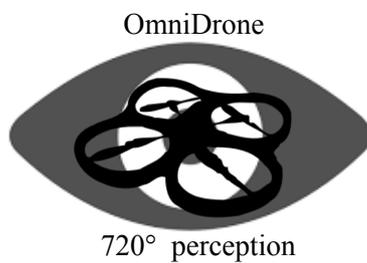
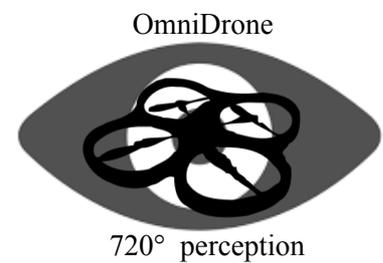


AANVRAAG VOOR EEN SBO-PROJECT MET EEN PRIMAIRE ECONOMISCHE FINALITEIT



Omnidrone



720° perception for safe and autonomous systems

1.1 Titel van het project.
OmniDrone: 720° perception for safe and autonomous systems
1.2 Basisgegevens
<ul style="list-style-type: none">• Primary nature of the valorization finality of the project: economic• Nature of the scientific and/or technological disciplines (or domains):<ul style="list-style-type: none">• <i>Technology domain:</i> Information and Communication Technology• <i>Keywords:</i> vision, cognitive vision, embedded processing, wireless networks• Expected starting date: 1 January 2017• Expected project duration: 4 years• Requested research budget and research support: 2,160,773 M €• Total number of man-months: 318 FTEs• List of participating partners:<ul style="list-style-type: none">• P01: Prof. Sofie Pollin, Katholieke Universiteit Leuven, ESAT-TELEMIC• P02: Prof. Tinne Tuytelaars, Katholieke Universiteit Leuven, ESAT- PSI/VISICS• P03: Prof. Toon Goedemé, Katholieke Universiteit Leuven, Technologiecluster Elektrotechniek - EAVISE• P04: Prof. Marian Verhelst, Katholieke Universiteit Leuven, ESAT-MICAS• P05: Prof. Anton Vedder, Katholieke Universiteit Leuven, CiTiP-iMinds• P06: Prof. Philippe Bekaert, Universiteit Hasselt, EDM

1.3 Samenvatting wetenschappelijke doelstellingen: **Scientific objectives and the research approach**

Unmanned areal vehicles (UAVs) are about to be part of our everyday lives and civil use. These drones enable a manifold of exciting new services, with applications ranging all the way from 3D modeling and surveillance of large areas, aerial video recording, to search and rescue and fire fighter missions. Large progress has been made in the past years regarding the mechanical hardware challenges of flying, as evident from the wide availability of commercial systems. However, regarding their practical deployment in large-scale commercial scenarios, several actors relevant in the field, both in Flanders and abroad, confirmed that there are important **electronic challenges to overcome regarding the drone's reliability and its ease-of-use**. Current state-of-the-art UAVs for professional applications require a highly skilled operator per drone to operate safely, and are not reliable enough to be allowed to fly close to a crowd. This significantly limits application scenarios and leads to a high operational cost. To overcome this, innovation is needed on the drone's payload to **increase its intelligence and its awareness of its environment**, such that it can assist the operator with various safety and reliability features similar to driver assistance in modern cars. This is exactly the OmniDrone focus.

To enable ultra-reliable and easy-to-use UAVs, the OmniDrone project will specifically invest in the innovative concept of enabling and exploiting on-board **3D omnidirectional camera systems** (denoted as 720-degree vision). Such cameras offer the drone omnidirectional and depth vision context information about the environment, enabling it to autonomously assist on mission and safety constraints. This requires innovations along the full 720-degree cognitive vision value chain. **The main technological objectives of OmniDrone are therefore 1.) enabling real-time, lightweight on board, 720 degree cognitive vision; 2.) exploiting it towards ultra-reliable operation and pilot-assist for ease-of-use, including robust wireless communication for seamless cooperation with the human operator, and 3.) exhibiting the gains from 720-degree enabled increased reliability and ease-of-use in 4 concrete valorization proof-of-concepts.** Measurable sub-objectives have been derived to achieve these goals.

1. **Enabling real-time 720-degree awareness (WP1)**

- a. SUB-OBJECTIVE1 (Year 1): Realize a panoramic *depth-aware stitching algorithm* that stitches based on 720 degree input and a novel adapted realtime stereoscopic sphere sweeping algorithm.
- b. SUB-OBJECTIVE2 (Year 1): Realize a visual *depth-aware person detection and tracking algorithm* that reliably can detect any person in a full viewing angle of 360°, up to distances of 150m, up to 70% occluded and with a precision and recall of 0.95 in realistic circumstances.
- c. SUB-OBJECTIVE3 (Year 2): Realize a *full 720-degree real-time embedded depth capturing system*, achieving 5fps, 6 x 8Mpixel cameras within a <10Watts power budget (FPGA- GPU based) for static 720-degree monitoring applications.

2. **Exploiting real-time 720-degree awareness for *reliable wireless* UAVs (WP2)**

- a. SUB-OBJECTIVE4 (Year 2): *Reliable wireless drone communication* by exploiting altitude information and dynamic link adaptation. Target: two relevant communication technologies (e.g., ad hoc IEEE 802.11 and 4G-LTE), 10 Mbps with 97% Packet Delivery Rate (PDR)
- b. SUB-OBJECTIVE5 (Year 3): *Reliable and stable flight* by exploiting 720-degree awareness for improved, real-time, embedded SLAM and 6DOF camera relocalization using neural networks mapped on on-board custom processor exploiting scalable resolution processing, 25fps, <2Watt.

3. **Exploiting real-time 720-degree awareness for *smart easy-to-use* UAVs (WP3)**

- a. SUB-OBJECTIVE6 (Year 3): *Safe and easy-to-use UAV operation*, based on a UAV that understands its environment and is capable of executing >3 specific navigation tasks autonomously.
- b. SUB-OBJECTIVE7 (Year 4): *Easy-to-use multi-drone communication*, exploiting 720-degree awareness towards autonomous dynamic multi-technology communication configuration, targeting 10 Mbps with 99,9% PDR when node mobility and altitude can be controlled.
- c. SUB-OBJECTIVE8 (Year 3): *Easy-to-use multi-drone video capturing*, exploiting real-time on-board relocalization information towards collaborative recording and framing over multiple UAVs.

4. **Exhibiting real-time 720-degree awareness in UAVs, pushing valorization (WP4)**

- a. SUB-OBJECTIVE9 (Year 2+3+4): Use the technological components developed in SO.1-8 towards 4 proof-of-concept application integrations for traffic monitoring, broadcasting, surveillance and inspection, jointly defined with the Industrial Advisory Committee partners and compliant with relevant laws and regulations to push valorization.

We believe that the OnmiDrone proposal is high-risk, while promising high gain, enabling many new future applications, exploiting safer and reliable UAV through omnidirectional depth awareness. We brought together a strong inter-disciplinary research team to bring together experts on all aspects of the 3D cognitive vision value chain (from hardware to algorithms), on ultrareliable communication, and on legal and regulatory constraints.

1.4. Samenvatting mogelijke impact (valorisatie): **Valorisation objectives and the valorisation approach**

Several market studies are predicting a real boost for UAV technology in the years to come. While UAVs have initially been introduced in a military context, civil and commercial usage is expected to outperform the military use in the years to come provided regulatory concerns can be solved. In all kinds of markets people are detecting potential applications for UAV technology both in a professional as well as in a entertainment context. Also in Flanders, a lot of initiatives in the domain are currently being set up, yet the main bottleneck hampering the deployment of the technology is reliability and ease-of-use. If reliability and ease-of-use can be improved, 720 degree UAV technology holds the promise of true situational awareness, remote precision inspection, 3D surveillance, automated person detection and localisation, precise mapping of the environment to innovative multimedia applications. **The market potential is broad and very large.**

The OmniDrone valorisation objectives cover the entire value chain from vision and communication technology providers, to system integrators and the broad landscape of stakeholders using parts of the UAV technology to deliver novel products or services. **To enable serving the entire value chain, for a broad and fragmented UAV market, our approach is to focus on 4 selected concrete valorisation application cases.** For each case, we have created a **sufficient and necessary sub-set of companies**, needed to enable the creation of the pioneering OmniDrone technology for each market:

- **Security and Surveillance** SECURITAS, DroneMatrix, Robovision, Luciad, Septentrio;
- **Professional Video Broadcast** VRT, Studio 100, RPASWORK, Argus Vision, DroneMatrix, EdelWISE, Orange;
- **Inspection** Argus Vision, Airobot, Gatewing, Orange, CityMesh/nCentric;
- **Traffic Monitoring** BARCO, MACQ, Luciad, FTA, Easics, Synopsys.

Fig. 1 below visualizes the OmniDrone technology value chain and relation to the 4 application cases.

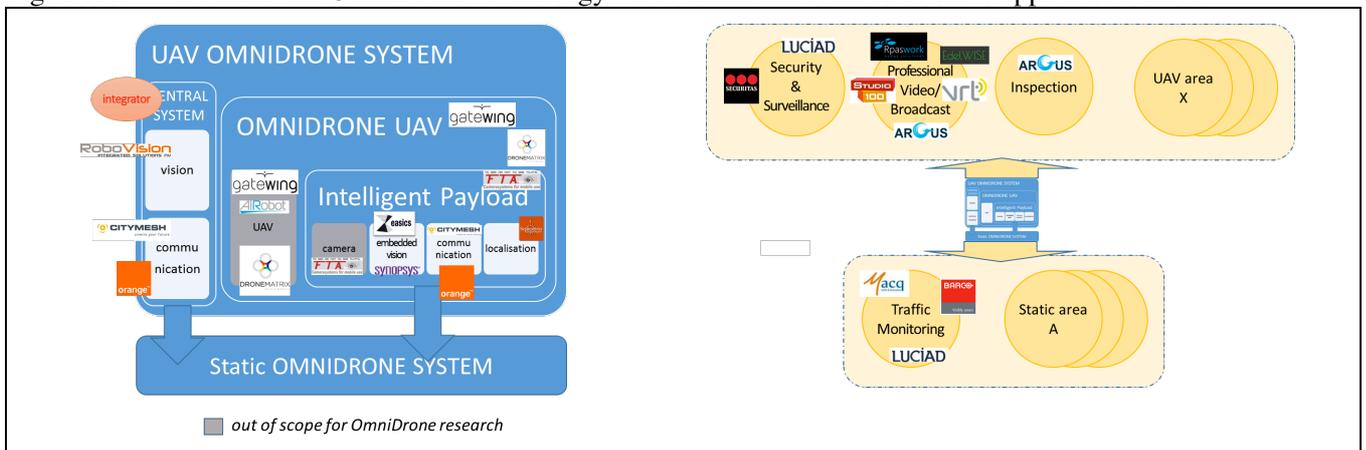


Figure 1: Value chain for OmniDrone technology. Left we see the core OmniDrone technology provided by the technology providers, and right the technology users for providing new applications and services. Applications and services are defined by the 4 identified cases (one static and 3 UAV focused ones), in addition to novel areas to be opened during the 4-year project.

From discussions with the stakeholders as represented in Fig. 1 (12 SME and 7 Large companies, as a sufficient set to start the IAC), we have identified **for each valorisation case must have technology solving a market problem.** We then translated these must haves into the eight OmniDrone scientific objectives summarized before. As tangible and transferrable output of the project, we will realize the must have technology and work towards a research proof-of-concepts for each case. Given the strong industrial interest in the outcomes of the OmniDrone project, we see real potential to transfer the results into the existing Flemish industrial landscape. As such the creation of a spin-off company will NOT be the primary valorisation goal of the project, although this is not excluded a priori. We will rather set up collaborative research projects, with the necessary and sufficient IAC members relevant to the case and intended technology. **The potential to realize successful follow-up projects is maximized by choosing a select, complementary and focused set of companies, with maximal interest in the must have technology and with a good cooperation track record or intention to cooperate.**

When discussing the OmniDrone technology with the many interested companies, we identified many ideas and alternative markets where our technology could play a role. Given the wide industry involvement, promising novel alliances can be created dynamically. OmniDrone targets the creation of at least 2 new directions, driven by existing and new IAC stakeholders. These evolutions will also be driven by the broader regulatory and valorization context in Flanders: BeUAS, DSP Valley, MediaNet Vlaanderen, BIPT and EUKA. To ensure broad enough valorization and align with regulation, we involve the KU Leuven IOF manager Greet Bilsen and the OmniDrone valorization account manager, and KU Leuven/iMinds research group CiTiP with expertise in valorization and regulation respectively.