City Intelligence Lab

Guillermo del Campo

IoTMADLab Technical Director

Universidad Politecnica de Madrid

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AGREEMENT BETWEEN THE MADRID CITY COUNCIL AND THE UNIVERSIDAD POLITECNICA DE MADRID (UPM) FOR THE APPLICATION OF SMART CITY TECHNOLOGIES IN MUNICIPAL AND CITY SERVICES FOR THE PERIOD 2024-2028

MADRID

POLITÉCNICA

UNIVERSIDAD POLITÉCNICA DE MADRID

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Demo & Validation Lab

HW Testing

Software Integration

City Pilots (SUSs)

Digital Twin

Training & Education

Public administration
- Municipal areas
- Public companies
- Regional and national goverments

Business
- Service providers
- Technology vendors
- Urban equipment manufacturers

Research and Education
- Universities and R&D centres
- Professional education
- Primary and High schools

Civil society/users
- Citizens
- Civil servants
- NGOs and associations

Madrid Digital Office

CeDInt POLITÉCNICA

UNIVERSIDAD POLITÉCNICA DE MADRID

ETSIT UPM

IoT MAD LAB
UNA CIUDAD CONECTADA

Context

- City Intelligence Strategy promoted by Madrid Digital Office.
- Smart (sustainable, secure and equitable) cities are powered by technologies such as IoT, Digital Twins, 5G, Edge Computing, Big Data, AI and XR.
- Transversal approach to all the challenges of a large city: mobility, energy, economy, public services, employability and citizen participation.
- Based on appropriate security measures (blockchain, SIEM and IDS, etc).
- Disruptions and innovations demand prior analyses before scalability in the set of municipal services.
- Common and interoperable framework for sensors, actuators and other specific elements deployed in the city's infrastructures, equipment and facilities.
- Data Model and Data Spaces that guarantee the unequivocal interpretation and sharing of information, facilitating data management by the different municipal services in order to improve efficiency and service quality.

Goals

- **Harmonize future smart city implementations.**
  - Identify open, neutral and interoperable IoT protocols and data models: technical requirements.
  - Enable interaction among municipal services.

- **Boost Public-Private Innovation towards optimization and competitiveness:**
  - Technological providers: devices, platforms, solutions, 5G operators.
  - Municipal services providers: management, applications, city platform.
  - Citizens: end user engagement & gamification.
  - Training and education: new skills for students and unemployed.
  - GovTech: digital government transformation.

- **Smart Urban Spaces as living labs:**
  - Laboratory environment (Phase 0).
  - University campus controlled environment (Phase 1).
  - Real urban environment (Phase 2).

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SCOPE - Areas of action

NETWORK

For the interconnection of the elements in the network, gateways are needed to securely link the elements located in one area with the rest of the network and with the management and operation platforms.

ENERGY

Energy management of all types of facilities

MOBILITY

Management of elements related to urban mobility (e.g. SER, APR, ZBE, parking spaces, connected traffic lights, EMT, BiciMad).

GREEN AREAS, PARKS, AND GARDENS

Monitoring and management of equipment and facilities and their use, as well as trees, flora and fauna, irrigation, water and energy meters

CLEANING AND WASTE MANAGEMENT

Monitoring of containers, garbage cans, garbage cans, sweepings, sweeping, and clean points.

LIGHTING

Lighting installations for exterior and interior environments and building illumination.

SECURITY AND EMERGENCY

Monitoring of activity in public spaces to enhance citizen safety and improve emergency response.

ENVIRONMENT

Monitoring of biodiversity air quality, atmospheric conditions, and light pollution.

URBAN FACILITIES

Management and maintenance of furniture, fountains, galleries, tunnels and other city facilities.

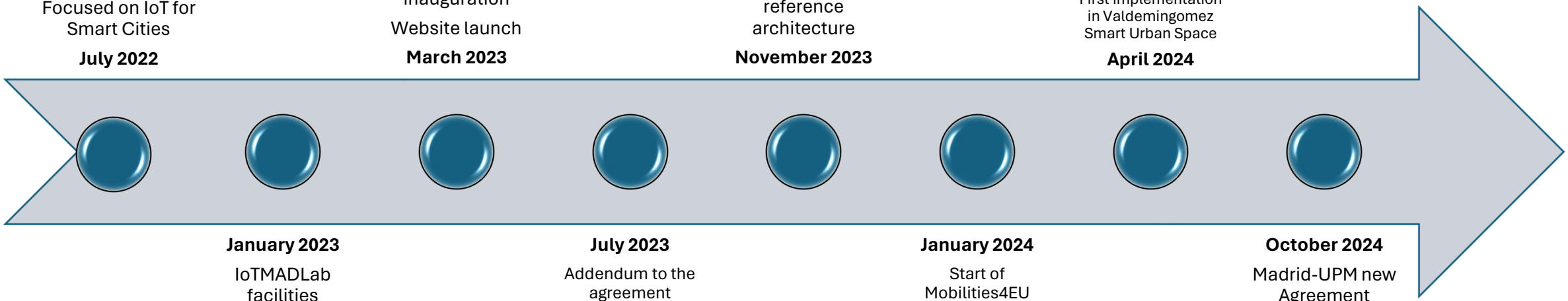
URBAN SPACES

Monitoring of licenses, authorizations, responsible declarations and previous communications to verify compliance (urban planning, activities, taxes, public road occupations).

PEOPLE

Interaction of people and their devices with those of the city's IoT and municipal services.

Timeline


Madrid-UPM Agreement
Focused on IoT for Smart Cities
July 2022
January 2023
IoTMADLab facilities
set-up
Indoor and Outdoor laboratories
IoTMADLab oficial inauguration
Website launch
March 2023
July 2023
Addendum to the agreement inclusión of 5G and Cybersecurity groups
Publication of IoT Network reference architecture
November 2023
January 2024
Start of Mobilities4EU Project
Mercamadrid Smart Urban Space
First implementation in Valdemingomez Smart Urban Space
April 2024
October 2024
Madrid-UPM new Agreement
City Intelligence Lab

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Flow chart

Government

- Joint Commission
- Executive Commitee
- Technical Office

Technology Working Groups

Internet of Things | 5G | Cybersecurity | Data/AI

Smart Urban Spaces

- Mercamadrid
- Valdemingomez
- Casa de Campo
- (up to 21 city districts)

City Challenges

- Connected vehicle
- Decarbonized cities
- Zero Energy Buildings
- Digital Twin
- Drones

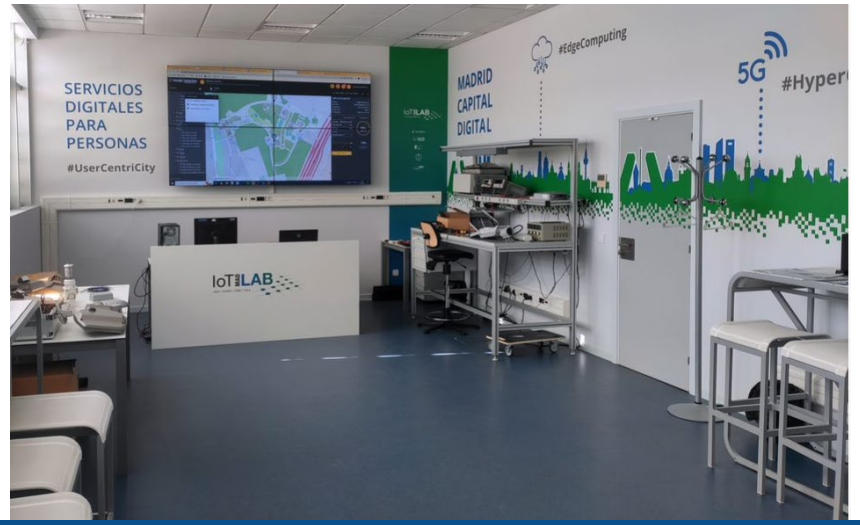
Impact actions

- National and international projects
- Degree Awards
- Employment courses

Collaboration

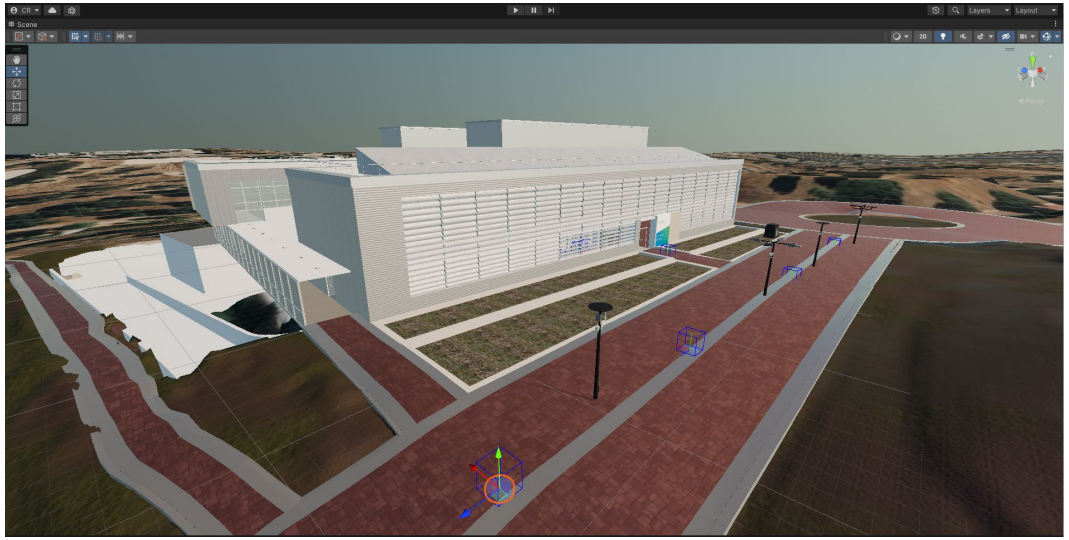
- Industry participation
- Education and Research
- International network

Indoor Laboratory: testbed and control panel

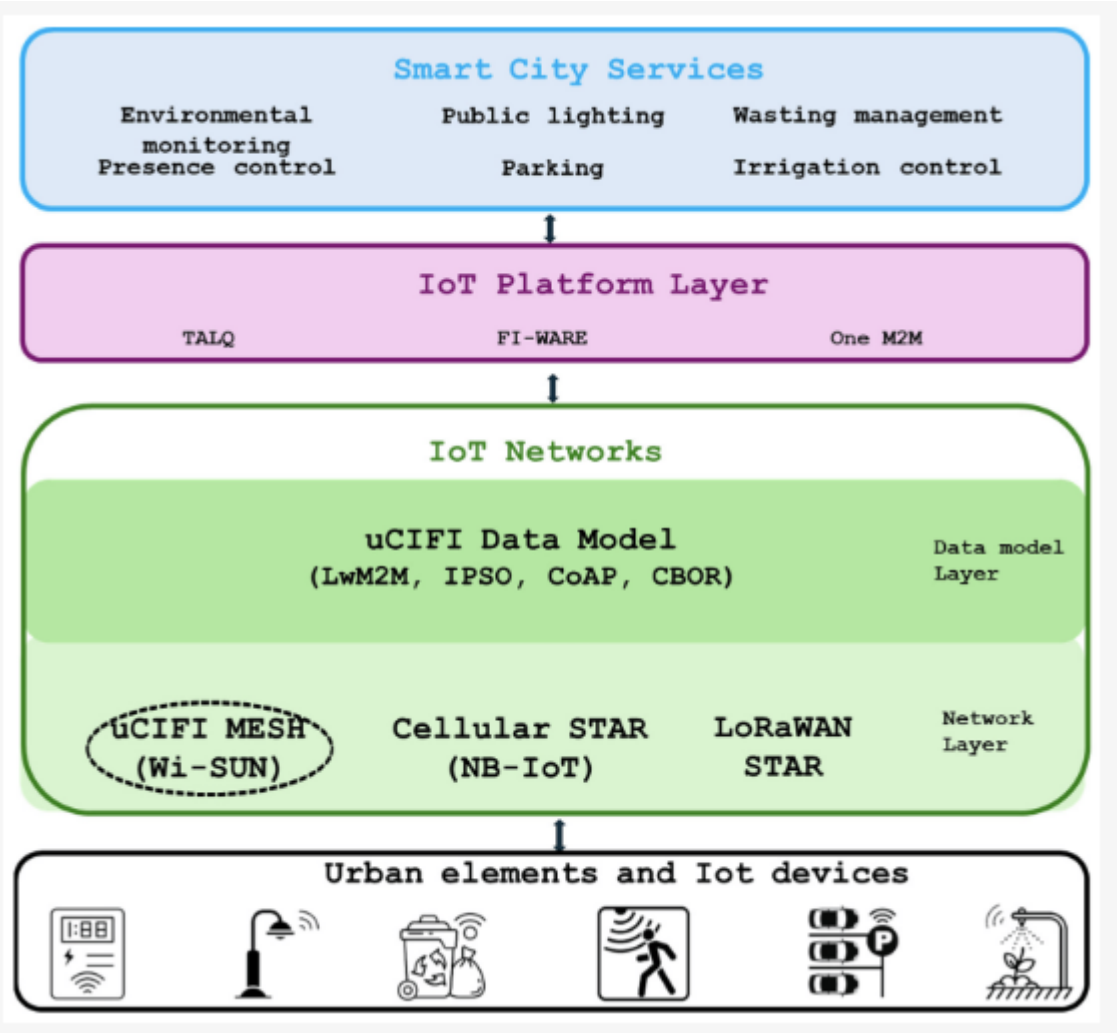


Outdoor Laboratory: Smart space in a controlled area

VR/AR Laboratory: Digital Twin development



IoT Network Reference Architecture



Object Name	ID	Instances	Object URN
Temperature Sensor	3303	Multiple	urn:oma:lwm2m:ext:3303

Resource	ID	Oper.	Mandatory	Type	Units	Description
Sensor Value	5700	R	Mandatory	Float	Defined by "Units" resource	Current measured sensor value
Min Measured Value	5601	R	Optional	Float	Defined by "Units" resource	The minimum value measured by the sensor since power ON
Max Measured Value	5602	R	Optional	Float	Defined by "Units" resource	The maximum value measured by the sensor since power ON
Min Range Value	5603	R	Optional	Float	Defined by "Units" resource	The minimum value that can be measured
Max Range Value	5604	R	Optional	Float	Defined by "Units" resource	The maximum value that can be measured
Sensor Units	5701	R	Optional	String		Measurement units definition e.g. "Cel" for celsius
Reset Min and Max Measured Values	5605	E	Optional	String		Reset the min and max measured values to current value

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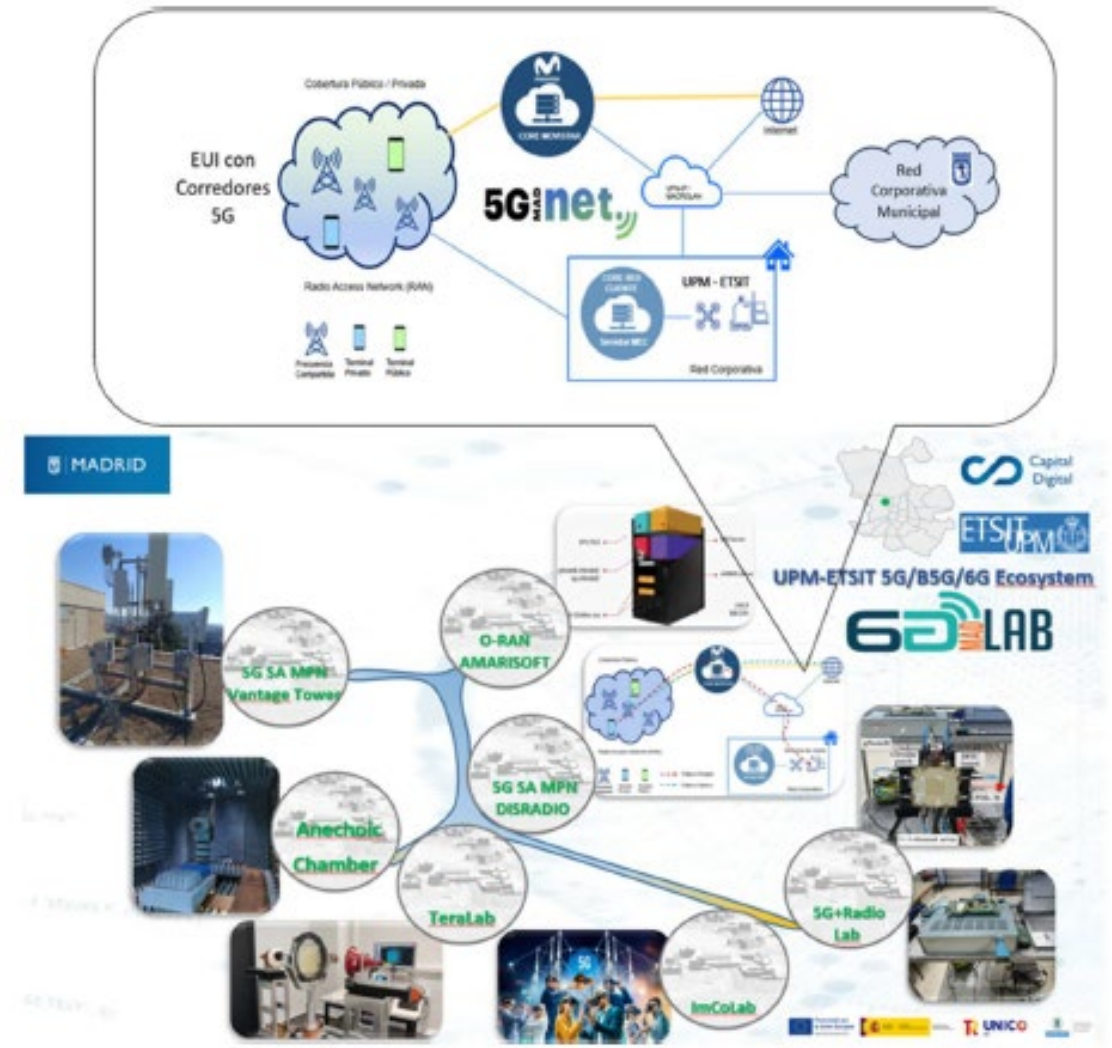
5G/6G



Collaborative work: between Madrid City Digital Office and ETSI Telecomm - UPM

Global focus: Deployment of a 5G private network aligned with the transformation strategy of Madrid Capital Digital (5G Agenda).

Real implementation: Application of 5G (5G+/6G) technologies in municipal services and services for citizens

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5G/6G

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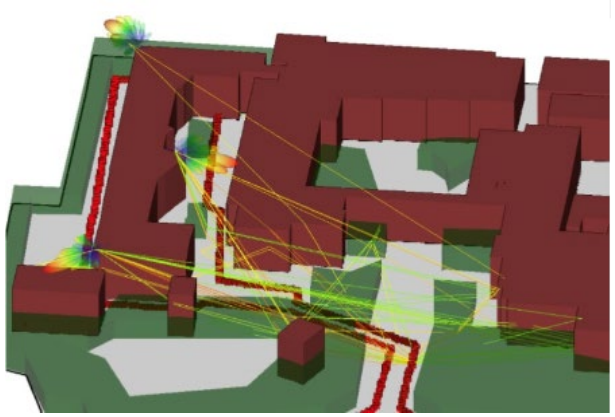
Vehicle mobility in mmWaves



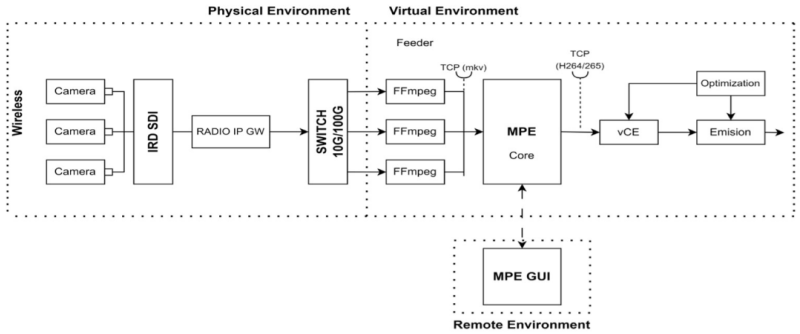
The proposed network architecture is based on the use of Repeater Nodes:

- Amplify-&-Forward - Layer 1.
- Decode-&-Forward - Layer 2.
- Working band: 26 GHz.

Tests and measurements on a fleet of municipal buses aims to use the deployed commercial 5G network and verify the improvement in data traffic and passenger quality of service through the use of the Decode-&-Forward Repeater Node.

To respond to one of the main limitations of the current broadband connectivity solutions in mobility, proposed in 5G.

Remote production of digital content



- MPE: Video mixer/mixer.
- vCE: Multimedia content compression and adaptation engine.
- Optimization based on reinforcement learning and content analysis.
- Contribution via 5G (wireless) network.

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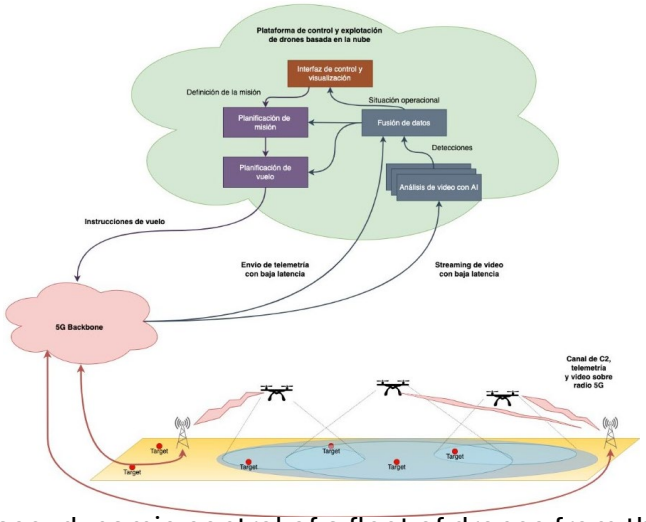
5G/6G

6G MAD LAB

Drone control and operation platform



- Use case: dynamic control of a fleet of drones from the analysis of their video channels.
- Problem: drones have low computational capacity.
- Possible alternative: processing and control from a centralized platform.
- Requirements: drone-platform communications must have high bandwidth, reliability and low latency.

5G Ultra-Reliable Low-Latency Communication - 5G URLLC

Intelligent fusion of local stakeholders in remote environments

- The user controls the position of the virtual camera so there is free navigation through the scene.
- Virtual views (not captured by real cameras) are synthesized using the information captured by the real cameras.
- Several virtual camera paths can be described simultaneously over the same live content.

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Cybersecurity

G3CS UPM RSTI CMAD Centro de Ciberseguridad Ayuntamiento de Madrid

Collaborative work: between Madrid City (CCMAD) and UPM.

Global focus: cybersecurity threats in all IoT layers within a Smart City**.**

Real implementation: theoretical analysis and experimental validation in EUIs**.**

IoT devices and communications

5G environments

Cyber-situational awareness

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Cybersecurity

G3CS UPM RSTI CMAD Centro de Ciberseguridad Ayuntamiento de Madrid

LABCIBER-IOT

- Cryptography (primitives, schemes and protocols)
- Secure identification
- IoT cryptographic sensors and devices

LABCIBER-5G

- Cybersecurity issues related to IoT devices and advanced 5G wireless communications technologies.

- **Theoretical-practical analysis of the IoTMADLab architecture**
- **Definition and integration of a Cybersecurity Checklist**
- **Definition of security tests on devices and experimental validation of IoT devices, gateways and IoT Platforms**
- **Analysis of security challenges and threats in 5G networks**
- **Design and deployment of virtualised tests**
- **Validation of risk management using ontologies**
- **Study of AI-based intrusion detection application for attack prevention and response**

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Cybersecurity

G3ZS UPM RSTI

CMAD Centro de Ciberseguridad Ayuntamiento de Madrid

LABCIBER-IOT

LABCIBER-5G

CHECKLIST - Technical requirements

I. The device must have unique identities, generically and within the IoT environment where it is deployed.

II. It must be possible to identify the device model.

III. Access to the configuration must be protected with simple and secure authentication and authorisation mechanisms.

IV. Security parameters must be unique, and it must not be possible to return them to generic values.

V. Security parameters must not be obtainable by automatic mechanisms or through public information. They must be stored securely and must resist brute force attacks.

VI. Cryptographic primitives and algorithms must be updateable.

VII. The device must have secure and automated update management mechanisms.

VIII. Sensitive data must be securely stored and erased.

IX. The information available on the device should be kept to a minimum.

X. All device interfaces, as well as the information contained therein and access to data exchange services, should have authentication, authorisation and confidentiality mechanisms, using strong cryptographic systems, for access to sensitive information.

XI. Data entered through interfaces, or exchanged in data exchange services, should be validated.

XII. The device should have functions to detect anomalies in the normal flow of operation of its interfaces, processing units, software/firmware and data exchange services.

XIII. All unused functions, software or interfaces should be disabled or removed.

XIV. Executed software should have the minimum privilege level necessary for its operation.

XV. The software must be protected against unauthorised use of test or debugging functions.

XVI. The software must securely store logs and allow them to be audited.

XVII. The software must store logs securely and allow for auditing.

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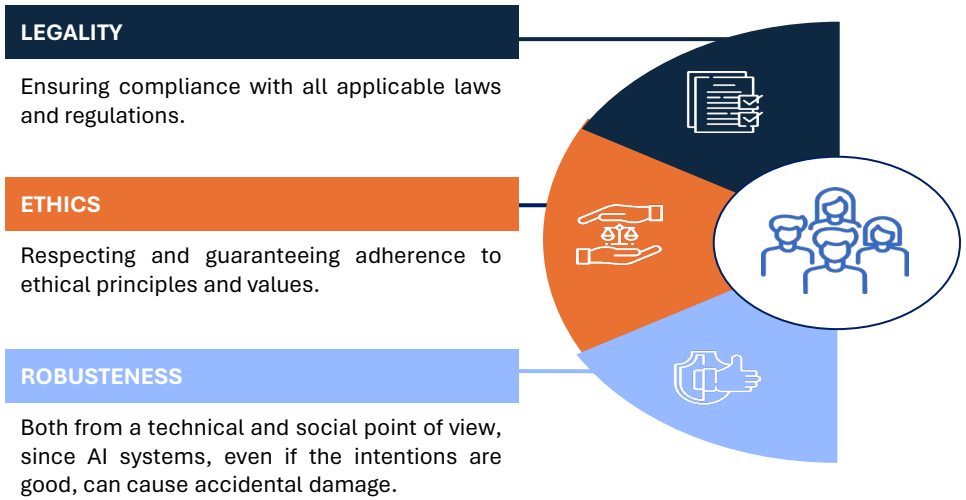
Data/IA

- Advanced data analysis to study the evolution over time of city uses and their representation through digital twins, virtual reality and augmented or extended reality (XR).
- Generation of Data Spaces that guarantee the unequivocal interpretation and sharing of information.
- Aligned with Madrid AI Itinerary



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Smart Urban Spaces in Madrid city

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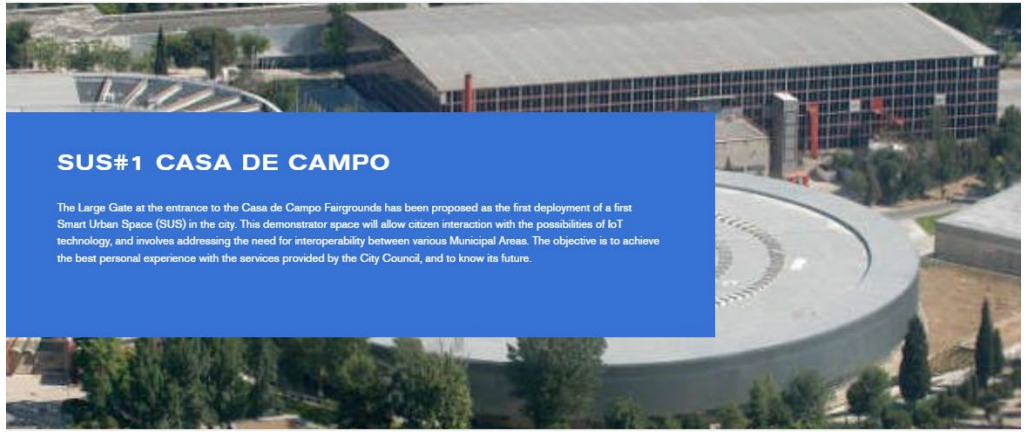

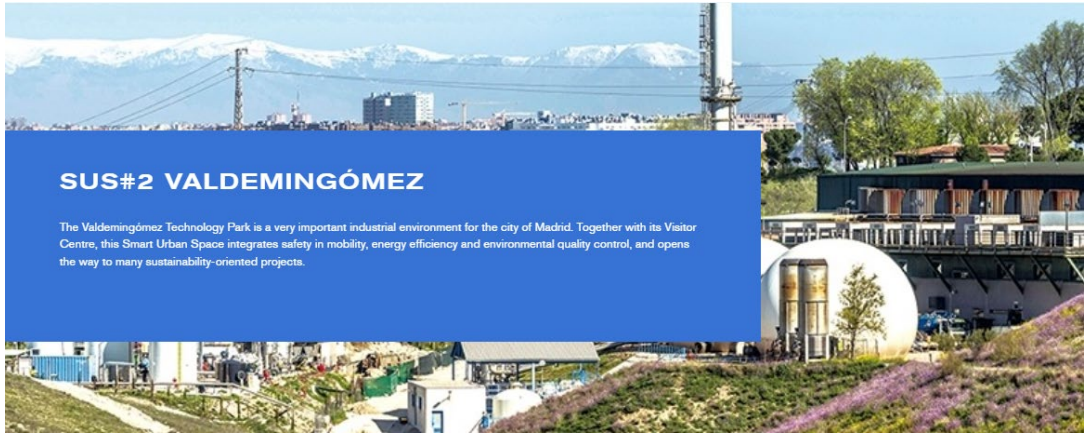

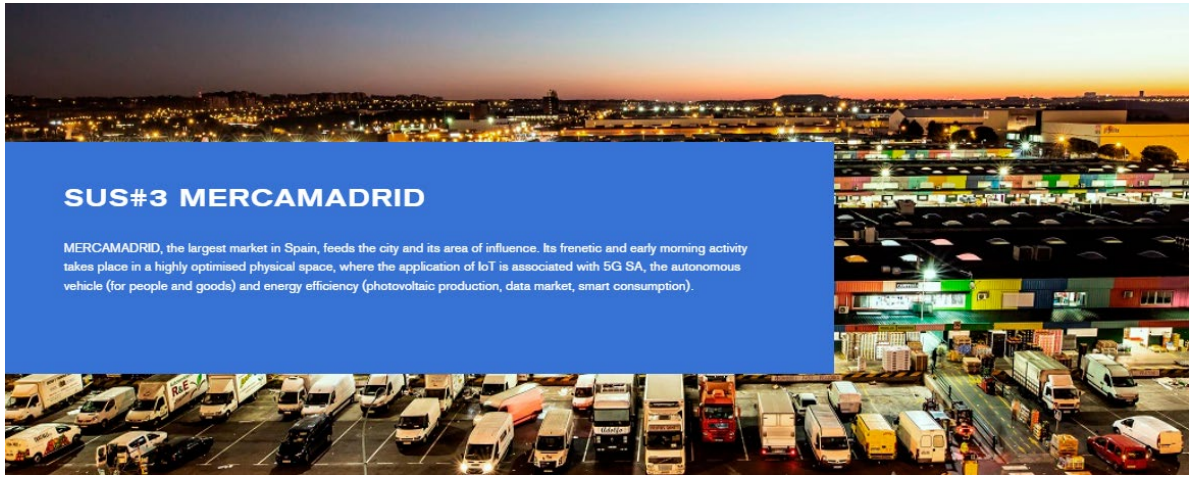

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SUS#1 Casa de Campo

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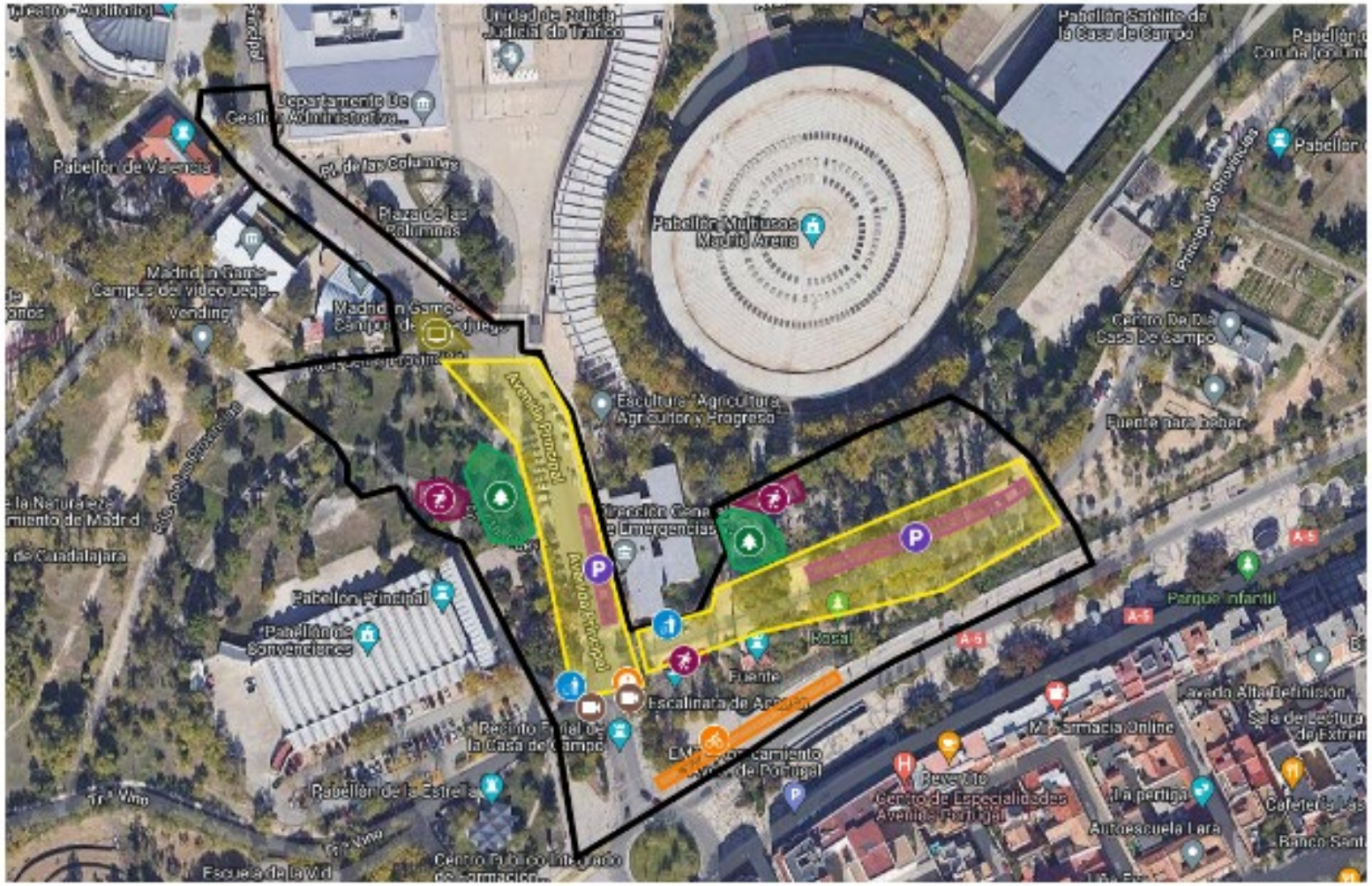

- Outdoor exercise facilities
- Parks and green areas
- Mobility cameras
- Parking areas
- Waste bins and cans
- VR digital twin experience
- Street lighting fixtures
- Citizens interaction
- Bike lane

Integration in a 5G corridor

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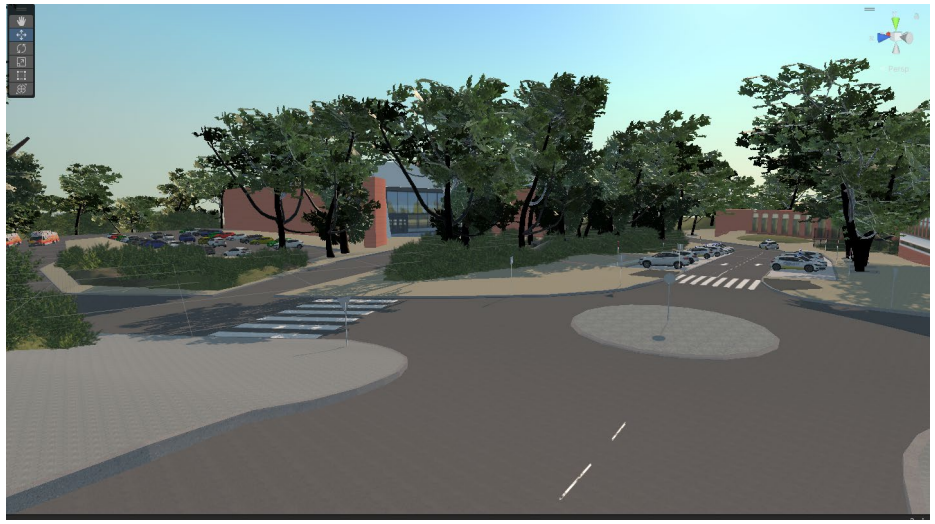
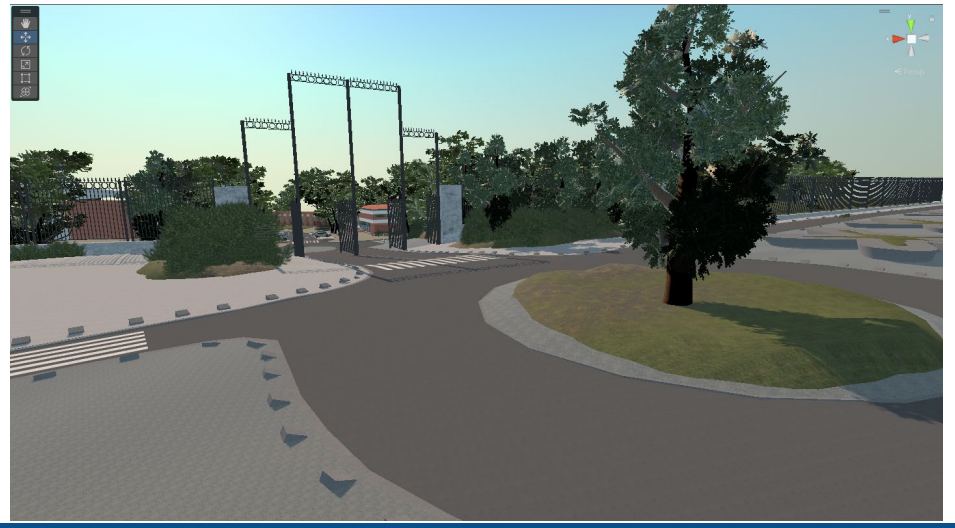
SUS#1 Casa de Campo





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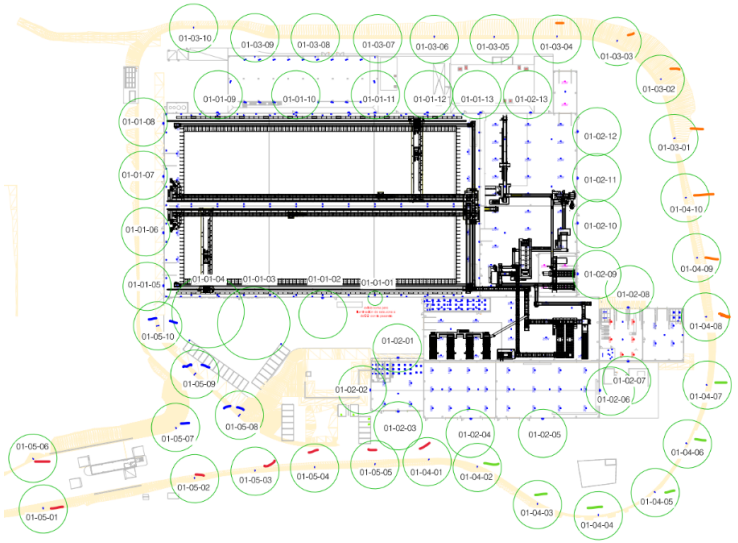
SUS#2 Valdemingomez



IDE	ZONA/CM	LINEA ELECTRI	IDE LUMINA	MODELO LUMINARIA
01-03-01	1	3	1	VERA S VRS 60 ROAD III 500mA 4000K 60W - HISPALED
01-03-02	1	3	2	VERA S VRS 60 ROAD III 500mA 4000K 60W - HISPALED
01-03-03	1	3	3	VERA S VRS 60 ROAD III 500mA 4000K 60W - HISPALED
01-03-04	1	3	4	VERA S VRS 60 ROAD III 500mA 4000K 60W - HISPALED
01-03-05	1	3	5	LEDROAD-ST-P2- 4000k 80W - OPPLE
01-03-06	1	3	6	LEDROAD-ST-P2- 4000k 80W - OPPLE
01-03-07	1	3	7	LEDROAD-ST-P2- 4000k 80W - OPPLE
01-03-08	1	3	8	LEDROAD-ST-P2- 4000k 80W - OPPLE
01-03-09	1	3	9	LEDROAD-ST-P2- 4000k 80W - OPPLE
01-03-10	1	3	10	LEDROAD-ST-P2- 4000k 80W - OPPLE
01-04-01	1	4	1	ALFUM60 AE 4000K 60W - BENITO
01-04-02	1	4	2	VEKA S 4000K 53,1W - CARANDINI
01-04-03	1	4	3	VEKA S 4000K 53,1W - CARANDINI
01-04-04	1	4	4	VEKA S 4000K 53,1W - CARANDINI
01-04-05	1	4	5	VEKA S 4000K 53,1W - CARANDINI
01-04-06	1	4	6	VEKA S 4000K 53,1W - CARANDINI
01-04-07	1	4	7	VEKA S 4000K 53,1W - CARANDINI
01-04-08	1	4	8	VERA S VRS 60 ROAD III 500mA 4000K 60W - HISPALED
01-04-09	1	4	9	VERA S VRS 60 ROAD III 500mA 4000K 60W - HISPALED
01-04-10	1	4	10	VERA S VRS 60 ROAD III 500mA 4000K 60W - HISPALED
01-05-01	1	5	1	ALFUM60 AE 4000K 60W - BENITO
01-05-02	1	5	2	ALFUM60 AE 4000K 60W - BENITO
01-05-03	1	5	3	ALFUM60 AE 4000K 60W - BENITO
01-05-04	1	5	4	ALFUM60 AE 4000K 60W - BENITO
01-05-05	1	5	5	ALFUM60 AE 4000K 60W - BENITO
01-05-06	1	5	6	ALFUM60 AE 4000K 60W - BENITO
01-05-07	1	5	7	TECEO 1 30 LEDS 800mA 4000K óptica 5303 77W - SOCELEC
01-05-08 a	1	5	8	TECEO 1 30 LEDS 800mA 4000K óptica 5303 77W - SOCELEC
01-05-08 b	1	5	8	TECEO 1 30 LEDS 800mA 4000K óptica 5303 77W - SOCELEC
01-05-09 a	1	5	9	TECEO 1 30 LEDS 800mA 4000K óptica 5303 77W - SOCELEC
01-05-09 b	1	5	9	TECEO 1 30 LEDS 800mA 4000K óptica 5303 77W - SOCELEC
01-05-10 a	1	5	10	TECEO 1 30 LEDS 800mA 4000K óptica 5303 77W - SOCELEC
01-05-10 b	1	5	10	TECEO 1 30 LEDS 800mA 4000K óptica 5303 77W - SOCELEC

FABRICANTE	
Denominación Social:	Schréder
Dirección física:	SCHRÉDER SOCELEC SA Pol. Ind. El Henares - Av. Roanne 66 19180 Marchamalo (Guadalajara), España +34 9 49 32 50 80
Página WEB:	https://sp.schreder.com/es
Mail de contacto:	mailto://comercialspain@schreder.com
EQUIPO	
Clasificación:	Luminaria viaria > Luminarias Post-top
Denominación:	IZYLUM
Referencia comercial:	
Versión / fecha de comercialización:	
Imagen	
URL del producto:	https://sp.schreder.com/es/productos/iluminacion-led-exterior-izylum
Características:	Altura recomendada para la instalación: 4 – 15 m. Temperatura de funcionamiento: -40ºC a +55ºC. Módulo de LEDs: 40 LEDs.
Sensores:	Como miembro fundador del consorcio Zhaga, Schréder ha participado en la creación del programa de certificación Zhaga-D4i y en la iniciativa de este grupo para estandarizar un ecosistema interoperable.

ANEXO I: CHECKLIST LUMINARIA	
Conector Zhaga superior	Sí
Conector Zhaga inferior	Sí
Protocolo Dali4	Sí
Alimentación	220 – 240 V
Control con nodo IoT	Sí
Control con sensor PIR	Sí
Descubrimiento en Plataforma IoT	Sí
Apertura sin herramientas	Sí

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SUS#3 MercaMadrid

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MOBILITIES FOR EU

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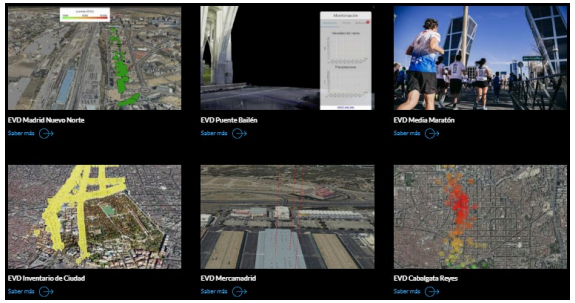
Challenges

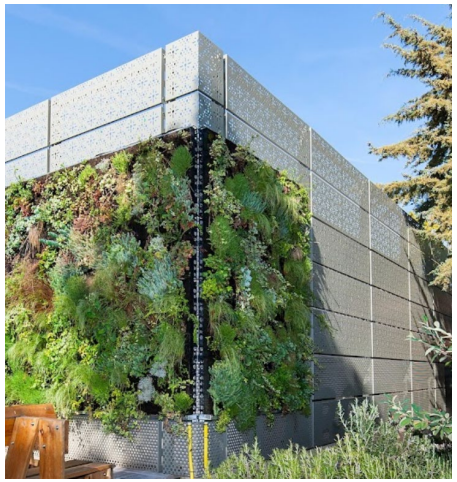
Decarbonized cities

Digital Twin



Connected Vehicle

Zero Energy Buildings



Drones

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Industry and International support

ferrovial
acciona
Schréder
PARADOX ENGINEERING
MinebeaMitsumi Group
NTT DATA
accenture
signify
ABB
CabinPaq
prezero
libelium
Behind the change. Beyond the challenge.
JCDecaux
ekiona
iluminación solar
Clear Channel
SULO
SICE
Tellink
EMT MADRID
vivepark
EURO CITIES
European Commission
LISBOA
CÂMARA MUNICIPAL
European Network of Living Labs
Université de Toulouse
LISBOA
UNIVERSIDADE DE LISBOA

Stakeholders benefits

Local government: IoT digital infrastructure harmonization.

Technological vendors: alignment with a technical definition.

Service providers: management capacity and competitiveness boost.

Municipal areas: provider agnostic (higher competency and transparency).

Research and academia: new collaboration and funding opportunities.

Citizens: engagement and co-creation enabling.

Education: digital and future skill courses and capacities.

International community: network of IoT living labs.