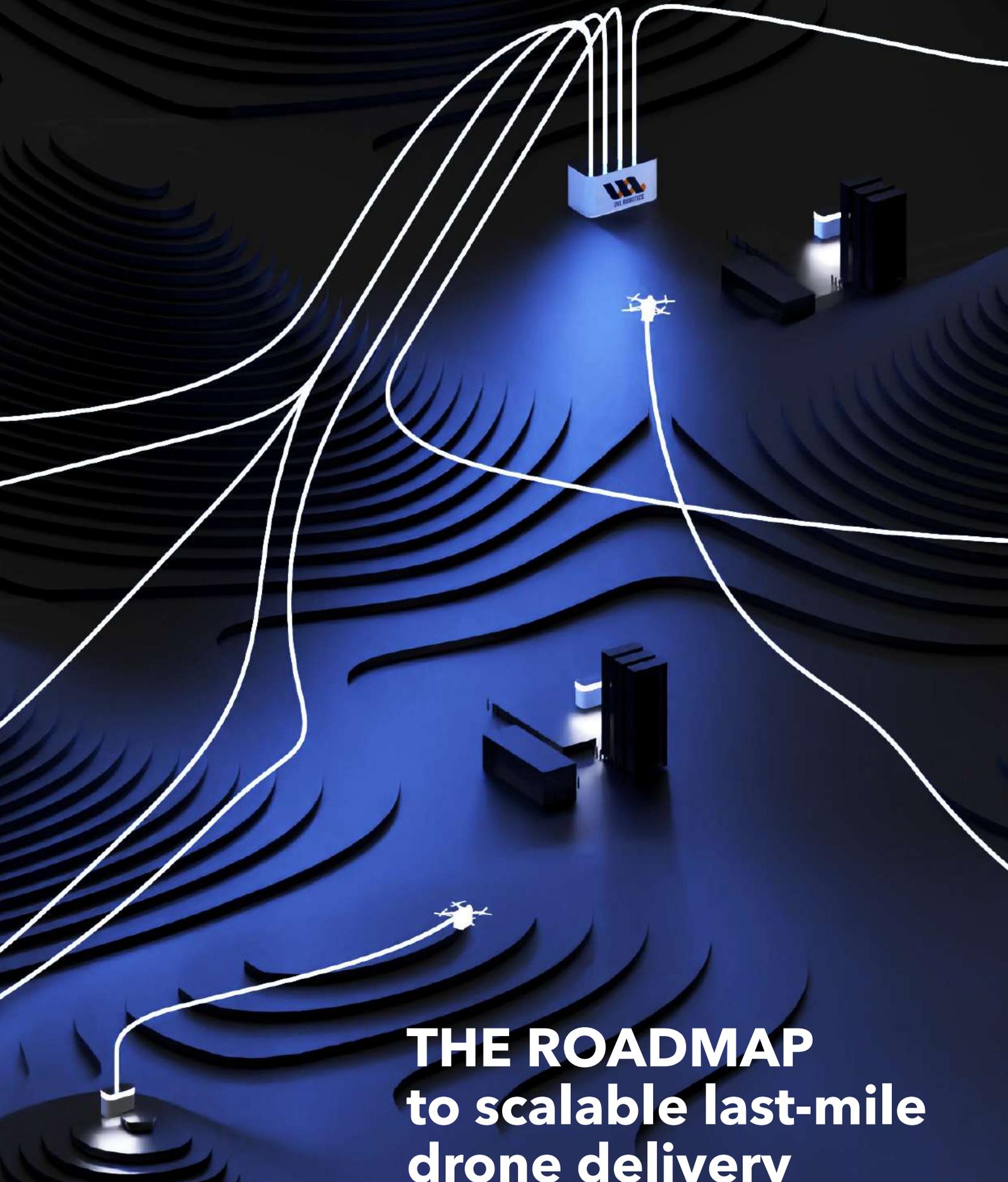




We improve logistics
with AI-powered drones



THE ROADMAP to scalable last-mile drone delivery

Table of contents

Foreword by the CEO.....	4
Foreword by recognized logistics experts.....	10
Key takeaways.....	12
Vocabulary.....	15
1. Our vision for scalable last-mile drone delivery.....	17
2. Increasing urbanization and consumption: new challenges for the logistics & supply chain industry.....	20
3. The impact of climate changes and co2 emissions on the delivery services industry	23
4. 2. How will logistics be transformed by drone delivery?.....	25
5. What is needed to offer drone delivery at scale	28
5.1. A drone delivery ecosystem framework.....	29
5.2. Customer service offering.....	32
5.3. A fully autonomous last-mile drone delivery solution.....	35
5.3.1. UAV technical requirements	36
5.3.2. Related infrastructure description	45
5.3.3. Software applications	50
5.4. Drone delivery operations.....	52
5.4.1. Staff training	54
5.4.2. UAV operator	55
5.4.3. Maintenance, repair, and overhaul.....	57
5.5. City integration	59
5.5.1. Physical infrastructure.....	63
5.5.2. UTM platforms	66
5.5.3. Connection with ground unmanned vehicles.....	68
5.6. Institutional and public acceptance.....	69
5.6.1. Regulation, certification, and airworthiness.....	70
5.6.2. Societal contribution and public trust.....	73
Conclusion.....	76
About UVL robotics incorporated	78

FOREWORD BY THE CEO

NEW CHALLENGES IN THE LAST-MILE DELIVERY MARKET

Today, customer expectations for last-mile delivery are higher than ever, whether they are ordering parcels, food, or medicine. Some 20 to 25% of consumers would pick same-day or instant delivery if it were available at a low price. This represents a sizeable share, considering only around 1% of orders are currently fulfilled this way. Consumers are aware of what is possible and expect a variety of options to obtain their products quickly and conveniently. Nevertheless, their willingness to pay for such a service is limited.

The continuous, rapid growth of e-commerce sales has vastly increased both the number of parcels delivered every day and the number of delivery vehicles (trucks, PMVs) in densely populated cities. This produces additional CO2 emissions, which we now know must be addressed imminently and radically to counteract climate change.

Ensuring the safety of package delivery is clearly another key challenge in last mile delivery. Here, the problem can be divided into two main issues:

1. The risks of injury to couriers who put themselves in constant danger to deliver orders within 15-30 minutes, sometimes violating traffic laws to fulfill their employer's KPIs.

2. The risks associated with the spread of COVID-19, as case numbers remain high, despite the peak being over. The risks of COVID-19, combined with the increased demand for delivery it caused, has accelerated e-commerce experimentation with and adoption of contactless drone deliveries.

All of the aforementioned challenges have prompted us to recognize the inevitability of introducing automated delivery solutions.

TOTALLY TRANSFORMING THE LASTMILE DELIVERY MARKET

The [global autonomous last mile delivery market](#) size is projected to grow from \$11.12B in 2021 to \$51.38B by 2028, representing a CAGR of 24.4%. Autonomous last-mile delivery is the last stage of the supply chain, where the parcel is delivered to end-users at their doorsteps without human intervention. In our case, this is achieved through the use of AI-driven drones and related software and hardware infrastructure.

In just a few years, shopping and urban commercial delivery trends have radically changed. The e-commerce boom has necessitated businesses, manufacturing plants, warehouses, and distribution centers to deliver small-scale orders to different locations at specific times. The increase in demand is staggering, as according to Insider Intelligence, Canada's e-commerce sales in 2020 were forecasted to hit \$39.22B, a more than 20% increase from 2019. Similarly, e-commerce sales in the US during 2020 were estimated at \$791.7B, up nearly a third from 2019. Furthermore, a survey from Capgemini found that 56% of online shoppers aged 18-34 expected same-day delivery, while 61% of all consumers polled were prepared to pay an additional charge for the convenience of same-day service. This trend will likely create and accelerate the demand for drone delivery.

These customer expectations are causing many large-scale enterprises to determine how to effectively cater to customers' needs and delivery solutions. As a result, e-commerce companies globally have announced \$1B in investments to enable faster deliveries, improve customer satisfaction, rein in costs, and gain a competitive advantage. Therefore, the need to fulfill customers' changing demands **will propel the autonomous packages delivery market in the future.**

Automation also has significant potential to increase efficiency in the logistics industry. Autonomous drone solutions as part of the Internet of Things (IoT) will be the dominant technology in the regard, and they have the power to transform the entire industry. Specifically, **the use of AI-driven drones could drastically decrease labor costs and has thus been hyped as a potential disruptor to the parcel & e-commerce delivery market.**



A GAME-CHANGING SOLUTION

UVL Robotics offers a revolutionary new approach to last-mile delivery, where the entire process will be fully automated, from loading the package to the drone to delivering the order to the customer. Important consequences of the introduction of an AI-driven autonomous solution will not only be the optimization of logistics costs or the allowance of urgent deliveries within predictable windows, but also social factors, such as a steep reduction in CO2 emissions within cities, improved road safety, and the ability to urgently deliver vital medicines to populations in need of them.

Our core value proposition is that we enable fast, on-demand drone delivery, with tech-enabled conveniences, such as smart parcel stations and dedicated mobile apps. We focus on different product categories such as prepared food, groceries, medicine, and commodities. Our target geography is mainly urban areas with high densities of supply and demand that fast delivery requires.

Foreword by the CEO

The UVL team is developing a new **ecosystem of 24/7 autonomous delivery**, where different industry players, be they manufacturers of different types of UAV platforms, developers of energy sources, UTM companies, or infrastructure solution manufacturers, can integrate with one another, and become a key element in the supply chain of delivering goods to the end buyer. In this new ecosystem, we will build relationships and collaborate closely with key stakeholders like regulators, cities, and the public.

Thanks to the accumulated experience of the UVL team in the logistics industry (much of our team are ex-managers of leading 3PL companies, transport companies, and retailers), we have already successfully launched a service

for the commercial autonomous intracity delivery of parcels in the Middle East market, specifically in the Sultanate of Oman, where we have received official BVLOS permissions from regulatory authorities. Our backgrounds also give us the expertise to understand exactly how to quickly scale the product to other regions and countries.



EASY TO SCALE

We have focused on designing a concept of a last-mile autonomous delivery ecosystem that could be quickly and easily scaled in any region, such as the Middle East, Europe, or America. The modularity of the design of our drone platform and smart parcel station allows for quick alterations to adapt to specific customer requests. Taking into account various product categories, we selected the optimized payloads. It was also necessary to take into account temperature control, since in the case of hot food, for example, the product must be kept warm, while biomaterials must be kept at a certain low temperature inside their containers.

Our fruitful collaborations with regulators also allowed us to understand their main requirements and concerns for the security of delivery drones, in addition to the necessary supporting IT infrastructure. We also have a very good idea of what the requirements for technical personnel for uninterrupted support of the entire autonomous infrastructure should be. For these purposes, we have created our own training center, and organized cooperation with leading drone centers and technical universities.



Eugene Grankin

Founder & CEO of UVL Robotics Inc.

Eugene has over 12 years of wide-ranging experience in warehousing and logistics, prior to founding since he UVL Robotics. Previously, he held a series of senior roles at Shell and Huhtamaki, where he successfully implemented several global supply chain initiatives, launched a number of distribution centers from scratch, and supported the Global GSAP team in implementing an ERP system across Europe.



Moosa Al Balushi

Co-founder of UVL robotics

Moosa Al Balushi is regional director in the MENA region and one of its team leaders. Moosa graduated from University of Liverpool, and later proved himself as a first-class specialist in logistics companies. Previously, Moosa worked at Engie Group and ASYAD-group, where he implemented a number of successful commercial projects.

**FOREWORD BY
THE RECOGNIZED
LOGISTICS
EXPERTS**

Foreword by the recognized logistics experts



Lorenzo Fornaroli

Global Logistics & Supply Chain Executive,
Director of Supply Chain Services in NEOM

"I believe that it will take several more years to fully integrate drones into the urban environment. In the perspective of 3-4 years, the consumer should become familiar with the advantages of last mile deliveries using drones, which bring speed, are not bound by any time horizons (they can order and receive deliveries any time of the day) and which are more environmentally friendly, safer, quicker. And it is the consumer who will become the driving impulse who will tell the business: "I will buy from you, because you have drone deliveries."



Wolfgang Lehmacher

Technology evangelist
in logistics, ex- President & CEO GeoPost

"The last mile is the most complex part of the supply chain. Therefore, it's a fragmented space. Drones will have their place in the mix. Last mile is an area of innovation and I do expect that AI will play an important role in optimizing last mile logistics through better utilization of vehicles and increased integration of logistics in the O2O chain and experience. The data available and it's sharing will help drone deliveries from an operational and an acceptance point of view.

The advantage of using delivery drones is a higher level of accuracy, transparency, and efficiency. Drones are robots that can be integrated into the world of connected supply chains operating together with other fully digitalized or semi-digitalized components of the chain. Drones are a means of digitalizing our supply chain networks."

KEY TAKEAWAYS



KEY TAKEAWAYS

This paper aims to illustrate UVL Robotics' vision for making last-mile drone delivery a reality. It describes our holistic ecosystem approach to last-mile delivery as one of the future industry champions in the last-mile drone delivery market. Within this ecosystem framework, UVL is creating a scalable solution for future last-mile delivery, by leveraging partnerships with innovative and established industry players and new ones alike. In doing so, UVL is actively shaping the future of last-mile delivery. UVL will provide safe, fast, cost-efficient, and reliable parcel delivery services directly to end clients. In addition to improved efficiency due to their independence from ground traffic, these

services will deliver unique experiences and compelling value to all stakeholders.

Last-mile delivery by drones is an emerging industry that involves the implementation of new types of AI-operated drones to a city's lower level airspace and smart-related infrastructure. For this form of mobility to scale and thrive, UVL Robotics needs to establish an entire value chain. We achieve this by forming mutually beneficial relationships with strong industry players (for example, FM Logistics, Asyad Group, Aramex & etc) that contribute expertise and scale in their respective fields and synchronously validate UVL Robotics' mission.

Key takeaways

This paper additionally gives a technical overview of the impacts of drone delivery operations at a city and out of city scale, and analyses key issues of energy consumption, infrastructure requirements, aerial congestion, privacy, and noise.

Scalability for last-mile delivery companies is a notable hurdle to overcome. In this respect, autonomous drone delivery can be an appealing solution, due to its simplicity and cost-effectiveness.

Aviation Authorities are globally striving to make drone delivery a reality, due to the intelligibility of **safety** components from drone companies and in line with law needs.

Decreasing emissions in urban areas is crucial nowadays due to the increasingly extreme effects of climate change. In this respect, drone delivery solutions can play an important role by reducing ground transportation pollution and making last-mile delivery sustainable.

Commercial drone operations have **lower production and operating costs** than alternative last-mile delivery methods like delivery trucks or vans. However, as the volume of drone deliveries increases, the amount of fixed, in-place infrastructure and investment costs will inevitably increase with them. As a result, the total unit cost of UAS package delivery will be a function of the lower overall operating costs and the number of deliveries that can be made by the system in a given timeframe. As the number of deliveries increases, the unit cost will decrease.

Consumers will **experience** the benefits of drone delivery by receiving highly fresh food and groceries that will be delivered in a matter of minutes.

UVL is scalling drone last-mile delivery service. Calculations based on the White paper show that price per in-city drone delivery (MENA region) for end user will be at parity with classic courier delivery prices. We state that an **order of 3 kg of food or grocery parcel** will be priced **lower than \$5.2***. Our cost assumptions includes at least **192 of flights (shipments) per day** and **6 drones in use**, average distance from loading depot to client location is **within 10 km**.

Taking into consideration the cost parity with a human delivery main disrupted points of UVL drone solution concludes in the following cases:

1. CO2 emission reduction for urban environment
2. approx 3 times delivery time reduction
3. 99% forecasted delivery time for end users - no awaiting due to human factor
4. Improving road safety and reducing accidents by reducing the number of couriers

**price was confirmed by top courier players in MENA region*

VOCABULARY

Vocabulary

In this Roadmap, the following words, abbreviations, and expressions have the following meanings:

BVLOS	Beyond Visual Line of Sight
UAV	Unmanned Aerial Vehicle
UAS	Unmanned Aerial System
Depot	A location for the storage of large quantities of equipment, food, or goods
PMV	Personal mobile vehicle
Smart parcel station	Smart locker / spot for the secure storage of packages. Consumers can then pick up their parcels from the station when it is convenient for them
UTM	Unmanned Traffic Management
Multi Rotor UAV	Any drone with more than one rotor; more rotors facilitate better flight control
Flight Controllers	Mechanism that communicates the pilot's input to the drone's motors
Accelerometer	An instrument that measures the drone's acceleration and tilt; also works with the gyroscope to maintain orientation
GPS	Global Positioning System; a satellite-based radionavigation system
FAA	Federal Aviation Administration; agency responsible for regulating civil aviation
LiDAR	Light Detection and Ranging. LiDAR is a method of detecting, measuring, and mapping using a laser.
NOTAM	Notice to Airmen. A NOTAM is a warning given to alert aircraft or UAS pilots of any possible hazards or flight restrictions along a flight route or specific location.
Telemetry	A two-way digital data stream between the UAV and a ground station that is used to communicate flight data and instructions to control the UAV.restrictions along a flight route or specific location.
DD Tower	Drone Delivery Tower. A control room for controlling autonomous deliveries

1

**OUR VISION FOR
SCALABLE LAST-MILE
DRONE DELIVERY**

1. OUR VISION FOR SCALABLE LAST-MILE DRONE DELIVERY

UVL has highlighted three primary factors that drive scalability:

The first is **hardware (UAV platforms or smart parcel stations), IT infrastructure, and design decisions**. During the design of both the delivery drones and the smart parcel stations, UVL considered fundamental factors related to subsequent scaling. For example, we emphasized the modularity of our designs, which refers to the capability of the hardware to be quickly configured for specific customer tasks. As a result, the modularity of the smart parcel station design allows you to quickly increase the number of storage cells depending on the volume of deliveries. Similarly, the drones were designed to work effectively in a wide temperature range and under different weather conditions. The type of payload for the delivery of orders with temperature control is also an important component, depending on the categories of goods. This is because different temperatures are required for the delivery of food, medicine, and commodities.

The second factor is the **scalability of technical operations teams and processes**. It is difficult to build scalable systems without our highly experienced team of engineers tuning all parts of the engine. UVL's team consequently issued a training guide for UAV technical and

operational staff to set up, control, and maintain the autonomous last-mile delivery process. UVL also has substantial experience in recruiting local staff and training them to work with the autonomous delivery system.

The final factor determining the scalability of last-mile drone delivery is the **long-term cooperation of regulators and city governors**. It is impossible to operate drones anywhere outdoors without obtaining the appropriate flight permits. It is therefore extremely important for us to comply with the rules and policies set by the local regulator. We therefore strictly adhere to safety regulations governing outdoor drone flights on agreed routes and employ several advanced software solutions to increase safety, including anti-obstacle collision, parachute systems, and close integration with UTM platforms. In addition, we pay special attention to privacy concerns and do not use cameras on board our drones, as a result. Over past years, UVL Robotics boasts of positive international experiences working with governments, regulators, and the general public. Harnessing this experience, UVL Robotics has developed an in-depth understanding of each stakeholder's views, challenges, and concerns regarding the launch of the last-mile drone delivery solution in urban areas.



This Roadmap will explain in detail how UVL Robotics' strong focus on the aforementioned drivers can help to implement the last-mile drone delivery ecosystem at scale.

2 INCREASING URBANIZATION AND CONSUMPTION: NEW CHALLENGES FOR THE LOGISTICS & SUPPLY CHAIN INDUSTRY

2. INCREASING URBANIZATION AND CONSUMPTION: NEW CHALLENGES FOR THE LOGISTICS & SUPPLY CHAIN INDUSTRY

Today, one of the main global developmental trends is the increase in the scale and density of urban centers. Every year, the pace of urbanization is growing. According to UN estimates, by 2050, [68% of world's population will live and work in urban areas](#). Cities are accumulating more and more economic and human resources, and their importance is steadily growing as a result. Many megacities (cities with a population over 1 million) are thus becoming the locomotives of the economy of their entire countries. Such megacities as Tokyo, Paris, Zurich, and Oslo now produce roughly one third of their countries' GDP.

At the same time, the continuous growth of these cities has exacerbated a number of related issues, including the deterioration of the environment, the depletion of natural resources, and traffic congestion. Consequently, if special measures are not taken, then these rapidly growing cities will become less and less comfortable for habitation. Urbanized space is already perceived by residents as an aggressive environment, wherein there is only room for work and a certain minimum of services, mainly concentrated

to ensure the effectiveness of the same professional activity. Conversely, tranquility, relaxation, and comfortable living are typically associated either with resorts or with the countryside, but in any case, with sparsely populated areas.

It is no secret that most metropolitan areas suffer from heavy traffic. It has already been proven that heavy congestion brings not only temporary inconveniences, but also substantial economic losses. According to IBM estimates countries lose an average of 1% to 3% of their GDP due to congestion alone. The impossibility of planning movements, air pollution from car emissions, dilapidated transport infrastructure, traffic accidents - these challenges must all be solved, when creating a smart city with AI-driven drones playing a central role.

This rapid urbanization is affecting consumer shopping habits, product preferences, and how these goods are delivered. To be successful, companies need to understand the characteristics, preferences, and buying patterns of consumers that will result from this shift to urban living.

Increasing urbanization and consumption: new challenges for the logistics & supply chain industry

According to the Council of Supply Chain Management Professionals, mass urbanization will drive greater spending in logistics, while also necessitating the development of more personalized delivery methods to complete orders more quickly. This will subsequently lead to increased spending on parcel deliveries. Specifically, supply chains will have to become leaner and more agile to keep up with consumers and their multiple connected devices, which enable them to order products from anywhere, at any time. Novel technologies, such as fully automated, intracity transport drones, automated pickup points, and location-based tracking will help companies optimize shipments and ensure they are delivered as planned. Elsewhere, in cases of unexpected disruptions, onboard unmanned vehicle telematics will allow deliveries to be redirected or rescheduled.

3

THE IMPACT OF CLIMATE CHANGE AND CO2 EMISSIONS ON THE DELIVERY SERVICES INDUSTRY

3. THE IMPACT OF CLIMATE CHANGE AND CO2 EMISSIONS ON THE DELIVERY SERVICES INDUSTRY

Goodchild and Toy (2018) provide a first attempt of comparing the CO₂ emissions and vehicle-miles traveled (VMT) of two delivery models, one by trucks and the other by drones, using several ArcGIS tools and emission standards within a framework of logistical and operational assumptions. In doing so, they identify the general conditions under which drones are likely to provide a CO₂ benefit. Meanwhile, Figliozzi (2017) uses several analytic tools to measure drones' potential effect on CO₂ emissions, accounting for different scenarios of average last-mile delivery distance. Both studies clearly demonstrate that delivery drones are significantly more environmentally friendly than conventional diesel light commercial vehicles (LCVs) on a per trip basis, both in terms of energy consumption and emissions produced. Our drones in particular can significantly reduce the CO₂ contribution of delivery vehicles, as they use high-torque electric powered motors and electric speed controllers that are highly efficient with lithium batteries and hydrogen fuel cells. In partnership with Inmarsat, [Cranfield University](#) used its own modeling and primary data resources to compare the CO₂ emissions emitted by UAVs and LCVs. According to their findings, an LCV delivering 10 similar

sized packages per 8-hour shift over a 5km delivery radius, and following a regular schedule of consecutive deliveries, produces an estimated CO₂ emission rate of 3,394 grams per 24 hours (3 shifts). In contrast, a large-sized UAV with a 50kg payload operating in the same delivery protocol as the LCV produces 1,800 grams of emissions per 24 hours, representing a 47% reduction.

Alternately, a medium-sized UAV with a 36km range, carrying a 5kg payload on a less-than-optimal operating pattern, where separate journeys were made from the central warehouse, as opposed to making consecutive deliveries, was estimated to produce 2,160 grams of carbon dioxide emissions over 24 hours. Despite the sub-optimal operating pattern, this still constituted a significant reduction of 36%, compared to the equivalent LCV road transport.

[link: sciencedirect](#)

[link: u.ae](#)

4

HOW WILL LOGISTICS BE TRANSFORMED BY DRONE DELIVERY?

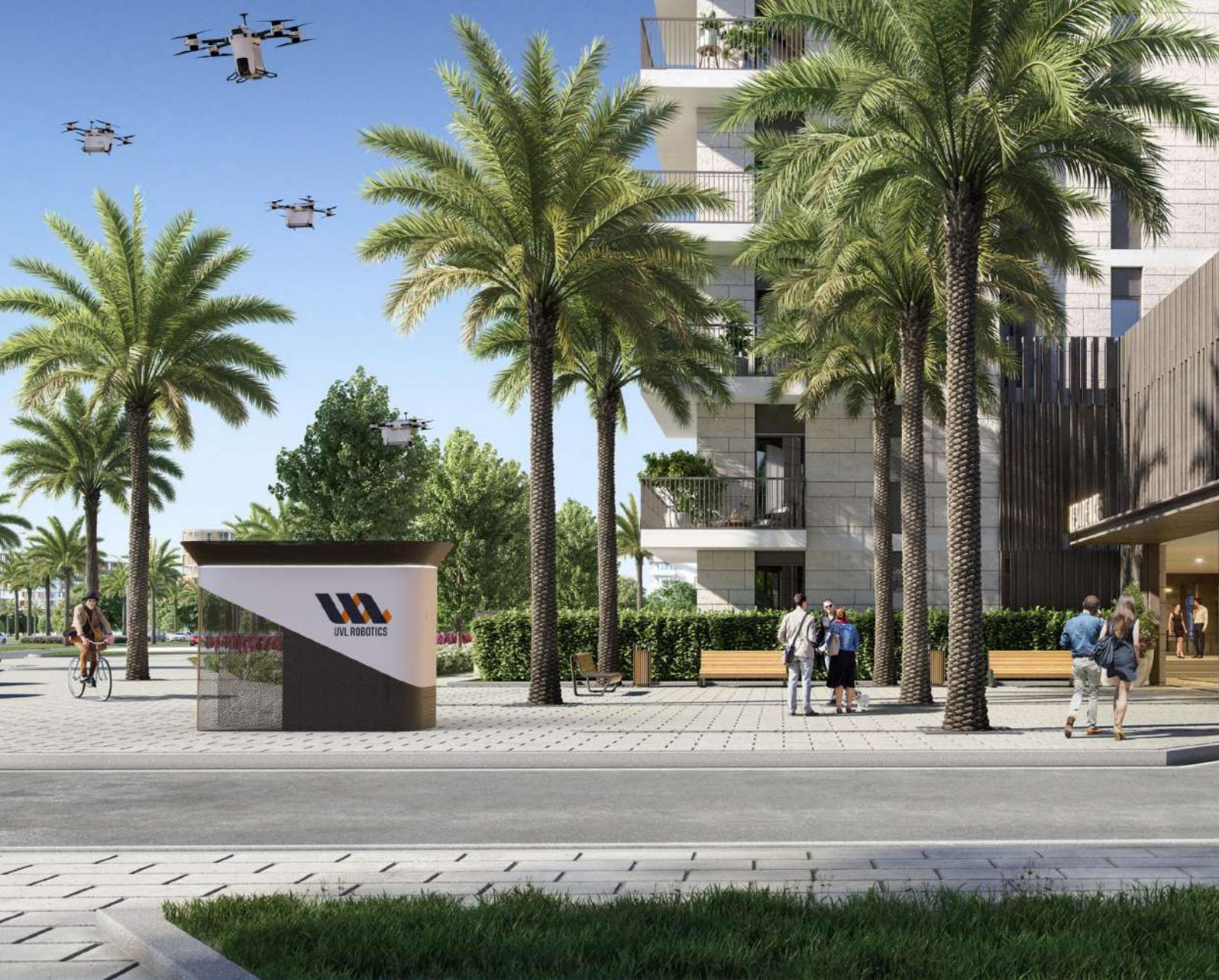
4. HOW WILL LOGISTICS BE TRANSFORMED BY DRONE DELIVERY?

E-commerce, facilitated by social media marketing, has grown rapidly over the past years. In 2016, the online retailer Amazon was reported to serve 310 million customers worldwide. In Europe alone, the number of online shoppers can be estimated at between 300 and 340 million. As the majority of goods purchased online are delivered directly to customers, last-mile delivery (the movement of goods from a transportation hub to their final destination) has become fundamental to this industry. However, home deliveries are currently inefficient, due to the spatial dispersion of residences and the frequency of failed deliveries. As a result, the cost of delivering parcels represents a significant expenditure for online retailers.

In the wake of e-commerce and its successful diffusion to most commercial activities, last-mile distribution is causing more and more issues in urban centers. Growing parcel volumes increase the number of delivery vans entering the city centers and thereby worsen congestion, pollution, and the health of inhabitants. It is unsurprising, therefore, that in recent years, many novel delivery concepts have been proposed. Among the most prominent solutions are unmanned aerial vehicles (drones) and autonomous

delivery robots, in place of traditional parcel delivery methods

In particular, the idea of using UAVs and related infrastructure (precise landing stations, automated pickup points and drop-off systems, specialized software applications, UTM, etc.) for last-mile delivery is gaining popularity. Nowadays, the use of drone solutions to deliver parcels, food, or medicinal goods has great potential to optimize logistics costs. Specifically, drones have no driver or truck costs eliminate congestion costs, and dramatically reduce the number of missed deliveries, due to the very short delay between item dispatch and delivery (e.g. 30 minutes). As a result, the technology is now the subject of intense research activities.



Drone delivery is also capable of bringing other notable advantages to companies that adopt the technology. From a consumer preference perspective, drone delivery combined with mobile phone applications to ensure traceability and scheduling, could provide the conditions for satisfying highest possible demand probability. This is because such a delivery system would combine home delivery with flexible delivery times, information traceability, and reduced costs. Drone delivery could also reduce the need for local road transport in cities, thereby decreasing congestion and air emissions.

Conversely, some potential issues have also been raised in terms of both the safety of drones to people and noise pollution. However, these problems could potentially be addressed by active noise canceling or bladeless systems. Elsewhere, limitations relative to the use of drone delivery services have been raised, particularly regarding the need to relocate or build new distribution centers closer to customers.

5

WHAT IS NEEDED TO OFFER DRONE DELIVERY AT SCALE?

What is needed to offer drone delivery at scale?

5.1 DRONE DELIVERY ECOSYSTEM FRAMEWORK

With scalability as a key consideration, our automated drone delivery system is built as an ecosystem of self-sufficient modules that can function independently or as parts of a greater whole.

The drone can work independently of all other hardware when completing the most basic ground-to-ground deliveries. Such deliveries can be initiated through our client application, combined with an online dashboard, where the delivery team can see and fulfill orders. Alternately, this may be achieved through an

independent method specific to our B2B partner.

Adding smart parcel stations to the mix, and with them the process of automated package reception, allows the delivery team to concentrate their efforts on the sender side of the delivery process. The parcel stations will therefore only need attending to when servicing is required, such as for scheduled technical checkups or direct requests from customers. UVL smart parcel stations also enable the customers to send their mail through our



What is needed to offer drone delivery at scale?

system, increasing their usefulness and thereby expediting their widespread acceptance.

Video of smart parcel station: [vimeo](#)

To serve a large number of smart parcel stations and manage a large number of arriving drones, we also provide an automated depot infrastructure, based on the “batteries included” principle. Each depot area can have multiple launchpads where drones can take off and land. Each landing spot can also be equipped with its own on-the-spot weather station, to better account for climate conditions such as wind and atmospheric pressure at launch. UVL depots may additionally have multiple delivery assistant dashboards to streamline the reception and preparation of orders from the client app. These dashboards display relevant information about the depot’s inventory, such as drones, batteries, and packages, as well as the statuses of launchpads and the list of incoming orders.

The launchpads are themselves automated, allowing for the unmanned loading and unloading of parcels. This enables drones to autonomously switch batteries, pick up parcels, and immediately set off for a new delivery, once a service worker has loaded a new parcel into them. This makes the circulation of drones in the system fully autonomous.

Depots can further be equipped with weather forecast displays for each route to assist the delivery team in the prioritizing of shipments. Some aspects of this functionality can also be integrated into the launchpad dashboards. In such a

scenario, the dashboards could then automatically advise workers that high priority orders be delivered first, or allow / forbid the launch of drones on certain routes, based on weather conditions.

Our depots additionally consist of an online flight monitoring dashboard that can be used to perform pre-flight checks and submit permission requests from airspace authorities. This can further be integrated with a UTM of choice, based on regional requirements, to automate the flight permission acquisition process.

Regarding the technology of the drone itself, our UAVs run a custom software solution that allows third parties such as B2B partners and local authorities to provide their own plugins to track drone telemetry and send the drones to their endpoints in the format that suits them most. This allows for great flexibility during integration and production.

Overall, we develop and utilize a wide variety of hardware and software solutions that are already powerful on their own, but together, multiply each other's strengths, and make our last-mile delivery solution truly one-of-a-kind.



5.2 CUSTOMER SERVICE OFFERING

The client is at the center of our entire last-mile drone delivery ecosystem. Customers determine all on-demand orders for drone delivery services. Moreover, people will only adopt the services and remain loyal to them if they meet their expectations, spark excitement and delight, and deliver the promised value offering.

To meet customer expectations, the industry first needs to understand their preferences and concerns. UVL Robotics therefore uses early customer engagements to attain a clear picture directly from its last-mile drone deliveries. It is worth noting here, too, that customers' demands have changed radically, post-pandemic. On-demand deliveries are rising day-by-day. As a result, consumers are now demanding much faster delivery times, and all last-mile delivery companies are trying to meet this growing need. Meeting the customer's expectations is naturally the most important thing for any business. At UVL Robotics, we are assessing the customers' burgeoning need for quick deliveries, as well as the current challenges faced by existing delivery companies. In conjunction, these form the basis for creating the value proposition of UVL Robotics. The core challenges of delivery companies and the needs of customers can be further divided as follows:

TIME PRESSURE/DELIVERY SPEED

Increasing parcel volumes have primarily been triggered by the steep rise in e-commerce activities. Despite the increased demand, however, most online retailers have made next- or even same-day deliveries one of their basic service promises. As a result, last-mile deliveries now face tight deadlines and considerable time pressure. The workload for last-mile deliveries is also highly volatile, so any workable last-mile concepts must be easily scalable on short notice.

In this regard, it is also important to point out that the demands of customers living in hard-to-reach areas, such as islands, the tops of mountains, and offshore accommodation, differ greatly from those living within city limits. Those in remote areas will likely be very happy to receive their orders within 48 hours, whereas customers living in cities typically demand it in hours. With drone delivery, we can reduce delivery times to hard-to-reach areas from days to hours and deliver within cities in less than 20 minutes.

PREDICTABLE TIME WINDOWS

As a rule, the window for delivery by couriers is up to 5 hours for same day delivery. Nevertheless, couriers are

What is needed to offer drone delivery at scale?

frequently delayed, they may mix up orders due to human error, or the courier may simply not deliver the order to the client at all. All of the above issues can severely damage the reputation of the delivery or e-commerce company. We understand that a client is not happy to waste their precious time waiting for couriers and would prefer to receive the order exactly at the time specified. However, it is impossible to guarantee the delivery of an order within a predicted time frame without the launch of new delivery technologies.

LOWER COSTS PER SHIPMENT OR ORDER

The last mile represents 45% of the entire logistics cycle and its costs constitute more than 50% of the total expenses incurred to deliver the goods to the customer. For example, a study using real-world data from Finland indicates that traditional van-based delivery options cost between €2 and €6, depending on customer density. Important reasons for the high (especially personnel) costs of traditional delivery methods are heavy congestion, a lack of parking spaces in high-density areas, and customers not being present to receive deliveries. As a result, first-time delivery failures reported by courier services range between 12 and 60% for different regions of the world. Therefore, alternative delivery concepts, especially those enabling unattended delivery or customer self-service, pose enticing alternatives to lower costs.

CUSTOMIZABLE PAYLOADS DEPENDING ON CUSTOMER NEEDS

UVL Robotics splits payloads into several

types, depending on the relevant vertical (food delivery, e-commerce, medicine or postal):

- **Small e-commerce or postal packages** are usually around 3-5 kg of average weight and require an average parcel size of 340x225x125 to ensure safe delivery, as well as some form of stuffing or product cushioning. In practice, there are a few common packaging options for utility:
 - **Corrugated boxes.** These are still the most popular form of product packaging used by retailers or e-commerce companies. They are sturdy, do not add weight to packages, and can be recycled. Double-walled corrugated boxes can also be used to provide additional strength and durability for heavier items.
 - **Padded mailers.** This form of packaging is best for shipping smaller, flat, or delicate items, such as jewelry, handcrafted goods, books, or electronics. Padded mailers can be further protected by adding recyclable paper or bubble wrap, though the latter is a less eco-friendly option for packing.
 - **Food packaging** is used in instances of meal kit deliveries, groceries, and restaurant prepared food deliveries. There are many sorts of food delivery packaging. Styrofoam is a popular choice as it can effectively insulate cold and hot foods, but is not very durable and can be crushed easily, often causing leaks. Plastic packaging is similarly popular due to its low cost



and high durability. Finally, biodegradable packaging is appealing due to its sustainability.

- **Medical thermal containers** are used for the transportation of vaccines and medicines, using specialized software for temperature monitoring.

Based on these needs and challenges, UVL Robotics has successfully developed

and launched fully autonomous delivery solutions, based on AI-driven drones and related infrastructure, that will help delivery companies to adhere to their customer needs. The solution will further improve customer satisfaction by increasing the speed and reliability of deliveries. Our aim is to bring our customer's orders to the location they want at the time they expect, with the assistance of a sophisticated notification and tracking solution.

5.3 FULLY AUTONOMOUS LAST-MILE DRONE DELIVERY SOLUTION

Fully autonomous last-mile drone delivery solution

NOISE LEVEL	65 dB	75 dB	90 dB	87 dB
APPLICATION IN URBAN CONDITIONS	Urban	Urban	Sub-Urban & Inter-City	Urban, Sub-Urban & Inter-City
INTERCITY	×	×	✓	✓
SPEED	54 km/h	50 km/h	100 km/h	150 km/h
CAPACITY	5 kg	10 kg	from 5 to 30 kg	to 200 kg
DISTANCE	to 25 km	150 km	200 km	250 km
	 AI DRONE	 HYBRID	 VTOL DRONE	 HELICOPTER

5.3.1. UAV TECHNICAL REQUIREMENTS

The above figure shows how our different drone delivery platforms can be divided into the following categories:

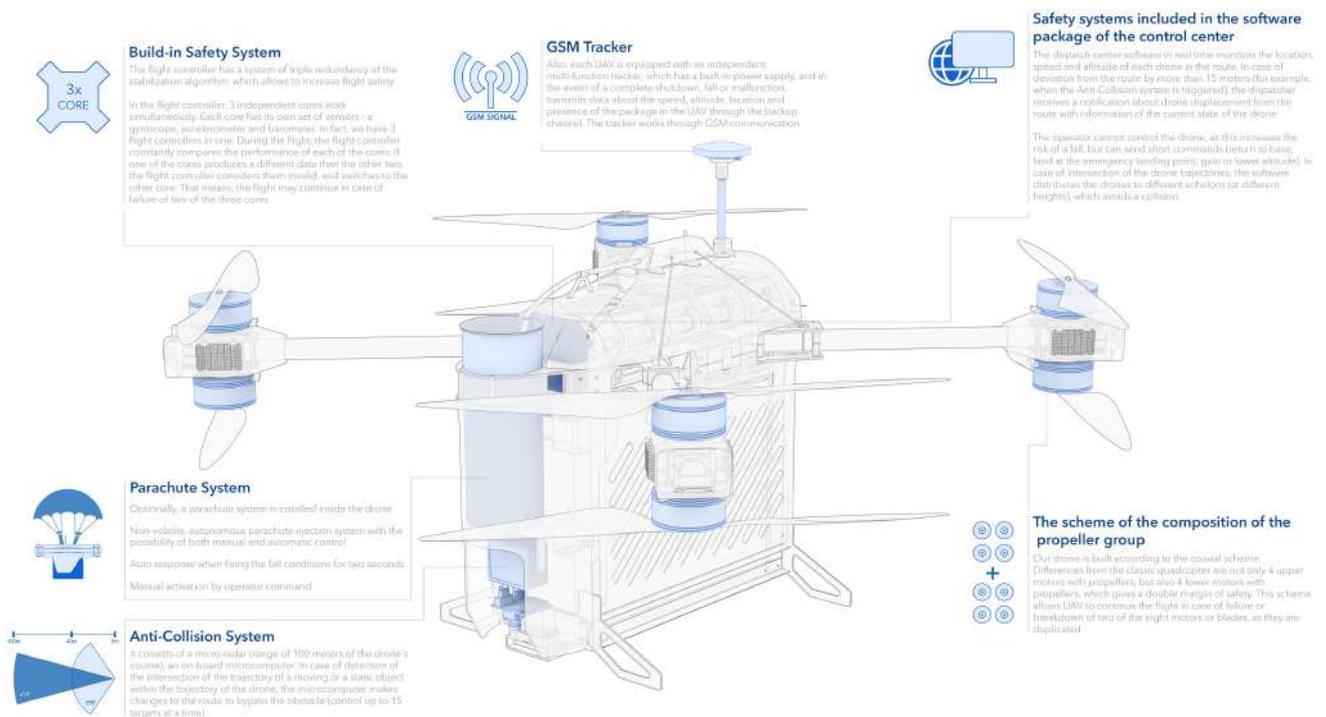
- Short distance intracity routes - we use an electric UAV platform to cover routes up to 25km, with payloads of up to 5 kg;
- Medium distance routes outside of city limits/deliveries to hard-to-reach areas - we use hybrid drones to cover up to 150 km routes, with payloads of up to 10 kg;
- Long distance routes to locations around 200 km outside of city limits - We use VTOL (Vertical Take-off and Landing) drones with maximum payloads of 30 kg;
- Long distance routes of around 250 - 300 km, with heavy payloads up to 200 kg - in these instances, we use the most optimal type of UAV - unmanned cargo helicopters.

Fully autonomous last-mile drone delivery solution

Diverse technical specifications are relevant for an aircraft design to be successful and efficient for each individual use case.

Flights in urban areas require high safety standards, low noise emissions, effective flight ranges and speeds, operating efficiency, and product lifecycle reliability. For day-to-day deliveries within city limits,

the most optimal drones are compact multi-rotor UAVs with payloads of up to 5kg. For example, the UVL AI (see - a Figure below), that is equipped with artificial intelligence, can recognize and bypass obstacles fully autonomously. The UAV is additionally equipped with a parachute system and the ability to integrate into any ground infrastructure. For more detail, see the figure below:





For use cases involving deliveries outside of city limits or covering longer areas, we use heavier UAV platforms with payload of up to 10 kg, based on generators. These UAVs produce more noise, but thanks to internal combustion engines (ICEs) , we are able to ship orders to hard-to-reach locations, like mountainous areas, cross deserts or rivers, or deliver to remote villages.

Our multirotor copter is a radio-controlled flying platform with 3, 4, 6, 8, or 12 brushless motors with propellers. In flight, the platform occupies a horizontal position relative to the earth's surface and can hover over a certain location for an extended period of time. See the above Figure for an image of the UVL Torok multi-copter platform.



As a promising alternative to using generator-powered drones for long-distance cargo deliveries, we have also developed a UAV platform that utilizes fuel cells as an energy source. The main advantages of this design are lower noise levels and higher efficiency than ICEs. In addition, UAVs powered by fuel cells produce little to no carbon emissions.

Many places around the globe are not well-served by road or manned aviation,

and are not suitable for multi-copters, due to limitations with their flight range. For these use cases, - **VTOL or Tilt-Wing** drones are one of the best UAV options. **VTOL or Tilt-Wing** aircraft also offer more efficient maneuverability and require minimal horizontal space to launch, as opposed to fixed-wing aircraft, which require a runway or a large open space to do so. They additionally have the capability to hover steadily, and to take off and land in heavy wind. Furthermore, when these benefits are taken in

Fully autonomous last-mile drone delivery solution

conjunction with their higher flight-speed than multi-copters, VTOL or Tilt-Wing aircraft have the capacity to solve several use cases for cargo delivery.

Unmanned helicopters with single rotors are our final option of UAV platform, and are specifically applicable for deliveries involving the highest possible payloads. Such UAVs are especially important in the delivery of consolidated cargo weighing greater than 100-200 kg, or for the delivery of oversized goods (for example, spare parts for drilling platforms) to remote areas, such as oil fields on the continental shelf. The advantage of

vertical takeoff and landing, which unmanned helicopters can also achieve, is obvious when there is no runway and no conditions or opportunities for the construction of one.

HIGH SAFETY:

UVL Robotics places great emphasis on the safe operation of its vehicles during the delivery of goods within the city and beyond. The table below presents the most frequently encountered risks for UAV. These issues are therefore the ones most prioritized by the company's engineers.

Table 1. Overview of relevant flight safety issues.

	Risk	Description	Solution
1	Multiple system failures	The difficulty of protecting against system failings of most critical hardware and software components	In manufacturing, we followed the aviation practice of duplicating systems critical for flight. The installation of multiple accelerometers, gyroscopes, and barometers allows engineers to completely eliminate the likelihood of a fall in the event of a partial equipment failure. Our UAV software also has a complex self-diagnostics system, which prohibits the launching of vehicles with faulty equipment.
2	Local damages	Damage due to crash landing or careless operation	Our drones are built on a modular system, meaning that it takes no more than 15 minutes to quickly replace external damaged parts.

Fully autonomous last-mile drone delivery solution

	Risk	Description	Solution
3	Rotor breaks	Propeller failure due to collision, failure of the motor, or failure of the regulator	The UAVs are powered by 8 separate motors. The duplication of motors allows the drones to continue flying even if 2 out of 8 motors fail. In the event of a collision with a bird, there are several possible scenarios, depending on the degree of damage to the rotor. If the upper or lower rotor is damaged separately, the drone will lose orientation for 3-4 seconds, with a slight loss of altitude. However, because the second motor remains operational, the drone will stabilize and return to its route.
4	Landing gear failure	If the landing gear fails, the drone cannot land, as this will cause severe damage to the UAV	The integration of light and durable composite materials into the carrier body of the drone fully eliminates the possibility of damage to the chassis.
5	GPS connection failure	Software or hardware failure of the GPS navigation system. This is typically the result of the UAV flying within the coverage area of an active GPS signal jamming system	The integration of inertial navigation modules into vehicles allows drones to switch to an autonomous navigation mode after losing the GPS signal. Based on the data received from its internal sensors, the UAV can continue its mission when the GPS system fails.
6	Tough climate conditions	<p>The negative impact of critical ambient temperatures on the performance of electronics, batteries</p> <p>Temperatures can reach -40* C in the northern parts of Europe and up to 50*C in Africa and the Middle East</p>	<p>High operating temperatures increase the risk of failure of critical equipment, and cause lithium-ion batteries overheat and lose performance.</p> <p>We calculated the aerodynamics of the UAV and directed the oncoming flow directly to the battery, and also applied a special battery structure. These design choices made it possible to double the heat removal efficiency and improve cooling.</p> <p>Low temperatures limit the performance of batteries, resulting in a loss of capacity. We solved this issue by equipping our batteries with a heating system, for operation in countries with cold climates.</p>

Fully autonomous last-mile drone delivery solution

	Risk	Description	Solution
7	Sand in deserts	The entrance of sand to the rotors or motors can damage vehicle bearings and reduce their service life	In our drones, we use specially designed motors that have demonstrated their reliability and resilience under repeated testing. As a result, they have a dust and moisture protection rating of IP54. The motor winding additionally has a special protection against aggressive environmental conditions, such as dust, pesticides, and salt water.
8	Strong wind	Gusts of wind can prevent the drone from following its intended route and increase the load on the battery and propeller group	By conducting multiple aerodynamic calculations in a virtual environment, it was possible to reduce the drag coefficient to 0.25. This made it possible to increase the resistance of the drone to gusts of wind and improve flight stability in bad weather.
9	Drone interception	The hacking and stealing of drones mid-flight	Our drones constantly communicate with the ground stations, UTM's, and each other, using a standard 3G or LTE cellular data connection. The data sent is encrypted by industry standard TLS protocol and signed with the JWT tokens. As a result, unless potential malicious actors have enough power to hack the likes of Google and Apple, who rely on the same technology stacks, UVL Robotics drones should have nothing to worry about.

“For the e-commerce and especially the QSR segment, the implementation of UVL drone’s delivery system means a delivery time reduction of over 30% and a significant decrease in operating costs. In order to ensure the safety of the food whilst being transported, UVL drone systems now come equipped with high-strength materials that withstand high temperatures and severe air pressure drops thus assuring of 100% flight safety even under the most difficult climatic conditions.

The introduction of UVL drone Systems as an additional delivery channel allows QSR and Grocery chain segments to service customers within urban landscape as well as deliver parcels in a short time to remote and hard-to-reach locations. A Drone service grid can allow servicing of a denser and larger geo landscape along with faster and more consistent delivery times for a better customer service quality and consumer experience. On average, using a drone delivery, businesses can increase their geographical coverage by 200%, thereby reaching a wider range of potential customers.”

Sanjeev Madavi, Group Chief Digital Transformation Officer of the Khimji Ramdas Group, on the potential of UVL Robotics’ drone systems.

Fully autonomous last-mile drone delivery solution

LOW NOISE EMISSIONS

Quiet operation is essential for intracity last-mile drone deliveries. The advent of drone technology and the prospect of skies filled with whirring UAVs have raised alarms about increasing noise levels and the resulting impact on society and the environment. This has necessitated drone manufacturers to find ways of reducing the noise they produce.

In addition, loud noise produces an unfavorable aerodynamic effect. This is because of the acceleration of the distribution of force in the air around the rotor blade, due to the passage of the blade through it, and is directed mainly under the axis of rotation of the propeller. This effect is reduced when using an enlarged propeller, while simultaneously reducing the speed of its rotation. This subsequently reduces the speed of the tip of the blade, while maintaining the desired level of static thrust.

The whirlwind interaction between blades occurs when a rotor blade passes near the vortices at the end of the swirl from the previous blade. This causes a rapid, impulsive load change on the blade, resulting in a directional impulsive load noise. This effect can be reduced, however, by using a specially shaped blade with an annular tip. The tip can have a blade profile both in the direction of the blade and in the direction of the air flow, with a certain angle of attack. The ultimate effect of the annular tip is therefore reduced power losses, improved blade aerodynamics, and reduced noise during propeller operation.

SUFFICIENT RANGE AND SPEED

Together, range and speed are perhaps the most discussed topics in the last-mile delivery industry. Compared to typical delivery methods, delivery by drones reduces parcel wait times in urban areas by approximately 2 times. Based on several studies, we know that the largest share of the urban delivery market is for short distances of up to 25 km. With a range of 20km, or approximately 12.5 miles, UVL AI drones can already easily serve most metropolitan areas across the world using existing technology. To illustrate the utility of such drones, the metropolitan areas of New York, Paris, London, Tokyo, Shanghai, Beijing, Sao Paulo, or Mumbai all have a radius of less than 30km from their city centers.

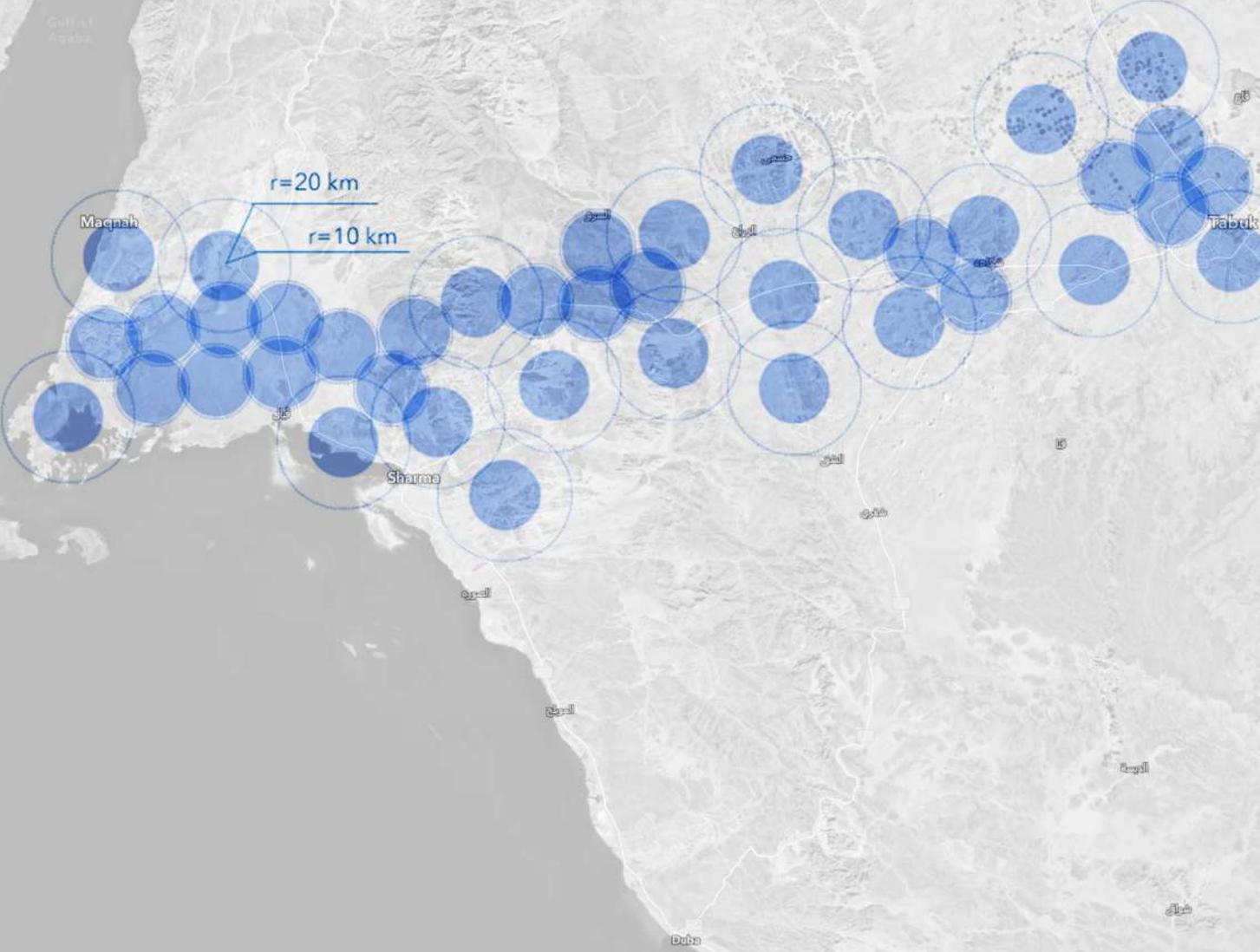
The task of timely delivery of a parcel to a direct line is also related to the task of maximizing drone flight speed. In respect to this, the UVL team has developed a unique streamlined hull with low drag, to increase the efficiency of achieving and maintaining maximum airspeed. In addition to the external body of the drone, the entire structure of the drone is designed for optimal aeronautics at high speeds. However, increasing the speed of flight required us to pay more attention to the flight stability and safety of the drone.

We have consequently conducted many tests of the propeller group to find the optimal balance between speed, stability, and flight time. The solution we have chosen allows us to achieve the maximum speeds that still allow the vehicles to attain the necessary stability required for the accuracy of landing at post offices and ensure the safe flight of the drones over cities.

DELIVERY NETWORK

How do we plan the network?
Optimized routes and parcel lockers locations
based on the population density

**PARCELS CAN BE DELIVERED ANYWHERE
WITHIN 20 MINUTES**



5.3.2. RELATED INFRASTRUCTURE DESCRIPTION

AUTOMATION OF PARCEL LOADING

The design of our depots allows for automated parcel loading into the drones and thus into the drone logistics system. The following paragraphs provide a description of the depots' work processes.

The depot functions as a warehouse for all the parcels that enter, leave, or transfer through it. Within the depot, parcels are sorted and stored inside by low-level staff. The depot buildings are also used as a location for the storage and repair of drones and batteries.

At the beginning of the workday, the low-level staff load the parcels and batteries into the launchpads, retrieve the drones from inside the building, and set them on the launchpads. The launchpads center the drones and load the parcels and batteries into them. Once the above tasks are completed, the drones are prepared for launch and ready for pre-flight checking.

Next, the technician engineer performs a pre-flight check and confirms the launch for each drone, providing the check reveals no problem.

Once the first batch of drones launched, the low-level staff bring out more parcels to each pad and any drones they might have remaining. The entire process is then carried out again.

Upon arrival of drones to the depot, they will have their batteries swapped and their next parcels loaded onto the launchpads. Once the technician engineer has again performed the pre-flight check, the drones will be ready to launch for the next delivery. Providing the drones have no issues that would cause the technician engineer to cancel their flight, the drones circulate within the system fully autonomously, getting assigned flight routes according to orders they carry by automated delivery system software.

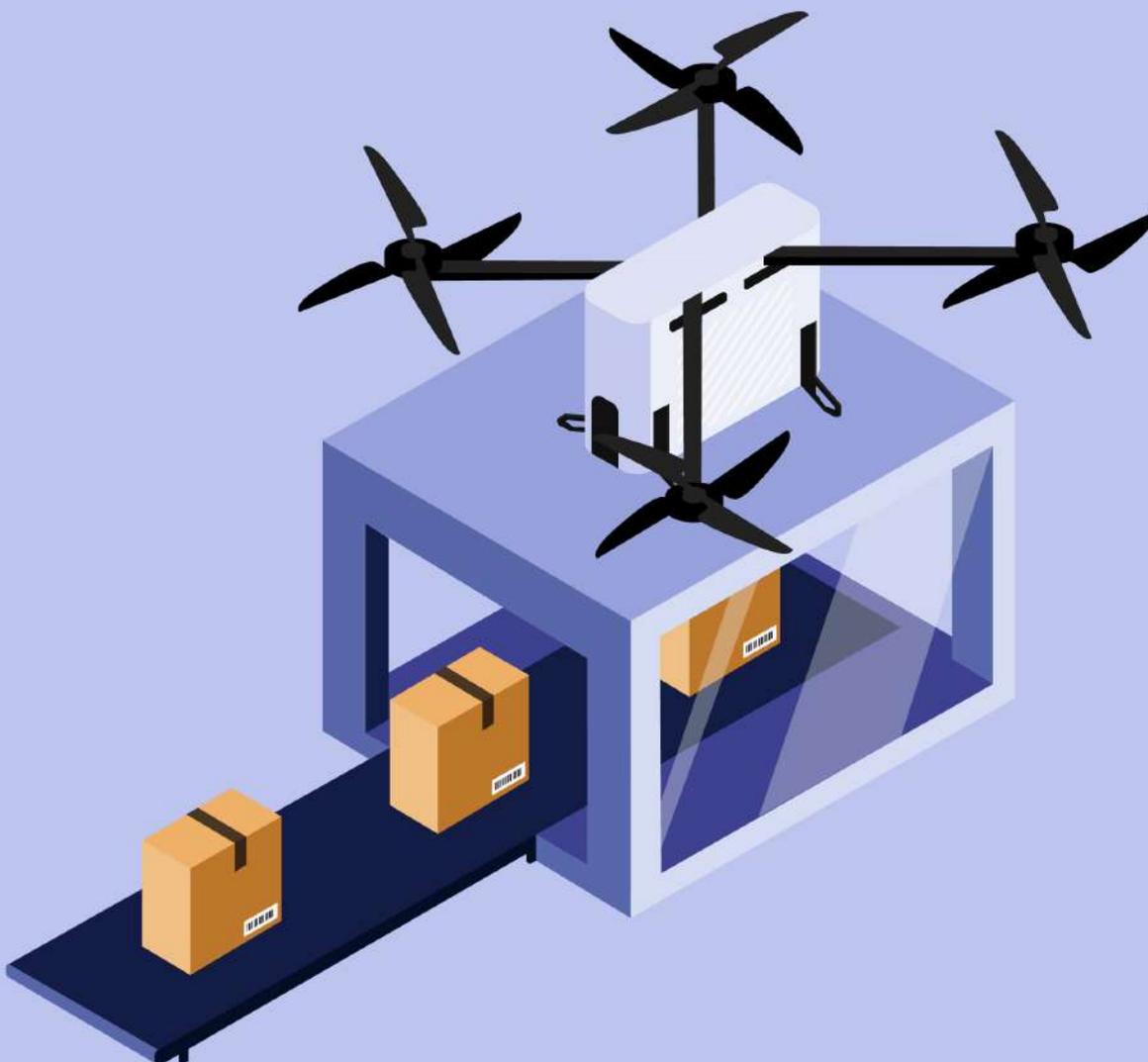
Throughout the process, a human operator watches the dashboard and monitors the drones, their sensors' states, and flight paths for any suspicious events. This enables them to quickly resolve any non-standard scenario that might occur and enter manual override mode for any drone that requires it. If they observe any suspicious activity that does not directly endanger the drone's operations, they will request that the drone in question be inspected by the technician engineer and operator at the depot it is coming to next. If any damage was done to the drone that hinders its performance, it is the technician engineer's task to repair it, so that the drone can re-enter the system.

Fully autonomous last-mile drone delivery solution

At the end of the workday, the low-level staff stop loading new parcels into the system and the drones, having landed on the launchpads, are retrieved, and stored within the depot. Once all the drones are securely stored for the night, the staff finishes the maintenance of the depot and the drones, closes the building, and leaves.

The most numerous staff members are the low-level workers. These employees are responsible for sorting large quantities of parcels, transporting

drones, batteries, and parcels around the depot, and loading batteries and parcels into the launchpads to be picked up by drones. Among them, there is one manager that directs and assists the team with their tasks. As with the pilots of traditional aircraft, each depot employs 2 operators. There are additionally one or more technician engineers, dependent on how many the depot requires to service all drones quickly and efficiently.



PRECISE LANDING SYSTEM AND AUTOMATION OF PARCEL PICK UP

Regarding landing, UVL Robotics utilizes an infrared (IR) beacon-based, high-precision system that provides reliable target detection under virtually any lighting conditions, regardless of the weather. The principle of operation for the landing procedure is simple and reliable. The drone is equipped with a video camera with a modified lens that is specially tuned to a specific wavelength of the light spectrum. A corresponding IR illuminator with the required wavelength is installed on the landing platform so that,

when approaching, the drone is able to detect the beacon from a height of up to 30 meters. Once detected, the drone's onboard computer calculates the vehicle's necessary position adjustments and send commands directly to the flight controller. This technology allows for a fit accuracy of 10 cm. In addition, our implementation of a solution that utilizes multi-directional video cameras, machine vision, and artificial intelligence will increase the overall adaptability of the system.



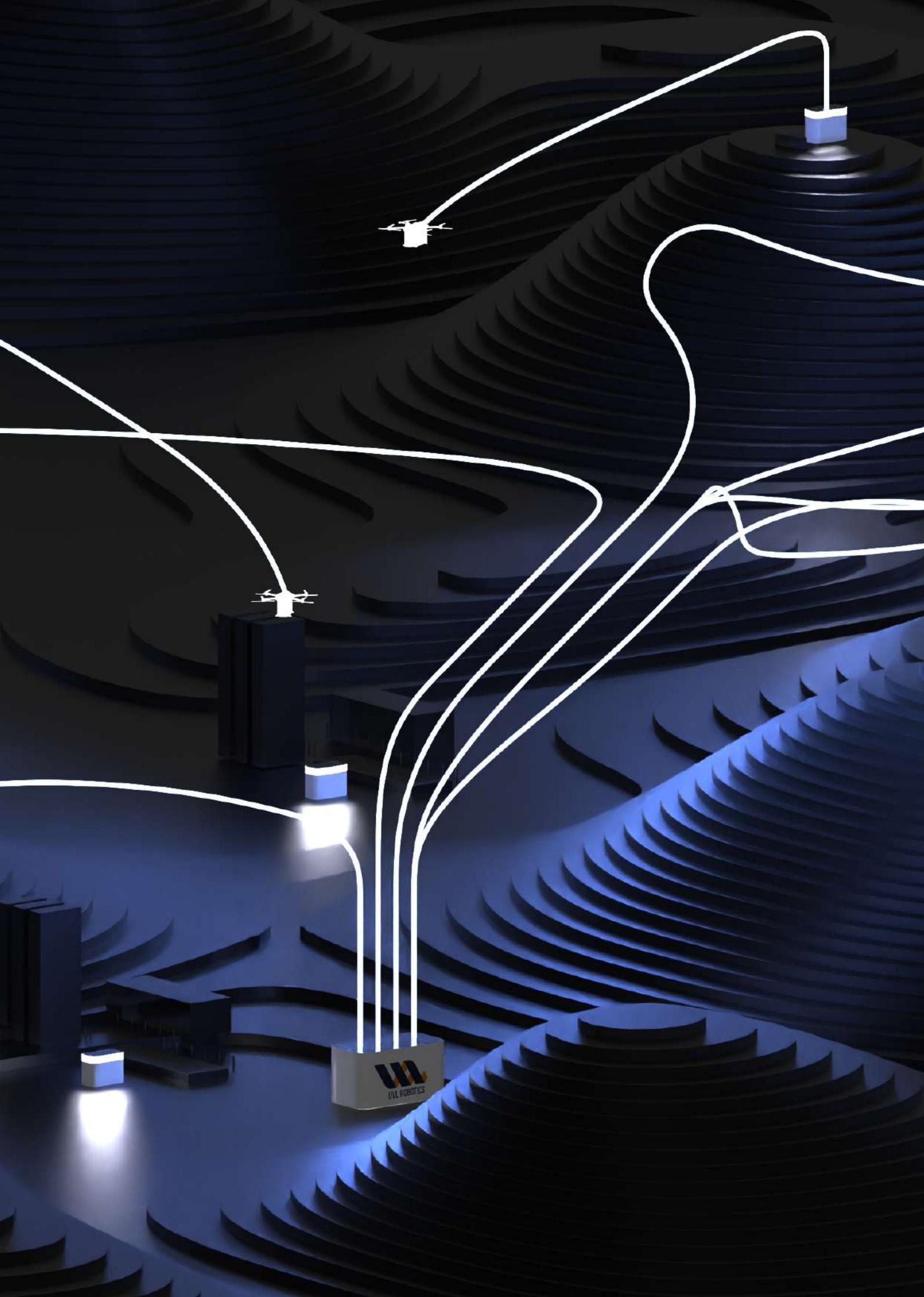
Fully autonomous last-mile drone delivery solution

UVL smart parcel stations works in conjunction with the parcel drones in a single system and have several unique qualities. They are able to receive parcels from the drone, store them, and issue them to the client. Packages can additionally be brought to the smart parcel station and transported to another station, allowing us to implement various complex algorithms for the delivery of goods by drones. Moreover, our smart parcel stations can act as intermediate point for drone routes, thereby enabling us to create a network of delivery points and facilitate long-distance deliveries using a single drone.

Below is a visualization of how parcels may move through a complex “grid” of smart parcel stations, thereby providing flows of both B2C and B2B goods.

To illustrate the process, let’s consider a situation where a UVL UAV is flying with a package to one of the smart parcel stations. After landing on the smart parcel station, the UAV is centered in the landing area using special crossbars. Next, a specially designed robotic arm rises out of the station to retrieve the parcel from the drone. After that, the waterproof hatch opens, and the package falls into the station. The cargo is protected from damage at this stage by a special system of sensors that knows the speed of the parcel at each segment of the “fall”. In response to how the system directs it, the robotic arm accelerates downward and simultaneously catches the parcel, while gently slowing it down. The caught package is then stored in a cell within the station, where the smart system registers which cell the package is located in.

To achieve this, the aircraft can pick up a parcel already in the post office, as well as a parcel received “from the street”. This refers to packages deposited by individuals into the smart parcel station. To send a parcel from the street, a person must go to the smart parcel station and enter the necessary delivery information of the parcel, such as its point of arrival and the recipient, using the application on the screen of the smart parcel station. The station will then provide the client with a standardized cardboard box with a pre-marked mark through the parcel delivery window. The customer must then place the sent parcel into the box, close it, and deposit it in the issuing window. Next, the smart parcel station will check the parcel according to 4 parameters, the overall dimensions of the box, and the weight of the box, to ensure that the package does not exceed the dimensions of the reference parcel. Upon successful verification, the package will be delivered by a courier drone.



SOFTWARE APPLICATIONS

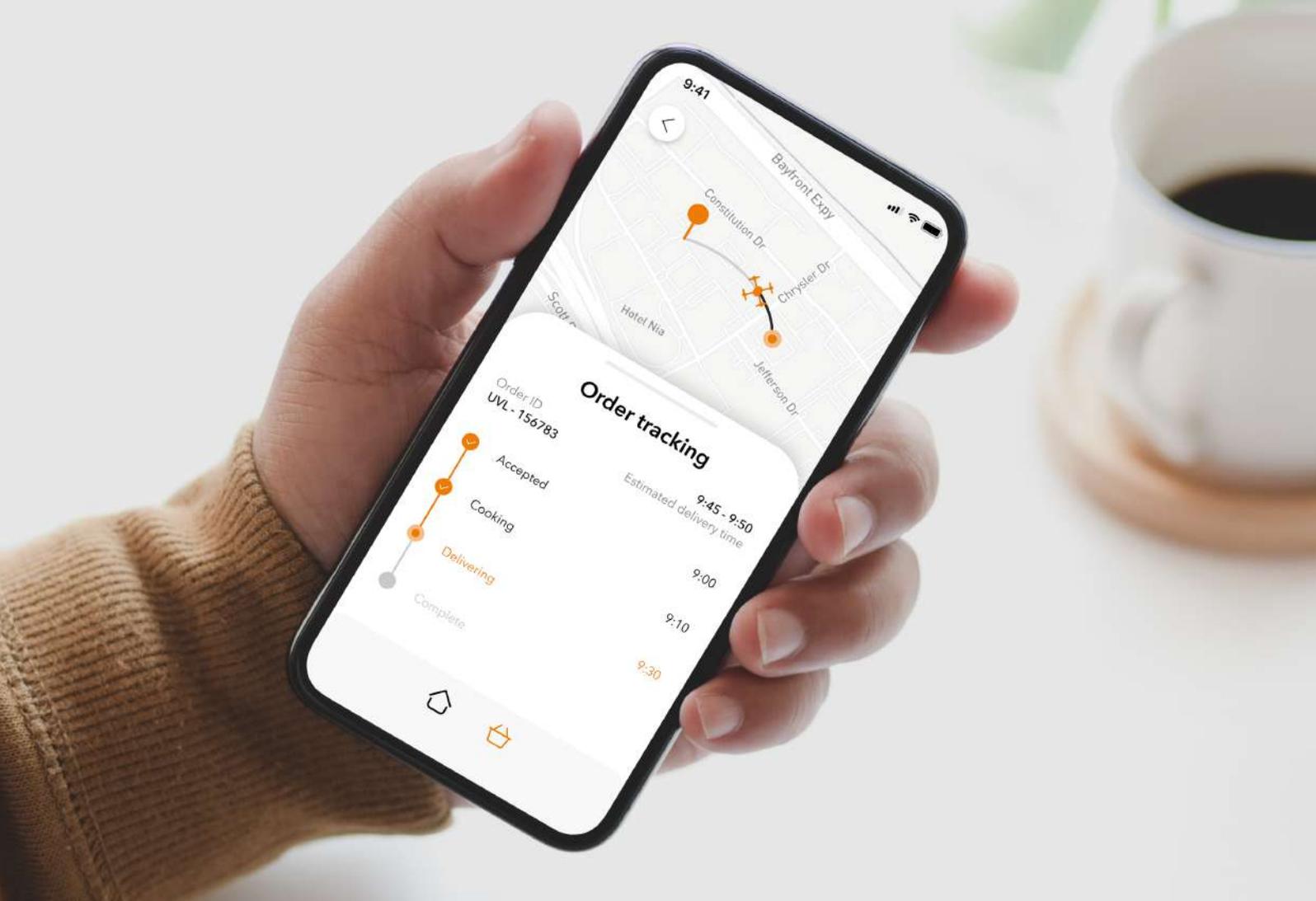
APPLICATION TO PLACE THE ORDER

In terms of software, the UVL team has developed a specialized user-friendly application for ordering and tracking deliveries. Specifically, it provides our clients with an online shop where they can select items for delivery, select a smart parcel station where they want them delivered, pay for their order, and then track the delivery process. Once the order is delivered, the app also sends the customer a retrieval code that is used to obtain the order from the smart parcel station.

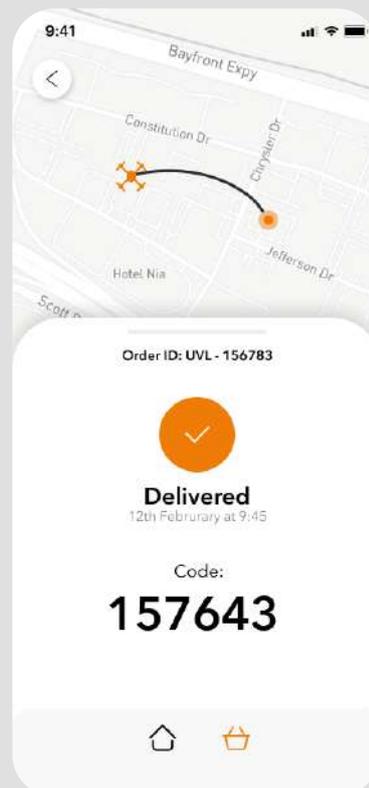
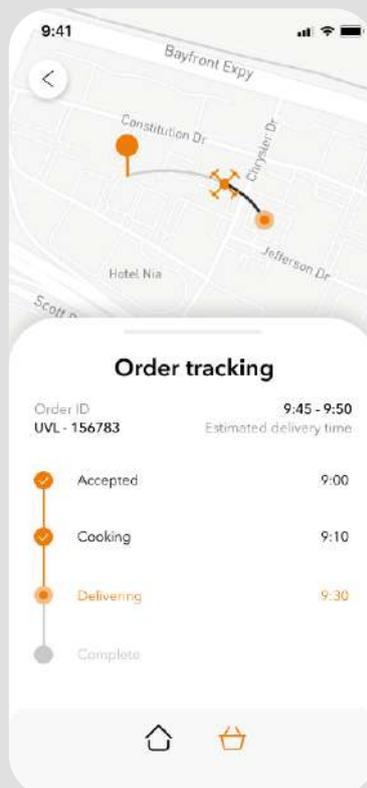
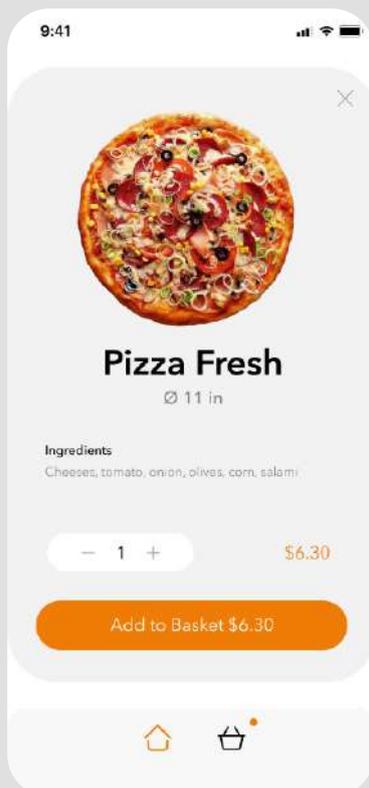
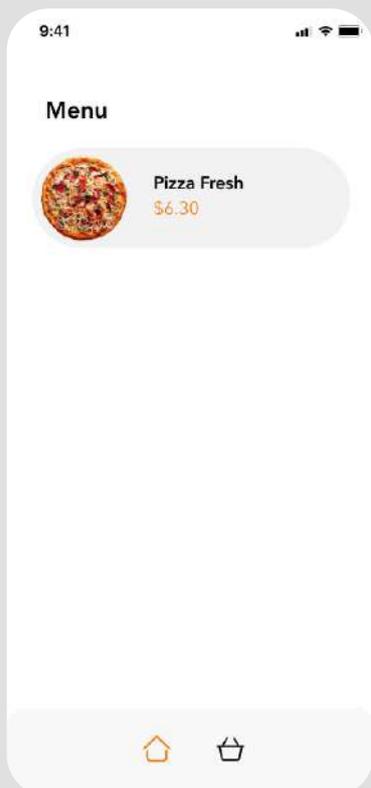
PAYMENT SECURITY AND TRANSACTIONS

The client can either pay for the service using the terminal at the parcel station itself, or through the smartphone application.

We support a comprehensive range of payment methods, provided by our regional partners. They supply us with the specifications and the payment hardware modules, and together, we create the most aesthetically pleasing and functional solution to our customers in each region. This model allows us substantial flexibility when integrating our solutions into regions with different customs and cultural norms.



Below are the screenshots of the selection of an item, the delivery tracking process, and the submission of the retrieval code on the UVL app.



5.4

DRONE DELIVERY OPERATIONS

DRONE DELIVERY OPERATIONS

Many established companies and delivery platforms of all kinds are seeking to employ drones in the delivery process, due to the time-consuming nature of traditional delivery methods and the capabilities of drones to meet the needs of residents in remote areas that currently lack continuous delivery services.

Drone delivery operations originally required a robust team with different competences. However, it is likely that this need will decline in the coming years. This is because the role of UAV pilot will be phased out, as companies shift from an operational model to a control room model. Providing the drone delivery process is fully autonomous, its flight will only require monitoring from the control room, or what we call the Drone Delivery Tower (DD Tower), to

Drone Delivery Tower (DD Tower), to ensure seamless delivery. UVL Robotics follows a strategy of fully automated take-off and landing. As a result, the use of AI for safety and pre-flight checks will form an important component of the take-off station, in addition to the battery replacement arm that will help to extend the time the drone can remain in flight. Moreover, the landing station will have its own safety mechanism, as depicted in the diagram illustrating the design of the drone landing station.

Throughout the operation, the operational team will go through several different checklists to ensure the safety and high efficiency of the drone operations.

- Pre-Start checklist
- Post-takeoff Checklist
- After landing checks

5.4.1. STAFF TRAINING

UVL's key operational employees are located at the depot, and are divided into the following roles:

- UAV operators (pilot)
- Technical specialists (UAV engineers)
- Depot operations staff

The UAV operator is the most qualified specialist. They are responsible for controlling the drone in various modes, imagining the design of the drone in detail, and solving non-trivial and critical situations that arise during the operation of the depot and drones under their control.

Technical engineers are mid-level specialists that can troubleshoot and change parts on a drone, post office, or launch platform. Technical engineers are not required to understand the reason for the device of the drone, it is enough for them to understand the devices themselves.

The depot operations personnel consist of low-skilled specialists who are engaged in parcel sorting, loading parcels and batteries into launch platforms, and taking drones into and out of the depot.

To ensure personnel are sufficiently qualified, UVL Robotics has established

its own training center, where operators and engineers are trained to work with drones. Both the theoretical bases and the technical aspects of drones are studied, including maintenance, the replacement of consumables, how to check the main components and replace them if necessary, and assembly/disassembly. At these training centers, periodic training of new and existing operators on the independent control of drones, the development of control interception, and emergency procedures are also carried out. While the operators do not directly take part in the flights of aircraft, they must control their operation and stability in special circumstances, so must be able to control the drones manually. Material elements of the drones, such as the installation of new elements and modules, various changes in the design, modifications, corrections, and the introduction of additional systems are also studied. Practical exercises, tests, and training flights are carried out on specially prepared devices. The acquired knowledge and skills of staff are recorded, various tests are taken, and a qualification is conferred, based on the results of the exams.



5.4.2. UAV OPERATORS

The operator must be able to manually pilot the drone in case of an emergency and have the appropriate certification. As a result, experience with drones is required, in addition to knowledge of aerodynamics, circuitry, and the technical aspects of the vehicles, as well as skills in the manual operational repair of a drone. In practice, this includes working with and setting up special applications and flashing flight controllers, in addition to assembling and disassembling UAVs.

UVL Robotics also mandates that all its UAV operators and engineer technicians obtain a certificate of qualification showing their successful completion of the preparatory courses at a UVL training

center. To obtain a certificate, it is necessary to demonstrate knowledge of the basics of flight, UAV design, the principles of operation and the operation of power plants, systems and instrumentation, pre-flight preparation and en-route flight planning, air traffic services rules, precautions and procedures in emergency situations, and understanding and application of avia meteorological reports. To start training, take the subsequent examinations, and receive further periodic confirmation of qualifications, it will additionally be necessary for prospective operators to obtain a medical opinion from the medical commission on their general state of health and the absence of contraindications (for example, vision).

Drone delivery operations

A specialist in the operation of unmanned aerial systems (technical engineer) will also need to complete this training and regularly confirm and / or improve their qualifications, since they perform similar functions to the operator and are responsible for the safe operation of flights.

OPERATORS will consider the following factors in the development of an operational flight plan:

- Flight environment
- Flight speed
- Flight altitude
- Flight path
- Battery status





5.4.3. MAINTENANCE, REPAIR, AND OVERHAUL

Pre-flight preparations and inspections include a list of necessary operations and checks at the beginning of each flight day, prior to the attachment of drones to launchpads, according to a special checklist. Each depot consequently has a staff of specialists in the operation of unmanned aerial systems (technical engineers), who perform these checks according to a certain scheme, sign route sheets, and are responsible for the release of UAVs on the line, so that they are ready to fly.

Local weather conditions are monitored constantly online by special weather stations, including the main ones at the depot and additional ones at each post office and landing platform. The decision on the possibility of flight is then made automatically, based on the received data from the weather stations. In the event of a sharp deterioration in weather conditions, a total ban on both departure and landing can be enacted. In extreme circumstances, this can even lead to drones turning around and returning to

Drone delivery operations

the point of departure, or to the nearest safe post office / depot.

Flight control is carried out from the dispatch center, and all data on each drone is monitored online. This analytical data is accumulated in data centers and stored for as much time as it is needed.. This helps identify devices in need of service, that can, if necessary, be removed from the line and sent to the appropriate depot. This can be both periodic maintenance at the end of the next flight, or repairs due to circumstances beyond control (force majeure). All drone parameters and controllers' comments are recorded and sent to the technical engineer, along with any drones removed from the route, for verification and correction. Logs are also copied for further study and analysis. Following maintenance, repaired and service drones then return to routes, according to our well-established procedure.

Parcels are unloaded both on any free plane (if necessary), and automatically, when landing on a parcel locker, with a special manipulator further sorting the parcels into storage cells. The return loading of the required package into the drone also occurs automatically, using the same manipulator, and is fixed to the drone with special holding devices. If necessary, the battery in the drone is automatically switched for a charged one. Once these processes are completed, the program records a report on the drone's readiness for flight. In the same way, if necessary, any parcel terminal located along the path of the drone to the desired point can serve as a kind of hub, by acting as an intermediate point, where the drone can replace the depleted battery with a charged one and continue moving along its specified route.

5.5

CITY INTEGRATION

HOW CAN CITIES BE PREPARED FOR LAST-MILE DRONE DELIVERY?

Drones are considered a workable solution to the problem of last-mile delivery, as they are not affected by the same obstacles that cause traditional delivery methods to be so inefficient. As a result, there is an urgent need for them in many cities

When discussing the process of rehabilitating cities to facilitate last-mile drone delivery, the importance of developing wireless networks that ensure communication and control of the drone is clear. For example, the traffic and emission problems in many metropolitan areas are both negatively affecting the economy and reducing quality of life. In addition, the identification and preparation of locations for last-mile drone delivery is also necessary. Elsewhere, flight paths for drones must also be determined, in line with the regulations and laws related to the mechanism of drone work, which cities must follow to provide drone delivery.

The principle of the work of the drone depends on the principle of the work of aircraft, but without the presence of a pilot. To operate, drones use air navigation systems such as GPS and GLONASS in their work, through satellites that provide information on targets like location and time, in all weather conditions, anywhere on the ground.

The principle of the work of the drone depends on the principle of the work of aircraft, but without the presence of a pilot. To operate, drones use air navigation systems such as GPS and GLONASS in their work, through satellites that provide information on targets like location and time, in all weather conditions, anywhere on the ground.

Drones rely mainly on Wi-Fi wireless networks, GPS systems that give accurate geographic coordinates data, and ultrasonic distance sensors to avoid obstacles in the air during flight. These aircraft are also greatly affected by weather and climatic conditions, so continuous work must also be done to develop navigation networks in cities to facilitate the delivery process. Similarly, it is important that wireless networks are developed to connect and control drones in all areas within the city they are travelling to.

Cities must also be prepared for the taking off and landing of last-mile delivery drones by preparing custom-developed drone landing pads that can be implemented throughout the cities where drone delivery is implemented. Such launchpads should additionally be protected from environmental factors that may affect their work.

City Integration

Finally, cities must follow the operating models of the last-mile drone delivery system. This system can be further divided into four types of operation that must be developed in the places where last-mile drone delivery is implemented, namely:

- Pure drone delivery, where the service is delivered by drone only.
- Drone-inner/Truck-outer, where consumers nearest to the depot will be served by drones, while customers further away will be served by traditional delivery vehicles.
- Truck-inner/Drone-outer, where consumers nearest the depot will be served by trucks, while customers further away will be served by drones.
- Shared Truck-Drone, where either trucks or drones can service any customer, according to the optimality of the objective function.

In developing this system, UVL Robotics has been in contact with many different categories of people, including scientists specializing in the logistics of urban agglomerations, transport and operations managers of global logistics and retail companies, urban planners, and other groups who are interested in shaping the future of last-mile delivery.

Regardless of the group, we are always asked the same, simple questions - **how will the world change due to automated delivery technologies, and what are the preconditions for its adoption?**

Our answer has remained quite similar. The use of an automated system based on

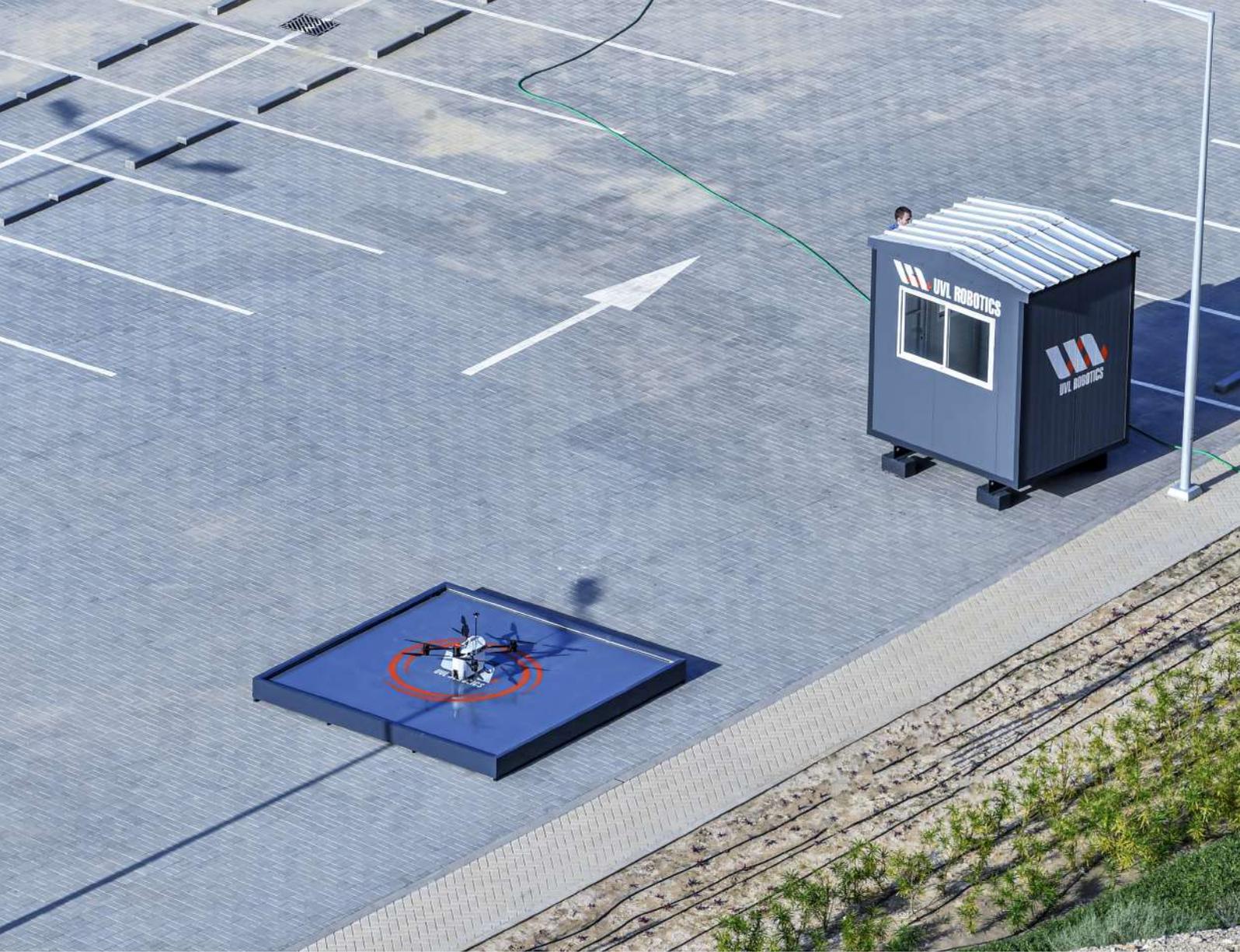
UAVs for targeted parcel delivery directly competes with PMV (personal mobility vehicles) couriers and the existing infrastructure of parcel terminals. It also minimizes the need for self-delivery, where buyers have to move to pick up their parcels themselves, either by foot, private car, or public transportation. In general, such a system fits perfectly into the current development of urbanizations, where couriers typically deliver parcels, as opposed to the customers themselves, but as a result, increase the burden on city infrastructure.

A major advantage of UVL last-mile delivery systems is that perishable or temperature-sensitive packages can be transported as freely as regular goods, without having to be tied to one type of cargo. Drones can generally also deliver parcels via the shortest route, whereas couriers can be delayed by an hour or more due to congestion and sub-optimal routing. However, it is worth noting that one marked advantage of the courier with PMV is that they can not only reach the client's location, but also take the elevator and place the parcel directly in their hands.




WIL ROBOTICS





5.5.1 PHYSICAL INFRASTRUCTURE

The physical infrastructure necessary for last-mile delivery drones consists of nodes of 2 types: smart parcel stations and depots.

The requirements of smart parcel stations are relatively straightforward. They require electricity and an internet connection, and need to be placed in strategic locations to balance maximizing the area they cover and optimizing drone flight paths.

Smart parcel stations might be banded together in high-throughput areas. However, there are also security concerns regarding the smart parcel stations locations. They must consequently be picked or terraformed to ensure the safety of people, and the drones themselves, during launching and landing. With this in mind, the locations of smart parcel should be carefully considered, and all possible concerns must be addressed.

City Integration

Depots require more infrastructure than the parcel stations, but, being dedicated work areas, it is easier to ensure their security for the delivery teams working in them. The placing of depots, however, is a very non-trivial task, since depots must maximize the coverage of smart parcel stations, enable smart parcel stations themselves to maximize their coverage, and, despite being large workspaces, have unrestricted access to open sky for drone launching and landing. Additionally, they require all the typical infrastructure needed of a typical warehouse-office hybrid that acts as a base of operations for a logistics business. Their only additional specific demands are high-quality, industrial-grade electricity for drone charging, and launchpad accommodations, with the second being markedly harder to provide.

For effective day-to-day operation of the automated drone delivery system, it is imperative that it is integrated with local data infrastructure. Specifically, smart parcel station security must be maintained in cooperation with local law enforcement, by installing surveillance systems, and providing law enforcement with targeted training on what to watch out for to prevent vandalism and parcel theft. Moreover, while depot launchpads will be located on private territory, the same law enforcement accommodations will be required to maintain security during non-operating hours.

Drone route maintenance additionally requires integration with local meteorological services and air traffic management systems. Due to the flexible nature of our solution, and the many points of integration within our ecosystem, many different airspaces

authorities' flight management processes, both digital and analog, can be accommodated in regions with existing UTM providers. The APIs of these providers can also be integrated into our system to enable a much quicker flight approval process.



UVL ROBOTICS



5.5.2. UTM PLATFORMS

Unmanned aircraft system traffic managements (UTM)s are air traffic management ecosystems for the autonomously controlled operations of unmanned aerial systems (UAS) by the FAA, NASA, other federal partner agencies, and enterprises. These groups are collaboratively exploring operational concepts, data exchange requirements, and supporting frameworks to enable multiple UAS operations beyond visual line of sight, at attitudes 400ft above ground, and in airspace where FAA air traffic services are not provided.

The key functions of the UTM are as follows:

- Coordination of drones in shared airspace. Many companies with their own drone solutions flying in the same airspace without communicating with one another is a recipe for an eventual disaster. The integration of a central flight management and communication system with each solution can help avoid this. Using the UTM, all drone companies, no matter their internal logic, will communicate with each other and take flights accordingly.
- Critical situation aversion and management. The day-to-day

operation of large fleets of drones will inevitably lead to critical situations. By communicating with other drone fleets through a UTM, a company can minimize or completely prevent damage from such a critical situation. For example, when a rogue drone is present in the airspace, drones will know to avoid it, and hunter drones may be also sent out to take it down.

- Monitoring and surveillance. Having many companies operate in the same airspace will give rise to disputes between enterprises. To resolve such disputes, a UTM can be used as a central source of truth and historical data. Flight hours, paths, and systemic problems like winds affecting drone flight paths can be tracked using a UTM. With a centralized system, the world is your oyster, and the sky is no longer the limit.

Current UTM's that UVL has experience of:

- Airmap. One of the leading providers of UTM solutions. It provides a vast functionality and a robust, secure API. The UTM is well-equipped, with flight zones, points of interest, weather integrations, and user customizations to match company structure. When we started working with Airmap, they

City Integration

were still in the early stages of development and making changes to their API. However, all these changes were for the best, and have made the system even more robust, while retaining flexibility.

- AirGo. A simpler UTM that is still in its early stages. Their API is very basic, but the developers are working hard to get their UTM up and running.
- AstraUTM. Another global UTM that is integrated with our solution. It already provides a more secure API and supports more complex drone information than its competitors, such as the sending of multiple altitude readings from the barometer and the GPS, respectively, to increase the precision of altitude estimation.

5.5.3. CONNECTION WITH GROUND UNMANNED VEHICLES

Our delivery system is an entire ecosystem, consisting of both transport hubs and smart parcel stations, the task of which is to centralize and manage large flows of parcels.

While transportation between the hub and the smart parcel station is carried out by UAV, between the smart parcel station and the end client, delivery is possible using ground systems.

As a result, scenarios exist in which drones can work in collaboration with unmanned ground vehicles to distribute parcels.

The need to connect the process of last-mile drone delivery to ground unmanned vehicles is increasing, due to the fact that the linking process has many benefits when compared to individual drone systems. Through the cooperation of unmanned ground and aerial vehicles, our system can have complete control over the required tasks, integrate information about the delivery process, and divide tasks based on the optimal delivery method, thereby accomplishing tasks more quickly.

The connection process is carried out through the support of satellites in internal and external navigation. The process also depends on a dedicated infrastructure and specialized mobile

work units, which is what happens through wired and wireless technologies.

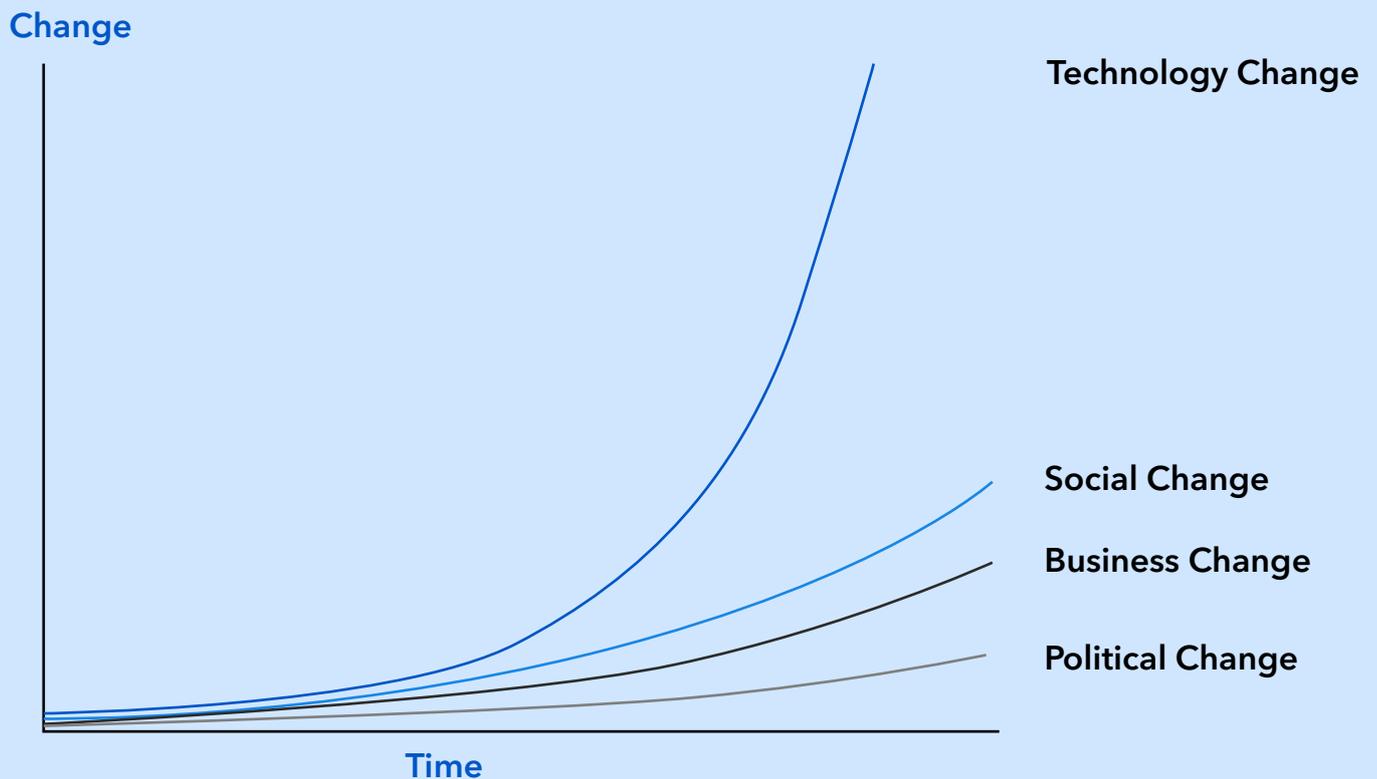
The most important technologies for the connection of unmanned vehicles and last-mile drone delivery are as follows:

- Laser scanners
- Global positioning satellites
- Thermal sensors
- Real-time thermography
- Kinect RGB-D sensors
- Infrared or LiDAR
- Reflector prisms
- Digital barometrics

5.6

**INSTITUTIONAL
AND PUBLIC
ACCEPTANCE**

The Law of Disruption



INSTITUTIONAL AND PUBLIC ACCEPTANCE

In addition to the tangible (and technically controllable) challenges of congested airspace and inherent risks, there is another, less-defined area of concern in the public domain. Consequently, regulators need to address the public's negative perception of UAVs. Today, there is a general level of fear and perceived threat associated with UAVs. A large part of this fear is

probably related to privacy issues: there is a view that cameras and other (potentially invisible) sensors attached to drones could be used for constant surveillance of every step one takes.

When considering the regulatory environment in regard to the adoption of new technologies, it is worth considering the 'Law of Disruption' model. This model

Institutional and public acceptance

describes an interesting pattern of how fast different types of change manifest themselves, and the model is very applicable to the current UAV situation. As illustrated, technological advancements tend to progress at a much faster rate than social and political change, and this is exactly what we can see happening with UAVs today.

Two of the public's major concerns over UAVs are as follows:

- Participants expressed that noise exposure would be potential risk of drone usage
- The potential violation of privacy was found to be the highest concern among the public

Usually, delivery drones are used to transport food, parcels, or goods to homes, and especially to hard-to-reach places, quickly, and to deliver shipments from nearby stores or warehouses, instead of relying on delivery drivers with ground transportation. Interestingly, these benefits of UAVs generate positive responses from both individuals and institutions.

As a result, the emergence of drones as a last-mile delivery option has caused many institutions and individuals to apply this technology effectively and positively, due to its numerous benefits, including its speed and its ease of access to remote areas.

It has also aroused the interest of institutions, as many companies and agencies are now using drones to provide their services quickly and effectively. In

particular, positive responses have been generated as a result of the drones' capacity to deliver to remote places in a way that doubles the speed of traditional methods. Hence, it is confirmed that both consumers and organizations accept the drone, as it can act as a vital link between them to deliver all kinds of goods and services.

Many institutions have recently implemented drones in the delivery of various goods. The most important of these is Amazon, who began using drones for shipping in locations where the drones were configured to operate. The technology has already also been implemented to provide residents in remote locations with necessary goods more quickly and easily than ever, as UVL Robotics did by providing drone delivery services to hard-to-reach areas in the Sultanate of Oman. Drone deliveries further have the potential to reduce traffic congestion and carbon emissions, and reduce the health risks of motorcycle drivers that previously may have had to drive recklessly to meet their delivery quotas.

Nevertheless, several concerns regarding drone delivery remain. The most important of these are the difficulty of providing the means for taking off and landing the drones, and the use of sending and delivering services through it, although these facilities can be developed quickly. Other concerns have also been raised regarding privacy issues and noise pollution.

5.6.1. REGULATION, CERTIFICATION, AND AIRWORTHINESS

The regulatory environment plays a crucial role in UAV adoption. Currently, there seems to be little common ground regarding laws governing drone usage across borders, let alone continents. Today, regulations consequently vary widely from country to country. Major legislative changes could be realized over the coming years, particularly in the USA. However, regulators have been the subject of constant criticism for moving too slowly on the matter. For now, most UAVs operate outside controlled or restricted airspace, and this minimizes interference with other airspace users. However, if UAV operations are to become widespread in logistics and other industries, integration will be essential. Inevitably, UAVs must operate in all types of airspace, and share this with airplanes, helicopters, and other flying systems. Going forward, this may pose a problem, as airspace is already overcrowded in many regions, especially around major cities, and air traffic control operations typically work at near to maximum capacity.

As the first player in the Middle East region, UVL Robotics led the race of implementing the BVLOS operation. After many experiments within the Sultanate of Oman, UVL Robotics received the first BVLOS permission in the region for drone delivery from the Sultanate's Civil Aviation

Authority, and commenced day-to-day operations. This constituted a major achievement, since BVLOS permission is notoriously difficult to obtain, owing to the fact that drone operators must demonstrate how their critical risk mitigations address the safety of other aircraft, people, and property below them.

5.6.2. SOCIETAL CONTRIBUTION AND PUBLIC TRUST

Today, drone delivery is perceived by a wide percentage of the public not as something out of science fiction, but as part of a realizable future that will help improve our lives, not only in terms of delivery and logistics, but also in terms of environmental preservation. Because drones do not need roads and complex ground systems to ensure performance, the only routes that the drone delivery industry must devise are comfortable paths from point A to point B. However, if we only ever try to improve and modernize the ground transport infrastructure, then air-based routes will be sidelined. Moreover, since airspace is currently dominated by and large aircraft, the structure is mainly created for them, creating large numbers of rules and difficulties with checks, coordination, and the creation of air corridors.

INFRASTRUCTURE DEVELOPMENT TODAY - HOW FAST IS IT DEVELOPING?

Due to the high activity of UAVs in various fields, the process of modernizing and optimizing infrastructure to cater to them has begun to actively accelerate. In only a few months, it will no longer be necessary to coordinate the departure of a drone for a flight along a known route, as it will simply be able to fly to the given destination along the route already given to it. Conversely, a year ago, for a drone to

be able to fly from point A to point B, the flight had to be coordinated for a week in advance, whereas today, this process takes only 1 minute, to ensure everything is in order and there are no factors preventing the drone from flying.

ADDITIONAL CAPABILITIES OF DRONES IN SAVING PEOPLE'S LIVES

From a logistical standpoint, drones provide the fastest delivery of goods of any method known today. Already, UAVs can easily deliver the correct parcels to hard-to-reach places. Drone-based logistics also ensure a reduction in traffic, by decreasing the amount of parcels moving along roads. We believe that each of us will be happier if we see fewer cars on public roads. In addition to regular deliveries, a drone can help in emergency situations when rescuing a person, in situations such as searching for missing people in forests, retrieving a drowning person from water, or delivering medicine to a hard-to-reach area.

HOW THIS ECOSYSTEM MIGHT EVOLVE IN THE FUTURE

In the near future, applications using UAVs to deliver goods will be actively developed. As a consequence, many questions will be raised about how the system can be optimized and integrated

Institutional and public acceptance

into everyday life. In this system, we see drone delivery as the penultimate or ultimate link in the logistics of moving parcels. From the depot, the drone delivers the goods to the client or to the smart parcel locker, where later, the client can pick up the package at a convenient time for them. In the case of delivery to the smart parcel locker, it is possible to combine the systems of UAVs and unmanned ground deliveries, whereby the UAV delivers the package from the depot to the district smart parcel locker, and the ground drone delivers the package from the locker to the client's house. However, a notable barrier to the proliferation of ground-based drones is the need to prepare road infrastructure for their use.

FOOD DELIVERY

The logistics of delivering food to places where people order it most often, such as business centers, can work especially well with drone technology. For example, if someone wanted a certain brand of pizza right now, a drone could realistically deliver the pizza to the parcel station within 15-25 minutes. Comparatively, delivery by courier takes an average of 40 to 120 minutes.

COMMODITIES

Additional applications of our technology include the express delivery of small goods or commodities. Whereas transport companies will typically deliver such goods within 2 days, with express delivery taking 2-5 hours, a drone can deliver the goods in 5-10 minutes, to either a smart parcel station or the customer's current location.

While designing future spaces, streets, and cities, architects, engineers, and city planners will understand what technologies will be used in the space and in this technological ecosystem. Going forward, it will therefore be possible to build beautiful cities, where you and I will see fewer masses of cars and more spaces for plant life and pedestrians., In short, drones will contribute to the establishment of cities where you want to live, work, and develop. These urban centers will not only improve personal health, but also the health of the world around us, where there is a pleasant and neat symbiosis of modern technologies, and all these elements are closely related to each other, yet at the same time do no harm.

CONCLUSION

CONCLUSION

If several years ago, drones were perceived only as fun toys for hobbyists, the massive growth of the Industrial Internet of Things (IIOT) has triggered the appearance of industrial drones, reliable communication and safety systems, and a breakthrough in infrastructure solutions, such as battery swap systems, refueling equipment, and smart parcel stations. We can therefore safely talk about the new stage of industrial use in the logistics and supply chain industry.

Today, it is important to talk about the development of a drone delivery ecosystem in general, as opposed to just drones themselves. That is why UVL Robotics has opted to become an active vector for cooperation with different UAV players, software and hardware solutions partners, and regulatory and state institutions. A competent ecosystem can only be built by joint efforts, and a shared desire to radically improve both logistics and quality of life.

Moreover, UVL Robotics sets itself an important mission of helping to solve social issues that the world face's today. These include the reduction of CO2 emissions, the prompt delivery of lifesaving and medical equipment to needy people, the delivery of food and other necessary goods to hard-to-reach areas where the population is blocked

from mature infrastructure, and the reduction of risk to couriers attempting to deliver goods within 15 minutes using PMVs.

We would like to thank the inexhaustible enthusiasm and performance of our engineers, developers, and designers. It is with their invaluable help that we were able to achieve significant results in the commercial launch of delivery drones in the Middle East, and plan to not stop there, but go on to become one of the recognized leaders in the drone logistics industry.

Thank you for your sincere interest in our Roadmap document. UVL Robotics welcomes your feedback for further improvements on the path to making last-mile drone delivery solutions a reality in every region of the earth. If you have any questions or comments, please reach out to us at:

whitepaper@uvl.io

**ABOUT UVL
ROBOTICS
INCORPORATED**



ABOUT UVL ROBOTICS INCORPORATED

UVL Robotics Inc. is a global provider of cutting-edge drone-based solutions with AI for logistics. The company is building the globe's first sustainable and scalable ecosystem of last-mile drone delivery to bring parcel shipments services to cities worldwide and out of city limits. UVL

Robotics is using the own-manufactured the UAV platforms, software systems and related infrastructure. The company cooperates with partners in infrastructure, operations and UTM to build the advanced ecosystem.



Having a wide logistics & supply chain expertise the UVL Robotics also developed and launched on the market the full autonomous indoor drone solution for warehouse stock-taking application. The company is providing the end-to-end commercial drone-inventory service for Fortune 500 large-enterprises companies, 40+ paying clients and none of churn.

In 2021 the company graduated from top-ranked b2b accelerator of Silicon Valley - Alchemist:

[link: techcrunch.com](https://techcrunch.com)

In 2022, UVL Robotics launched the first commercial day-to-day drone deliveries in Sultanate of Oman, obtained the BVLOS approvals from Oman governors to operate the regular drone deliveries:

[link: markets.businessinsider.com](https://markets.businessinsider.com)

Founded in 2018 by Eugene Grankin, UVL Robotics has 45 employees in offices in US, Abu Dhabi, Oman, Turkey and Netherlands. The company has raised a total of \$3M.

Find out more at: www.uvl.io