EXPERT PANEL

Environmental Sensing: Difficulties for Sensing and Processing the Correct Data

The Fifteenth International Conference on Sensor Technologies and Applications
SENSORCOMM 2021
November 14, 2021 to November 18, 2021 - Athens, Greece

NetWare Experts Panel I

Environmental Sensing: Difficulties for Sensing and Processing the Correct Data

(medium dependency, body sensing, sensing mobile targets, predictive maintenance, mission critical sensing, precision, failures, etc.)

NetWare 2021

Chair

Antonio L. L. Ramos, University of South-Eastern Norway (USN), Norway

Panelists

Anne-Lena Kampen, Western Norway University of Applied Sciences, Norway

Paula Louro, ISEL-IPL; CTS-UNINOVA, Portugal

Sandra Sendra, Escuela Politécnica Superior de Gandia/Universitat Politècnica de València, Spain

Manuel Vieira, CTS-UNINOVA, Portugal

Aurilla Aurelie Arntzen, University of South-Eastern Norway (USN), Norway

Panellist Position

Panel Chair and Moderator

Prof. Antonio L. L. Ramos, PhD

University of South-Eastern Norway (USN), antonior@usn.no

Topics of interest and Research activities:

→ Signal Processing: Adaptive Filtering and Array Processing;

→ Communication Systems;

→ Real-time Systems with Embedded Systems;

→ Artificial Intelligence.

Panellist Position

Issues and Possible Solutions for Predictive Maintenance in Industry Environments

Anne-Lena Kampen, Western Norway University of Applied Sciences, Norway alk@hvl.no

- Use cases for communication in industrial environments
- Communication requirements
- Characteristics of some candidate protocols
- Discussion of the advantages and disadvantages of the protocols

→ Communication in industrial environments is subject to both spatial and temporal changes

→ Timeslot communication is often needed to reduce the number of collisions

→ Channel hopping is often needed to reduce interference

→ Sleep protocols may be needed to reduce energy consumption

→ Several network solutions may need to cooperate to support all requirements of the application

Panellist Position

Visible Light Communication: Indoors navigation and wireless communication capacity

Paula Louro, ISEL-IPL, CTS-UNINOVA; Portugal; plouro@deetc.isel.ipl.pt

- Optical wireless communication technology operating in the visible spectrum likely of integration with other communication technologies
- Attractive due to the ubiquitous use of energy efficient LEDS for lighting
- Bi-directional communication with VLC based down- and up-links
- Wide range of applications: indoor location-based services, IoT, Li-Fi, Vehicular Networking, Smart Cities, Under Water Communications.

→ Increased bandwidth, use of a free licensed spectrum in the THz range

→ The use of VLC enables infrastructures to communicate with mobile entities, resulting in ubiquitous indoor location-based services, together with wireless communication capacity

→ Feasibility of using VLC as one of the enabling technologies for beyond 5G/6G technological trends

IARIA

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Panellist Position

Low Power WAN Technologies for non-conventional environments.

Dr. Sandra Sendra Compte,
Universitat Politècnica de València (Spain)
sansenco@upv.es

- Use of LPWAN technologies in different environments
- Communication features
- Environmental constrains
- Solving recent needs of society

→ The recent global pandemic situation has put pressure on the research community to demonstrate its capacity

→ New technology must evolve with the demand of society

→ New developments should be reachable for all

Panellist Position

Vehicular Visible Light Communication (V-VLC)

Manuel Augusto Vieira, CTS-UNINOVA manuel.vieira@isel.pt

- Last generation vehicles perceive their surroundings, and interact with it in semi-autonomous, and eventually, fully-autonomous fashion.
- Road infrastructure has evolved with adaptive traffic lights.
- Two-Way-Two-Way Traffic Light Controlled Crossroad
- The goal is to develop a cooperative system that supports guidance services
- An Intersection Manager increases the throughput of the intersection by exchanging information and directing the incoming Connected Autonomous Vehicles

→ Multi-vehicle cooperative localization

→ Intelligence is shared between the vehicle and the infrastructure through a continuous communication.

→ The introduction of VLC between connected vehicles and the surrounding infrastructure allows the direct monitoring of relative speed thresholds and inter-vehicle spacing increasing the safety

Panellist Position

Drones operations in Urban Environments : Challenges and Opportunities for the U-space

Prof. Aurilla Aurelie Arntzen Bechina,
University of South East Norway,
USEPE EU project, aurillaa@usn.no

- Drone operations as a service for urban mobility (delivery, surveillance, monitoring, ect..)
- Dynamic capacity management of drones
- Sensing for a safe separation of drones

→ The domain of drones is ranging from healthcare purpose to agriculture

→ Innovation in Urban mobility is on its way

→ Techniques, and societal changes need to be considered

Panellist Position

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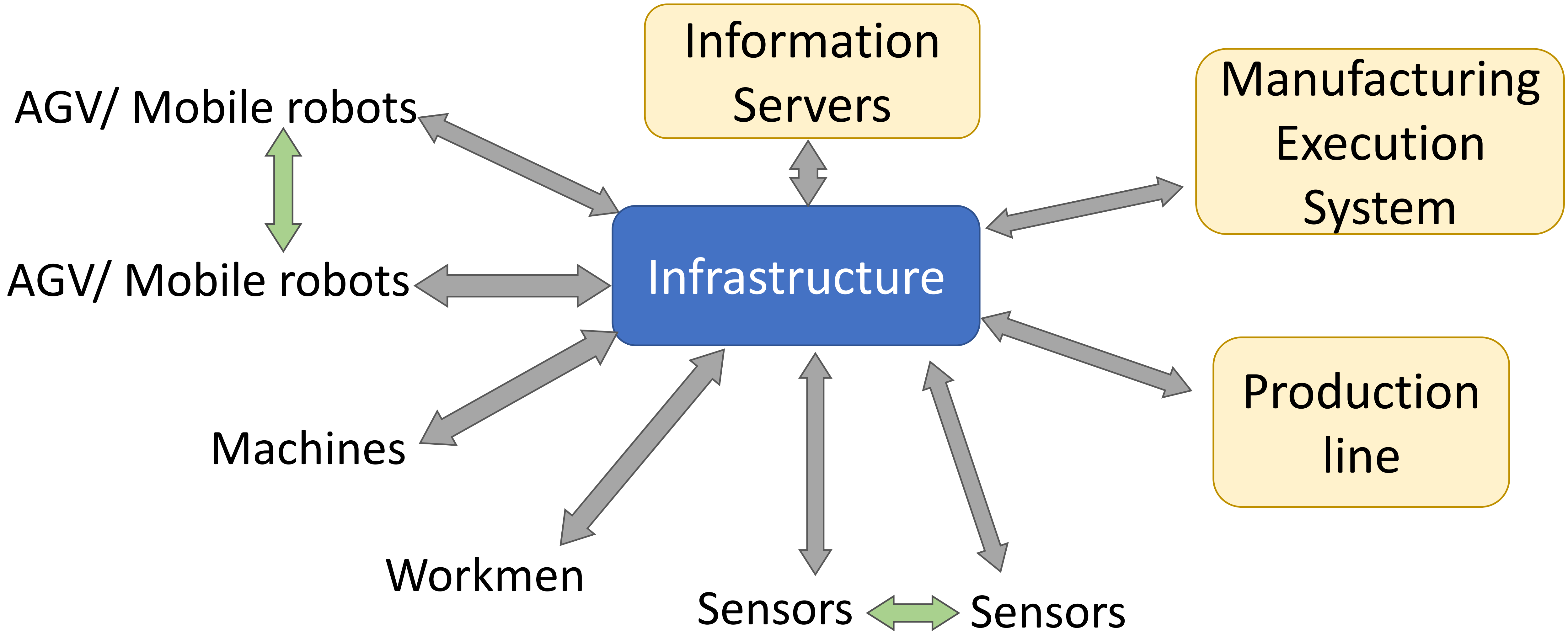
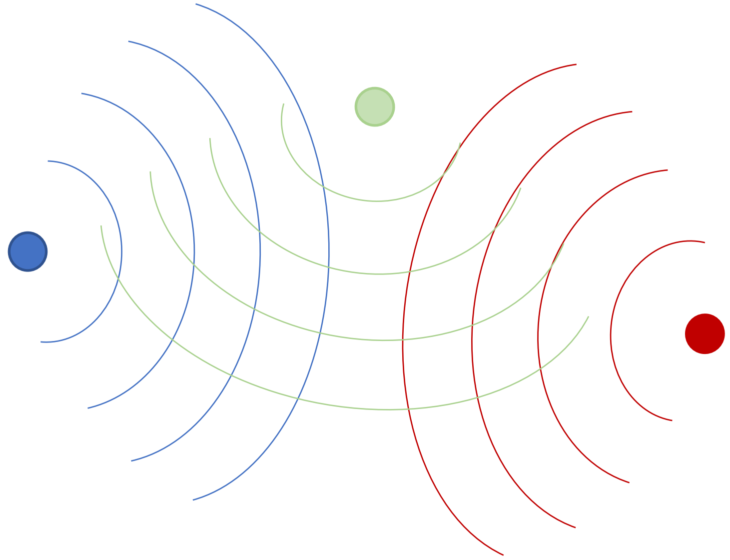
Use cases for communication in industry environments



Why wireless ?



- Lower installation costs than wired networks.
- Less mechanical wear and tear.
- Ability to provide critical information even from moving components.
    - Moving nodes may communicate directly with each other
- Prevent that moving components cutting cables (cutting communication cables)
- Scalability

Communication requirements

- Reliable
- Low delay
- Availability
- Energy-awareness
- Security
- Maintain connectivity while moving

- Insusceptible of EMI (electromagnetic **interference**)

- Candidate protocols
- Characteristics
- Discussion of the advantages and disadvantages of the protocols

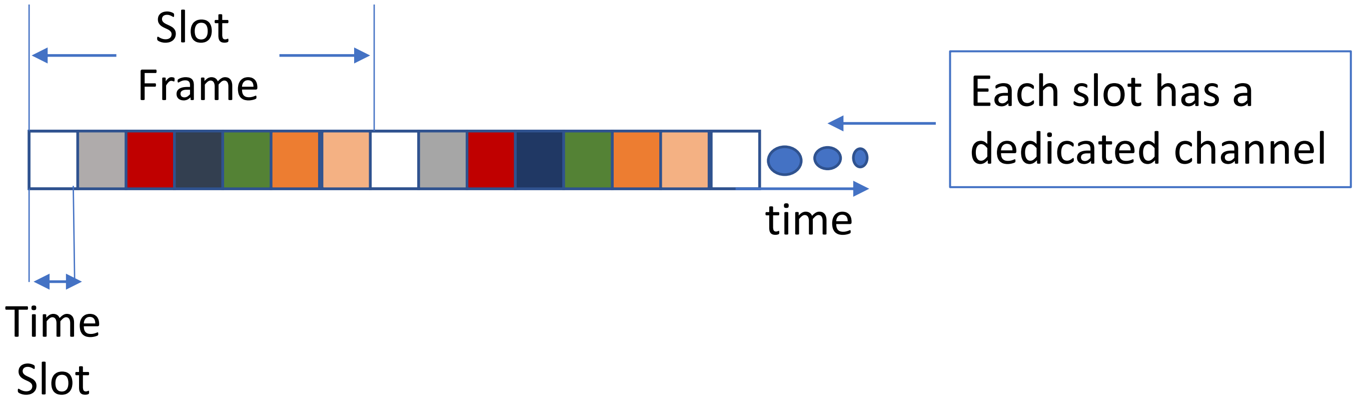
Mainly based on:

[1]: Kampen, A. L., Fojcik, M., Cupek, R., & Stoj, J.; . Low-Level Wireless and Sensor Networks for Industry 4.0 Communication–Presentation. In International Conference on Computational Collective Intelligence (pp. 474-484). Springer, Cham., 2021, September

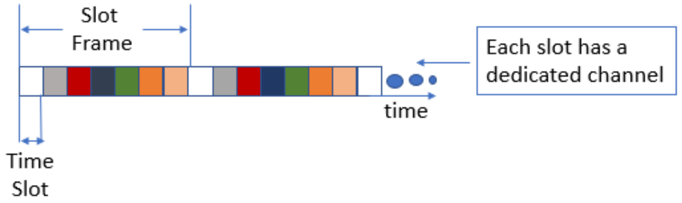
[2]: Kampen, A. L., Fojcik, M., Cupek, R., & Stoj, J.; The requirements for using wireless networks with AGV communication in an industry environment. The 17th International Conference on Wireless and Mobile Computing, Networking and Communications, WiMob, IEEE, 2021

IEEE802.15.4e : Time-slotted Channel Hopping (TSCH)

- **TSCH** defines repetitive **slot frames** in which each slot-frame is a **collection of timeslots**.
  - Timeslot communication (**TDMA)** combined with **channel hopping**
  - Generally, the timeslots can either be **dedicated** or **shared**.
  - The **dedicated** timeslots are assigned for reliable communication between two devices, one as the source the other as the receiver.
  - The **shared** slot uses the CSMA-CA access method (or slotted Aloha)

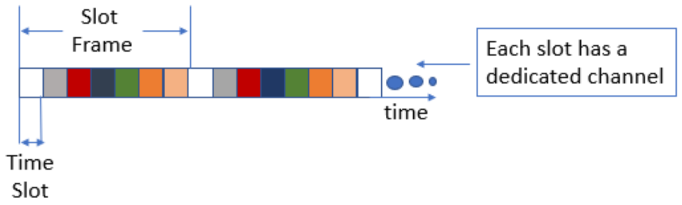


WirelessHART



- Wireless Highway Addressable Remote Transmission (WirelessHART)
- Standard that defines the wireless interface to field devices.
- Targeted toward industrial applications
- Based on IEEE802.15.4 at the physical layer
- The MAC layer uses TSCH
  - CSMA is typically only used in joint and shared timeslots.
    - Otherwise, **TDMA** (TSCH) is used.
  - A channel with high interference or noise is blacklisted
    - Removed from the hopping sequence
- A wirelessHART network is a hybrid wireless-wired network that consists of a **wired network manager, a security manager** and **gateways**.

ISA100.11a



- ISA100.11a is developed by the International Society of Automation (ISA)
- Defines a wireless system for industrial automation and control applications.
- Based on IEEE802.15.4 at the physical layer
- TSCH at the MAC layer
  - It supports the adaptive blacklisting of channels
  - In addition to slotted channel hopping
    - Sow hopping, a group of contiguous timeslots uses the same channel.
    - Hybrid hopping combines periods of both slow and slotted hopping.
  - ISA100.11a supports five preprogrammed hopping patterns,
- The DLL layer of ISA100.11a provides routing capabilities
  - using routing graphs that are calculated and managed by a manager.
  - The DLL routing is terminated at the backbone router

ZigBee

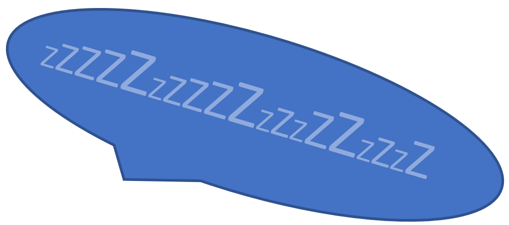
- Based on the IEEE802.15.4 PHY and MAC layers

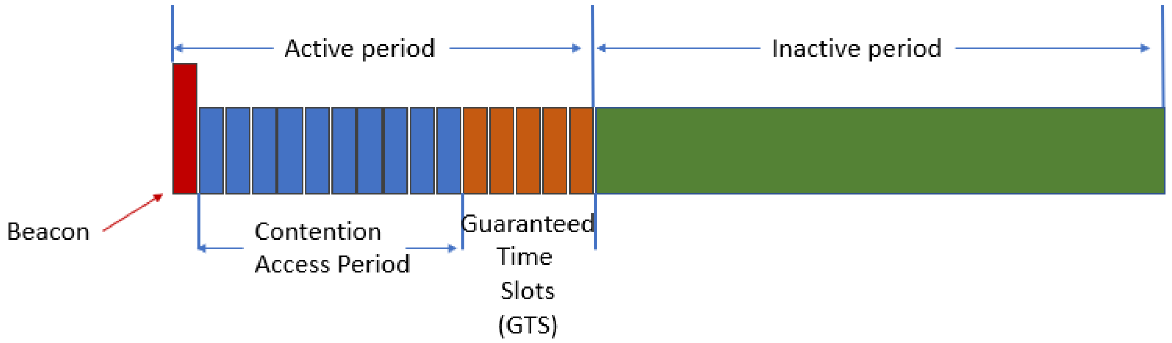
- Low-power, low-rate, short-range and low-cost wireless standard that is Targeted for battery-powered applications

  - The nodes are duty cycled.
    - nodes periodically enter a sleep state to save energy.

  - To enable the TDMA access method.
    - Use GTS

  - Does not support channel hopping.

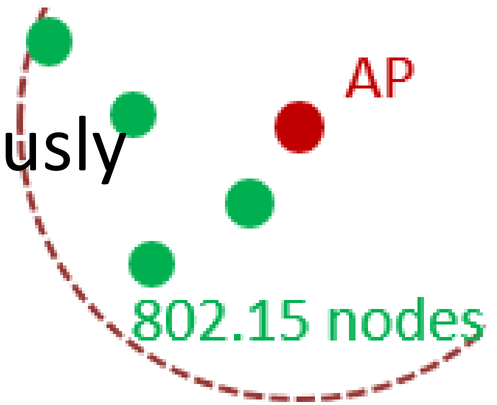




IEEE802.15.4 , IEEE802.15.4e

- IEEE802.15.4, industrial indoor environments, experimental results [1]
  - Performance depends on the nature and the peak power of the surrounding electromagnetic interference.

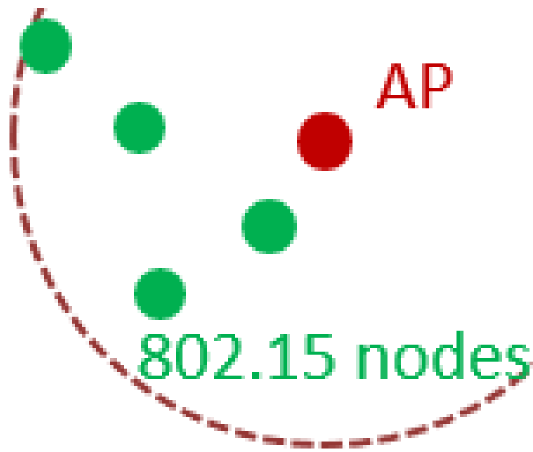
- Experimental, office environment, IEEE802.15.4 [2]:
  - The PDR changes, from 0% to 100%.
    - Never occurred on all of the frequencies simultaneously
  - The beaconing activity (WiFi network is idle)
    - PDR drop from 90% to 70-80%



1. A. Kadri : Performance of IEEE 802.15. 4-based wireless sensors in harsh environments: 2012.
2. Watteyne, T., et al.: Lessons learned from large-scale dense IEEE802. 15.4 connectivity traces: 2015

WiFi interfering with ZigBee

- Experimental test of coexisting ZigBee and WiFi:
  - Reduces the PDR of ZigBee by up to 51.5% when overlapping channels are used [1].
  - Whenever the WiFi network was powered on, the transmission of management frames between the APs caused corruption in the received ZigBee [2].



1. Wang, X.,et al.: A real-life experimental investigation of cross interference between WiFi and zigbee in indoor environment: 2017
2. Tao, Y., et al.: Performance of coexisted wifi and zigbee networks: 2013

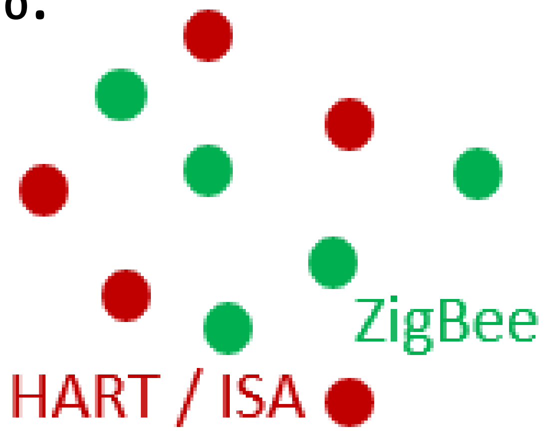
WirelessHART and ISA100.11a in harsh environments

Experimental tests, industrial environment [1]:

- Before any ZigBee node was activated.
    - WirelessHART PLR: 0.98% ; ISA100.11a PLR: 1.18%.
- Tested against ZigBee.
    - WirelessHART PLR: 1.43% ; ISA100.11a PLR 1.62%

➢ Harsh environment main impact on PLR,

  ➢ but PLR would increase linearly with the number of interfering nodes.



- Coexists with IEEE802.11n
    - The PLR of WirelessHART 3.36% ; ISA100.11a 3.47%

1. Ding, Y., et al.: Experimental investigation of the packet loss rate of wireless industrial networks in real industrial environments. 2015

	ZigBee	Wireless Hart	ISA100.11a	IEEE 802.11
Topology	Star, mesh,	Star, mesh	Star, mesh	Star
Channel hopping	No	Yes	Yes	NO
Energy consumption	Very low	Low	Low	High/ Medium
Real time/ guaranteed time	No	Yes / no	Yes / no	no
Access method	TDMA CSMA	TDMA	TDMA / CSMA	CSMA-CA

Conclusion

- Wireless communication is advantageous in industrial environment
  - Avoid cutting cables, Move freely, Scalable (easy to include new devices)
- Communication in industrial environments are subject to both spatial and temporal changes.

- Technology solutions
  - Timeslot communication to reduce the number of collisions
  - Channel hopping to reduce interference
  - Let nodes enter sleep state to reduced energy consumption
    - There is a general tradeoff between delay and energy consumption

- Maybe it is necessary to use two (or more) different types of networks
  - one optimized to reduce energy consumption
  - A second to support delay-sensitive operations.

- Thank you !!

Environmental Sensing: Difficulties for Sensing and Processing the Correct Data

NetWare Experts Panel I

Athens, Greece, November 2021

Paula Louro
ISEL-IPL, CTS-UNINOVA, Portugal

Paula Louro

plouro@deetc.isel.ipl.pt

Professional experience

- Full professor at Electronics, Telecommunications and Computer Dept. in ISEL, Lisbon School of Engineering (since 2001).
- Integrated member in the research Center of Technology and Systems, CTS-UNINOVA (since 2007).
- Junior optoelectronics engineer (1992-1998).

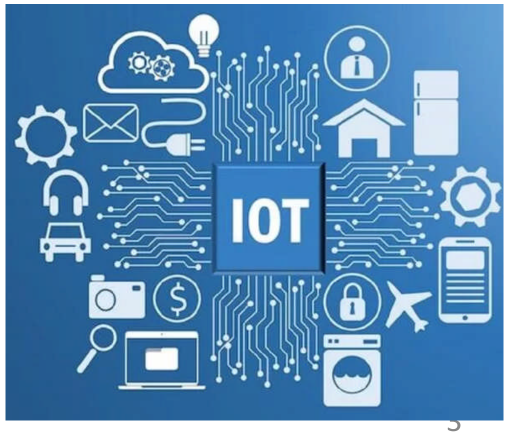
Publications & Activities

- Indoor and outdoor geo-localization and navigation by visible light communication, Proc. SPIE, 2021
- Bidirectional visible light communication, Opt. Eng, 2020.
- Redesign of the trajectory within a complex intersection for visible light communication ready connected cars," Opt. Eng., 2020.
- Geolocation and Wayfinding Services Using Visible Light Communication, Sensors & Transducers, 2020
- Positioning and advertising in large indoor environments using visible light communication", Opt. Eng, 2019.
- Cooperative vehicular communication systems based on visible light communication, Opt. Eng, 2018.
- Optical Communication Applications based on white LEDs, J. Luminescence, 2016.
- Viability of the use of an a-SiC:H multilayer device in a domestic VLC application", Phys. Status Solidi C, 2014.

November 2021

WHY VLC?

- VLC is a subset of **O**ptical **W**ireless **C**ommunication (**OWC**) technologies
- VLC emerged as a promising solution in the past decade
- VLC is based on **LEDs** used everywhere as lighting solutions
- VLC operates in the **visible** range of the electromagnetic spectrum
- VLC is a promising solution for upcoming high-density and high capacity **5G/6G** wireless networks
- VLC can also play an importante role in **IoT** where a large number of devices are connected to sense, monitor and share resources.



MAIN ADVANTAGES of VLC?

- VLC operates in a free licensed, non-regulated spectrum
- VLC offers 10 000 times more bandwidth capacity than rf-based technologies
- VLC is not harmful to humans
- VLC is secure in electromagnetic-sensitive areas (hospitals, nuclear plants, aircraft cabins)
- High security communication due to high spatial confinement
- VLC presents very low power consumption for communication purposes
- VLC systems can be either unidirectional or bidirectional

Cost Action CA 19111

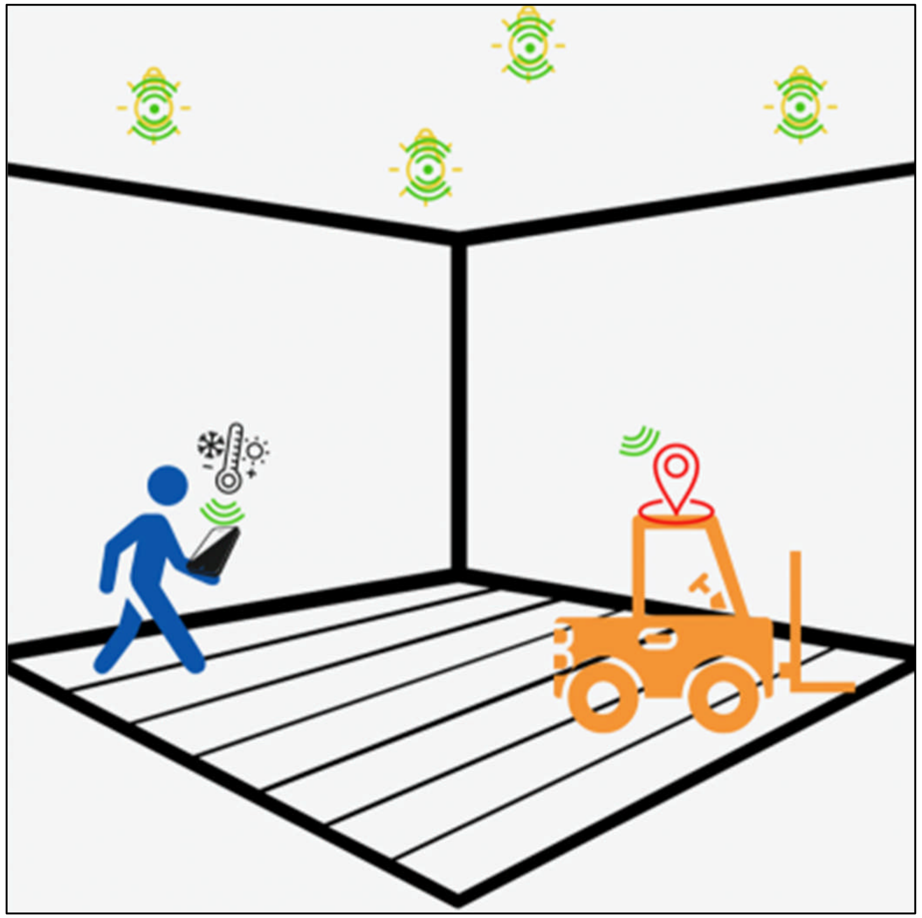
2020-2024

European Network on Future Generation Optical Wireless Communication Technologies

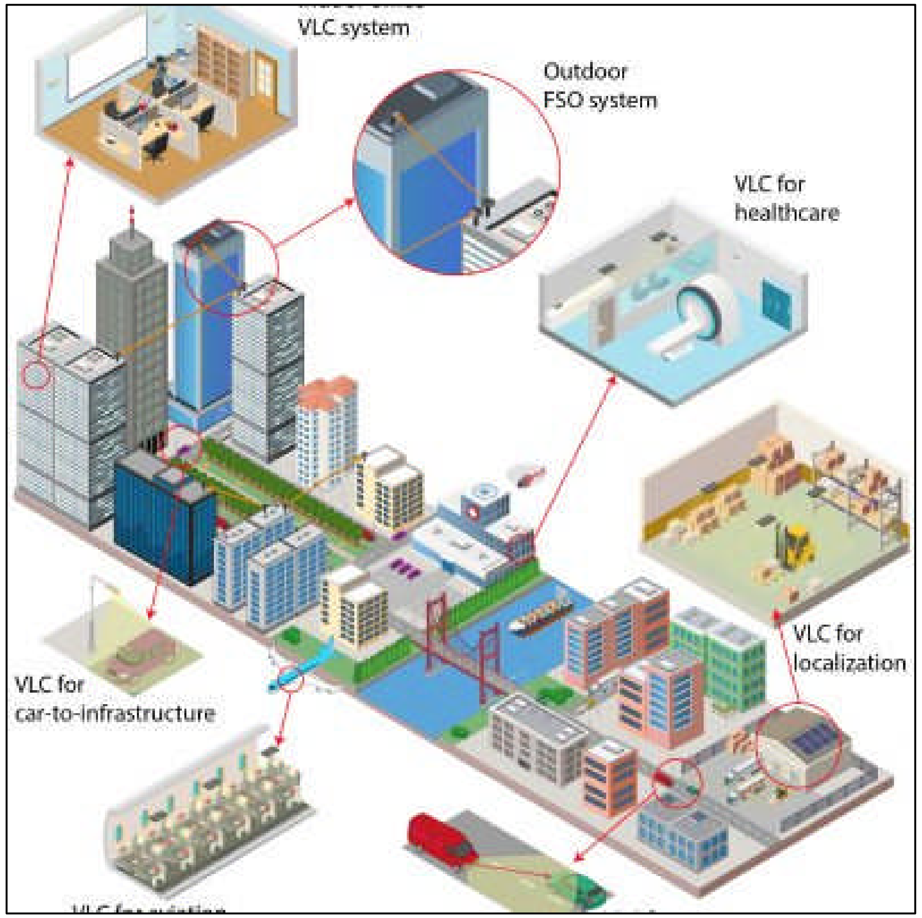
“The main aim and objective of the Action is to position optical wireless communication (OWC) as one of the key enabling technologies for Beyond-5G-Networks and a number emerging specific applications, in particular, to address the ever-increasing demand for bandwidth in high-speed and ubiquitous wireless access with high reliability.“

MAIN APPLICATIONS OF VLC

SHORT RANGE
few meters



MEDIUM RANGE
few meters to few kilometers



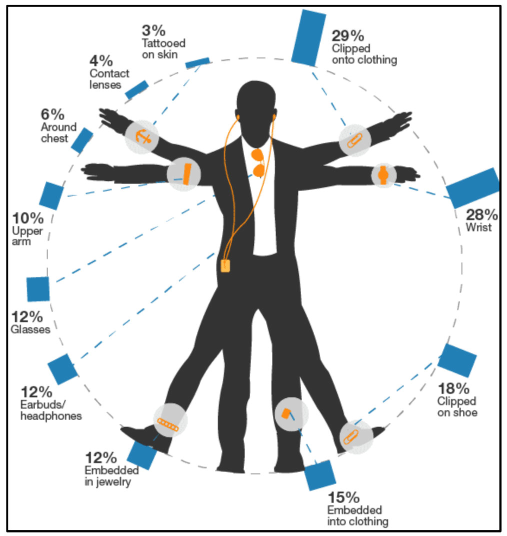
SHORT RANGE

Links up to a few meters: The deployment of intensity modulated artificial optical sources, such as LEDs, enables infrastructures and sensors to communicate with mobile entities, resulting in ubiquitous indoor location-based services, together with wireless communication capacity.

Li-Fi

- **VLC** uses the current day ubiquitous presence of LED lamps

Wearables

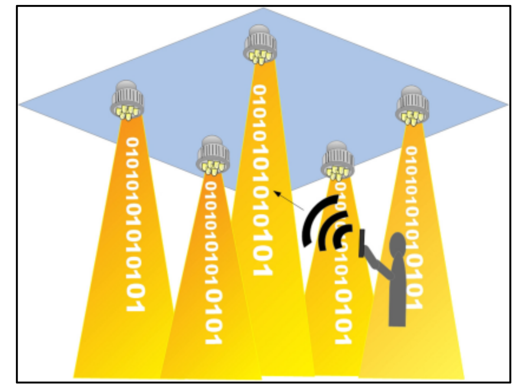


- Current advancements in OLED technology enable the integration of **VLC** transceivers into wearable gadgets and clothing

Short range IoT

- Smart spaces and buildings
- Smart manufacturing: autonomous machine to machine (M2M) links

Localization

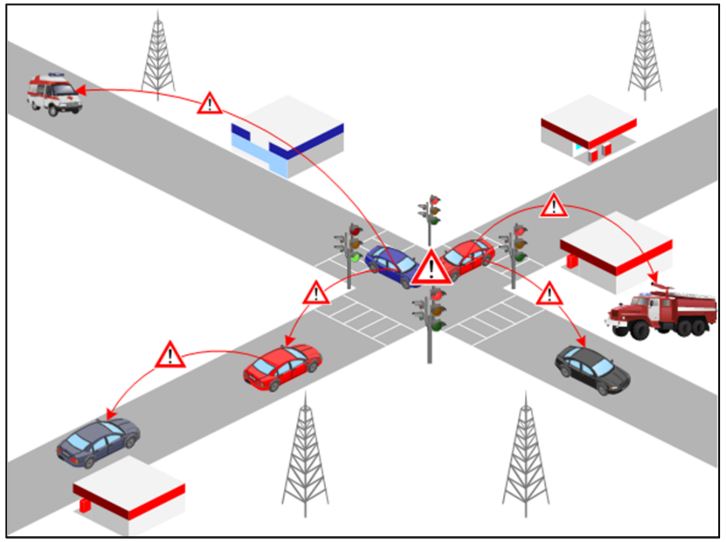


- Location based services provided by **VLC** using LED lamps

MEDIUM RANGE

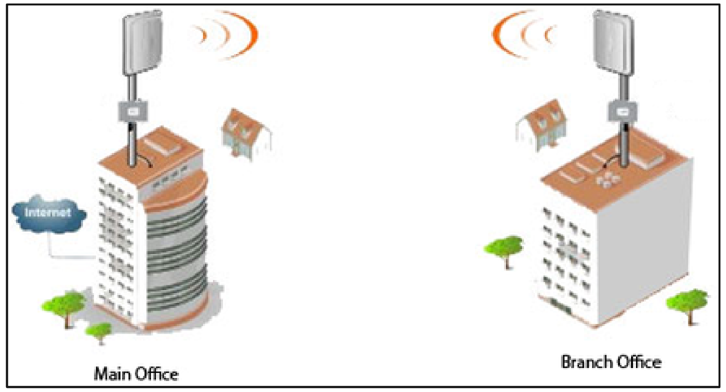
Typical range of few meters to few kilometers . VLC-based solutions for smart-cities and intelligent transportation systems, first- and last-mile access and backhaul/fronthaul wireless networks, hybrid FSO/RFadaptive wireless connections, and underwater communications for sensor networks

Vehicular networking (VN)



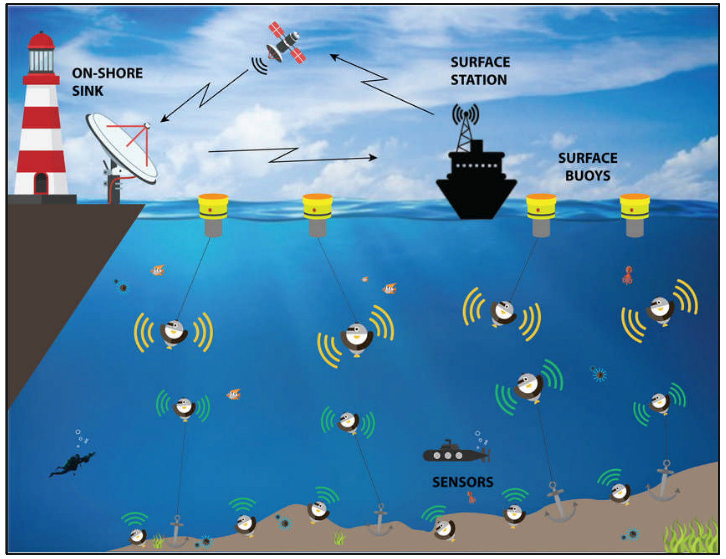
- Wide use of LEDs for vehicle, traffic and street lights
- **VLC** emerges as a natural solution
- VLC-based VNs: V2V, V2I, I2V links

PtP WA links



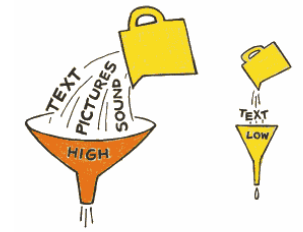
- Outdooor PtP terrestrial **FSO** links as a solution for first and last mile access WNs.
- Typical applications: high speed trains, low altitude drones, data centre networks,

Under Water (UW) communications



- **VLC** enables high data rates, low latency and high energy efficiency (outperforms acoustic and RF communication)
- Applications: environmental monitoring, UW exploration, port security, disaster prevention

GENERAL VLC CHALLENGES



Bandwidth/Transmission rate

- Currently controlled by LED devices.
- Phosphor based LEDs speed is limited by the slow phosphor decay. RGB LEDs provide faster operation speeds and the possibility of signal multiplexing.
- Need to re-design LEDs for lighting and communication purposes.

Receiver saturation

- Background illumination due to artificial or natural light sources, especially under direct sunlight.

Flickering

- Basic requirement: not perceptible by the human eye.
- Demands appropriate modulation techniques and codification schemes.

Dimming

- Signal coverage even under low intensity signal.

LoS and Non-LoS

- Need to adress diffused optical transmission configurations, multipath propagation and multiple access interference.

Integration with other communication technologies

- Integration of VLC in heterogeneous WNs as well as cognitive hybrid links.
- Improvement of reliability, quality of service (QoS) and quality of experience in coexisting optical and rf links.

OUTDOORS VLC CHALLENGES

OUTDOORS COMMUNICATION

- Short communication distance.
- Drastic attenuation of received signal strength due to visibility-limiting weather conditions.
- Interference due to ambiente light radiation from the sun, skylights, streetlights and other sources.
- Large amount of noise from background lights.
- Photodetector saturation especially under direct sunlight exposure.

VEHICULAR NETWORKS

- Safety functionalities: latency and reliability are the primary issues.
- Links establisment while on the move, link availability on multi-lane highways

UNDER WATER (UW) COMMUNICATIONS

- Strong signal attenuation of the aquatic channel, especially in turbid waters.
- LoS requirement.
- Need to design high-sensitive receivers and powerful error-correcting codes to allow the extension of the communication range and improve link reliability.

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- Communication features
- Environmental constrains
- Solving recent needs of society
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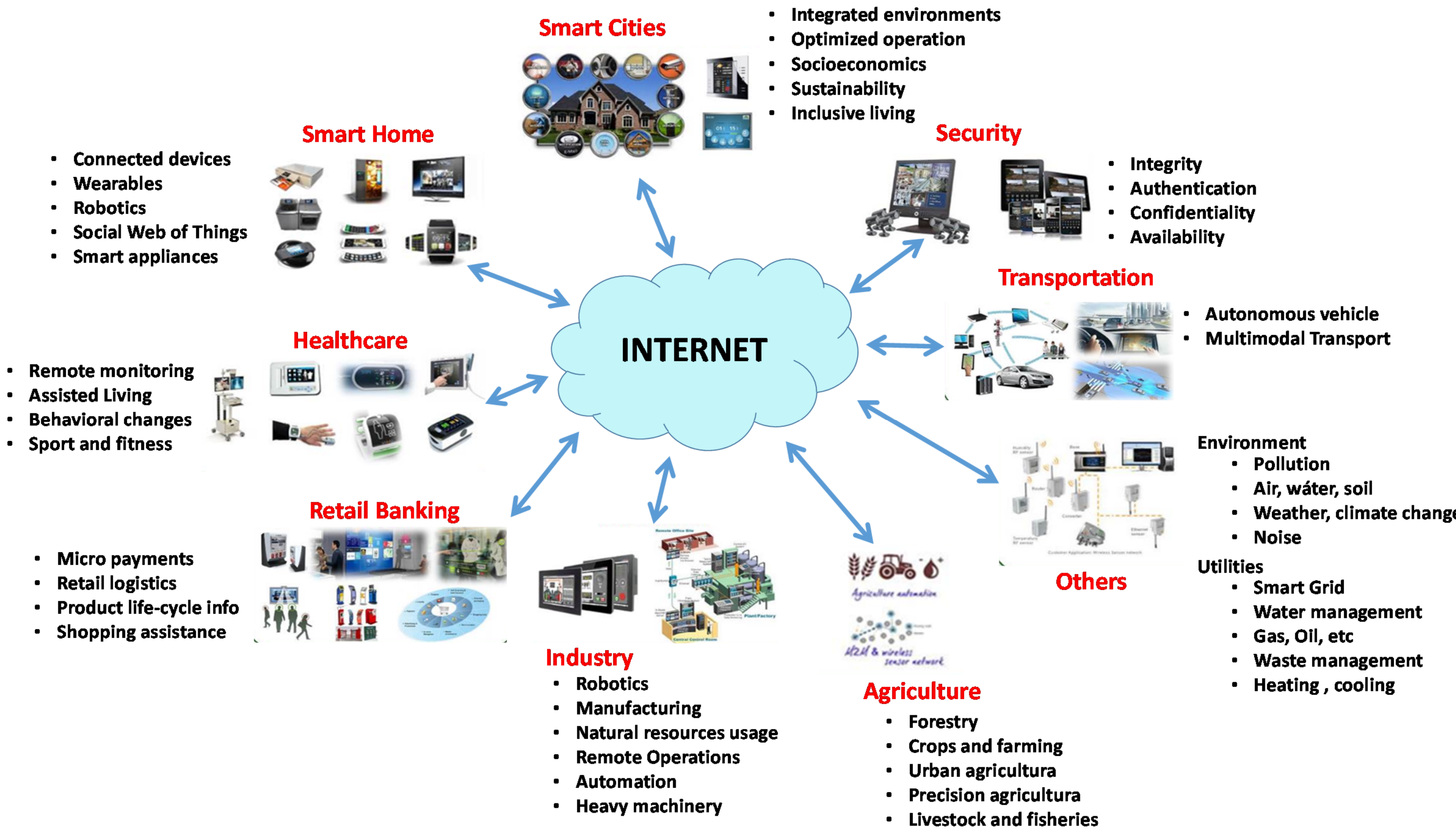
    - → New technology must evolve with the demand of society
      - → New developments should be reachable for all

Application fields for Wireless Sensor Networks



Main Features:

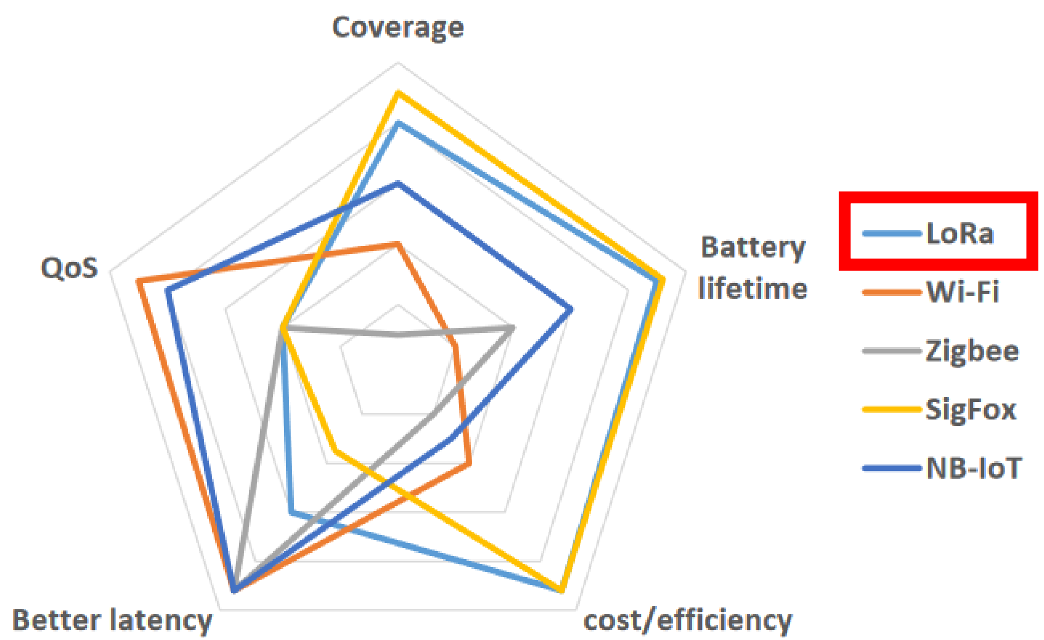
- **LPWAN** is increasingly gaining popularity in industrial and research communities because of its characteristics:
  - low power,
  - long range,
  - low-cost communication
- **Long-range** communication up to 10–40 km in rural zones and 1–5 km in urban zones.
- Highly **energy efficient** and inexpensive,

- **Cost of a radio chipset** being less than 2€ and an operating cost of 1€/devide per year.

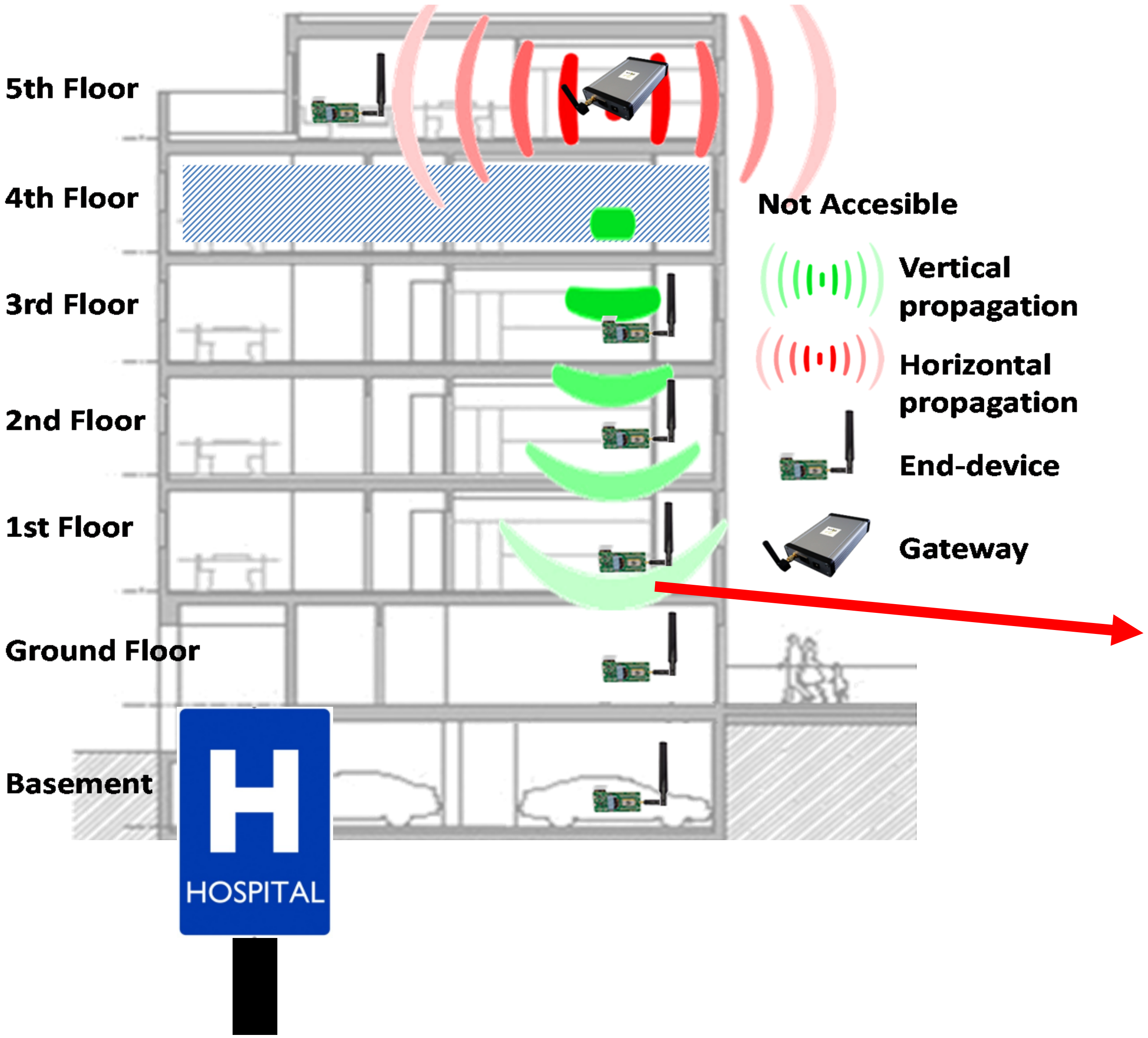
- LPWAN is **highly suitable for IoT applications**
  - Transmit tiny amounts of data in long range.
  - Many LPWAN technologies have arisen in the licensed as well as unlicensed frequency bandwidth.
  - Sigfox, LoRa, and NB-IoT are today’s leading the lasts proposed solutions.

Comparison WiFi vs. LPWAN Technologies

	LoRa	Wifi	ZigBee	SigFox	NB-IoT
Frequency	868 MHz (EU); 915 MHz (USA); 433 MHz (Asia)	2.4 GHz and 5 GHz	868 MHz (EU); 915 MHz (USA); 433 MHz (Asia); 2.4 GHz	868 MHz (EU); 915 MHz (USA), 433 MHz (Asia)	Depends on the frequency licensed to LTE
Standard	IEEE802.15.4g, LoRa Alliance	IEEE802.11	IEEE802.15.4	SigFox (Owner)	3GPP Standard
Coverage	5 km (urban),20 km (rural)	50 m (indoor), 40 km (outdoor, as a function of the visibility)	10–100 m	10 km (urban), 40 km (rural)	1 km (urban), 10 km (rural)
Modulation	LoRa, FSK, GFSK	BPSK, QPSK, 16 QAM, 64 QAM, 256 QAM, 1024 QAM	BPSK, OQPSK	BPSK, GFSK	QPSK, OFDM (DL, SC-FDMA (UL)
Power consumption	Low	High	Medium-Low	Low	Low
Theoretical Data Transfer Rate	22 kbps (LoRa), 100 kbps (GFSK)	2.4 Gbps (IEEE802.11 ax, 2 streams with 1024 QAM)	250 kbps at 2.4 GHz, 20 kbps at 868 MHz, 40 kbps at 915 MHz	100 bps	10 Mbps
Price of end devices	3–5 €	3–5 €	2–5 €	>2 €	>20 €
Price of Gateway/ Base Station	100 € Gateway/ >1000 € Base station	20–600 € Gateway	40–1000 € Gateway	4000 € Base station	15000 € Base station

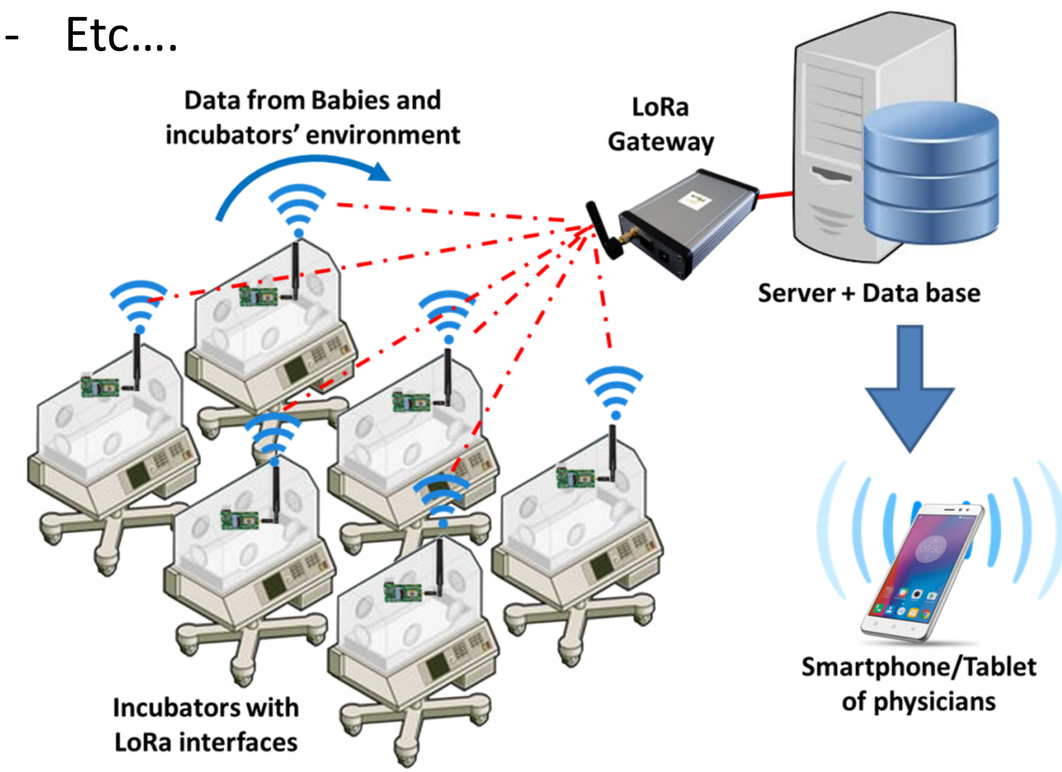


LPWAN in indoors (Use in medical environments):



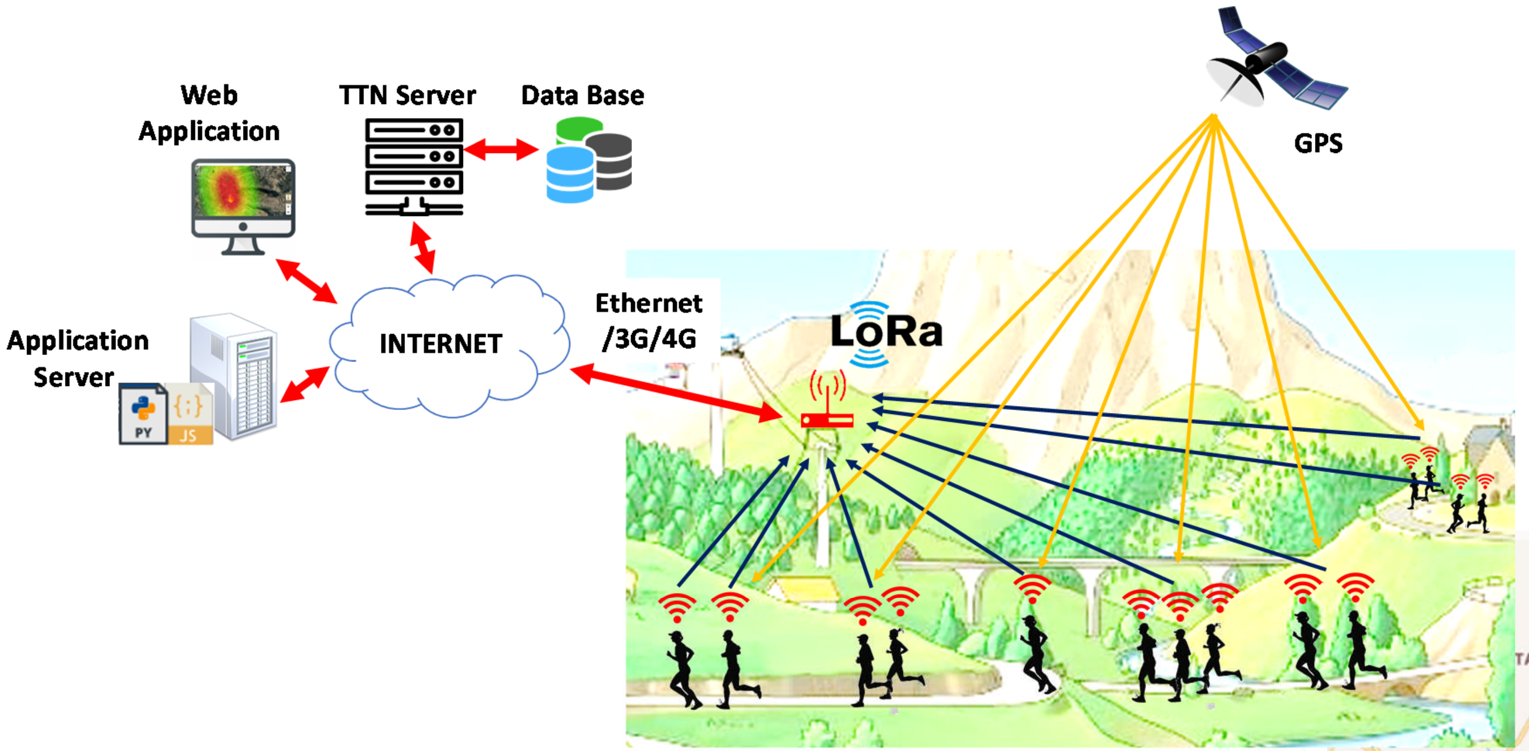
Recent and required applications:

- Continuous monitoring in contagious diseases (p.e.: COVID)
- Remote monitoring
- Ambient assites Living
- Etc….



Network architecture

LPWAN in outdoors (Traking systems for humans, animals, objects):



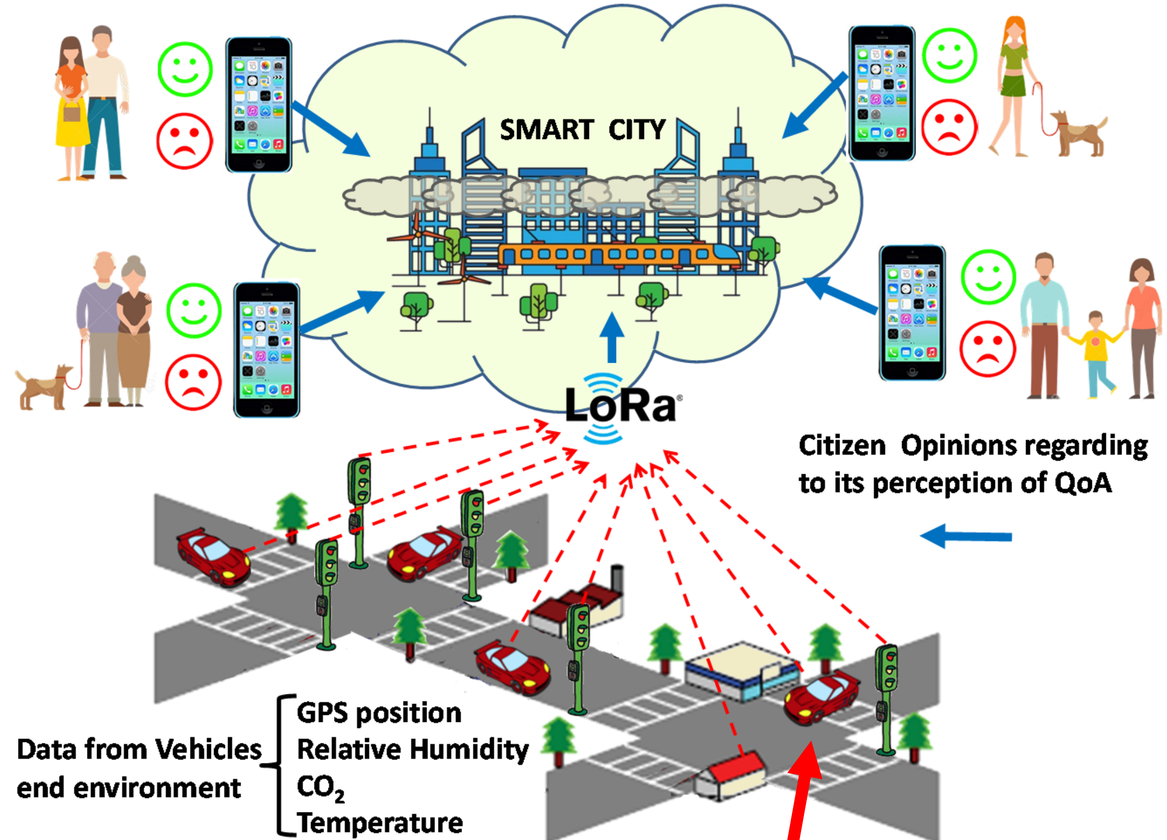
Modern applications required by society:

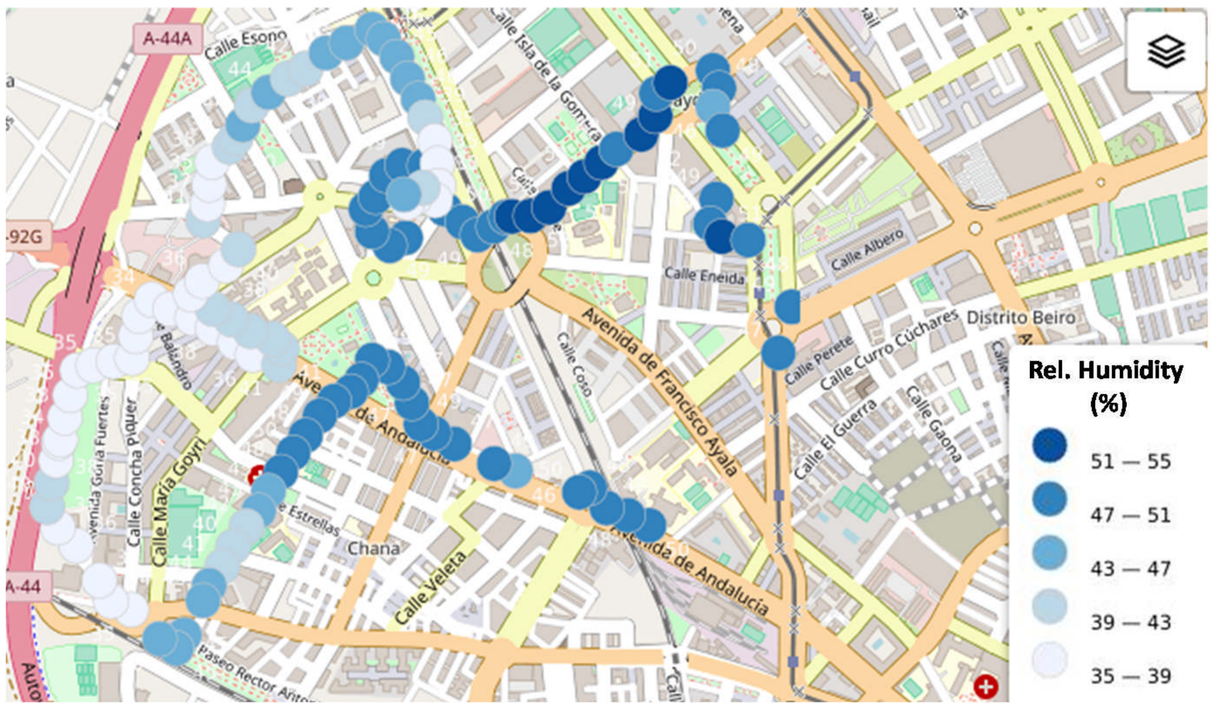
- Tracking domestic pets
- Controlling farm animals
- Protect victims of domestic violence
- Etc….

LPWAN in outdoors (Tracking and monitoring systems in smart cities):

Modern applications required by society:

- Monitoring air quality in cities
- Intelligent transport system
- Intelligent system for solid urban waste and bulky waste collection





Sensors installed in Cars and traffic lights

Advantages and disadvantages

Problems?

- Noisy environment
- Interferences with medical equipment
- Volume of data to be sent
- Point-to-Point connection
- Prices for using this service → **$0??**

- **LoRa/LoRaWAN advantages:**
  - High tolerance to interference
  - High sensitivity to receive data
  - Robust modulation
  - Low power Consumption
  - Working frequencies: 915Mhz America, 868 Europe, 433 Asia

Conclusion

- The field of WSNs and IoT is still growing and widing its horitzons.

- LPWAN communication technologies are providing new applications fields where its presence is highly usefull.

- The quick spreading of these solutions and developments should be potentiated by a low Price of technology and services with no fees (or very low fees).

Required as a future work.

  - In depth investigations to improve the network performance of LPWAN

  - More synergies between industry-academy-public institutions.

Thank you very much!

Panel on Environmental Sensing :

Difficulties for Sensing and Processing the Correct Data

NetWare Experts Panel I

Athens, Greece, November 2021

Manuel Augusto Vieira

ISEL-IPL, CTS-UNINOVA, Portugal

INSTITUTO SUPERIOR DE ENGENHARIA DE LISBOA

instituto de telecomunicações

CTS

V-VLC

Vehicular Visible Light Communication

Manuel Augusto Vieira was born in Portugal. He graduated in Electronic and Telecommunication Engineering by Instituto Superior Técnico (IST) of Lisbon from the Technical University of Lisbon. In 2004, he received the Master of Science in Electronic and Computers Engineering by the Superior Technical Institute of Lisbon and in 2012 its PhD by the New University of Lisbon. The title of the thesis was ”Three transducers for one photodetector: essays for optical communication”

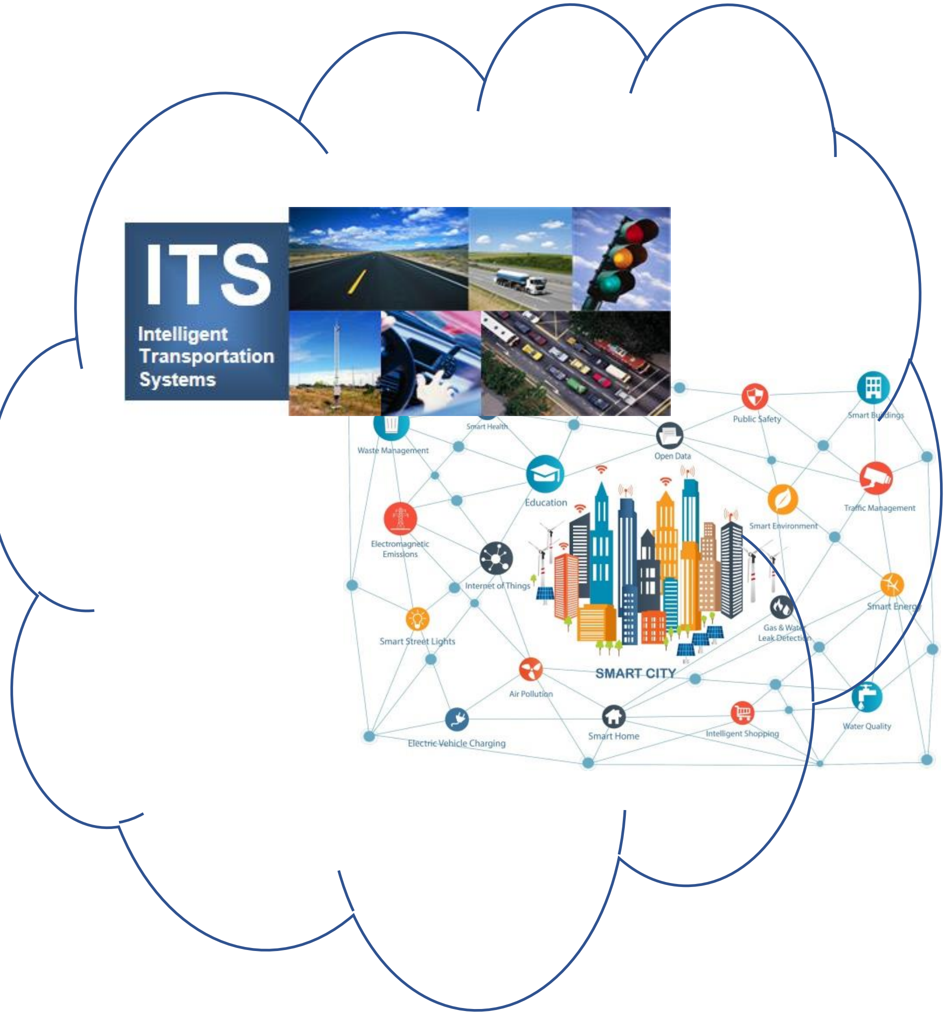
Currently he is Professor in Electronics inside the Electronic Telecommunication and Computer Department of ISEL, Lisbon, Portugal and investigator in the M2P group of CTS-UNINOVA.

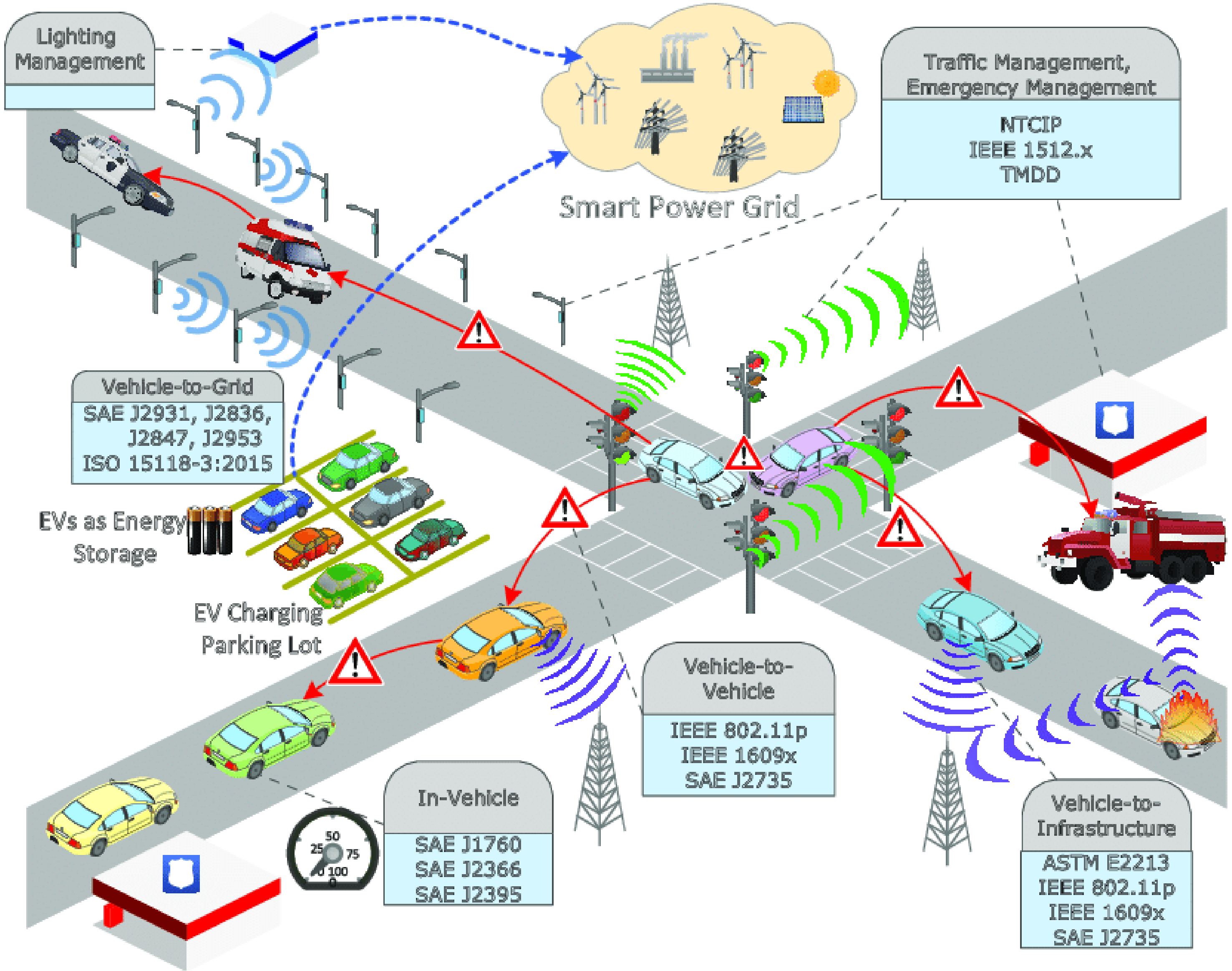
The major research interests are related with traffic control, vehicular communications, operations management, stochastic control, optimization and discrete event dynamic systems, scheduling, inventory control, simulation infinitesimal perturbation analysis, queuing networks.

He was director of the traffic department of the City Hall of Lisbon for more than twenty five years.

Authored and co-authored several publications in refereed journals and conferences proceedings. He is an IARIA Fellow since 2020.

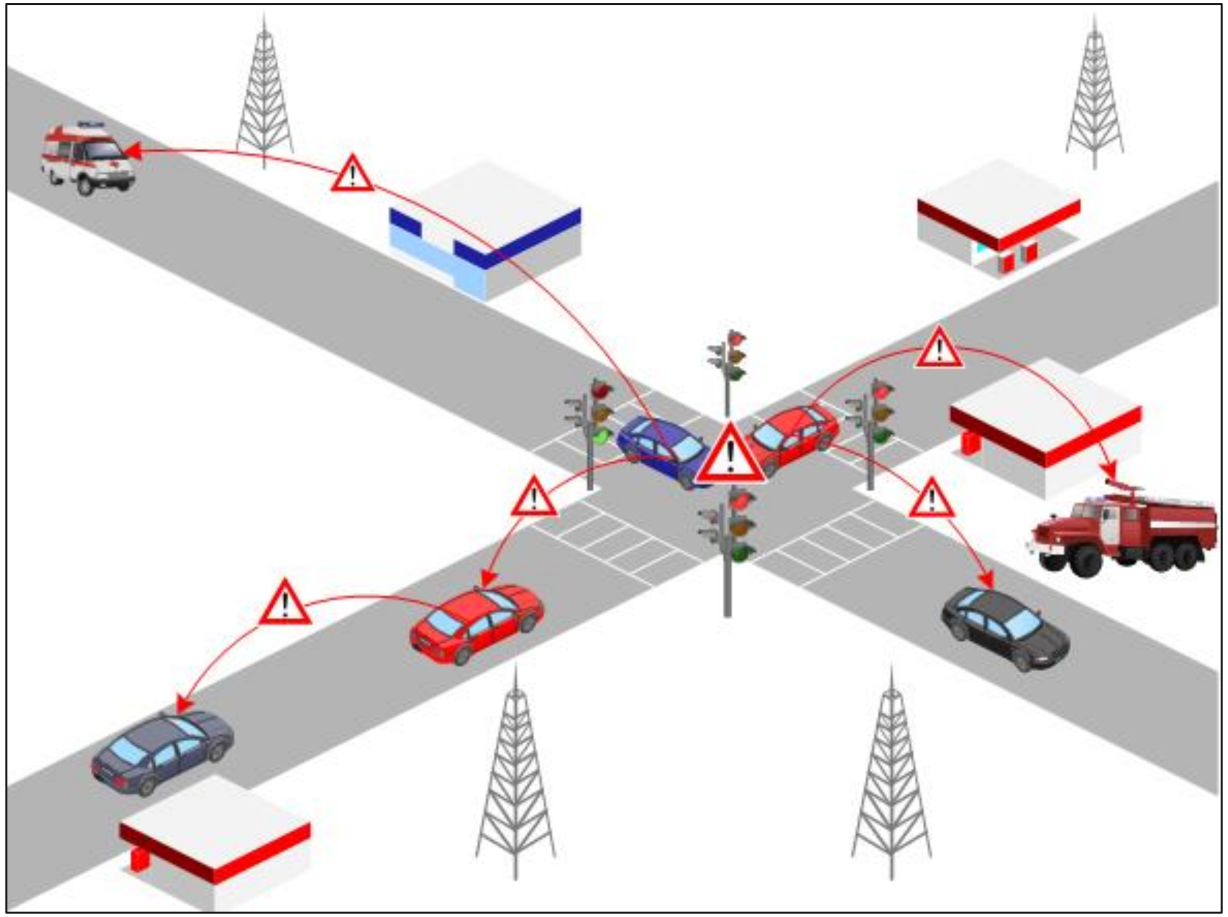
Intelligent Transportation Systems and Smart City are closely coupled





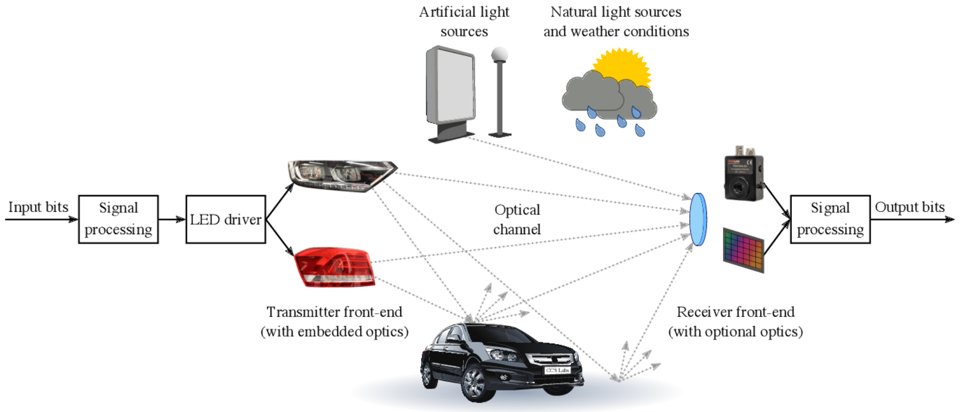
V-VLC-based solutions for smart-cities and intelligent transportation systems (ITS)

Typical range of few meters to few kilometers .



Vehicular networking (VN)

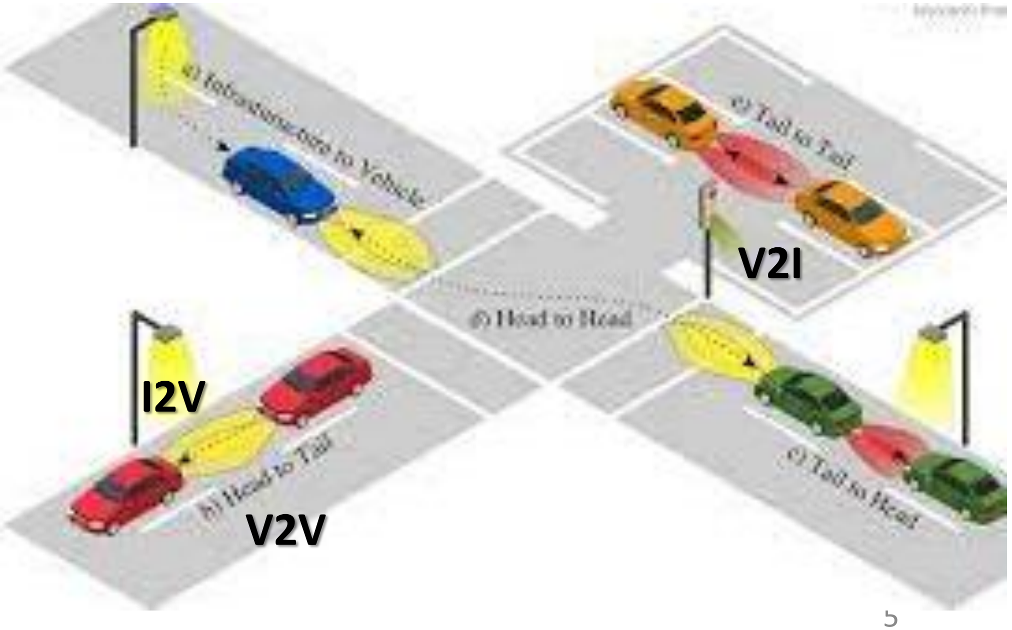
- **VLC** emerges as a natural solution
- Wide use of **LEDs** for vehicle, traffic and street lights
- **VLC-based VNs**: V2V, V2I, I2V links



- Vehicular communication enables a variety of safety, infotainment, mobility, and environmental applications.
- Autonomous vehicles significantly benefit from seamless wireless connections between cars (V2V) or between cars and the infrastructure (V2I).
- V-VLC can be considered as a complementary technology to RF-based communications.

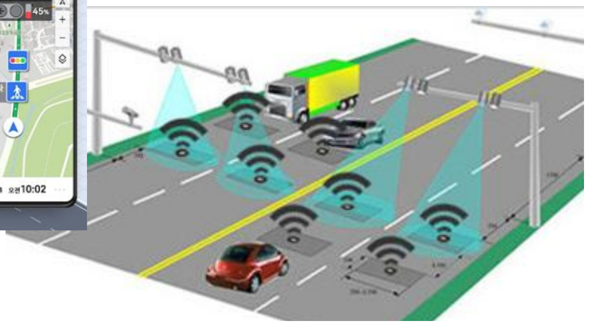
- V-VLC have a great potential for applications due to their relatively simple design for basic functioning, efficiency, and large geographical distribution.

- V-VLC is based on **LEDs** used as lighting solutions. (Luminaires, Traffic Lights, Head and Tail Lights).
- V-VLC is a promising solution for upcoming high-density and high capacity **5G/6G** wireless networks.
- V-VLC can also play an importante role in **IoT** where a large number of devices are connected to sense, monitor and share resources.

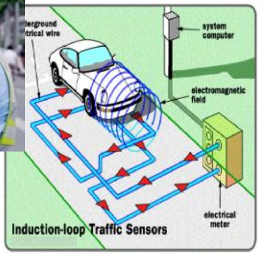


I2V –GPS navigation

I2V –Vehicle detection



V2V -brake lights, turn signals



V2I- Loop detectors

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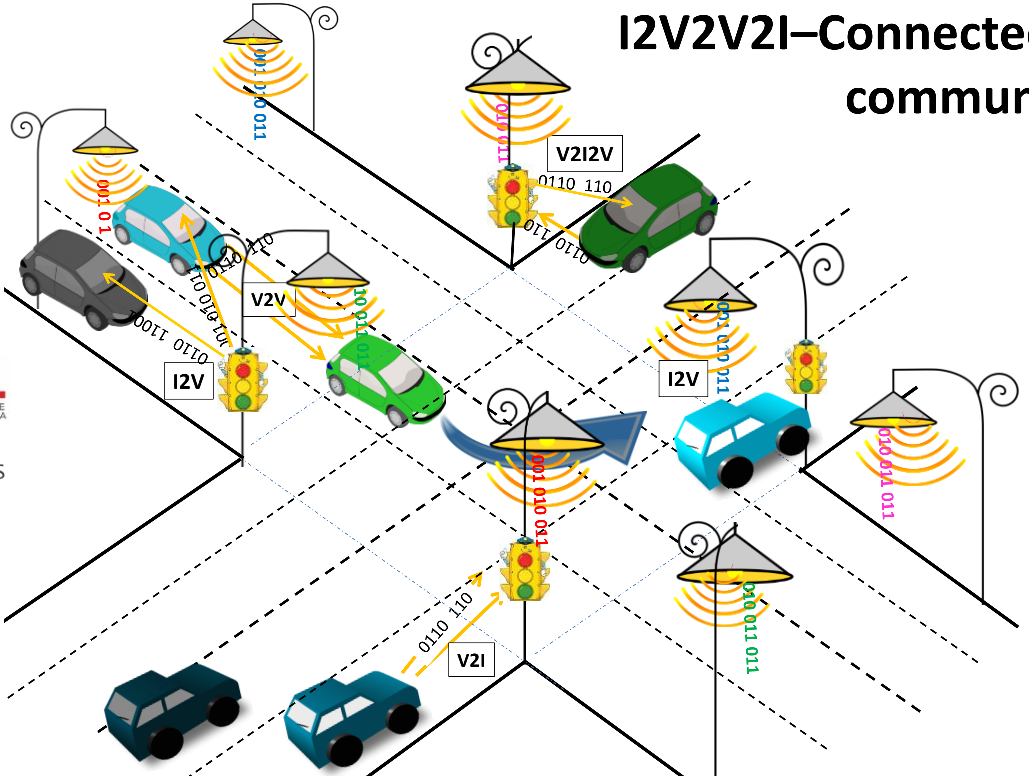
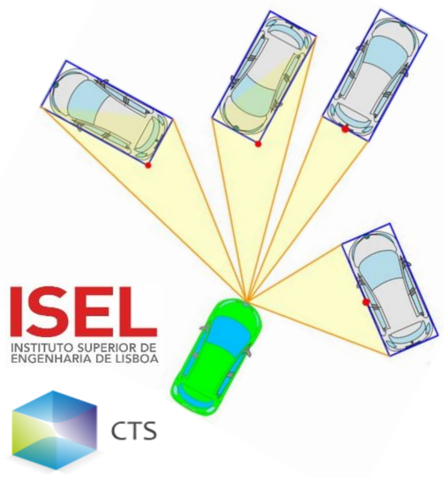
I2V2V2I–Connected vehicles communication

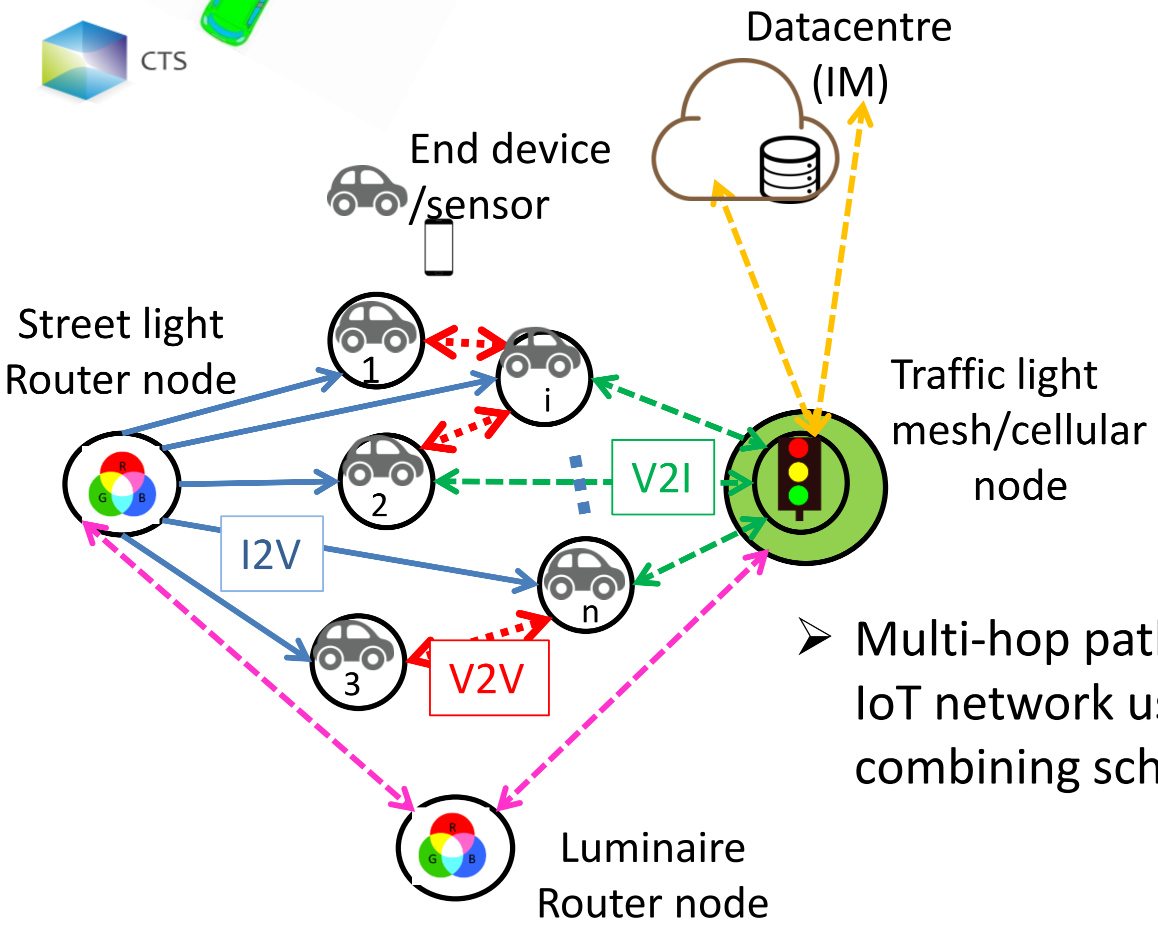


Multi-vehicle cooperative localization

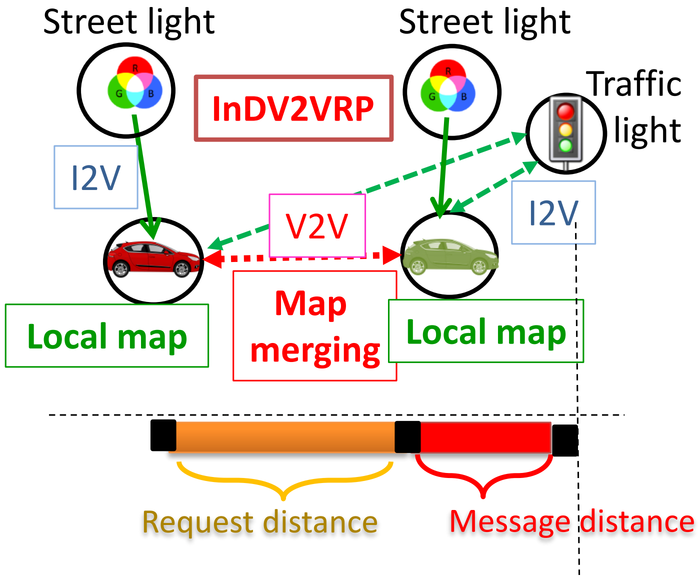


- To navigate autonomously, a vehicle must be able to localize itself with respect to its driving environment and the vehicles with which it interacts.

➢ Exchange of local dynamic maps (LDM), which are cyber-physical representations of the physical driving environment containing poses and kinematic information about nearby vehicles.

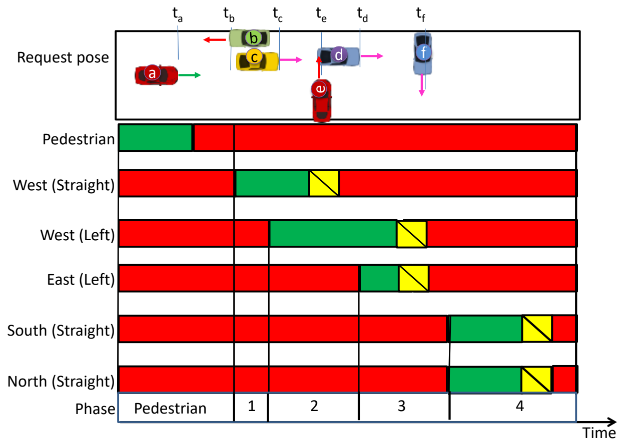


➢ Multi-hop paths in a VLC-based IoT network using diversity combining schemes

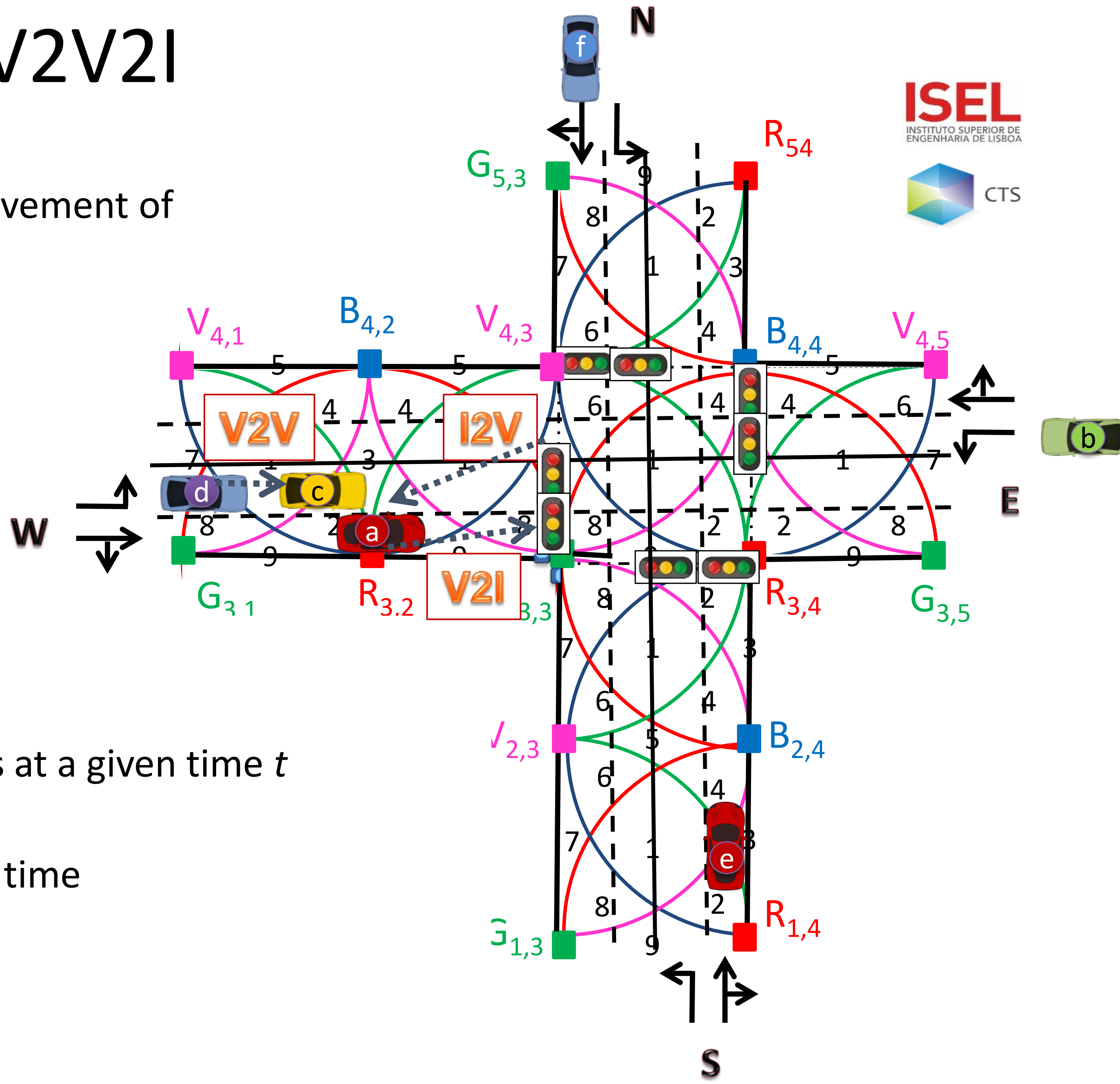


Virtual road network: I2V2V2I

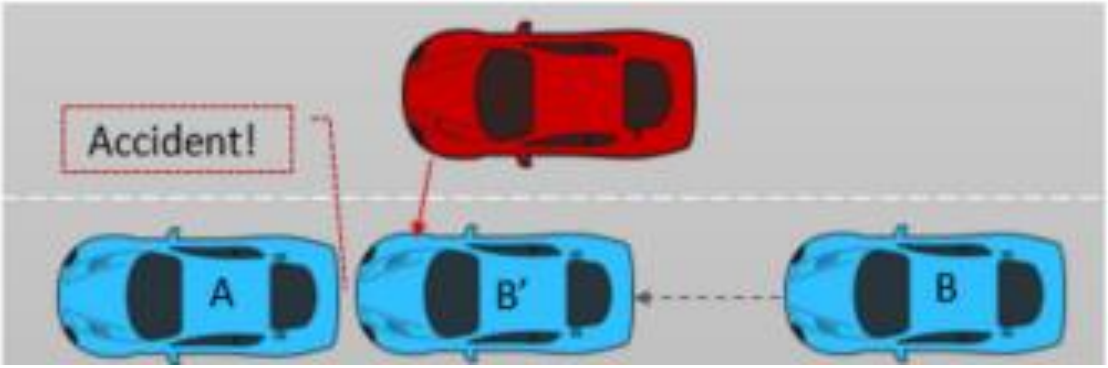
- Information flow towards the traffic light: Improvement of control by precise information about traffic



Traffic Light Phase Assistant” NETWORK



- Locations, speeds, and accelerations of all CVs at a given time *t* are placed in a virtual roadway.
- The signal phases and timing adapt to the real time conditions.
- Traffic actuated.
- Responds to traffic are more efficient .



The privacy and integrity be compromised by:

- ***Illusion*** creating false traffic events by altering vehicle sensor readings to trigger the sending of false traffic information messages
- ***Bogus*** information generate bogus traffic information and make other vehicles choose different paths
- ***Sybil*** a single intruder node can declare itself as multiple nodes, eventually leading to extensive damage to network topologies and consuming large amounts of bandwidth
- ***Timing*** a malicious vehicle receives a message, adds some time delay, and then forwards the message to other vehicles, thus leading to improper timing information
- ***Impersonation*** providing a vehicle with a false identity
- ***Alteration/replay*** attacks employing any previously generated frames to send and communicate with other nodes, with or without alteration

Vehicle manufacturers compete with each other in integrating Artificial Intelligence (AI)

Opens doors for vulnerabilities.

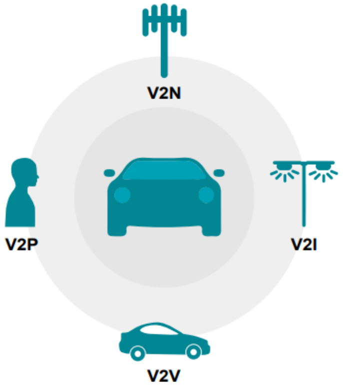
Vulnerabilities.

As threat types vary, understanding its origin, scope and potential impact that it can cause to passenger safety is critical.

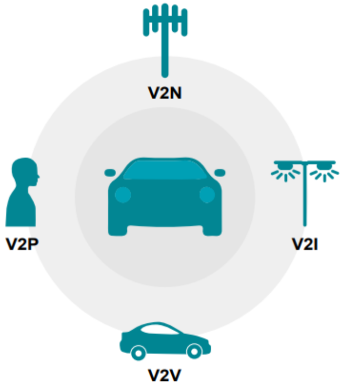
Need of new architectures that utilize Systems of Systems (SoS) approach to detect and mitigate threats.

Such architectures should focus on securing critical units with

- cryptographic and non-crypto based algorithms,
- registration,
- authentication procedures,
- hierarchical layer framework to isolate threats and attacks in three layers:
  - ✓ **control** -vehicle speed control and motion planning
  - ✓ **communication**
  - ✓ **sensing GPS**



V-VLC Challenges



Outdoors communication

- Short communication distance.
- Attenuation of received signal strength due to visibility-limiting weather conditions.
- Interference due to ambiente light radiation from the sun, skylights, streetlights and other sources.
- Large amount of noise from background lights.
- Photodetector saturation especially under direct sunlight exposure.

Vehicular networks

- Safety functionalities: latency and reliability are the primary issues.
- Links establisment while on the move, link availability on multi-lane highways

Integration with other communication technologies

- Integration of VLC in heterogeneous WNs as well as cognitive hybrid links
- Improvement of reliability, quality of service (QoS) and quality of experience in coexisting optical and rf links.

Environmental Sensing: Difficulties for Sensing and Processing the Correct Data

NetWare Experts Panel I

Athens, Greece, November 2021

Aurelie Aurilla Arntzen Bechina
University of South-Eastern Norway

Aurelie Aurilla Arntzen Bechina

aurillaa@usn.no

Dr. Aurilla Aurelie Bechina Arntzen is Professor at Buskerud and Vestfold University College in Norway since January 2008. She is the co-founder of the research group " Advanced Cognitive systems and Data Science" ACSADS ,Kongsberg, Norway. She is **Co-Founder** of the Norwegian Network on Artificial Intelligence and Robotics, KIRN, Oslo, Norway . She is the co-founder of the Institute for Knowledge and Innovation (IKI-SEA) South East Asia, Bangkok, Thailand.

She received her Ph.D. in Automation, from INSA (Institute National des Sciences Appliquées) of Strasbourg, France in 1997. She has several years combined teaching and research IT experience from several well-known International institutions. Her academic interests are broad ranging from real-time systems development to the conception of knowledge systems. In her consultant role, she has been working with customers in Project management, training, Business process improvement, and information and knowledge management systems. She has participated and co-lead several European projects. She served as an expert evaluator for the European commission and the Norwegian research council. She is author and co-author of several technical and scientific publications

Opportunities for Urban Air mobility

Market?

- **European drone market will reach 10B€ per year by 2035 and by 15 15B€ per year 2050**
- **Value added services are expected to represent the largest market opportunity in the drones' value chain.**
- **Developments of drones in term of size, payload, performance are increasing**
- **Potential applications for drone is growing in different fields such as in agriculture, monitoring, deliveries, surveillance, ect…**

USEPE

Drones operations in Urban Environments : Challenges and Opportunities for the U-space

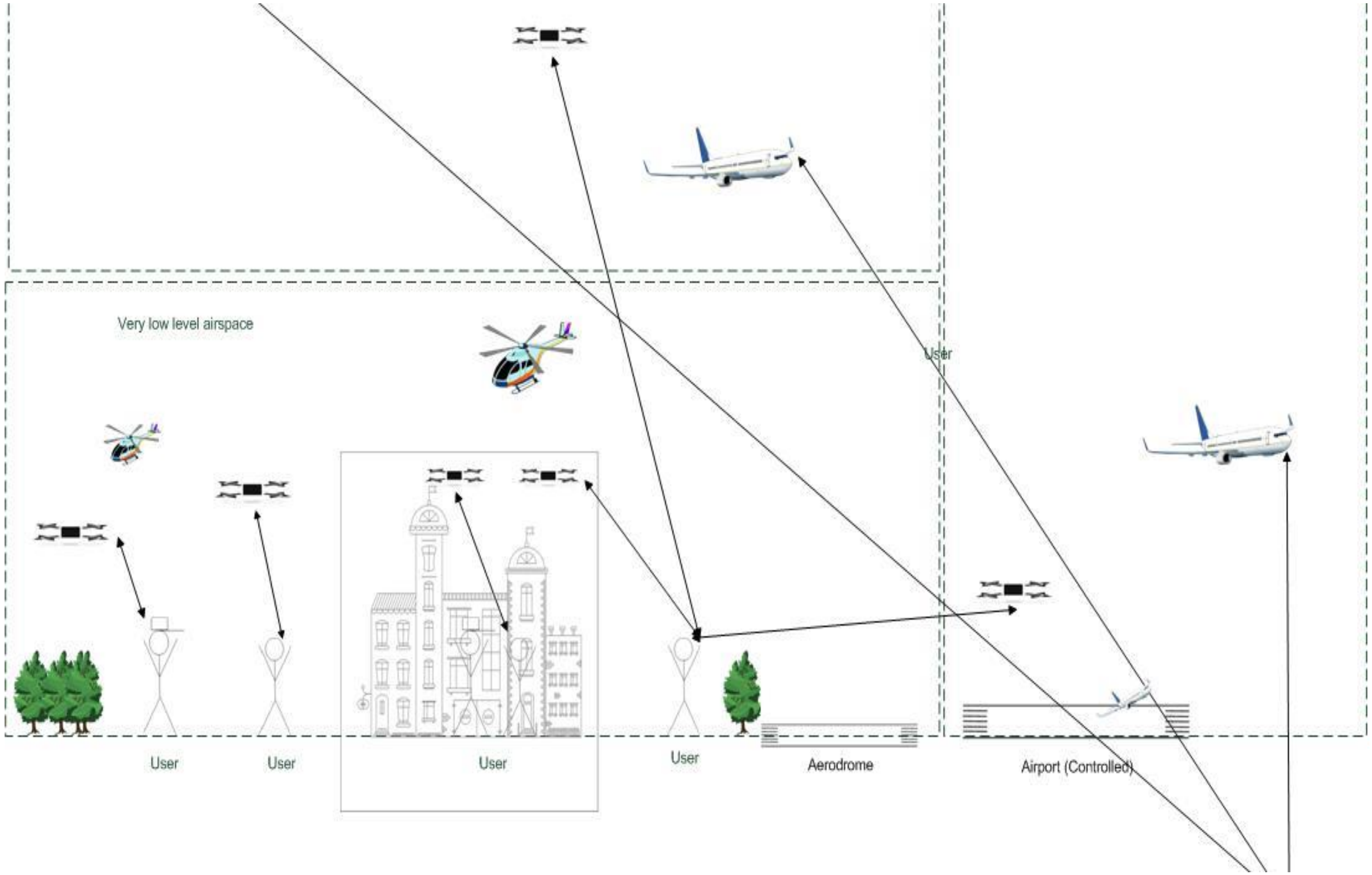
Airspace integration of drones

* All airspace classes

*All types of drones sharing airspace with manned aircraft

*All types of flights

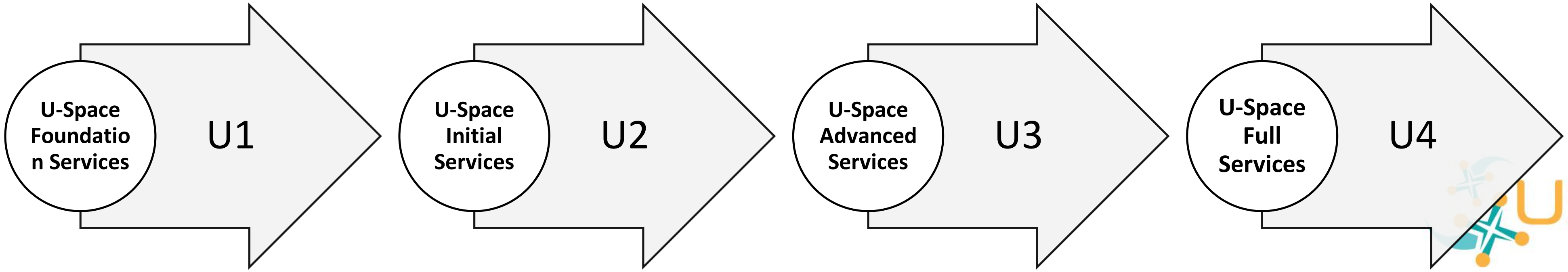
*



U-space an enabler for urban air mobility?

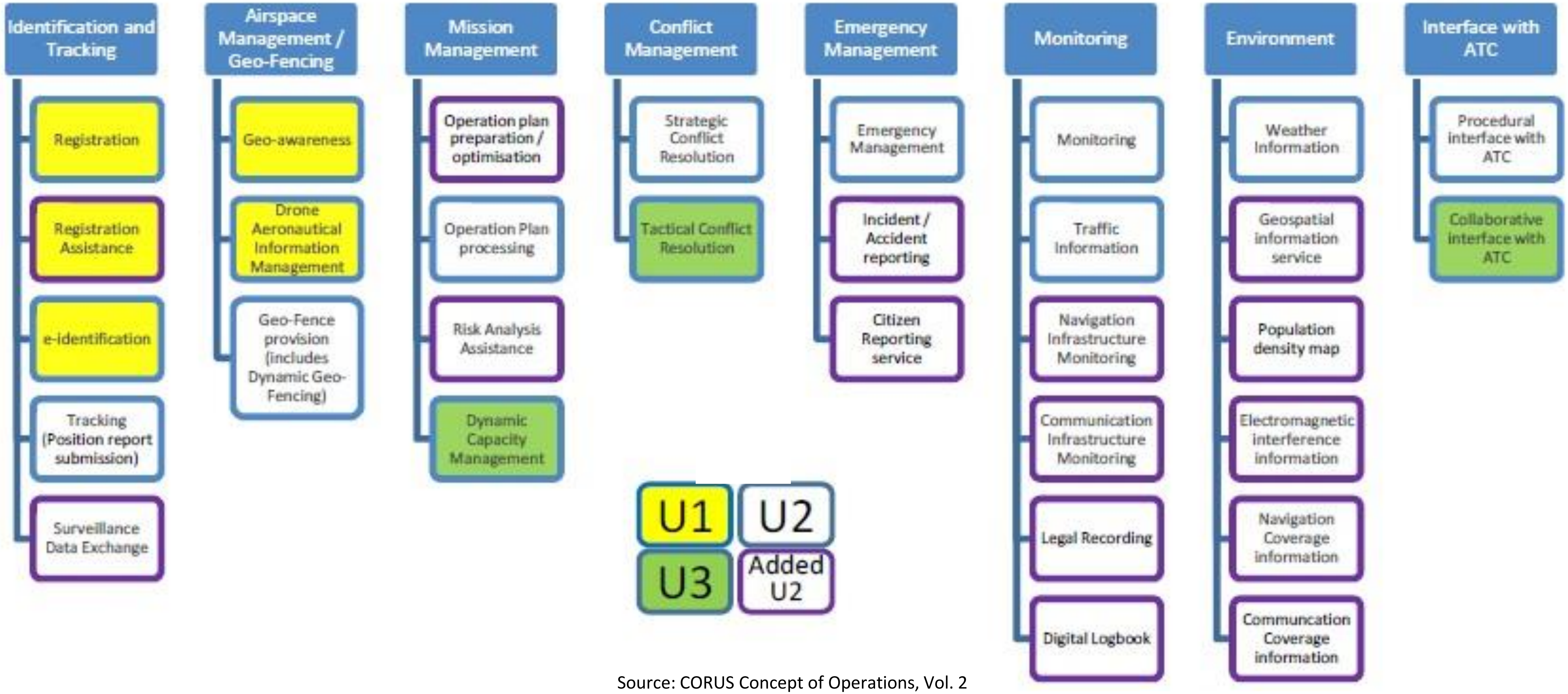
U-Space: set of services and procedures to support safe, efficient and secure access to airspace for large numbers of drones

- U-Space is the European term equivalent to Unmanned Traffic Management (UTM) (Kopardekar, 2014)
- The technology framework for implementation relies on digitalization and automation, IoT, AI and cybersecurity (SESAR J.U., 2018)
- Europe intention is to deploy it in four steps.



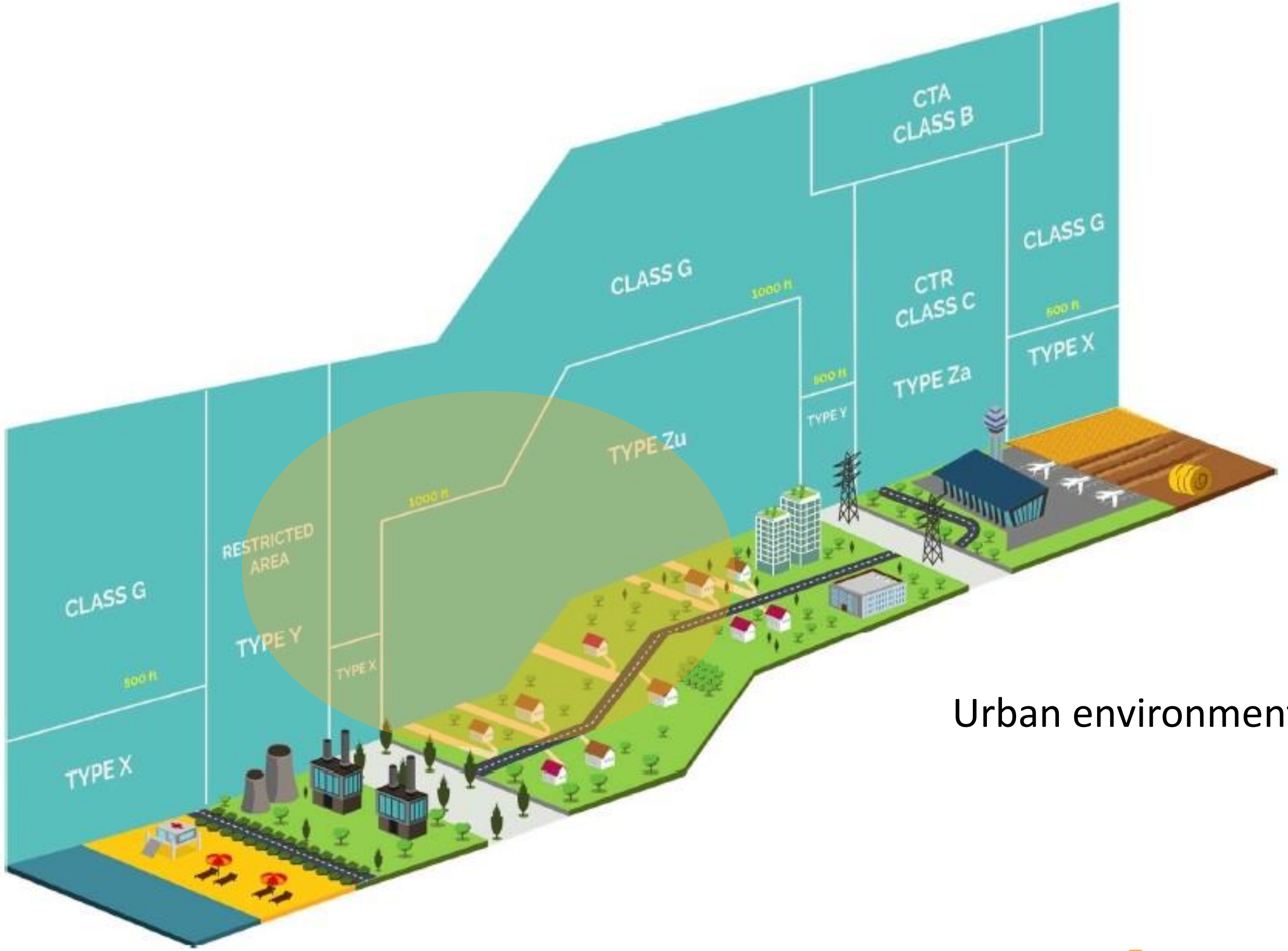
Source: U-Space Bluepring (SESAR J.U., 2018, adapted)

U-Space services applicable to urban environments



Source: CORUS Concept of Operations, Vol. 2

Volumes of airspace in U-space and why it matters to UAV



Urban environment

Source: CORUS Concept of Operations, Vol. 2

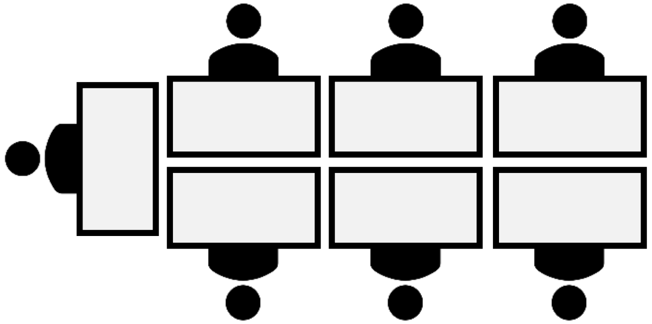
EPE

USEPE (U-space SEParation in EUROPE)

Consortium

Coordinator

Isdefe
your best ally



NOMMON

USN University of South-Eastern Norway

DLR Deutsches Zentrum für Luft- und Raumfahrt German Aerospace Center

Leibniz Universität Hannover

POLIS CITIES AND REGIONS FOR TRANSPORT INNOVATION

indra

Supporting Organizations

Gemeente Enschede

MADRID

GUARDIA CIVIL

AESA AGENCIA ESTATAL DE SEGURIDAD AÉREA

GOBIERNO DE ESPAÑA MINISTERIO DEL INTERIOR

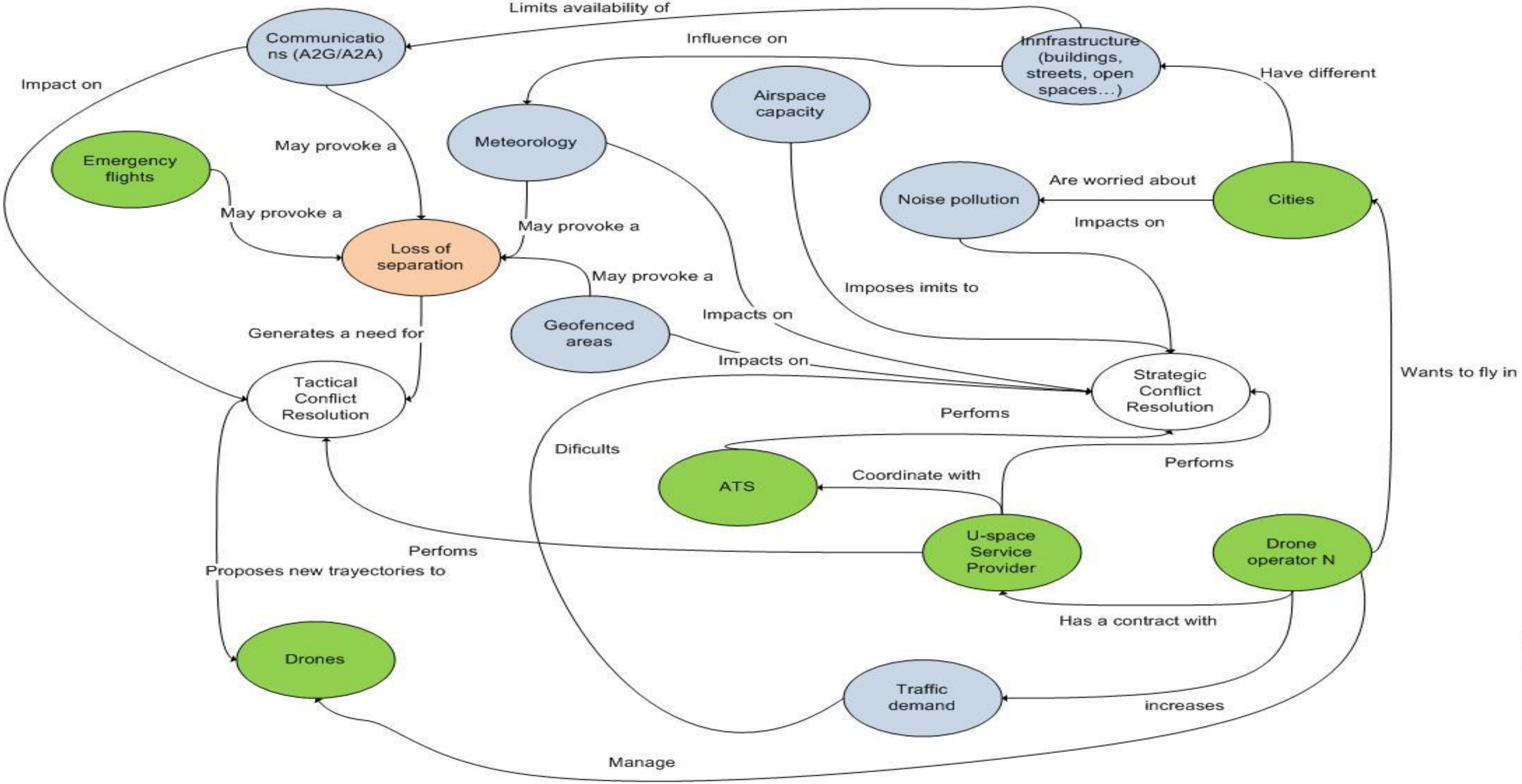
24 months

January 2021

December 2022

USEPE

Systemigram of the Operational Context



E

points to tackle for USEPE (U-space SEParation in EUROPE)

- Conflict detection--Conflict resolution
- Airspace capacity
- Traffic demand
- Meteorology (micro weather)
- Noise pollution.
- Airspace optimisation
- Ground structure (buildings, streets, open spaces)
- Availability of communications (obstacles)
- Geofenced/forbidden areas (fixed or sudden ones)

What are the technical/societal challenges for an urban air mobility?