Requirements examples

Importance	Meaning
1	Must be fulfilled: Defines a requirement that has to be satisfied for the final solution to be acceptable.
2	Should be achieved: This is a medium-priority requirement that should be included if possible, within the agreed delivery time. To be targeted at, shall be reviewed at each milestone. It needs justification if included or discarded, and there is a strong incentive to include it in a (later) industrialization, but not a Must for AERIAL-CORE.
3	This is a nice-to-have requirement (time and resources permitting), but the solution will still be accepted if the functionality is not included.

The following requirements have been captured for Long-Range tasks in Table 1.

Table 1: Long-range task system requirements

Requirement ID	Description	Importance	Success criteria
Req-LR-01	Be able to fly following the electrical line for several Km	1	The UAV is able to detect the power line and navigate following it
Req-LR-02	Be able to perform a preliminary evaluation of the power line distances to detect defects and hot spots using visual and thermographic information at the same time	1	Defects and hotspots can be detected while flying
Req-LR-03	Be able to take detailed pictures around the electrical tower	1	The combination of the UAV velocity, camera resolution, and camera

Requirement ID	Description	Importance	Success criteria
			stabilization, allows taking detailed pictures
Req-LR-04	Camera resolution should be enough to allow visualizing as many parts of the tower as possible	2	The pictures taken allows performing a detailed analysis of the electric tower
Req-LR-13	Collect data from all the sensors types from a single flight	3	The system only needs one flight to collect the whole required data
Req-LR-17	Autonomous/automatic safe landing in case of aerial robot entering in emergency mode	1	The system starts autonomously a safe landing procedure when entering in emergency mode
Req-LR-18	Reliable long-range communications with the aerial robot in case of HMI is required	1	Aerial robot - ground communications are never lost for the range of the aerial robot.

Functionalities examples

The identified functionalities are listed in Table 2, and explained in the following subsections, with their validation plan included.

Table 2: Long range use cases functionalities

Functionality ID	Functionality	Short description
Funct-LR-01	Perception for power line tracking	Perception algorithms to identify and track power line structures.
Funct-LR-02	Guidance for power line tracking	The perception system for power line tracking will be interfaced to the guidance module of the eBee autopilot. This will allow

Functionality ID	Functionality	Short description
		the long-range platform to autonomously follow the power lines.
Funct-LR-03	Hybrid fixed-wing, rotary-wing	This functionality is the ability of a vehicle to morph itself from an efficient, fixed-wing configuration into a configuration that will enable it to hover in place and conduct inspection tasks. This functionality opens the possibility of linking, in the future, long-range functionalities with local manipulation and coworking functionalities.
Funct-LR-06	Camera for preliminary tower inspections	For preliminary tower inspection the senseFly Duet-T camera will be used.
Funct-LR-07	High-quality camera for detailed tower and surroundings inspections	For detailed tower inspection we envisage to develop a new camera (RGB and thermal) with gimbal stabilization
Funct-LR-10	Long-distance UAV	Two platforms will be used, one for preliminary distance evaluation and tower inspection, and the second one with the morphing wing technology to allow slow flight needed for the detailed tower inspection use case.

These functionalities are linked with the requirements in the way presented in Table 3. The notation is the following:

- ‘L’ means that it will be tested only inside the laboratory.
- ‘O’ means that it will be tested in a controlled outdoor environment once it has been tested inside the laboratory if needed.
- ‘R’ means that it will be tested in a realistic environment once it has been tested before in an outdoor controlled and laboratory environment.

Table 3: Long-range functionalities link with requirements

	Req-LR-01	Req-LR-02	Req-LR-03	Req-LR-04	Req-LR-13	Req-LR-17	Req-LR-18
Funct-LR-01	R						
Funct-LR-02	R						
Funct-LR-03	O		O				
Funct-LR-06		R	R	O			
Funct-LR-07	R	R	R	R			
Funct-LR-10	R	R			L	R	O

Validation plan examples

- ### Funct-LR-01 Perception for power line tracking

Within this functionality partners will research line in visual inertial odometry and event-based perception. This line of research brings the drone the capabilities to detect and track the power line in a relevant environment under different weather conditions. In order to achieve such functionalities, we will develop HDR perception, generate images without motion blur from the latest dynamic vision sensors and fuse them with GPS positioning for a long traverse. In addition, super resolved intensity images will complement the novel solutions. Super resolved imaging generates a visually high-resolution (HR) output from its low resolution (LR) input. However, this inverse problem is ill-posed since multiple HR solutions can map to any LR input. The proposed validation plan is indicated in Table 4.

Table 4: Validation plan for Funct-LR-01

Environment	Start date	End date	Goal	Output
Laboratory	Month 20XX	Month 20XX	Power line detection and tracking in a laboratory indoor mock-up	Research perception algorithms to identify and track power lines
Outdoor controlled	Month 20XX	Month 20XX	Power line detection and tracking on custom drone in unstructured environment	Develop the algorithms in a real scale scenario. Preliminary tests outdoors

Environment	Start date	End date	Goal	Output
Realistic	Month 20XX	Month 20XX	Power line detection and tracking in a realistic scenario	Integrate and adapt the algorithms for realistic flying robots. Test under realistic conditions

- Funct-LR-02 Guidance for power line tracking

In this function we assume that the perception function Funct-LR-01 delivers two type of outputs:

- the power line direction
- the distance between the power line and the drone

Both vectors are expected to be expressed in the camera frame.

The idea is to use the perception information to correct the guidance from the original flight planning as altitude is often know with a poor precision.

The perception information will be expressed in the drone body frame using the knowledge of the mechanical configuration of the perception device within the drone. Then the drone's navigation algorithm will be used to express the perception information from the drone body frame to the local navigation frame (North, East, Down).

Knowing both the power line direction and its distance to the drone in the navigation frame, we can compute corrections to adjust the original flight plan to maintain the drone at the desired distance from the power line. The validation plan of this functionality is indicated in Table 5.

Table 5: Validation plan for Funct-LR-02

Environment	Start date	End date	Goal	Output
Outdoor controlled	Month 20XX	Month 20XX	Validation of the integration of the perception device	Flight data recording of a known environment
Outdoor controlled	Month 20XX	Month 20XX	Validation of the flight plan correction	Flight data recording of a known environment