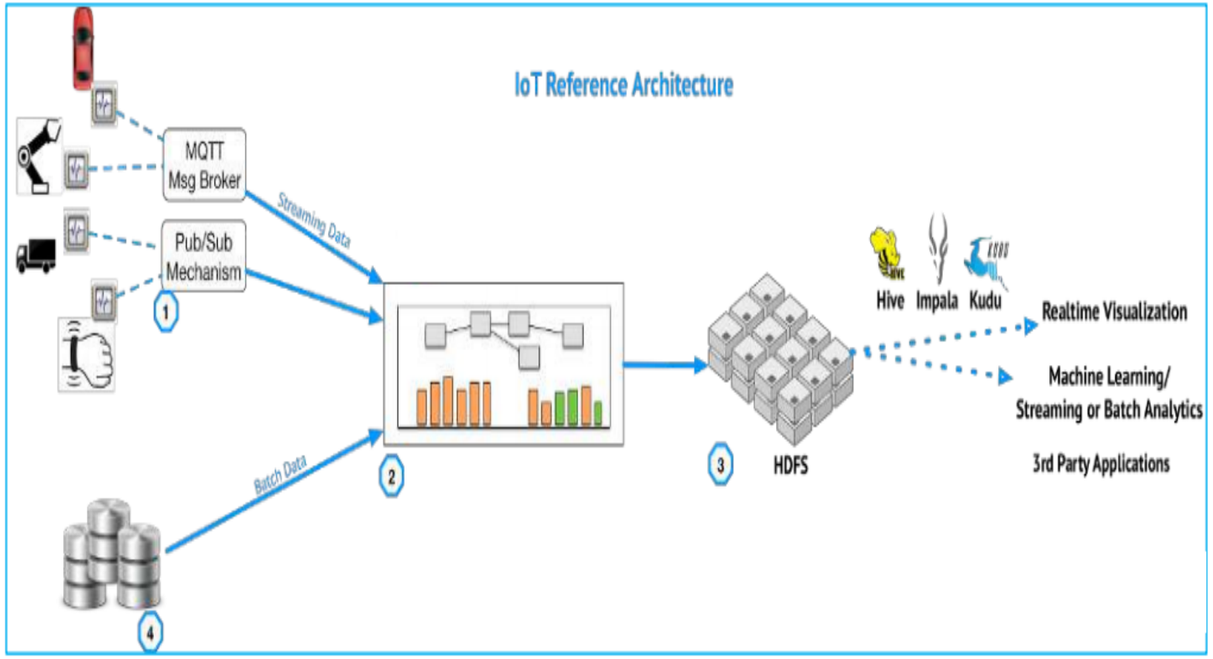
# Access Point, Gateway and Servers



# InfoBroker



# The Infobroker and the Smart Cloud Microservices




Business Level

Web Portal, Dash Board, Api Management, Web Services

| | | | | | |
|---|---|---|---|---|---|
| Data Security | Management | Cognitive and Prediction | Store & Analyze | | |
| IOT PKI | Reporting, Assurance, Configuration | Mining & Machine Learning | Big Data | Harvest | Storage |

Sensor Data → Integration Middleware → Hadoop Cluster → Evolution Middleware → Analytical Database → Business Level

# Q&A?

Thank you

http://labiot.tnet.it

https://www.tnet.it