To answer to the challenges described in the previous section, the project has identified a set of scientific and technological objectives in the following areas:

- **Autonomous ground navigation**: Robots must be able to **autonomously** navigate in a rather structured environment in a
safe
way for human beings, for the facilities and safeguarding themselves. To achieve such a degree of autonomy it is necessary to address some challenging topics:

- **Smart combination of topological and metric maps**. The large scale areas the robot should move in, introduces an additional complexity to the problem. Managing metric maps for such huge areas is not computationally affordable; however topological reasoning is not accurate enough for the requirements of maintenance applications. Therefore MAINBOT proposes a smart combination of both approaches.

- **Local navigation strategies adapted to inspection and maintenance activities**. In a traditional navigational problem, the robot controller has to plan the path to be followed based on the objective of achieving a target position in a map. However in the maintenance scenario the task itself (inspection) has to be used to close the navigational control loop. For instance, when inspecting a pipe using an ultrasonic sensor, inspecting the surface of a reflecting mirror, or any other inspection application, to obtain good quality sensor readings it is necessary the robot moved following specific patterns (angle, distance, velocity,…).

- **Accurate localization** in extensive areas. DGPS technology combined with maps provides a coarse localization mechanism. However, as the robot needs to operate in a deterministic distance of the element to be inspected (especially true for some inspection technologies), we need to introduce additional localization mechanisms that provide a more accurate position of the robot. The approach will be to combine widely used laser scanners with visual based localization mechanism that use natural or/and artificial landmarks in the surroundings to minimize positioning error.

- **Autonomous climbing robots**: Climbing robots have to face the following challenging requisites to navigate in vertical structures:
  - Robots have to reach the entire surface of the vertical structures.
  - Self planning of paths depending of simple geometrically description of the structure and information from environmental sensors.
  - Orientation based on landmarks.

- **Mobile manipulation** for maintenance and inspection activities in order to assist in cleaning or replacing parts, to manipulate inspection devices, to inspect highly occluded components, etc. The challenge is twofold:

- Real time coordination of manipulator´s end-effector and mobile platform based on sensor information and inspection task strategy.
- Safe manipulation of inspection devices and actuators that require physical contact with the inspected part/infrastructure.

- **Sensor fusion**: The robot must be equipped with highly reliable sensors to perceive its surroundings, not only for navigation but for inspection and manipulation. The use of robots for maintenance allows using multiple sensing technologies at the same time. However to exploit the information provided by each of these technologies in a more efficient way we propose introducing the concept of sensor fusion. We will introduce a smart engine to dynamically adapt the fusion process according to the working conditions and environmental parameters (lighting conditions, velocity, etc.); i.e. context aware sensor fusion.

A **high level task planner** will be developed in order to plan robot actions for autonomous inspection and maintenance missions. This task planner will resolve specified tasks (defined by maintenance operators through Human Robot interface) and plan the resulting motions and sub-tasks for the robot. The plan generated will contain a sequence of actions (e.g. movement, picking up items, manipulating items) with assigned resources (e.g. sensors, gripper). A hierarchical planning approach will be considered, where a high level task is decomposed in a sequence of subtasks that will be managed by second level planners (manipulator, mobile base, inspection system) to produce primitive actions (i.e. non decomposable).