Drone Interest Group (DIG)

Deep Dive #2

28th June 2022

GSMA DRONE INTEREST GROUP

Deep Dive # 2

2022

GSMA Foundry - 5G Autonomous Drone

Moderator

Invited Speakers

BARBARA PAREGLIO

Executive Director for Connectivity for Aviation and Drones at GSMA

GSMA

DAVID MORO FERNANDEZ

Head of Service & Platform

Telefónica

KIM CLEMENT

CTO of Unmanned Life

UNMANNED LIFE

GSMA

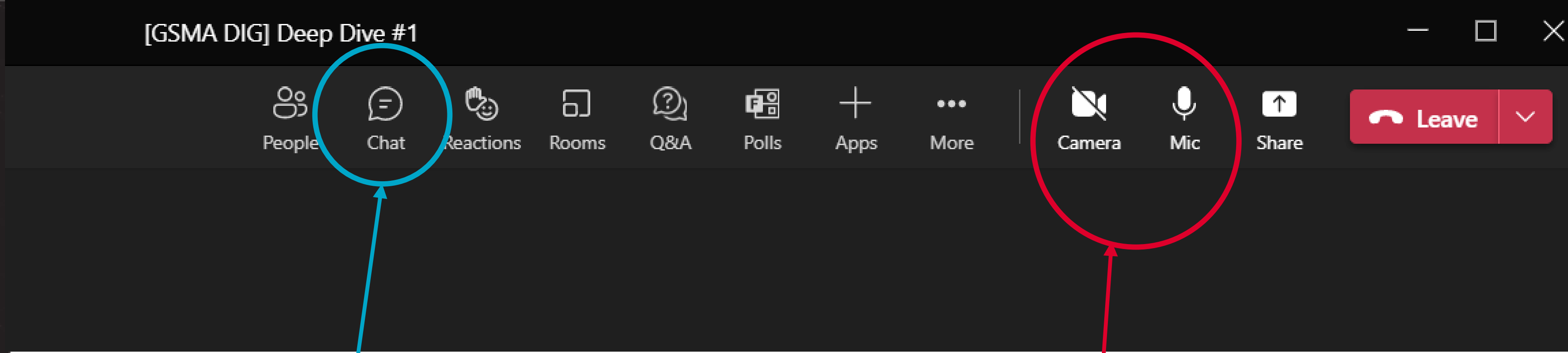
28th June 2022

2:00 - 4:00 pm BST

https://www.gsma.com/iot/drones-interest-group-dig/

Agenda

14:00-14:15	Welcome & Introduction	Barbara Pareglio, **GSMA**
14:15-14:45	5G Autonomous Drone: Implementing drone orchestration over the operator platform using cellular connectivity and edge	David Moro Fernandez, **Telefonica**
14:45-15:30	5G Autonomous Drones: Drone swarm and AI enabled Use Cases	Kim Clement, **Unmanned Life**
15:30-15:30	Q&A	All
15:30-16:00	GSMA closing remarks	Barbara Pareglio, **GSMA**
Meeting Close		



housekeeping rules for the session

- Camera and microphone off for all participants except for presenters/speakers.
- Please use the chat for your questions, indicate for whom is the question and we will try to answer as much as we can during the session.

GSMA Advance Air Mobility

Introduction

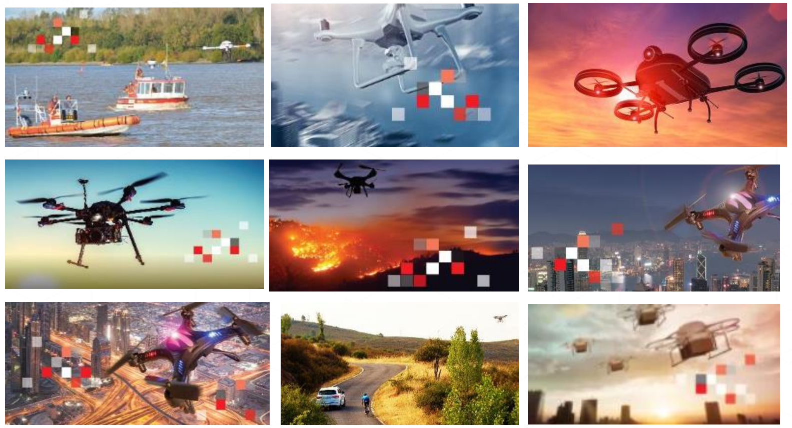
Barbara Pareglio

GSMA activities and groups for AAM

- GSMA Working Groups
- GSMA Regional Support & Engagement
- GSMA Foundry Projects
- GSMA MWC Events
  GSMA 360 Events

Available resources

Case studies



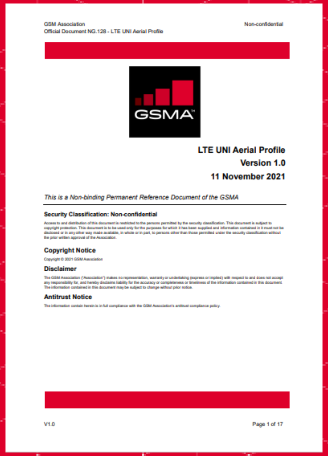
Whitepapers

Glossary

A	B	C	D	E	F
Q	R	S	T	U	V

- Registration
- Regulated Airspace
- Reliability
- Remote Identification
- Remote Pilot-in-Command

Guidelines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Official Document NG.128 - LTE UNI Aerial Profile

GSMA

LTE UNI Aerial Profile
Version 1.0
11 November 2021

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V1.0 Page 1 of 17

WebTalks

GSMA FOUNDRY

Join us to scale business solutions, fast.

GSMA.com/Foundry

Let's shape the future together!

The GSMA Foundry is the go-to place for cross-industry collaboration and business development, where GSMA members and industry players come together to rapidly develop real-world solutions to industry challenges, nurture new ideas through initial commercial trials and scale proven solutions at a regional and global level to forge our digital future.

The Foundry utilises the global power and reach of the GSMA to convene, engage and unify the end-to-end connectivity ecosystem.

Focus on fixed term tangible projects with resource commitments from partners

GSMA Foundry 5G Autonomous Drone Project

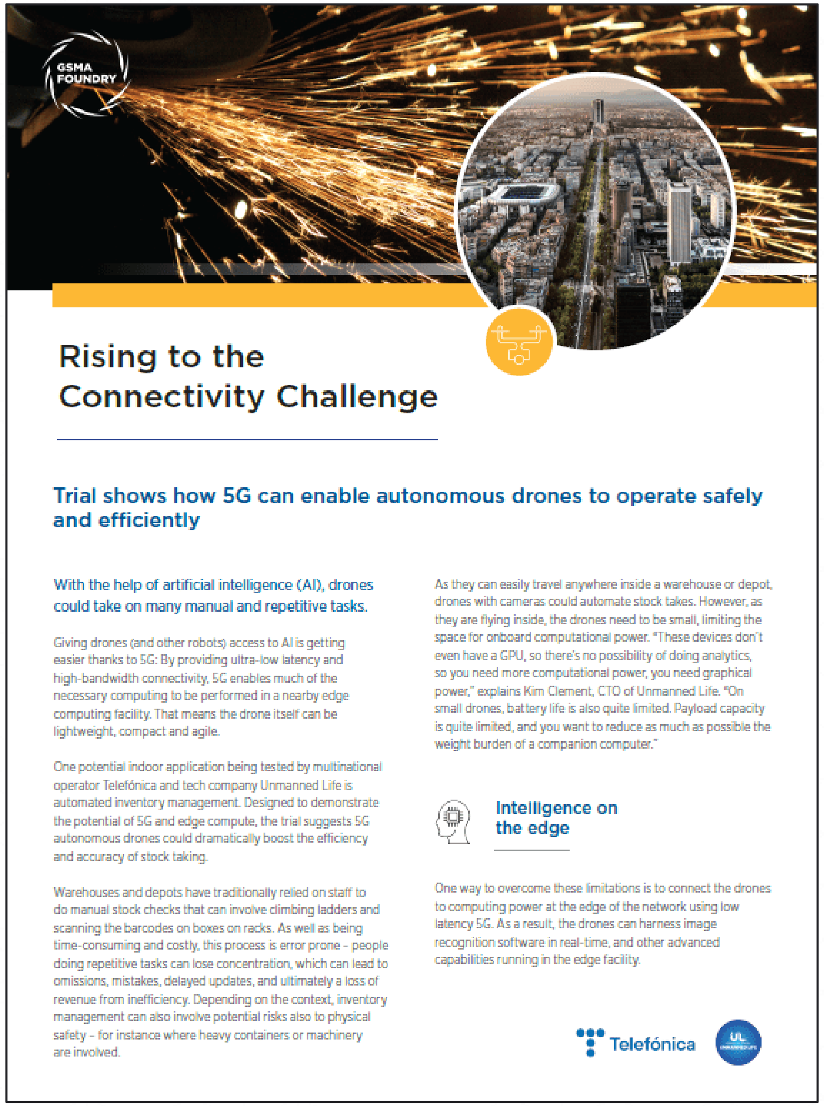
5G Autonomous Drones (Aug 21 – May 22)

Orchestrating 5G autonomous drones to improve security and inventory for warehouses

Two trials showing how 5G and AI can enable safe and efficient automated inventory management with drones, and the value of investment in connected drones and proper orchestration of those drones for efficient premises surveillance.

- One of the winner of **GSMA Foundry Excellence Award**
- More information here: https://www.gsma.com/foundry/5g-autonomous-drones/

Case Study: Rising to the Connectivity Challenge



GSMA FOUNDRY

Rising to the Connectivity Challenge

Trial shows how 5G can enable autonomous drones to operate safely and efficiently

With the help of artificial intelligence (AI), drones could take on many manual and repetitive tasks.

Giving drones (and other robots) access to AI is getting easier thanks to 5G: By providing ultra-low latency and high-bandwidth connectivity, 5G enables much of the necessary computing to be performed in a nearby edge computing facility. That means the drone itself can be lightweight, compact and agile.

One potential indoor application being tested by multinational operator Telefónica and tech company Unmanned Life is automated inventory management. Designed to demonstrate the potential of 5G and edge compute, the trial suggests 5G autonomous drones could dramatically boost the efficiency and accuracy of stock taking.

Warehouses and depots have traditionally relied on staff to do manual stock checks that can involve climbing ladders and scanning the barcodes on boxes on racks. As well as being time-consuming and costly, this process is error prone – people doing repetitive tasks can lose concentration, which can lead to omissions, mistakes, delayed updates, and ultimately a loss of revenue from inefficiency. Depending on the context, inventory management can also involve potential risks also to physical safety – for instance where heavy containers or machinery are involved.

As they can easily travel anywhere inside a warehouse or depot, drones with cameras could automate stock takes. However, as they are flying inside, the drones need to be small, limiting the space for onboard computational power. "These devices don't even have a GPU, so there's no possibility of doing analytics, so you need more computational power, you need graphical power," explains Kim Clement, CTO of Unmanned Life. "On small drones, battery life is also quite limited. Payload capacity is quite limited, and you want to reduce as much as possible the weight burden of a companion computer."

Intelligence on the edge

One way to overcome these limitations is to connect the drones to computing power at the edge of the network using low latency 5G. As a result, the drones can harness image recognition software in real-time, and other advanced capabilities running in the edge facility.

Telefónica UL

Case Study: Digital Eyes in the Sky

GSMA FOUNDRY

Digital Eyes in the Sky

Telefónica and Unmanned Life are demonstrating how swarms of 5G-connected drones can transform surveillance

For any organisation with property and land, drones could soon become essential tools.

Equipped with video cameras, drones can quickly and efficiently perform a wide range of tasks, such as inspecting damage and checking for security breaches. Using 5G networks, the footage from these cameras can be streamed to edge computing facilities, where the images can be analysed by software that can immediately identify anomalies.

As a result, connected drones can be much more effective than existing surveillance methods, such as CCTV, which are constrained by fixed angles and limited range. These limitations can mean false call outs, which are labour intensive and can be error prone. In cases where helicopters are used for surveillance, there is the risk of an accident and injury to the crew, as well as the expense involved in flying such a large aircraft. It can cost more than €1,000 an hour to keep a helicopter in the air.

Given the high cost of manual surveillance, drones could cut costs dramatically by providing a flexible and efficient means of surveying large areas and detecting problems. Telefónica estimates drones could be up to 15 times more efficient than a fixed camera, while also speeding up response times 80-fold in unattended environments.

Telefónica and Unmanned Life are testing and demonstrating 5G-connected d[illegible]or surveillance purposes at the telco's headquarters in [illegible]olas, in the north of Madrid. Telefónica says its connected drones are attracting interest from analytical companies, sports clubs, the military and police.

"When we make the business case, our focus is for the security, but we know that the drones can be used for more than this aspect," says Miguel Álvaro Fernández, a drone specialist from Telefónica Ingeniería de Seguridad. "Every day, we note new functionalities that the drone service can do, as customers suggest more functionalities that we don't have in our road map."

Trialling drones in testing conditions

The Madrid headquarters, which holds 14,000 people, is a challenging testing ground for drone technology. Located in a busy air space area, the headquarters is close to Madrid Airport,

Telefónica UL

GSMA Foundry Case Study - Drone Swarm Surveillance 1

GSMA

Telefónica

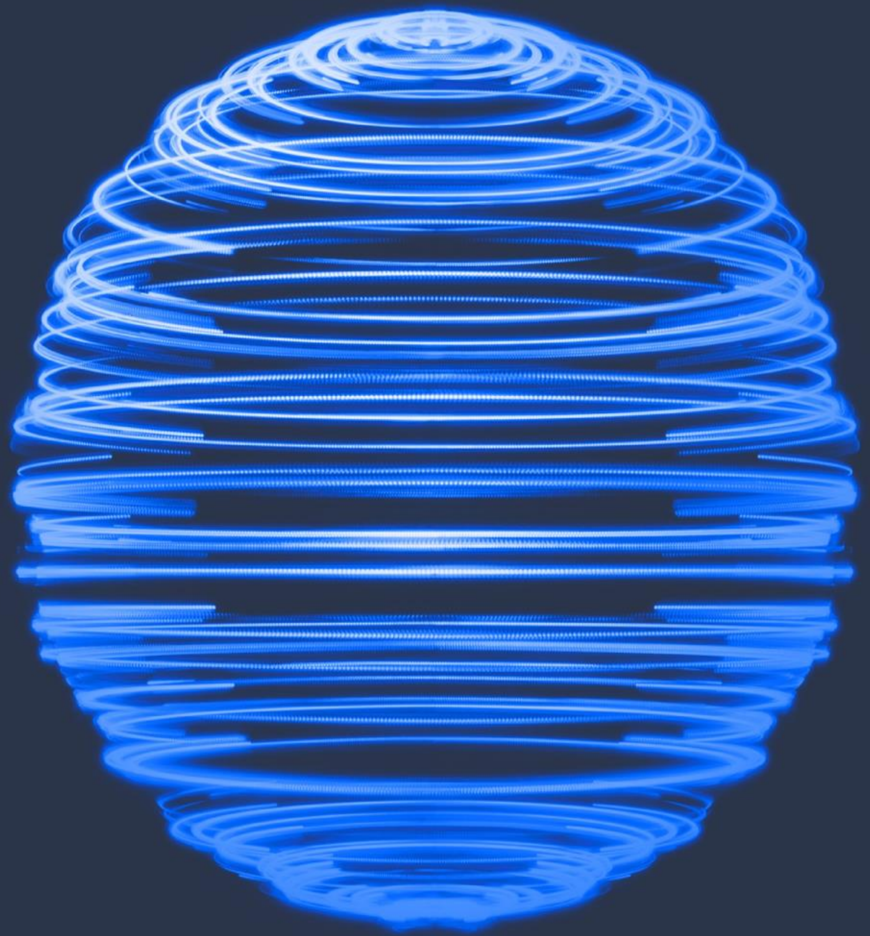
5G Autonomous Drones

Implementing drone orchestration over the operator platform using cellular connectivity and edge

indoors and outdoors use cases

DAVID MORO

Telefonica CTIO



contents

Background and context

01

Background & Context

- 2021. GSMA Telco Edge trials - Edge aggregation use case with BT. A search and save use case.

- 2022. GSMA Foundry projects.

- 2021-22: Telefonica Wayra 5G use case lab. Permanent demonstrator for indoors and outdoors use cases.

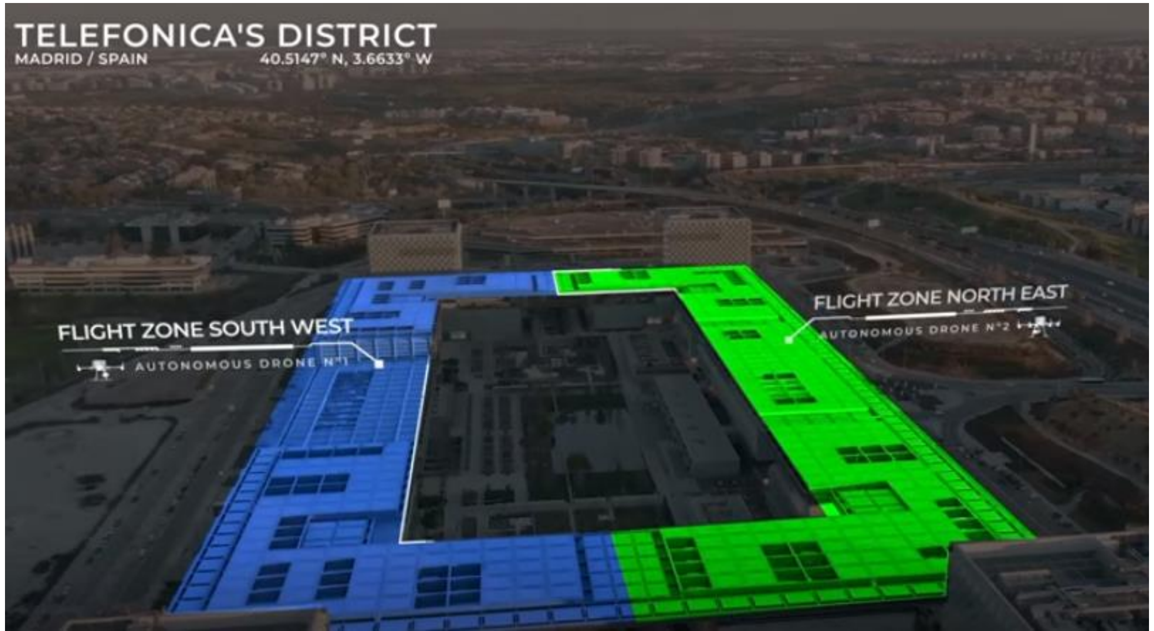
GSMA Foundry

Objective

- Deploy Unmanned Life´s Drone orchestration platform (autonomy as a service) in our network over our edge.

- Have permanent demonstrators in our HQ facilities to be run by non experts in robotics or drones necessarily.

- Have representative use cases for indoors and outdoors scenarios.
    - Warehouse management for indoors in an industry ambience
    - Surveillance use case – in the future, critical infrastructure inspection.



Overall Operator scenario

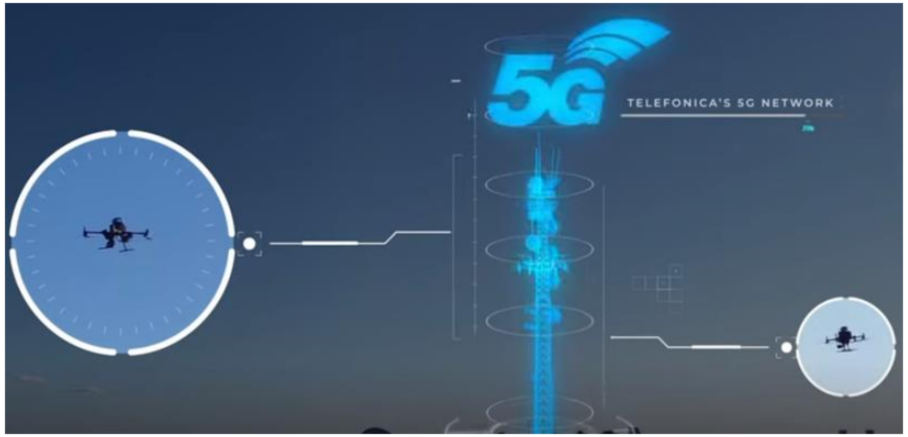
02

Scenario

- B2B demo center and Surveillance control. demonstrators for exploitation – showcasing to Customers (B2B, Govern, Institutions).

- Coverage challenge:
  - Indoors – Demo center.
  - Outdoors – aerial coverage- Telefonica HQ campus.

- Commercial network: focus on 4G and 5G NSA.
  - 5G SA pilot.



requirements

- The solution has two components:
  - mission control
  - Video analytics – bar Code detection (stock management) , element identification (surveillance)

- Requirements from Unmanned Life posed to our operator platforms:
  - Low latency: 20 ms ideal. 50-60 ms valid (even reaching 100 ms)
  - Enough throughput for video streams (30 Mbps ideal to avoid buffering)

- These use cases are not the most stringent ones - on purpose.

- Low latency is required for mission control – especially for reacting immediate to a Abort mission order and for camera control.
- Throughput is required for video streaming without freezes for end user experience and for Computer vision to work accurately

Challenges for the deployment in Operator networks

03

challenges

- Drones requires a peer to peer connectivity .
- Operator public network is designed for internet-based communication .
  APNs, Firewalls, addressing spaces.

- Aerial and indoors coverage
- Indoors localization

- GPU – video analytics processing in Edge.

- industrialization of demo kits: testing and fine tuning
  - Tens to 100s flights

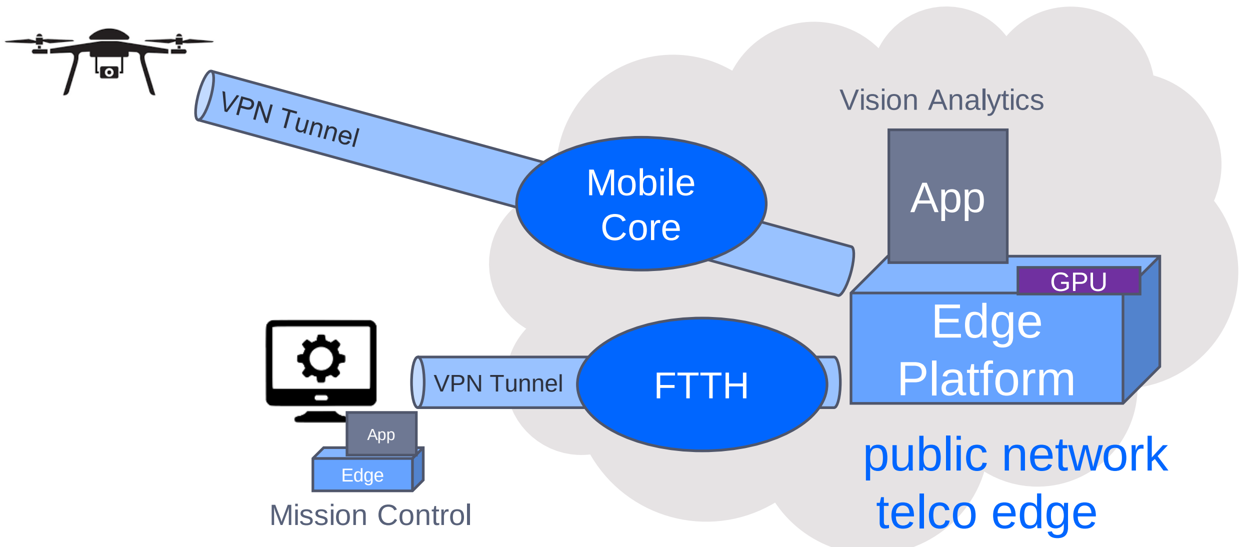
Connectivity and edge architecture

04

Simplified Architecture for trials (As is)

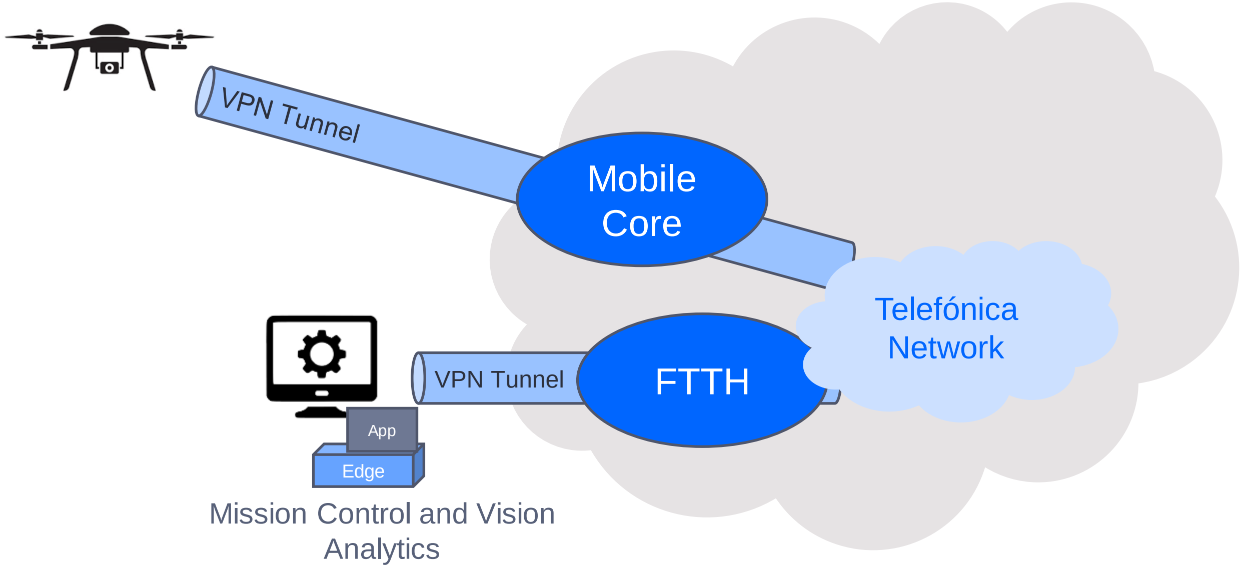
- Regular APN with static addressing over the commercial network
- Hybrid Edge architecture: on premise edge device + public network telco edge

Indoor



On side edge device

Outdoor

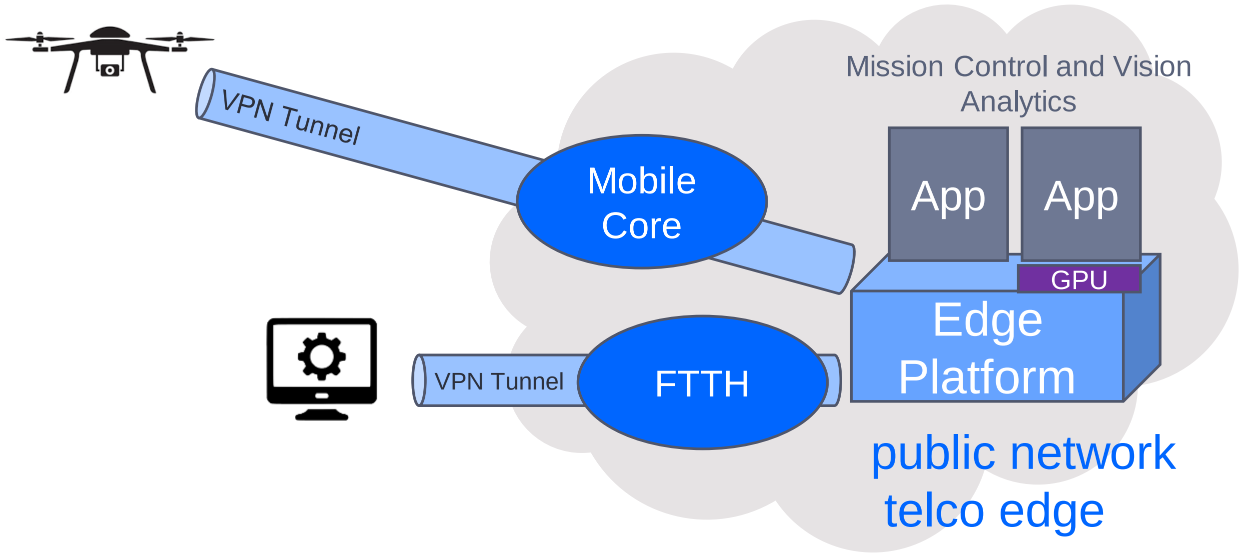


On side edge device

WIP Architecture (To be)

- Regular APN **without** static addressing over the commercial network
- Full public network Edge architecture

Indoor and Outdoor



Lessons learnt

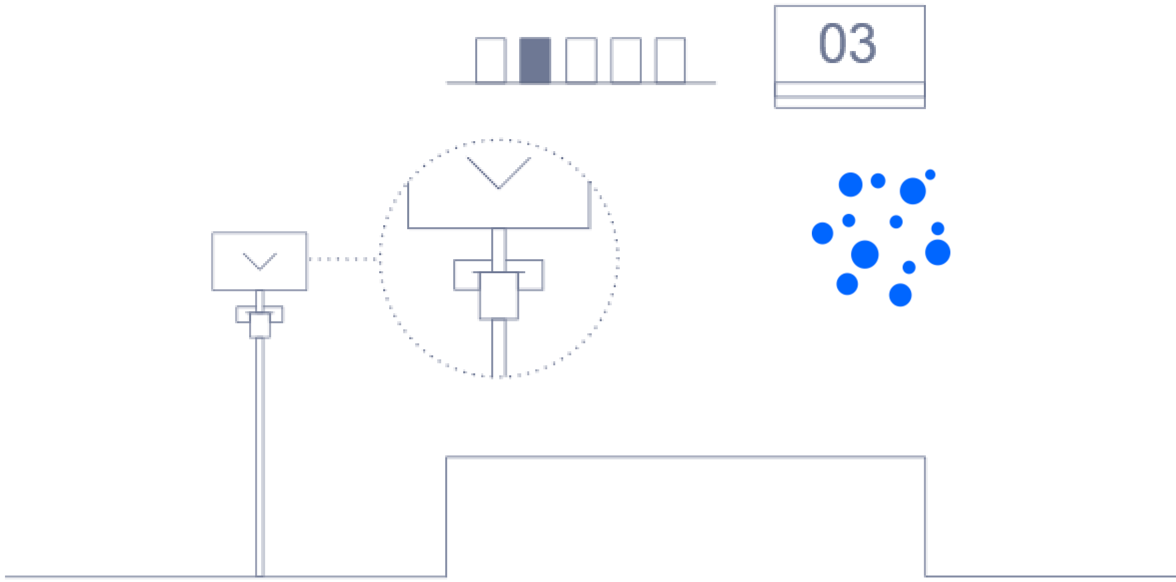
05

Lessons learnt – operator view I

We want to have a generic solution that can be deployed over any connectivity scenario in CARRIER GRADE environments:

- Public APN for internet access
- Public APN with static addressing
- Private APN for IOT devices
- Private networks.
- Others.

- The Telco Network is not as a private network on-premises. There is some specific configuration and restrictions as CGNAT, FW, etc that affects the network design. It is important to be aware of:
  - ➢ How is created the drone p2p connectivity (e.g.VPN) and which is the path that the information packets follow
  - ➢ Which is the size of the packets
  - ➢ Which are the IP ports used: it is not possible to use them randomly.
  - ➢ How the solution microservices are communicated between them



Lessons learnt – operator view II

- The radio coverage could change depends on drone’s physical location and altitude between 5G and 4G and this could affect the connectivity if it is not taken into account.
- The Video has to be optimized to assure good quality of the image.
- Network: “Predictability /stability” is better than “low” (i.e. latency, throughput, packet loss).
- Indoors GPS weak signal or no signal requires improved drone and solution elements for collision avoidance and localization.

Evolution paths

06

Lessons learnt – operator view

- QoS and NEF/DAF APIs
- Slicing
- SA improved latencies
- Ful telco edge deployment with granular capillarity and mobility support.
- Aerial radio planning
- 3GPP - evolution to support optimally UAVs.
- Drone identification and inhibition when using 5G.

Telefónica

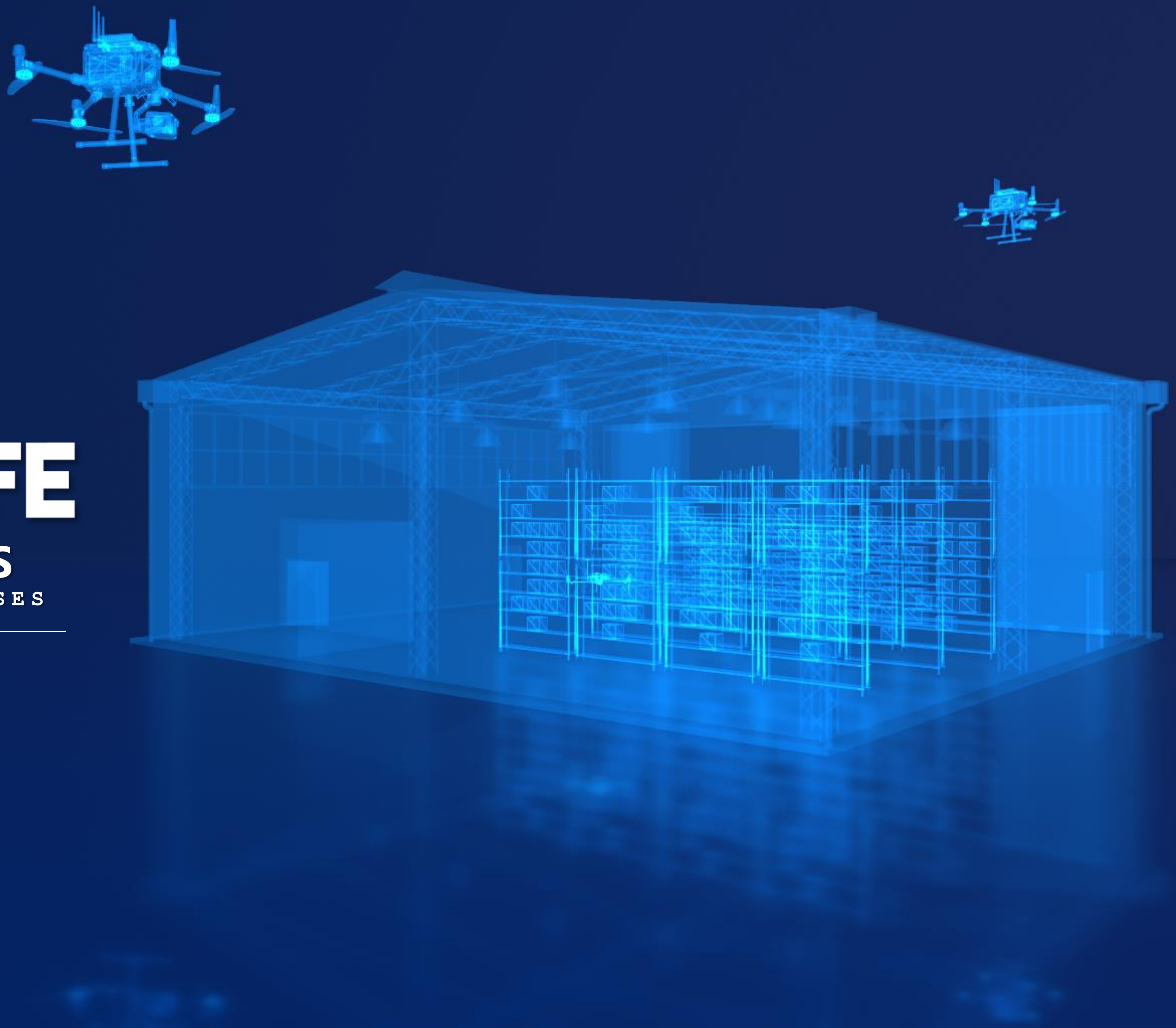
Autonomy-as-a-Service

UNMANNED LIFE

5G AUTONOMOUS DRONES

DRONE SWARM & AI ENABLED USE CASES

WWW.UNMANNED.LIFE



FRAGMENTATION OF ROBOTICS

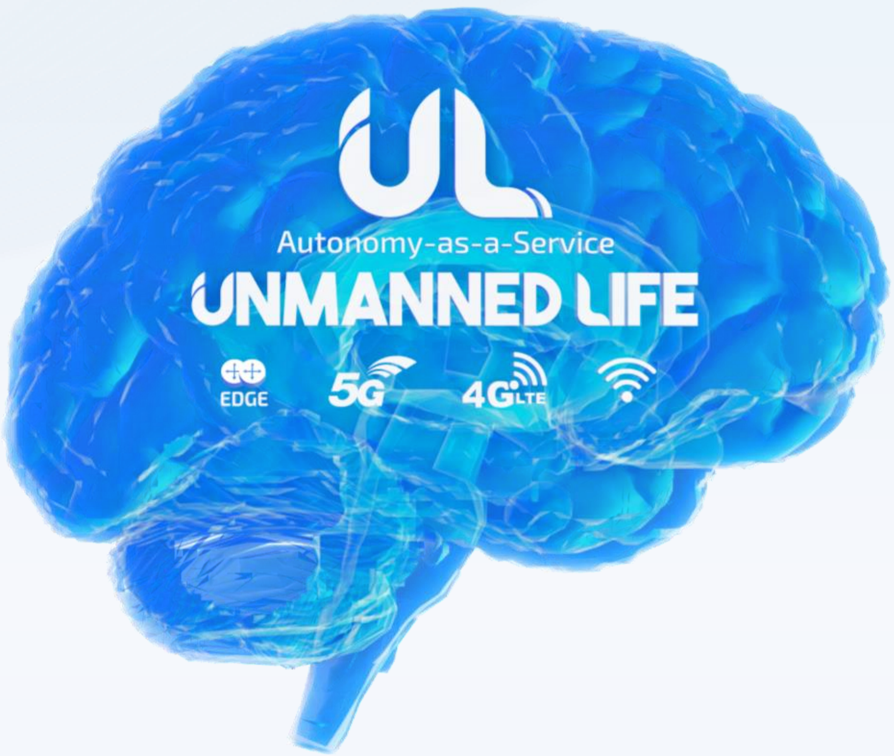
Autonomous Drones and Robots are going to reach a ceiling in the efficiencies they provide to businesses

37M
Industrial Robots
(AAA)

17M
Commercial Drones
(GSMA)

- Each robot runs on different proprietary hardware and software
- Drones and robots cannot functions together using the same language
- Network interoperability is a challenge preventing scalability in deployments

OUR SOLUTION

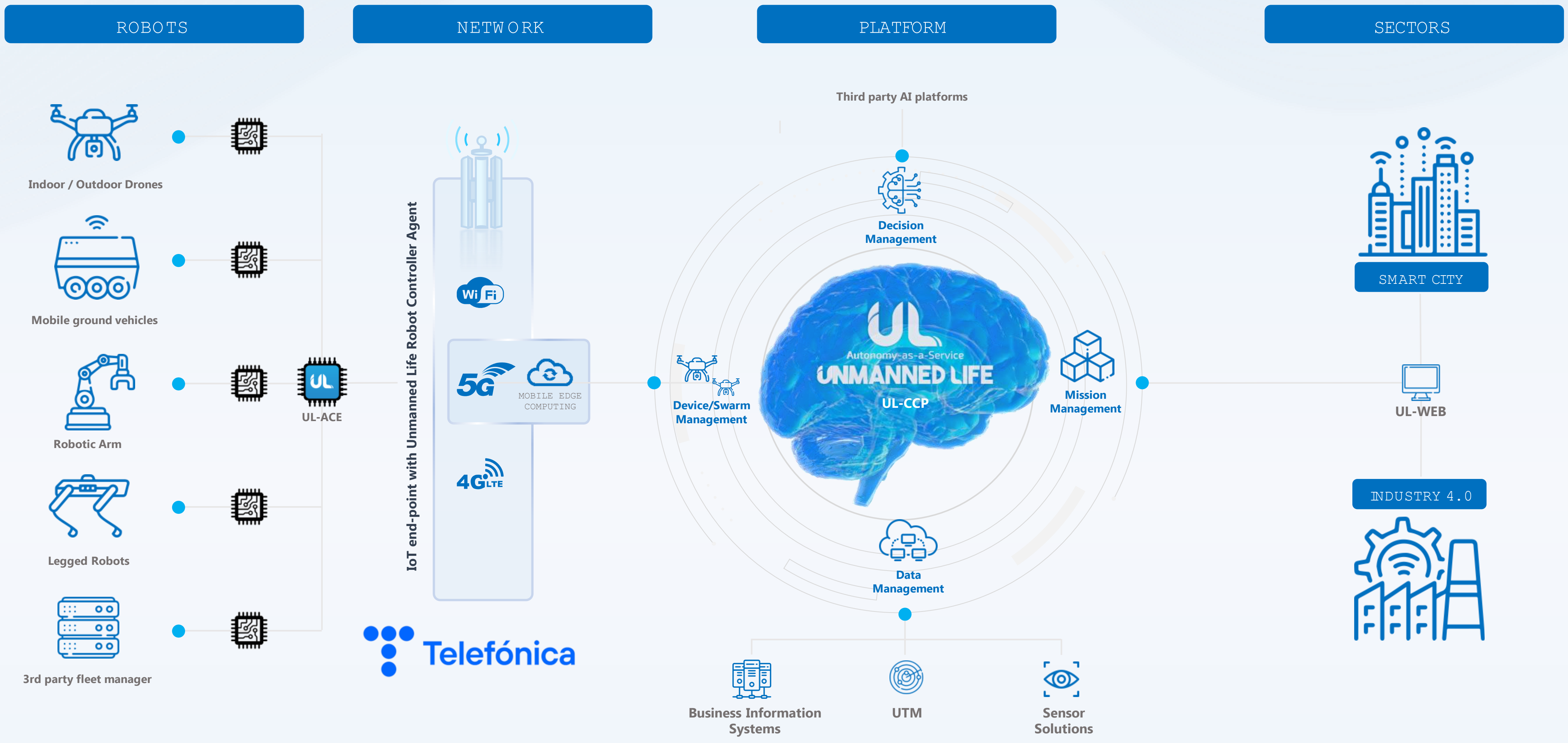


ONE PLATFORM

to autonomously deploy, control, and orchestrate swarms of drones and robots.

SOLUTIONS ARCHITECTURE

Unmanned Life enables the development of Autonomous Industries and Smart Cities



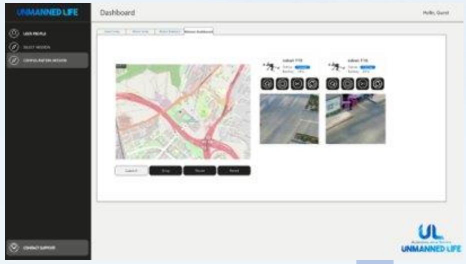
SOLUTION MODULES

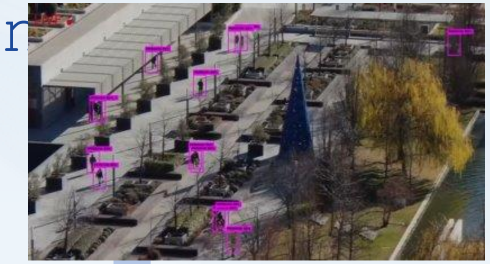
L7	Graphical user interface	Unmanned Life provides a web based graphical user interface to monitor and manage the solution	UL-WEB
L6	Business information systems / 3rd party expert platforms	Integration with business information systems to share and collect data and with AI/ML platforms or digital twins	API
L5	Mission Management	Orchestration layer at the heart of the platform managing the devices in the field enabling the end to end use cases	UL-CCP
L4	Decision Management	Drives the orchestration layer based on alarms, trigger event, anomality detection or object recognition	UL-CCP
L3 – L3b	Data Management	Data collection from devices and sensor used for context, business information systems and 3rd party applications	UL-CCP
L3 – L3a	Device management	Hardware abstraction layer integrating and configuring the devices capabilities and status into the platform	UL-CCP
L2	Wireless Network	Proprietary device networks are opened up to connect to different wireless networks such as 4G and 5G	UL-ACE
L1 – L1b	Logical Device Control	Each device will have it's own controller	UL-ACE
L1 – L1a	Devices	The devices are considered tools to perform a function or collect data. Off the shelf devices are used as the foundation	UL-ACE

SOLUTION MODULES

	L7	Graphical user interface
	L6	Business information systems / 3rd party expert platforms
	L5	Mission Management
	L4	Decision Management
L3	L3b	Data Management
L3	L3a	Device management
	L2	Wireless Network
L1	L1b	Logical Device Control
L1	L1a	Devices

Use case example: lar





UL-WEB

API

UL-CCP

UL-ACE

Autonomy-as-a-Service

UNMANNED LIFE

EMERGENCY RESPONSE: SEARCH AND RESCUE

TELCO EDGE TRIALS

TELCO EDGE TRIAL FEATURES

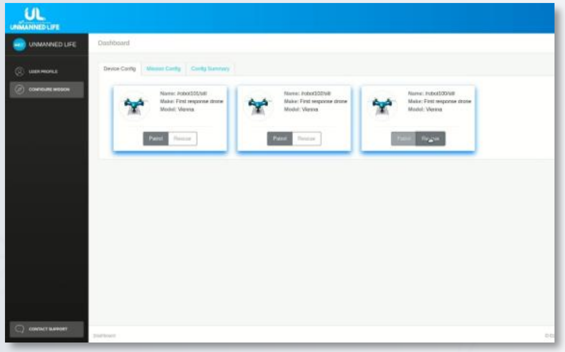
Autonomous Search and rescue demonstration

	DEMONSTRATION FEATURES
HARDWARE	External localization system / 3DR Iris+ drones
MISSION TYPE	Autonomous search and rescue
CENTRAL SYSTEM	Orchestration via Unmanned Life interface
AI ALGORITHM	Unmanned Life’s in-house algorithm for object recognition
NETWORK	BT and Telefonica 5G network
COMPUTING CAPABILITIES	Local Edge Computing capabilities

WORKFLOW

AUTONOMOUS SEARCH AND RESCUE SYSTEM

1



SIMPLY CHOOSE AND CONFIGURE THE MISSION BY SELECTING THE:

- Drones
- Area of Surveillance
- Flight parameters, such as maximum height or speed

2

OUR ORCHESTRATION PLATFORM WILL AUTONOMOUSLY:

- Connect the drone swarm over the integrated network
- Plan and manage the mission in real-time
- Deploy the drones to perform the mission

3

AI ANALYTICS WILL BE RUNNING ON TOP ON THE VIDEO FEED:

- Recognizing people or objects predefined by the client's requirements
- Alerting the system to any detected anomalies

4

ONCE DETECTION IS CONFIRMED, THE DRONE WILL AUTONOMOUSLY:

- Launch, and fly to the selected location
- Safely deploy a rescue payload
- Enable communication to the victim

Autonomy-as-a-Service

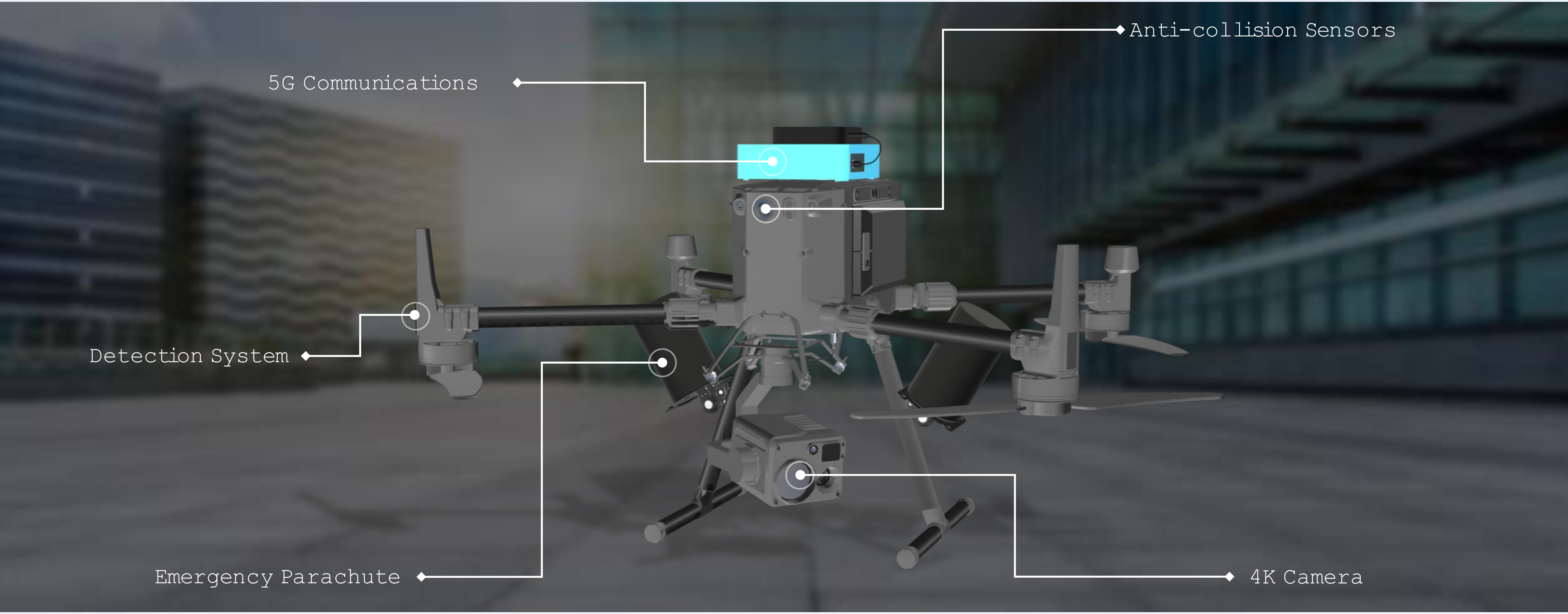
UNMANNED LIFE

AUTONOMOUS CAMPUS SURVEILLANCE

DISTRITO TELEFONICA IN MADRID

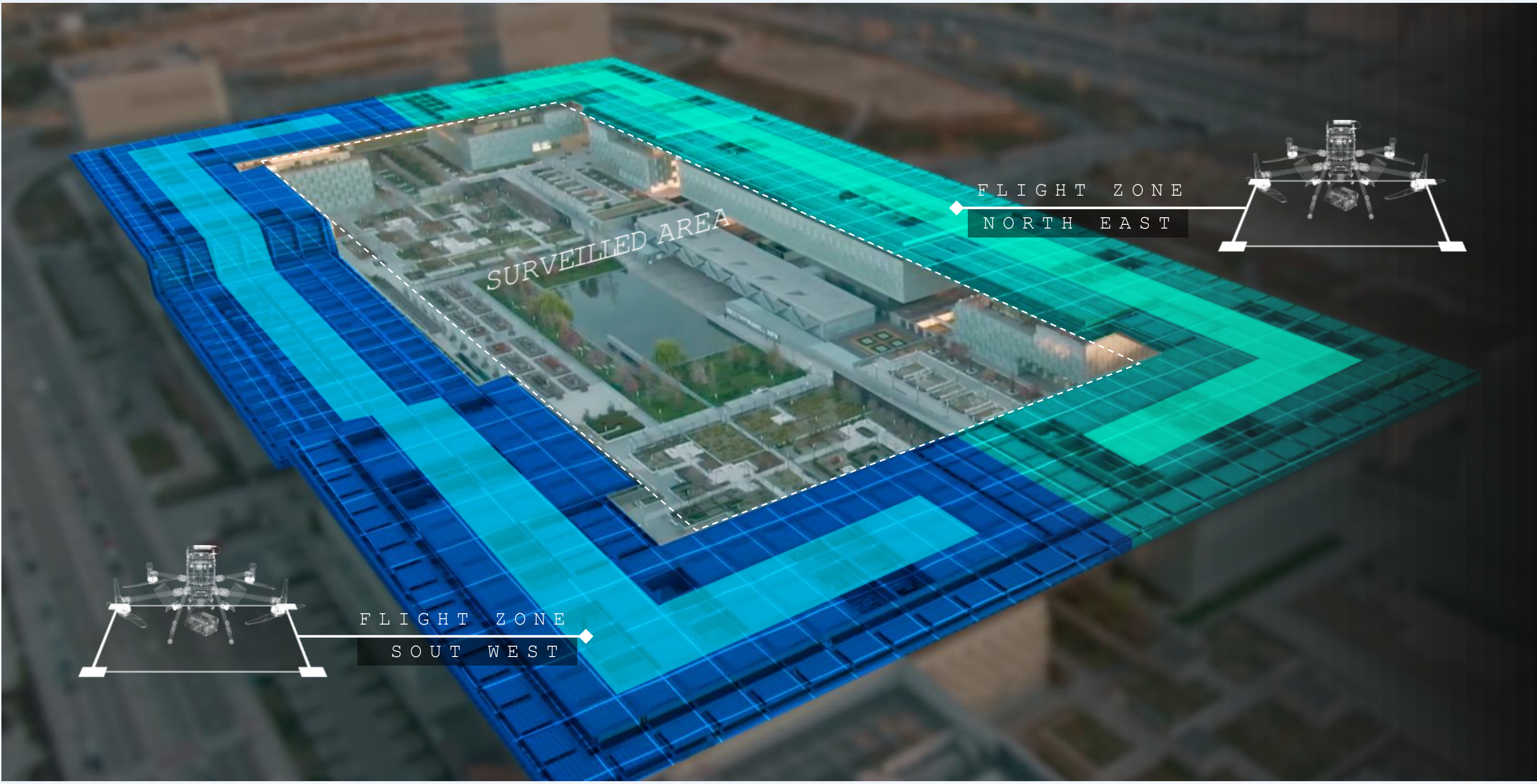
AUTONOMOUS DRONE SWARM SURVEILLANCE

Overview of the Drone components



AUTONOMOUS DRONE SWARM SURVEILLANCE

Flight Zones, Are of Surveillance, and Key Benefits



AREA OF SURVEILLANCE – 200m x 400m

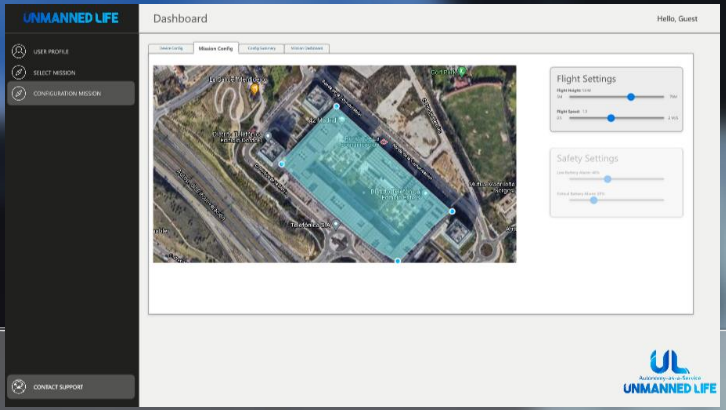
POPULATION DENSITY – Over 20,000 people

MISSION TIME – Under 10 minutes

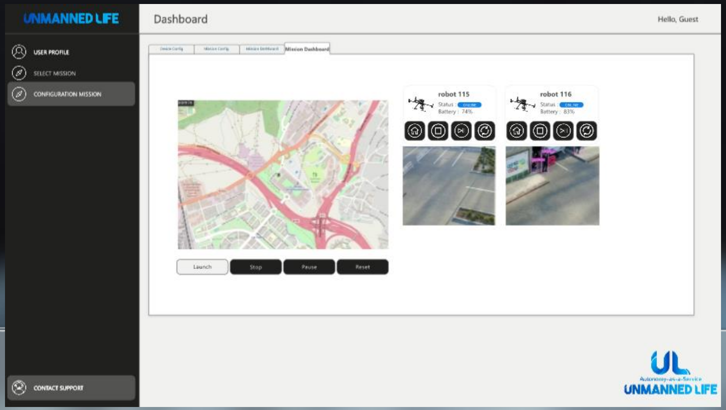
INCIDENCE RESPONSE vs Manual – 2.3X Faster

Telefonica Deployment in Pictures

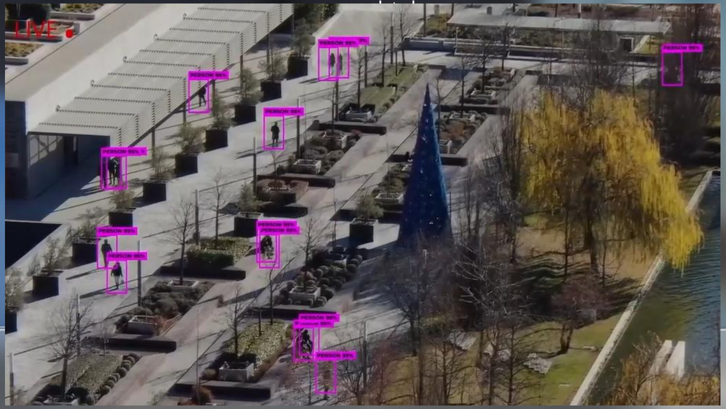
Site Selection via the Interface



Interface Monitoring for Security



AI Detection for Trespasser



Drone Swarm for additional / faster

>>Video<<

Autonomy-as-a-Service

UNMANNED LIFE

AUTONOMOUS INVENTORY MANAGEMENT

DISTRITO TELEFONICA IN MADRID / WAYRA GERMANY

DEMONSTRATION KIT FEATURES

Autonomous Inventory Management Demonstration Kit

	DEMONSTRATION KIT FEATURES
HARDWARE	One platform-enabled ModalAI drone
MISSION TYPE	Autonomous inventory management
CENTRAL SYSTEM	BT central system via Unmanned Life interface
AI ALGORITHM	Unmanned Life's in-house algorithm for barcode detection
NETWORK	Telefonica 5G network
COMPUTING CAPABILITIES	Local Edge Computing capabilities

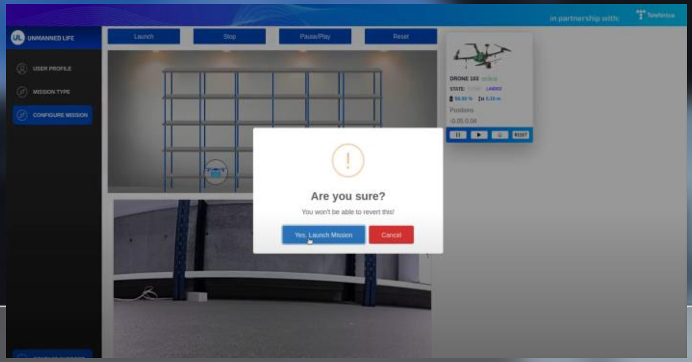
KEY CAPABILITIES

Autonomous Drone Inventory Management Demonstration Kit

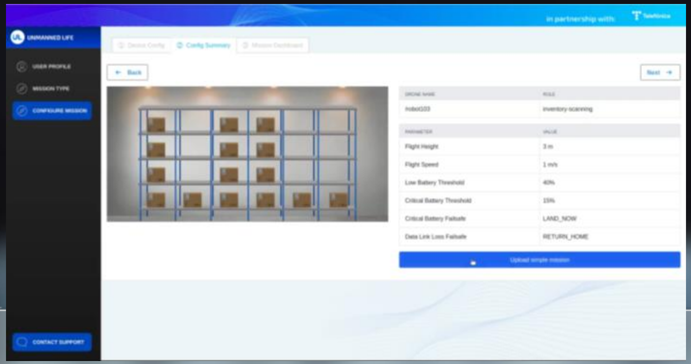
- Network Integration for real-time data offloading
- AI for Barcode Detection
- Autonomous mission management, path planning, and decision making
- Centralized web interfaces for mission overview
- Real-time HD video streaming
- Indoor Localization

AUTONOMOUS INVENTORY MANAGEMENT IN PICTURES

Launch Mission via Interface

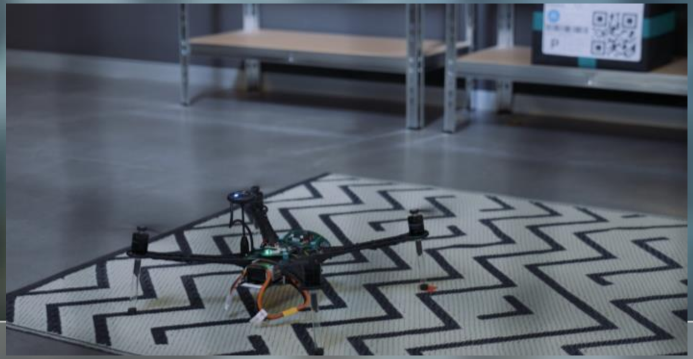


Interface Monitoring for Inventory



Artificial Intelligence for Barcode detection

Autonomous Landing



>>Video<<

5G & AUTONOMY-AS-A-SERVICE:

Where does 5G fit in?

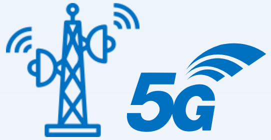
Telefónica

DEVICES	NETWORK	CLOUD / EDGE / SERVER

HYBRID LOGISTICS

EMERGENCY RESPONSE

LOGISTICS



Navigation

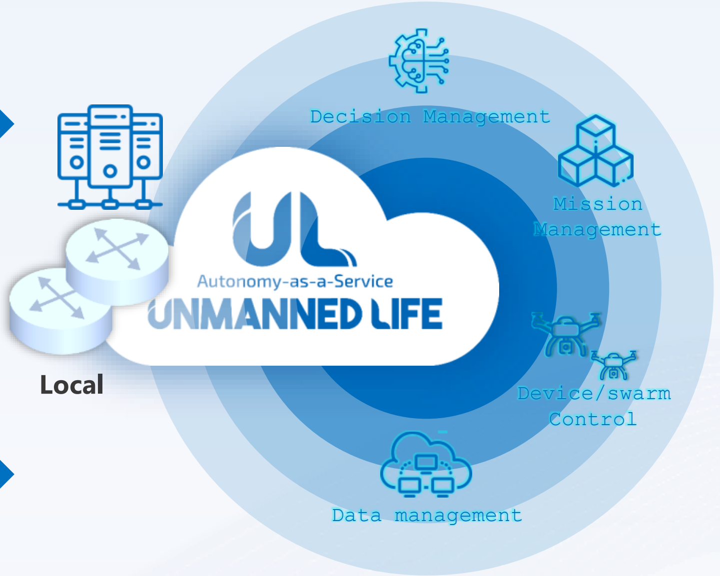
Big Data / AI processes

Voice/image/object recognition

3D sensing, Local mapping, human detection, routing

Motion control, collision avoidance

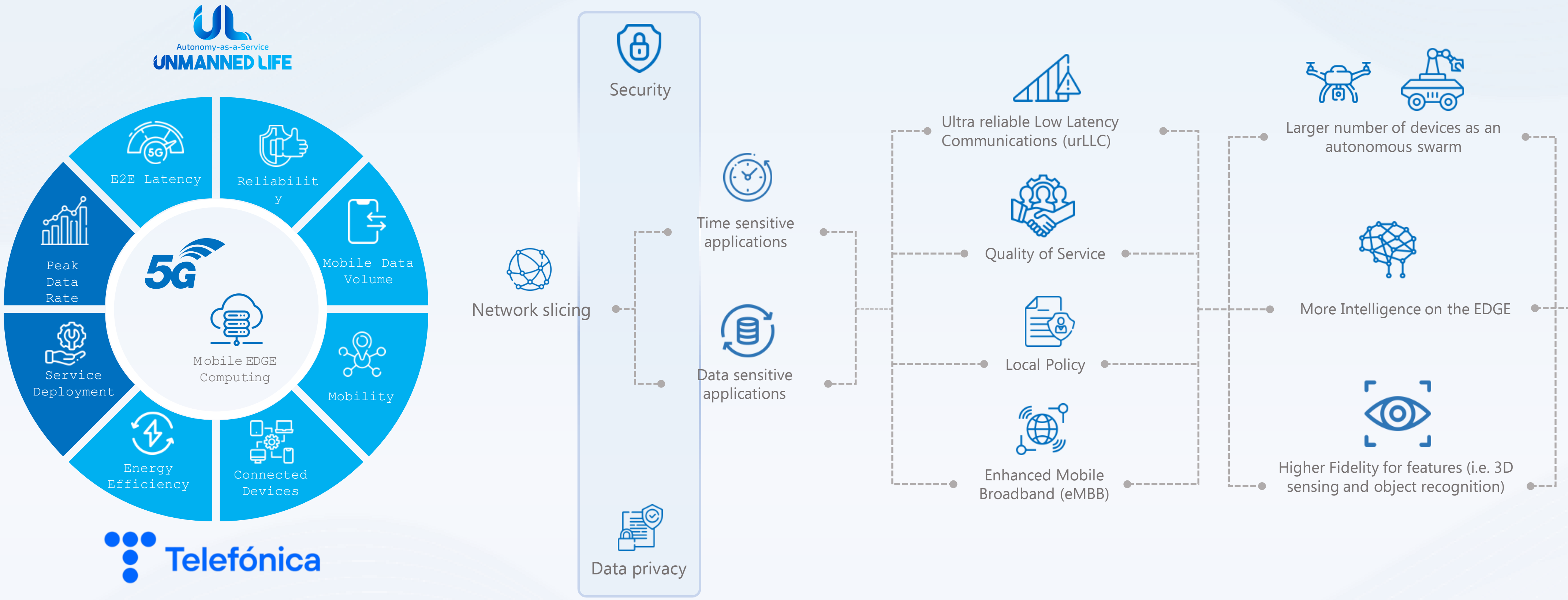
Emergency mission

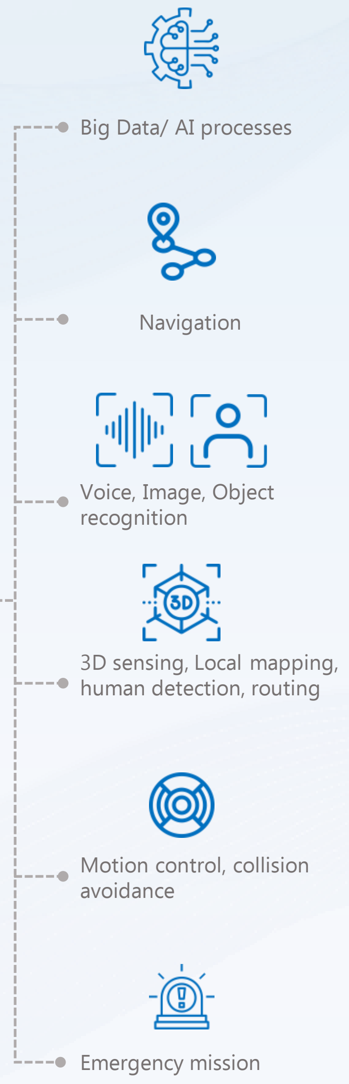


5G ALLOWS OFFLOADING OF THE COMPUTATIONAL POWER TO THE EDGE FOR AUTONOMOUS ROBOTIC WORKFORCES, WHILE STILL ENSURING RELIABILITY AND MISSION CRITICAL CONTROL OF THE SYSTEMS. OFFLOADING THE SENSOR DATA AND COMPUTATION CENTRALIZES THE DATA AND ALLOWS THE UNMANNED LIFE PLATFORM TO CREATE 1 SINGLE CONTEXT FOR EACH SWARM AND USE CASE WHICH INCREASES SAFETY AND EFFICIENCY OF THE SYSTEM.

KEY 5G FEATURES

Why 5G and edge computing is important

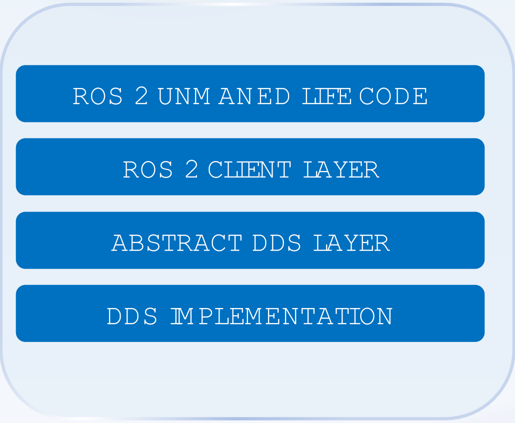




Mobile robots such as AMR's, UAV's, AGV's require wireless communication and computational resources. Combining and optimizing computational resources using edge computing in combination with secure network environments for connectivity such as 5G enables secure and add scale deployment of robotic swarms

UNMNANNED LIFE NETWORK FUNDAMENTALS

- UL platform is built over **ROS2**, that uses **DDS** as middleware. DDS provides:
  - Distributed discovery
  - Serialization
  - Transportation
  - Protocol control over different “Quality of Service”
- DDS provides
  - Use peer-to-peer model communication, where firstly nodes need to be discovered between them.
  - Works by default in multicast , can also work in unicast providing a list of peers
  - Uses a variable range of ports (inside a range) that are derived from different parameters
  - Natively, <u>can not work with NAT</u>:
    - Peer-to-Peer communication instead client-server
    - Port usage is not following GCNAT rules
    - Address of other peers needs to be discovered

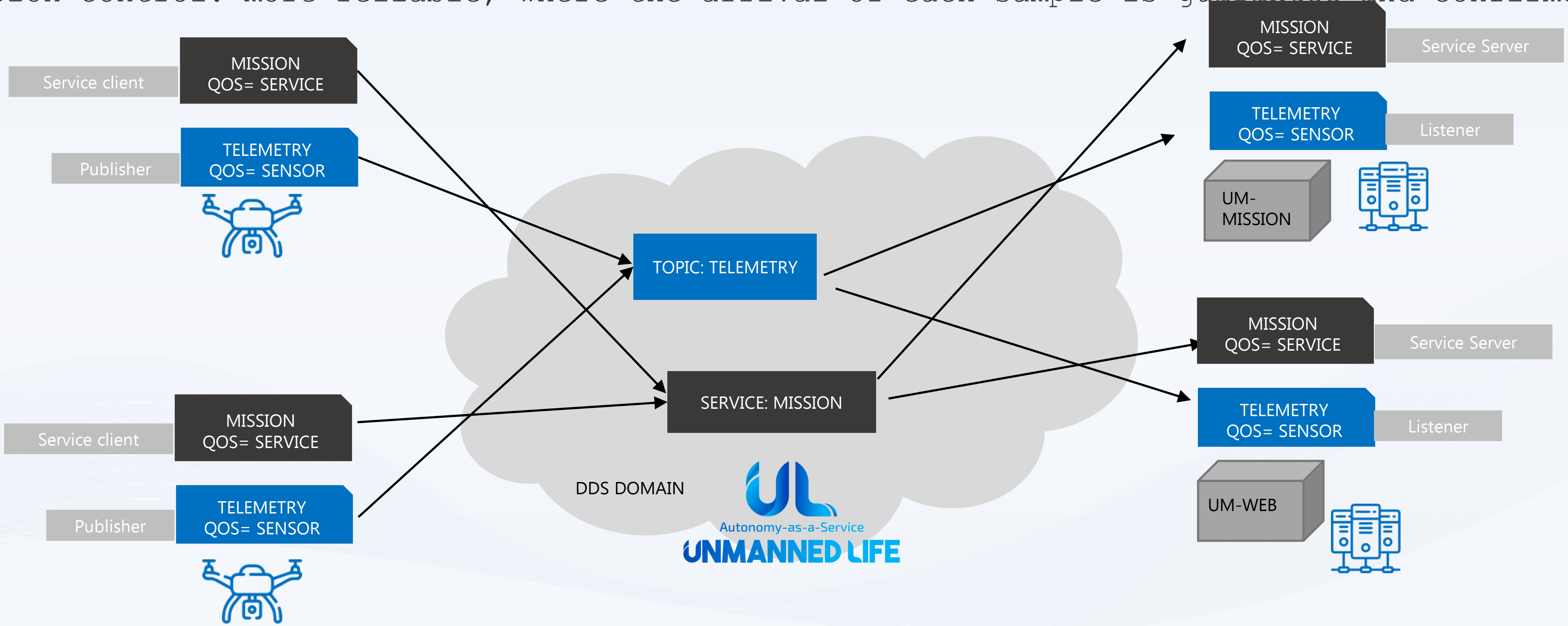


DDS PUBLISH SUBSCRIBE M O DEL

DDS introduces a virtual Global Data Space where applications can share information by simply reading and writing
data-objects addressed by means of an application-defined name (Topic) and a key.

DDS QOS can be adjusted to change the behavior of the DDS depending on the topic that we want to transmit.

- Telemetry information: less reliable, we do it at best-effort
- Mission control: more reliable, where the arrival of each sample is guarantee and confirmed



TELCO EDGE BENEFITS & CHALLENGES

Main benefits and challenges on 5G and Edge Computing

BENEFITS

- Telco Edge Computing together with the Telco 5G network offers the best possible combination to minimize the latency and maximize the bandwidth from devices to servers
- Routing traffic to the nearest location is key to provide the best communication with the APP servers in complex deployment, Telco Edge architecture can provide that kind of capabilities
- Unique offering of APIs to assets network conditions, query device location or improve network capabilities in a given time trough API calls
- Operators can provide private APNs to work on a more secure environment, isolating the solution from other devices

CHALLENGES

- 5G deployment still in early stages, handover from 5G to 4G is not supported in some deployments creating network issues
- 5G antennas are being setup to provide ground coverage, drones flying at highs altitudes can have problems receiving signals from this antennas
- Cloud deployment capabilities can be improved to support better containers orchestration
- Telco Edge Computing can offer to the developers a set of APIs to maximize the performance or create new services. This APIs need to be standardized and implemented to allow developers a smooth integration
- 5G Modems required firmware configuration and adaption to operator network to maximize the performance (carrier aggregation, new 5G bands roll-out)

FUTURE KEY CHALLENGES

NETWORK COVERAGE

When deploying over large areas there is often instances of limited connectivity and complete loss of connectivity with the EDGE

EDGE MOBILITY

Instances of Cloudlet switching to optimise latency introduces challenges of the management of real time data being used for orchestration.

PUBLIC / PRIVATE

Integration between typically restricted Industrial Private Networks and Private Edge Infrastructure with Public and Cloud-Based knowledge bases and applications.

PRIORITIZATION

To ensure QoS of mission critical data, dynamic network slicing will be key.

DEVICE INTERACTION

Connecting heterogeneous robotic swarms with the 5G network and onboarding of the edge applications.

LEGISLATION

Today full autonomous drone solutions deployed BVLOS (Beyond visual line of sight) are still not allowed unless exempted by the regulatory bodies. Close collaboration with authorities help provide them insights and confidence while innovating in a safe and sustainable way.

Autonomy-as-a-Service

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Some resources

- Outdoor: https://youtu.be/bJSe4MYNUgM
- Indoor: https://vimeo.com/622609895/b69c1ebb3f
- GSMA Foundry page: https://www.gsma.com/foundry/5g-autonomous-drones/

Thank You!

https://www.gsma.com/iot/aviation/

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