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Collaborative Mobile Multi-Robot Systems (MMRSs)

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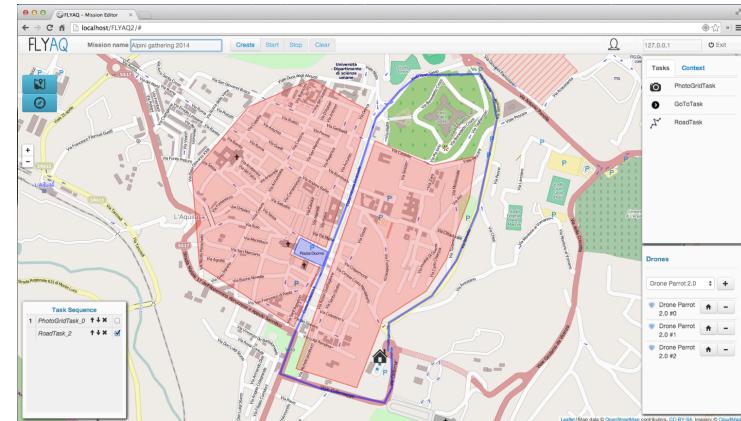
Mobile multi-robot systems

- CPSoS (Cyber-Physical System-of-Systems)
 - Classical predictability assumptions of safety and cyber-security assessment and certification no longer hold
- Constituent systems should be autonomous
- Directed SoS
 - The integrated SoS is built and centrally managed to fulfill specific purposes
 - Constituents maintain an ability to operate independently, but their normal operational mode is subordinated to the central managed purpose
- Both mission-critical and safety-critical



First project

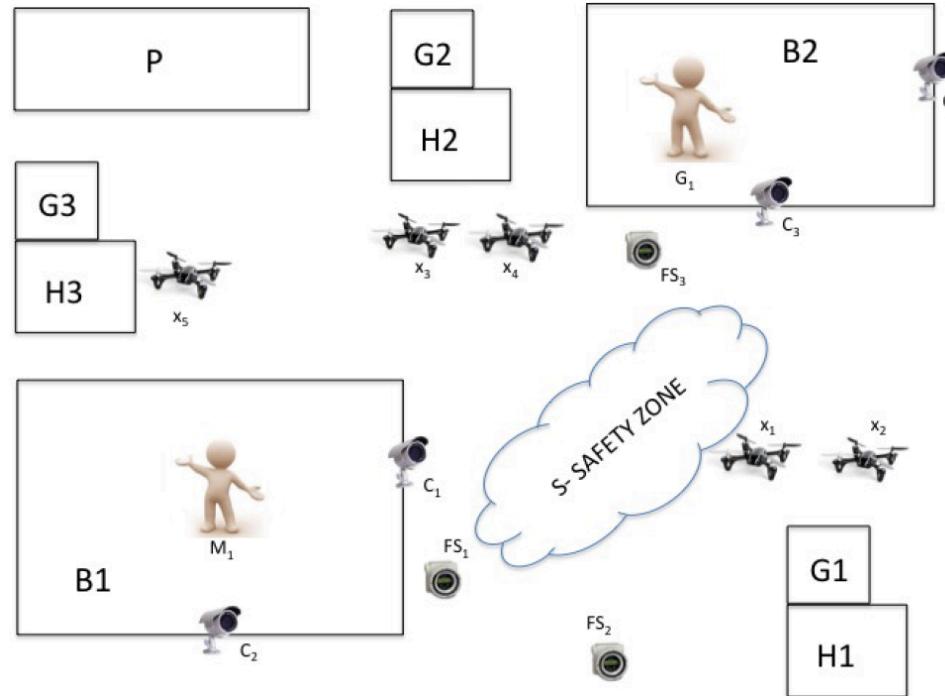
- FlyAQ: Enabling non-expert users to program missions of autonomous multicopters
- Graphical Specification and Execution of Missions
 - Definition of missions for a team of multicopters
 - Automatic generation of detailed flight plans that prevent collisions and respect no-fly zones
 - Execution of the mission



<http://www.flyaq.it/>

- *David Di Ruscio, Ivano Malavolta, Patrizio Pelliccione, Massimo Tivoli. Automatic Generation of detailed Flight Plans from High-level Mission Descriptions.* In the ACM/IEEE 19th International Conference on Model Driven Engineering Languages and Systems (MODELS), to appear, 2016.
- *Darko Bozhinoski, David Di Ruscio, Ivano Malavolta, Patrizio Pelliccione, and Massimo Tivoli. FLYAQ: Enabling Non-Expert Users to Specify and Generate Missions of Autonomous Multicopters.* In Automated Software Engineering (ASE), 2015 30th IEEE/ACM International Conference on, pages 801–806. IEEE, 9-13 November 2015.

Mixed scenarios: robots, devices, and humans



Second project



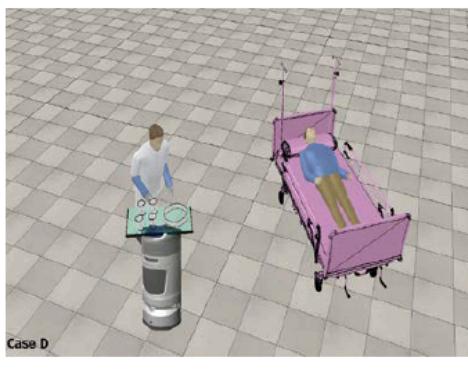
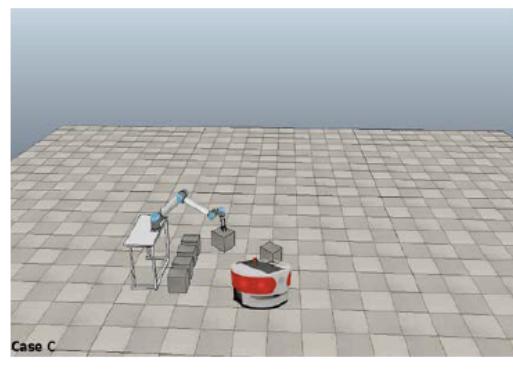
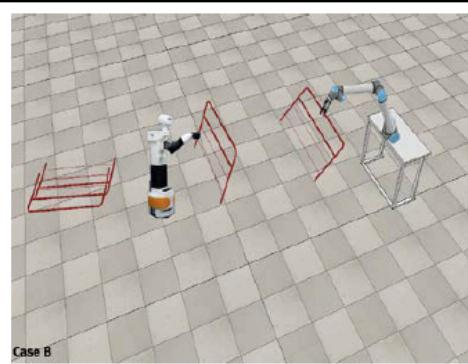
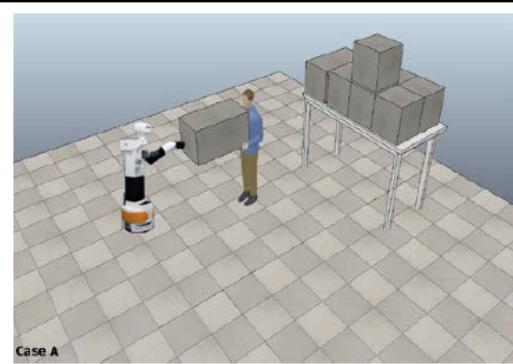
H2020-ICT-2016



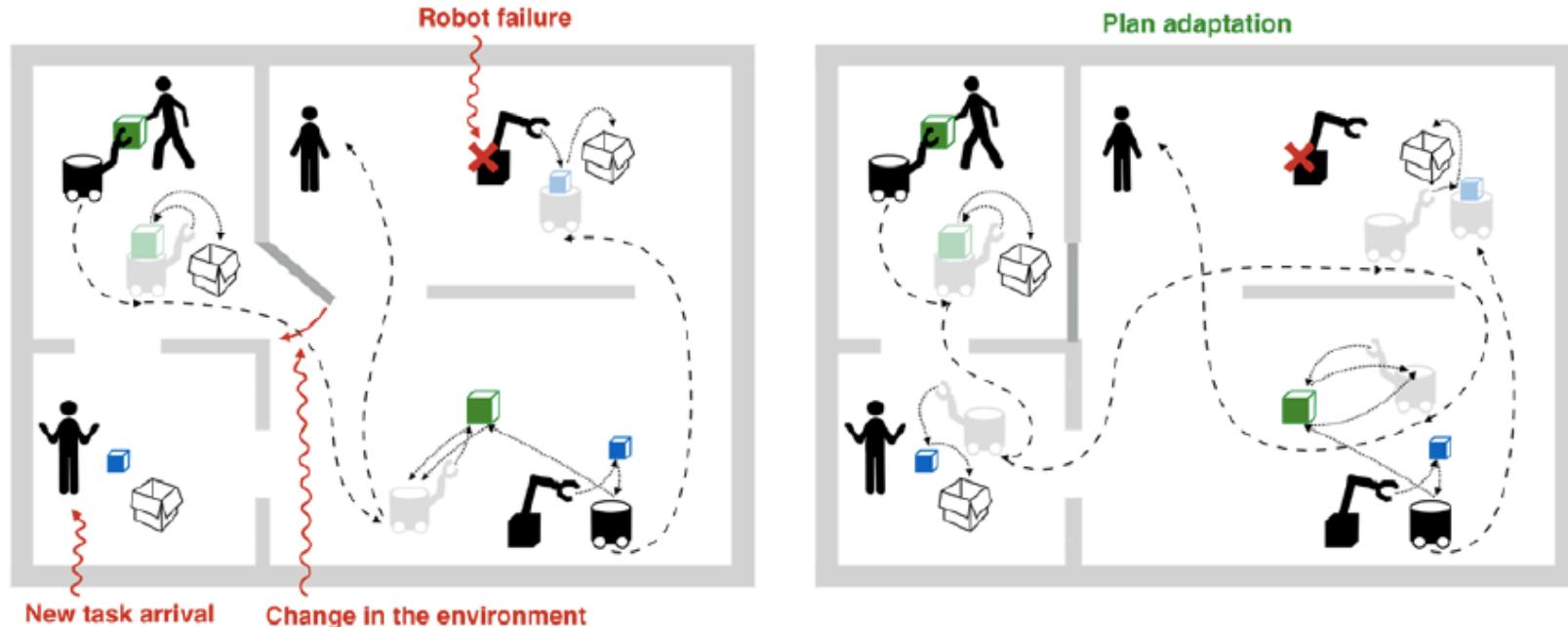
“Achieving Complex Collaborative Missions via Decentralized
Control and Coordination of Interacting Robots”

Participant No	Participant organisation name	Country
1 KTH (Coordinator)	Kungliga Tekniska Högskolan	Sweden
2 Bosch	Bosch	Germany
3 NTUA	National Technical University of Athens	Greece
4 PAL	PAL-Robotics	Spain
5 FORTH	Foundation for Research and Technology - Hellas	Greece
6 UGOT	University of Gothenburg	Sweden

Some scenarios



Re-configuration and adaptation



UGOT role

- Definition of the **architecture** and implementation of the *Co4Robots* software platform
- **Systematic** approach for creating **re-usable** robot building blocks, i.e. modules with clear interfaces, semantic description, and well defined properties
- We will make use of Model Driven Engineering (MDE) and this will permit to systematically concentrate on different levels of robot application abstractions - each providing a view for specific stakeholders
 - Improving **usability** in everyday applications
 - Enabling **customizability** in different and specific domains
 - Promoting **reusability** of the different algorithms, methods, and techniques conceived in the overall project
 - **Managing variability and complexity** both before and during the mission execution

UGOT role

- Specification languages especially tailored to the robotic domain and accessible to the end-user
 - Intuitive but rigorous: the language will be conceived for users that have little expertise in ICT and, yet, want to specify temporal properties in an intuitive way
- Configuration mechanisms
 - Start-up configuration
 - The user will be able to customize the robot system before use according to needs of various domains and contexts
- User run-time configuration and run-time self-configuration
 - The user will be able to alter the robot system behavior during the cycle of operation, e.g. by assigning new tasks, and the robot system will self-reconfigure accordingly



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