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# UAVs opportunities and prospects for Brussels Smart City

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**Abstract**

To make a positive contribution to the development of Brussels as a Smart City, "Brussels Smart City", a common project of the Brussels-Capital Region and the "Centre d'Informatique pour la Région Bruxelloise" (CIRB), takes part in the Region's digital strategy. Through this project, the involved players want to use technology, digitalization and IT architecture to:

- make a positive contribution to urban life,
- stimulate the Brussels Region creating opportunities for urban development and
- building bridges between citizens, the private sector, academia and public institutions.

Concerning UAVs, they have invested in a specialized unit of the federal police. This unit supports the 6 police zones and other partners in the security chain (such as Brussels Mobility or the SIAMU) [1].

The number of professional UAV pilots in Belgium continues to grow: at present, there are more than one thousand professional pilots. Since 31 December 2020, flying with UAVs has been subject to new European regulations that stimulate much attention from the press [2]. Brussels Mobility is very interested to integrate UAVs as a complementary tool for mobility management. This paper will present in detail the different initiatives that have been taken in this field, and in particular with the federal police's drone team, and the future perspectives. Brussels is not the only city to take a close interest in this, Europe and other cities such as Dubai are working and sharing their progress [3].

After analyzing the European UAV market, we will present three concrete applications that have been carried out with drones within Brussels Mobility: the use of drones during our mega-control, the integration of drones during fire exercises in the Brussels tunnels and, finally, the use of a drone to count traffic before modifying a roadway.

Finally, we will present different ideas for integrating more UAVs in the future, for example : being able to rapidly deploy visualization systems in a short period in order to follow a traffic event or to help the surveillance of building sites. In summary, a series of initiatives to contribute to the development of a European capital smarter than ever !

## 1 Introduction

The need for a smart city is increasingly felt with the climate challenges we face. By "smart city" we mean the interconnection using digital and ICT technologies in order to improve urban services and reduce costs and consumption of resources. Several projects are emerging in Europe and more particularly in the European capital with the "Brussels Smart City" project. The drone has now become an essential tool for a smart city, attracting a lot of media attention and a significant increase in the number of professional drone pilots in Belgium. Currently, there are more than a thousand professional pilots [2].

In Brussels, a specialized unit of the federal police has been set up to support the 6 police zones and other partners in the security chain (such as Brussels Mobility or the SIAMU). The drone is gradually becoming a complementary tool to the helicopter [8]. We can also mention Brussels Airport and Skeyes, who last April carried out tests to detect undesirable drones in and around the airport, with the aim of increasing security [9].

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## 2 UAV's definition

A Unmanned Air Vehicle (UAV) is a flying vehicle able to evolve in the earth's atmosphere and fly autonomously. It is referred to as an aerodyne aircraft, which means that lift is provided by aerodynamic forces such as lift. It may be required to carry one or more payloads and is capable of performing specific tasks during a specific flight time determined by its design (type of battery, number of batteries, motor consumption, payload mass, etc.). Another name for this type of vehicle is drone, in reference to the noise emitted by the male honey bee.

It is common to classify UAVs according to their size, range and altitude. Figure 1 shows the classification proposed by Polski [4]. He categorizes drones as follows :

- MAV: Micro Air Vehicles, <300 m altitude and <2km range,
- LASE: Low Altitude, Short-Endurance, 1500 m altitude and 10 km range,
- MALE: Medium Altitude, Long Endurance, 9000 m altitude and 200 km range,
- HALE: High Altitude, Long Endurance, beyond 9000 m altitude and no range range limit.

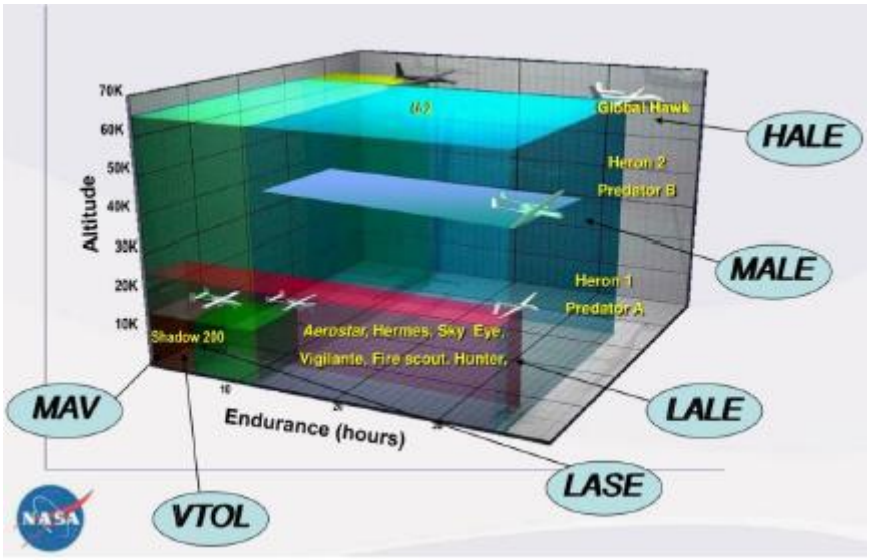


Figure 1- Categorization of drones according to their size, range and altitude [4]

## 3 Civilian UAVs in the European market

UAVs have been introduced less rapidly in Europe than in the United States and Israel. However, the experience gained from their use in military operations in recent years has improved the European view of their usefulness. The success of UAVs is due to the acquisition of real-time information that contributes to both to the effectiveness of the mission and to the protection of the staff.

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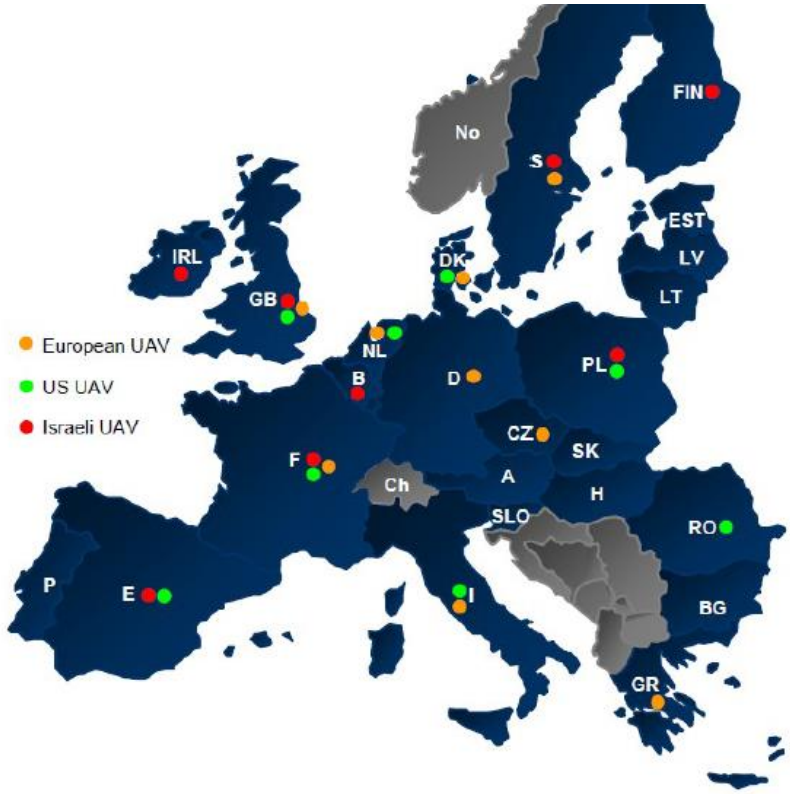


Figure 2- Military UAV purchase in Europe, by supplier nationality [5]

The United Kingdom, France, Germany and Italy have taken the lead in military drone procurement. Germany is distinguished as a unique major buyer of locally produced drones. In Eastern Europe, the Czech Republic, Poland and Romania are accumulating significant experience in this area. Hungary has also experimented with drones in civilian applications such as firefighting.

In addition, a number of small companies are interested in this emerging field. It is clear that the European industry has suffered from a lack of investment in research. National governments as well as EU institutions have not done enough to support drone development activities, especially in the civilian sector. This has encouraged European industry to focus on partnerships with American or Israeli companies, to the detriment of developing a European alternative. This trend has broad implications for the competitiveness of European companies in the new global market, but the situation is improving.

Following is a list of potential applications:

- Government
    - a) Urban supervision (police, civil security, demonstrations, works, traffic, etc.).
    - b) Border surveillance.
    - c) Maritime surveillance (traffic, pollution detection, etc.).
    - d) Provision of emergency rescue in a hostile area
- Natural disasters
    - a) Monitoring of forest fires.
    - b) Monitoring of other major incidents (avalanche, volcanoes, tornadoes, etc.).
    - c) Emergency rescue (mountain, desert, sea, etc.).
    - d) Damage assessment in case of floods, storms, oil spills, earthquakes, etc.
- Energy sector
    - a) Monitoring of the oil and gas industry infrastructure.
    - b) Monitoring of electrical networks.
- Environment
    - a) Meteorological studies and forecasts.
    - b) Aerial photography, cartography and topography.
    - c) Pollution monitoring.

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d) Detection of toxic gases or radiation.

- Communication and broadcasting
  a) Communication relay.
  b) Use by the cinematographic industry.

It is clear that the potential of the civilian market is considerably greater than the military one and it is currently growing exponentially. According to Figure 7 taken from Statista, one of Europe's leading providers of data and statistics, the turnover for French manufacturers and operators had a growth of 1000% between 2012 and 2017, or 200 million euros (Figure 3) [7]. Worldwide, the turnover is estimated at $5.6 billion for 2020 (Figure 4) [6].

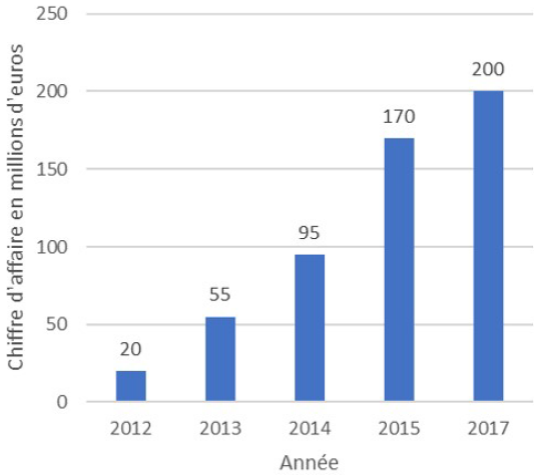


Figure 3 - Turnover of French manufacturers and operators of professional and hobby UAVs from 2012 to 2017 (in millions euros) [7]

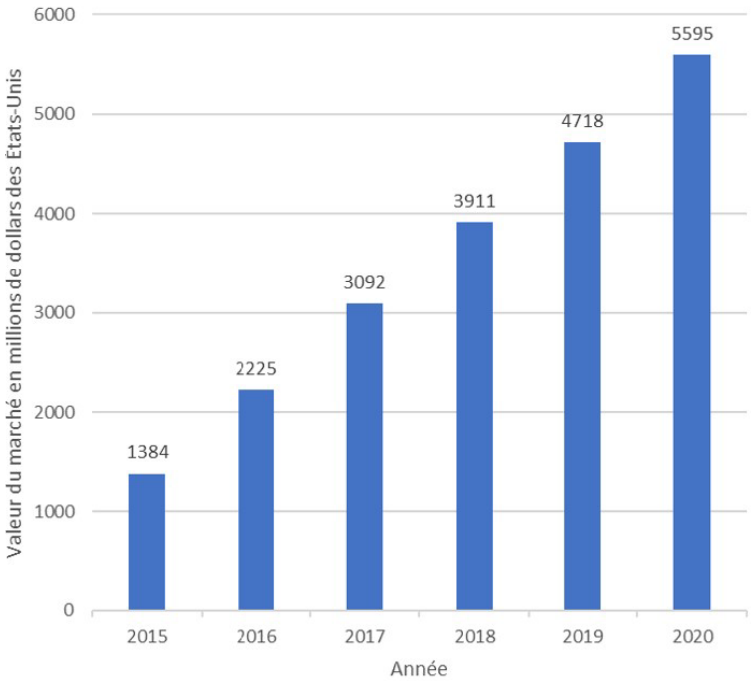


Figure 4 - Growth projections for the worldwide professional drone market from 2015 to 2020 (in millions dollars)[6]

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## 4 A new era for aviation

The European Commission has set out its intention to unlock the European market for UAVs through a combination of new and existing regulations at the European level, including safety and privacy requirements. In recent years, drones have been used for a variety of civil applications. They allow photo hobbyists to take pictures and videos from angles that were previously impossible. Even the Belgian national field hockey team, the Red Lions, has used a drone to film a specific area of the field to better observe their techniques and improve their performance. Moreover, their price has become much more democratic. Indeed, it is now possible to obtain a professional quality drone like the DJI mini from 300 euros. Civilian drones have therefore taken off and are very successful in terms of sales. A specific law is already in place. We will try to summarize below the new regulation of drones that came into effect since December 31, 2020.

Until then, a national regulation was applied by each Member State of the Union. The European Commission has developed two European regulations, EU 2019/945 and EU 2019/947, with the aim of promoting the development of UAVs and harmonizing in Europe as well as in Iceland, Liechtenstein, Norway and Switzerland. This new European regulation distinguishes 3 categories determined by the level of risk related to the drone and/or the flight area:

- Open: low operational risks,
- Specific: increased operational risk,
- Certified: operational risk too high.

The European Authority for Aviation Safety (EASA), based in Cologne, is the European Union agency that is in charge of aviation safety since 2003. It is responsible for the implementation of this new regulation in collaboration with national authorities such as the "Direction Générale Transport Aérien" (DGTA) in Belgium. The national authorities are listed for some countries in the Figure 5.


Figure 5 - National authorities that are equivalent to the Belgian DGTA for other European countries

The DGTA approves operations based on the level of risk. The higher the risk, the more the DGTA is involved [8]. Operations in the "Open" category must meet the characteristics listed in Table 1. These include the characteristics that must be satisfied by the UAV, the operation, the operator and the pilot. Once the operating conditions exceed those of the "Open" category, the operations fall into the "Specific" category:

- increased Risk,
- at a height above 120 m Above Ground Level (AGL),
- above people and
- Beyond Visual Line of Sight (BVLOS).

If the risks are too high for this category, there is a third and last category, the "Certified" category for which the operating conditions are not yet fully defined.

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Table 1- Characteristics of the "Open" category [8]

| Classe | Poids max. | Sous-catégorie | Restrictions | Enregistrement exploitant | Formation pilote | Âge min. pilote |
|---|---|---|---|---|---|---|
| Construction privée / UAS non Cx | < 250 gr. | A1 (peut aussi voler en A3) | - Vol toléré au-dessus de personnes non impliquées<br>- Vol interdit au-dessus d'un rassemblement de personnes | Non, sauf si muni d'une caméra ou d'un capteur et si n'est pas un drone jouet | - Aucune formation requise **mais** recommandée<br>- Lecture du manuel utilisateur exigée pour les UAS non Cx<br>- Respecter les zones géographiques et leurs conditions | Pas d'âge min. |
| C0 | | | | | - Lecture du manuel utilisateur exigée et formation recommandée<br>- Respecter les zones géographiques et leurs conditions | 14<br>Pas d'âge min. si drone jouet |
| C1 | < 900 gr. | | - Vol interdit au-dessus de personnes non impliquées<br>- Vol interdit au-dessus d'un rassemblement de personnes | Oui | - Lire le manuel utilisateur<br>- Suivre la formation en ligne<br>- Réussir l'examen théorique en ligne | 14 |
| C2 | < 4 kg. | A2 (peut aussi voler en A3) | - Vol interdit au-dessus de personnes non impliquées<br>- Vol interdit à moins de 30 m de distance horizontale de personnes non impliquées (5 m si mode lent) | | - Lire le manuel utilisateur<br>- Suivre la formation en ligne<br>- Passer l'examen théorique en ligne<br>- Suivre et déclarer une formation pratique personnelle<br>- Réussir l'examen écrit à la DGTA | 16 |
| C3 | < 25 kg. | A3 | - Vol loin des zones habitées (> 150 m)<br>- Vol interdit à moins de 30 m de distance horizontale d'éventuels passants | | - Lire le manuel utilisateur<br>- Suivre la formation en ligne<br>- Réussir l'examen théorique en ligne | 14 |
| C4 | | | | | | |
| Construction privée / UAS non Cx | | | | | | |

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## 5 Brussels Mobility and UAVs

### 5.1 Brussels Smart City

Brussels Smart City is a common project of the Brussels-Capital Region and the "Centre d'Informatique pour la Région Bruxelloise" (CIRB), which is part of the Region's digital strategy. Through this project, the players involved want to use technology, digitization and IT architecture to: make a positive contribution to urban life, stimulate the neighbourhoods of the Brussels Region, creating opportunities for further urban development, building bridges between citizens, the private sector, academia and public institutions.

The strategy implemented is based on six axes summarized in the Figure 6. These axes are detailed below in a non-exhaustive way :

- Environment
  - Reducing air and noise pollution
  - Waste management
  - Energy and water consumption
- People
  - Social and/or digital inclusion,
  - Enhanced citizen engagement
  - Trainings
- Living
  - Physical and mental health
  - Quality of housing
  - Reducing criminality and increasing safety
- Government
  - trust in public institutions
  - the accessibility of public services
  - reduction of administrative costs
- Economy
  - Economic growth
  - Employment
  - Tourism
  - Entrepreneurship
- Mobility
  - Accessibility
  - Road safety
  - Enhanced comfort and travel experience

For drones, concrete results of this strategy are already present as the drone team of the federal police. In 2019, the drone team has realized 187 missions with a total of 240 flight hours with 8 drones and 6 pilots. Indeed, as mentioned above the Brussels experience is unique of its kind: a specialized unit of the federal police supports the 6 police zones and other partners in the security chain. Drones are becoming a real complementary tool to helicopters.

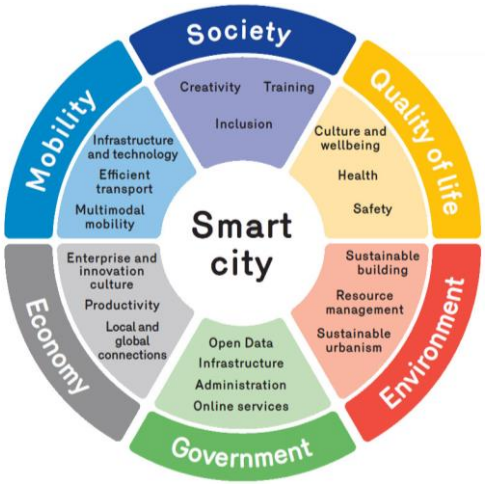


Figure 6 - The six strategic axes of the Brussels Smart City project

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## 5.2 Belgian Civil Drone Council

A platform to allow a permanent dialogue on technological, operational and regulatory issues related to UAVs has been set up in Belgium. The Belgian Civil Drone Council BCDC was officially launched on July 2, 2019. It can give advice or make proposals to public authorities and develop recommendations for the sector, but can also organize its own events to promote its activities within the sector and to political authorities. Its role is to give advice or make proposals to public authorities and to elaborate recommendations for the sector. It also organizes its own events to promote its activities within the drone sector and to political authorities. Six working groups (WG) have been set up to achieve this :

- WG1 – Operations, Regulation and Use,
- WG2 – Airworthiness,
- WG3 – Drone Integration,
- WG4 – Security & C-UAV,
- WG5 – Support & Promotion,
- WG6 – Innovation, Research & Development.

Brussels Mobility is also present in several working groups, most actively in WG 6 coordinated by Patrick Hendrick, with more than 50 partners from the private sector, academia and public institutions.These working group is divided into 4 sub-groups :

- WG6-1 Smart Cities and Drones
- WG6-2 BVLOS, Data Processing and Connectivity
- WG6-3 Vectors for sensors – Challenges on the drone side
- WG6-4 Special and Innovative Applications – Environment integration

Brussels Mobility is leader of the sub-group WG6-1. There are two co-leaders for this sub-group, one to represent the city of Brussels and the second to represent the city of Antwerp. This allows us to cover two major cities in our country.

The main lines proposed for this sub-group are :

- IoT
- Smart city
- Traffic monitoring
- Surveillance and security (police operations)
- Inspection and detection (e.g. tunnels)
- Surveillance and mapping
- Transport and delivery (road traffic reduction)

## 5.3 What Brussels Mobility has already done with UAVs ?

### 5.3.1 Mega-control

Mega-control is a road control of passenger transport, such as taxis and limousines, driving school vehicles or specialised regular transport such as trucks. This control is organised by Brussels Mobility in collaboration with the local police zone and the federal police drone team.

We can see in the Figure 7 the federal police takeoff of the drone in the heart of the city without any barrier with the people around except the two orange blocks deposited on the ground. The police is equipped with a command car to transmit the live video stream.

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Figure 7 - The federal police's drone team

The advantage of having a drone team for this type of mission is multiple :

- To start the biker in time to intercept the desired vehicles
- Unreported control over Waze and social networks (see Figure 8)

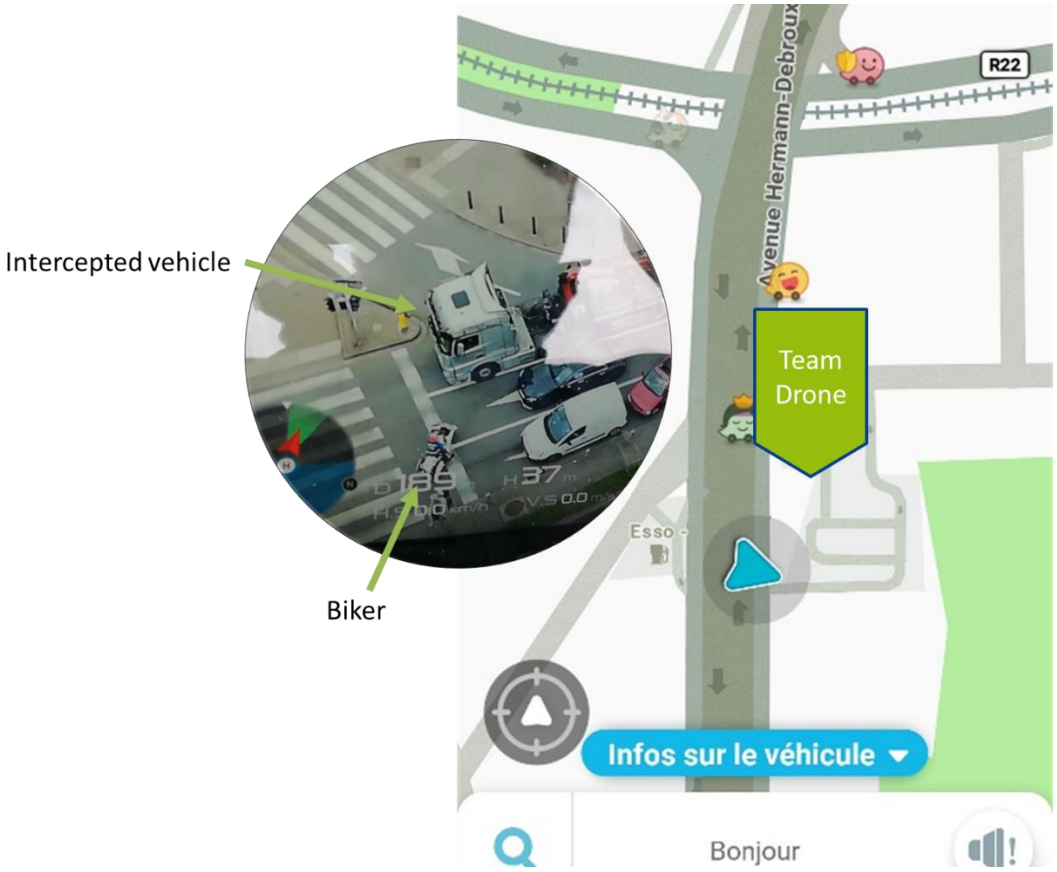


Figure 8 - Unreported control over Waze and truck interception

The difficulty is to get a clear communication between the local police team and the drone team to communicate the geolocation of the vehicle to be intercepted to the police bikers. It is therefore important to set up a clear communication process between the different entities. The Figure 9 summarizes the process. The drone team flies over an area close to the controlled zone. Brussels Mobility communicates the types of vehicles desired according to the availability of the teams in the control area. The drone team detects the vehicles using the video images. Once a desired vehicle is

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detected, the drone team contacts the bikers directly via the radio while continuing to follow the vehicle via the onboard camera until the interception (Figure 8).


Figure 9 - Control procedure for the interception of vehicles with the drone team of the federal police

### 5.3.2 Fire exercise

Brussels Mobility organizes annually fire exercises in order to guarantee the safety of the citizens in the Brussels tunnels. In fact, in collaboration with the fire service, a real-life exercise is carried out. We can see on the Figure 10 and 11a drone view of the tunnel exit and entry. The objective of these exercises is to allow the firefighters to get a better knowledge of the tunnels in case of a real fire.

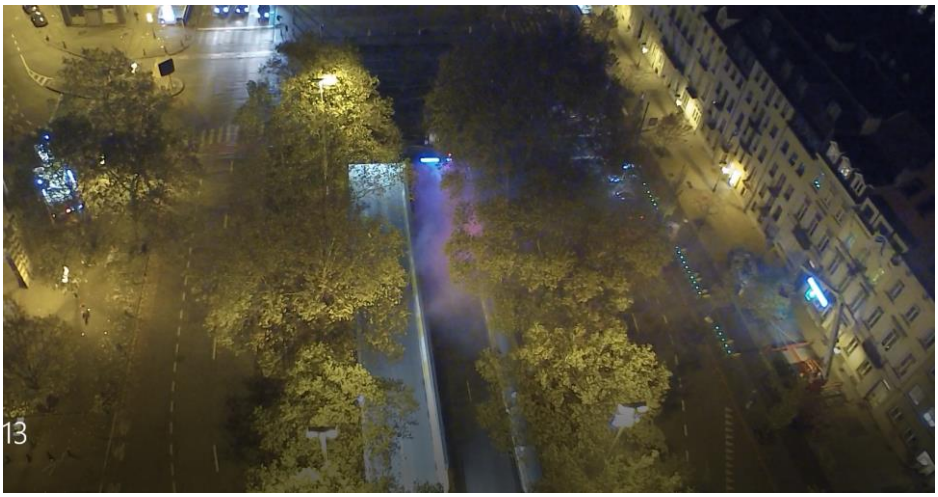


Figure 10 - Helicopter view of the hall port tunnel with the fake smoke

We tried to use drones to get images in the smoky tunnels. On the Figure 12 we can see an image taken inside the tunnel with smoke, simulating the tunnel on fire. We need here a different type of drone to fly into the tunnel. The drone use the Loki drone from Skyheros. An advantage of the tunnel is that the image transmission is not lost. It seems that the tunnel acts as a catalyst. The drone can therefore fly through the entire tunnel and the image continues to be transmitted. Nevertheless some interference has been observed. This could be compensated by relays inside the tunnel.

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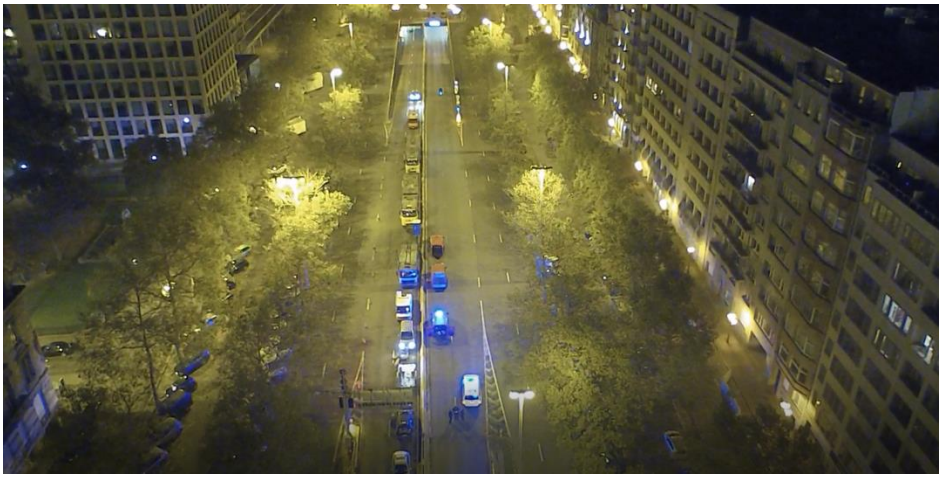

Figure 11 - Helicopter view of the hall port tunnel with the intervention teams

One of the difficulties encountered is the acceptance of integrating this new tool into the work process of firefighters. Indeed, this type of exercise is extremely stressful and the addition of the drone is not yet perceived as a real necessity in this type of exercise. Nevertheless, it is clear that once integrated into their work process, the drone will allow them to obtain images of the situation in the tunnel quickly and to better direct the firefighters inside the tunnel to save a maximum of lives in case of fire.


Figure 12 - View into the tunnel with Loki drone

### 5.3.3 Traffic count

The Figure 13 is a helicopter view of the place sainctelette. The colored lines correspond to different types of vehicles and routes. Before changing traffic flow we use traffic counts to analyse the AS IS situation and make an evidence-based decision. To perform this analysis, software exists but needs a video source. This video must film the area to be analyzed. The larger the area, the higher the camera must be to get the right angle of view. Here we used a wired drone (the cable is visible in Figure 13) to allow a flight of several hours without stopping and to obtain a video long enough for analysis.

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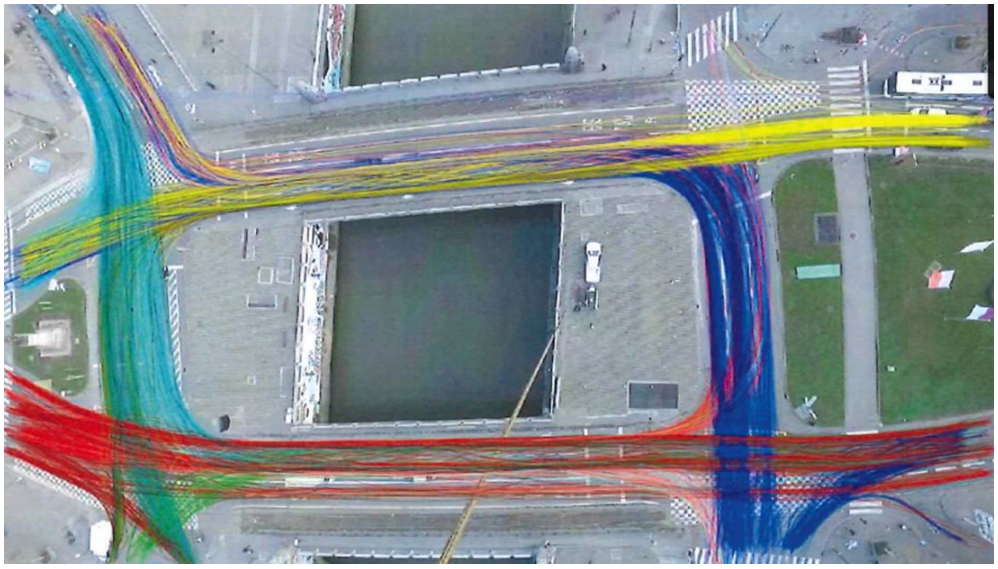

Figure 13 - Helicopter view of the place sainctelette

## 6 Conclusions and perspectives

We will present here what we would like to do with UAVs in the future. As conclusions and perspectives we have listed all the activities we would like to do or continue to do using drones:

- To be able to quickly deploy visualization systems in a short period of time in order to follow a traffic event in a continuous and evolving way.
- To assist with surveillance during traffic controls and more particularly during the “Mega-control”
    - Verify the good functioning of the control zone
    - Control the traffic in real time
    - Analyze in real time if for each checkpoint we have a significant sample controlled otherwise detect the vehicles of this sample in order to bring them back to the control zone
- Support for the supervision of construction sites
    - Check the site markings
    - Check that the site deviation plan is respected
    - Analyze the impact of this site deviation plan
    - Material identification (Qr Code, long range RFID)
- Deployed in case of a missing or disturbed camera
    - Before a tunnel re-opens
    - Long range RFID for indoor positioning where no GPS is available.
- Supervision of very exceptional transport and transport of dangerous goods (ADR)
- Traffic counting and observation for analysis

To do this it will be necessary to take into account some transverse aspects such as :

- Legal (privacy,...)
- Telecommunication (4G/5G, real time,...)
- Counting (angle of view,...)
- Data/GIS aspects (tracking)

Several steps will be necessary for this:

- Analyze the feasibility from a legal point of view
- To define with the DGTA how to be a recognized drone operator
- To define a SORA (Specific Operation Risk Assessment)
- Analyze our material needs

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- Define our operation manual which will include all solutions and procedures to be implemented during our operations
- Define and implement the necessary training for our pilots

The coming years will allow us to carry out these different steps.

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