CHALMERS | UNIVERSITY OF GOTHENBURG

The Role of Parts in the System Behaviour

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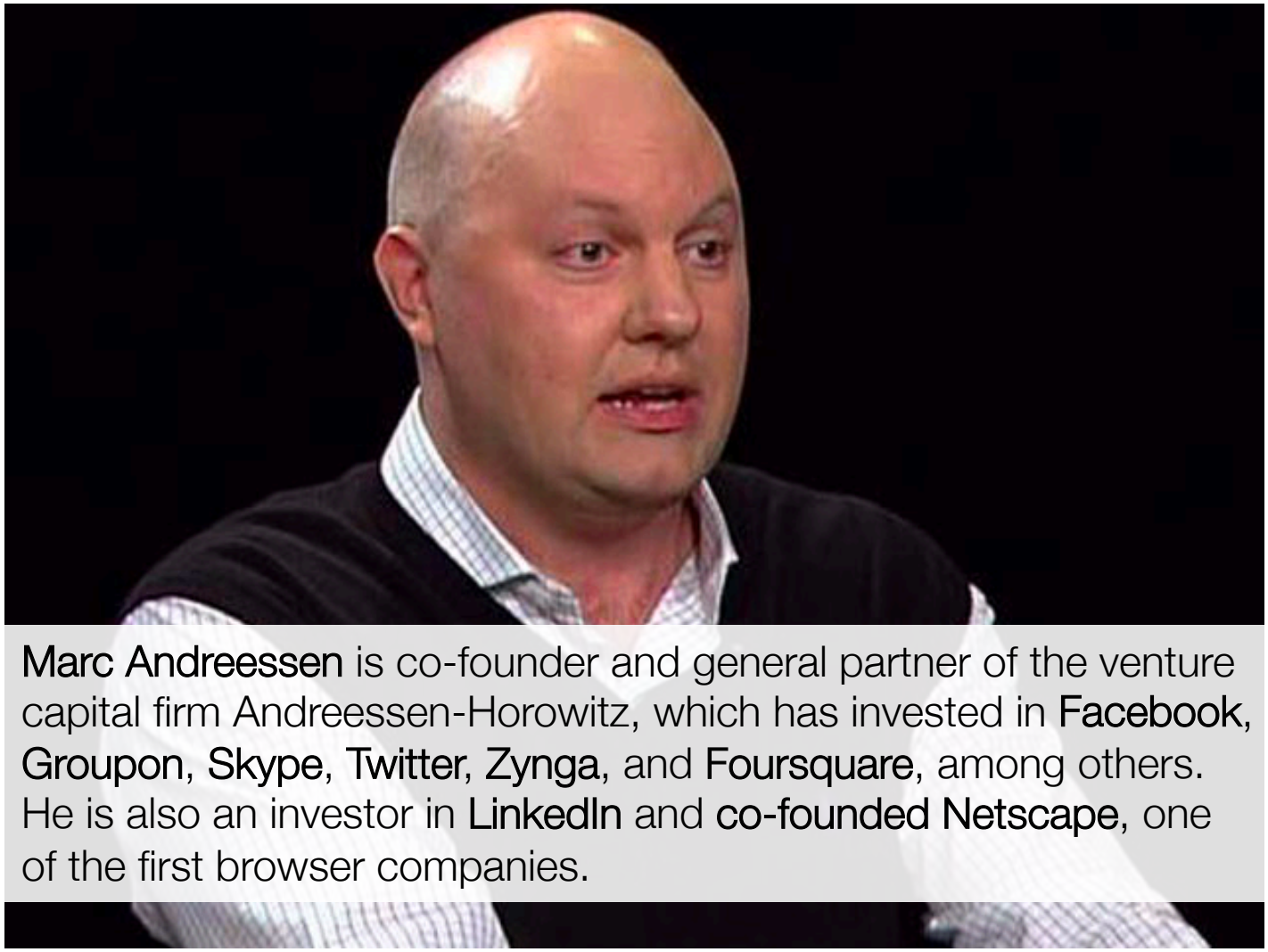
Istituto Nazionale di Fisica Nucleare



Marc Andreessen is co-founder and general partner of the venture capital firm Andreessen-Horowitz, which has invested in **Facebook**, **Groupon**, **Skype**, **Twitter**, **Zynga**, and **Foursquare**, among others. He is also an investor in **LinkedIn** and **co-founded Netscape**, one of the first browser companies.

"Software is eating the world"

http://online.wsj.com/news/articles/SB10001424053111903480904576512250915629460

Major music companies

iTunes

PANDORA

Spotify

Largest bookseller

amazon

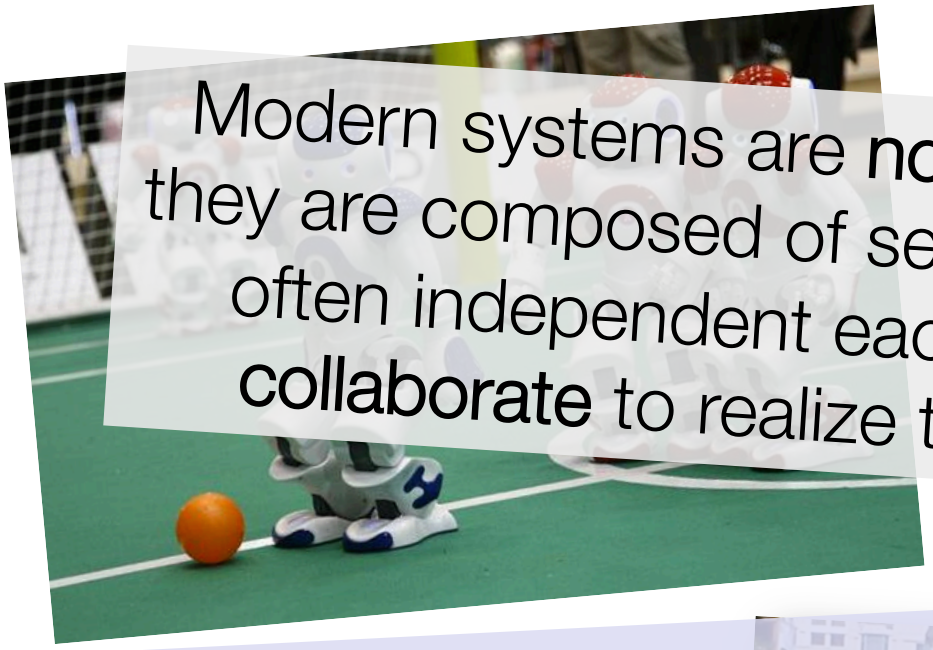
$440 million

45 minutes

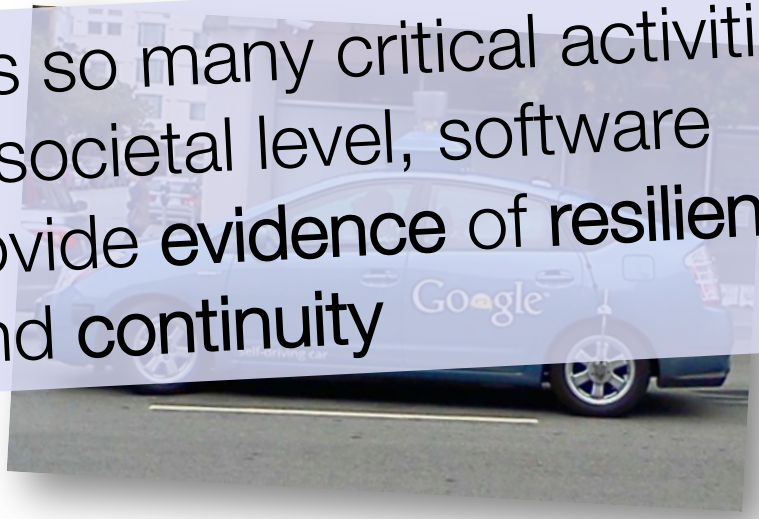
August 2, 2012

Knight Capital Group announced on August 2, 2012 that it lost $440 million when it sold all the stocks it accidentally bought the day before due to a software bug

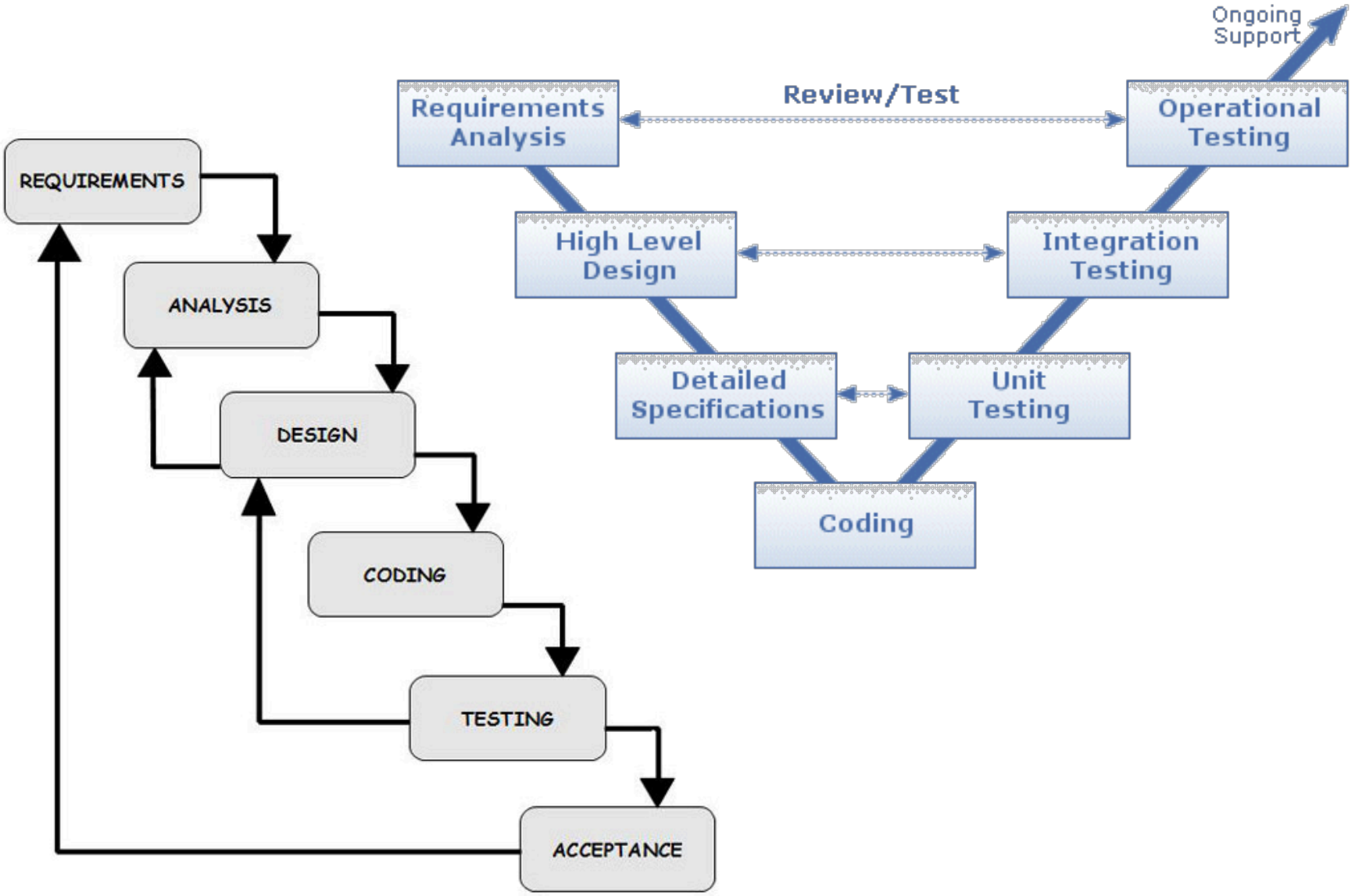

In 10 years, about 10,000,000 cars have been recalled due to software-related problems



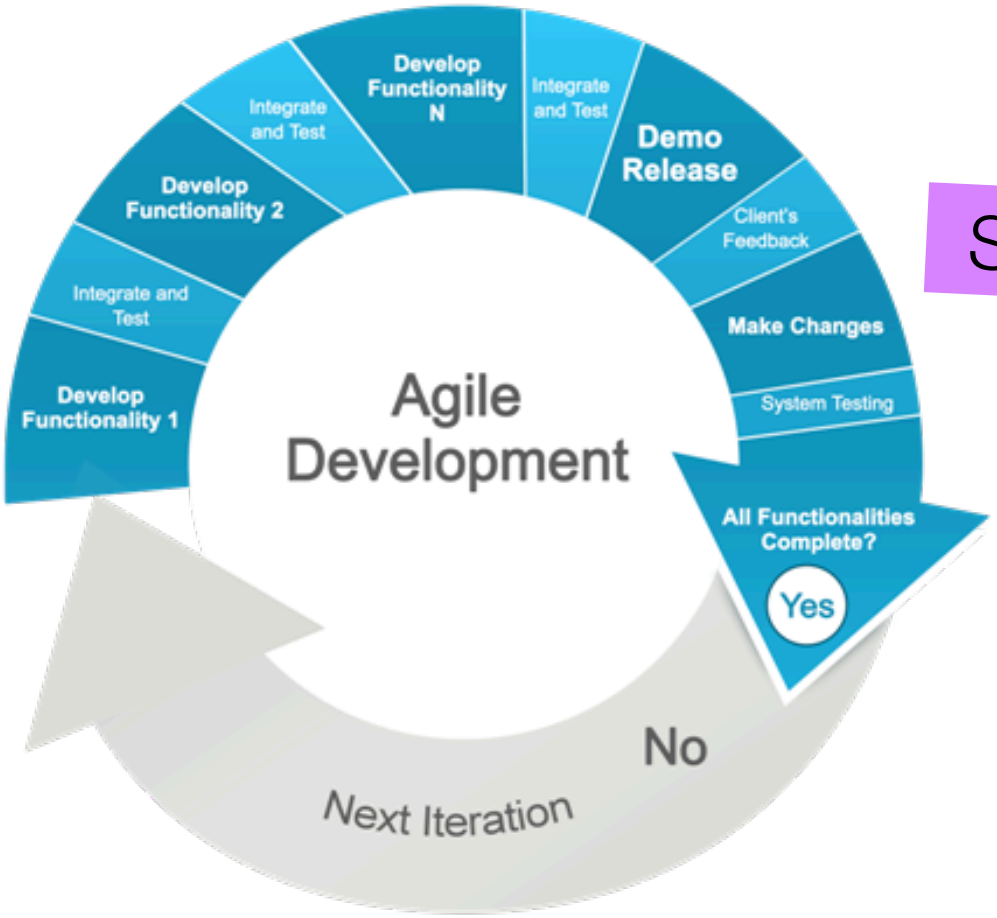
Modern systems are **no more standalone**; they are composed of several **sub-systems**, often independent each other but that **collaborate** to realize the system **goal**



Software controls so many critical activities, and thus, at societal level, software is required to provide **evidence** of **resilience** and **continuity**


REQUIREMENTS
ANALYSIS
DESIGN
CODING
TESTING
ACCEPTANCE
Ongoing Support
Review/Test
Requirements Analysis
Operational Testing
High Level Design
Integration Testing
Detailed Specifications
Unit Testing
Coding

Flexibility



Speed

Safety-critical systems

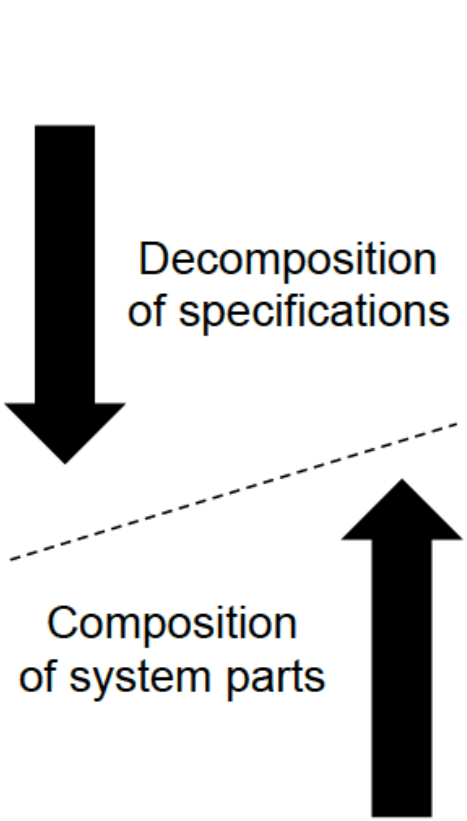
How to improve Agile dev. processes

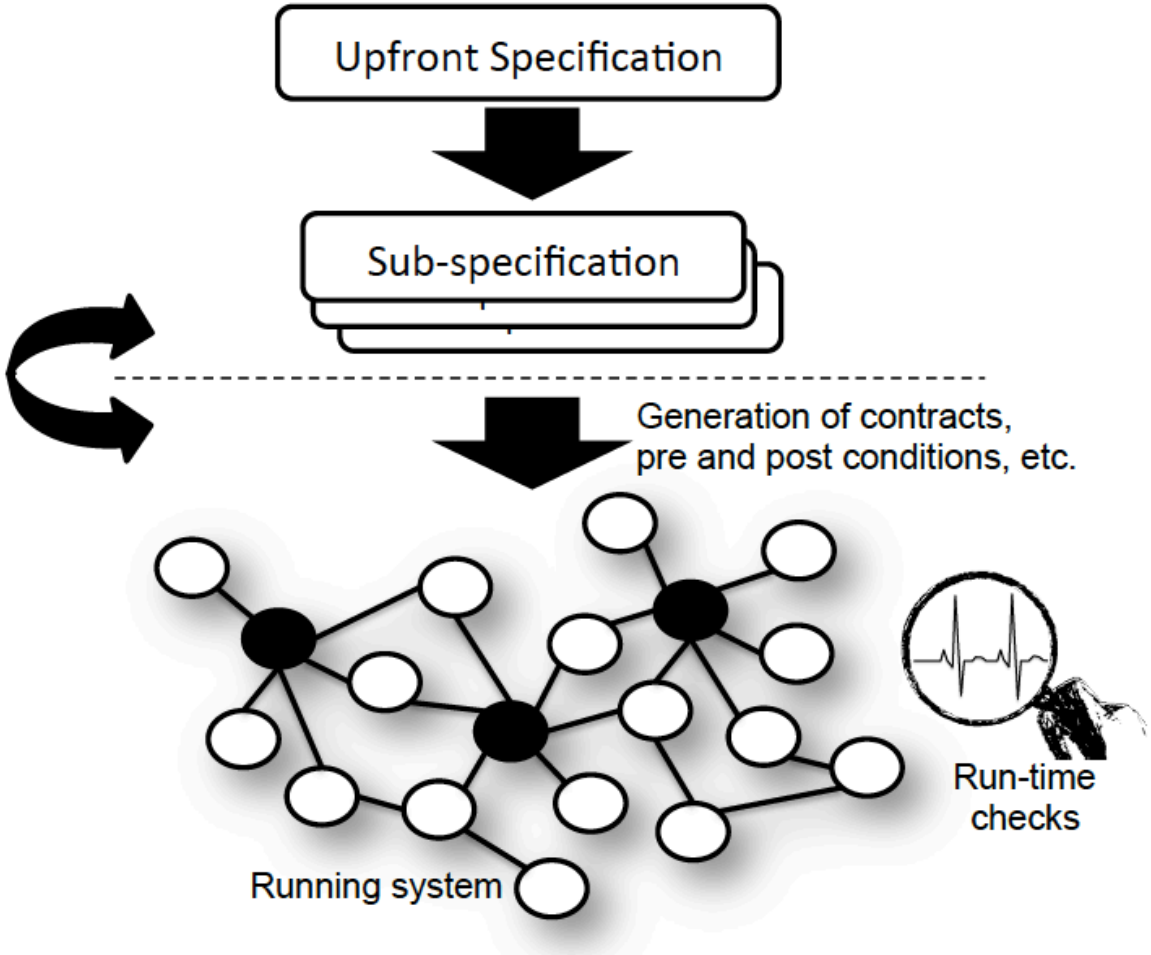
- Up-front design and incremental development of safety arguments
  - Iterative and incremental development should construct not only software, but also arguments that the software is acceptably safe
- Safety-by-Design
  - Intrinsic safety, i.e., no component can be in an unexpected state
- Lightweight traceability of requirements at development time
- Identify high-risk system properties that need special handling

"A specification is a written description of what a system is supposed to do. Specifying a system helps us understand it. It's a good idea to understand a system before building it, so it's a good idea to write a specification of a system before implementing it."

Leslie Lamport

Agility and resilience





Ensuring resilience in a swarm of autonomous quadrotors

Il drone della polizia Usa Qube


Anche in Gran Bretagna la polizia sperimenta l'uso di droni

What is a quadrotor?

- Special kind of helicopter
  - high **stability**
  - omni-directional
  - smaller fixed-pitch rotors
    - **safer** than classical helicopters
  - **simple** to design and construct
  - **relatively inexpensive**

- **However it requires a trained pilot…**

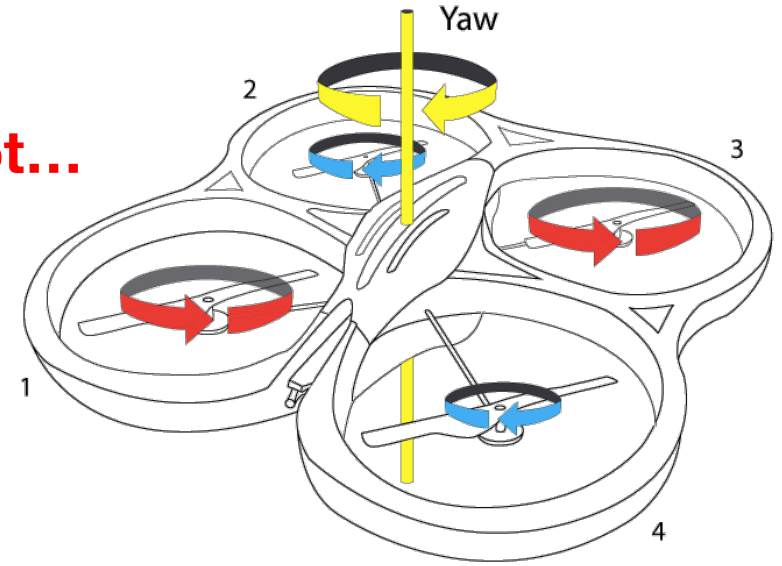


image from http://goo.gl/FJFS5l

Multi-quadrotors missions

- Monitoring missions can be executed by a swarm of autonomous quadrotors
  - lower mission completion time
  - fault-tolerance w.r.t. mission goal fulfillment
  - enables the use of highly-specialized quadrotors

- All the quadrotors in the swarm perform their actions to fulfill the common goal of the mission

- **However…**

Challenges

- **On-site operators must be expert** of all the types of used robots
  - in terms of dynamics, hardware capabilities, etc.

- On-site operators have to **simultaneously control a large number of robots** during the mission execution

- Robots provide **very low-level APIs** and very basic primitives
  - error-prone development
  - task-specific quodrotors
  - no reuse

These issues ask for
- abstraction
- automation

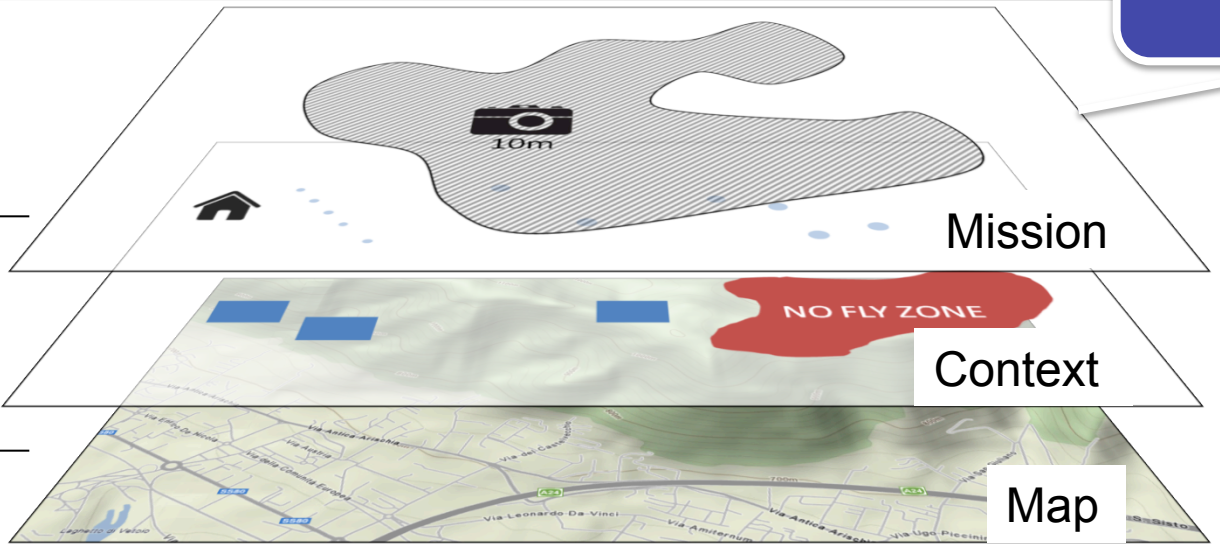
FlyAQ mission

To make the definition and realization of missions for a swarm of autonomous quadcopters possible for people that are neither expert in ICT nor in robotics.

Overview of the FLYAQ platform*

(rif. D. Di Ruscio, I. Malavolta, P. Pelliccione - www.flyaq.it)

this layer is extensible

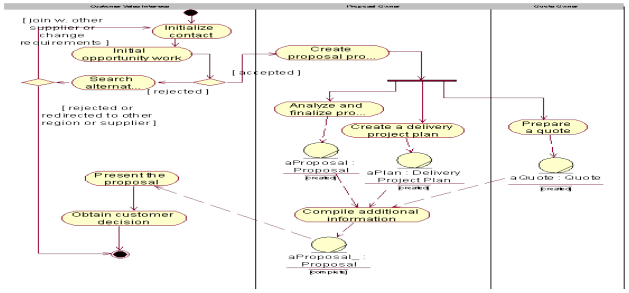


MML

QBL model implementation

Quadrotors configuration

QBL



Drone behavior specification

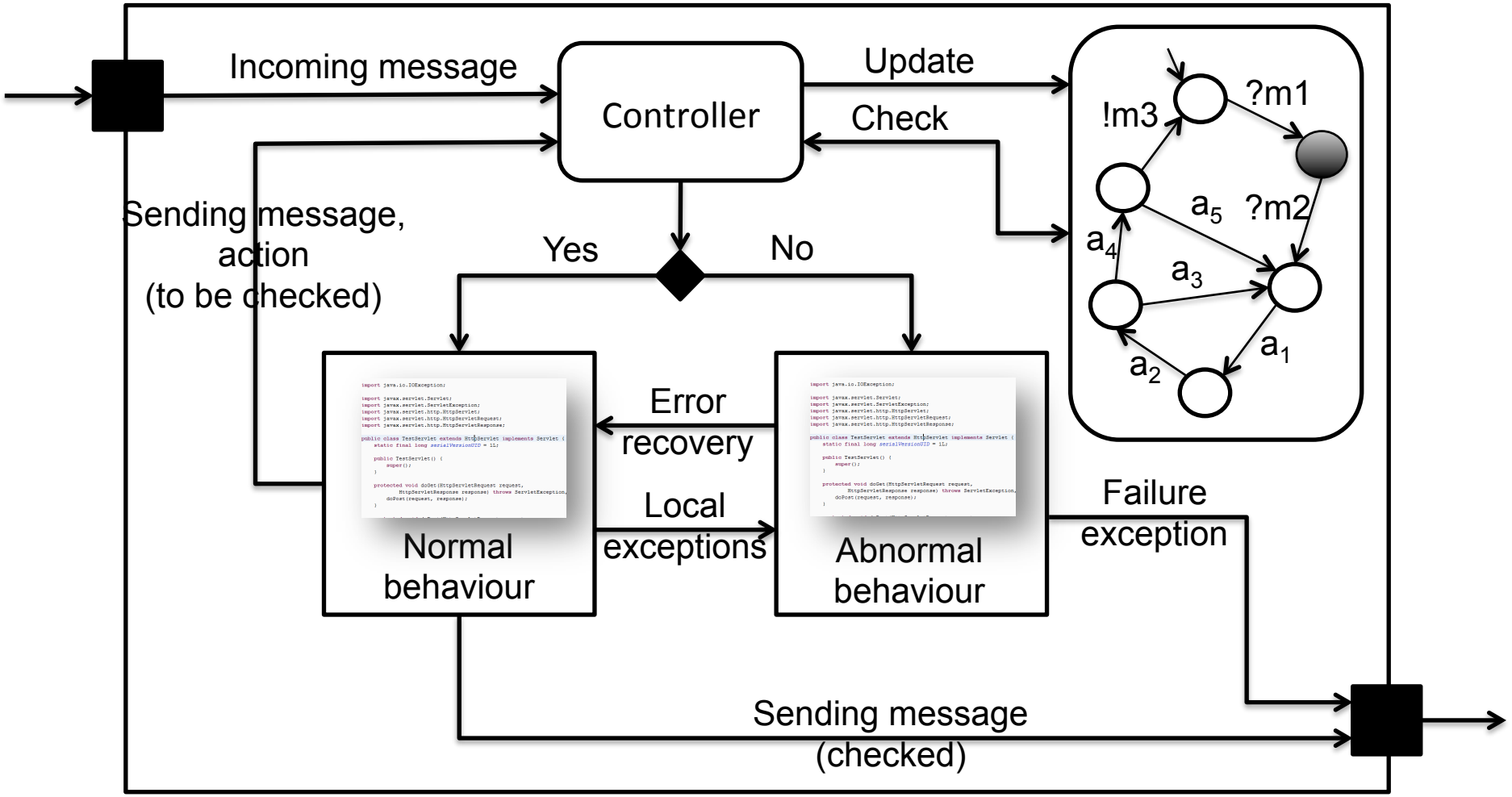
Mission Execution Engine

*supported by TELECOM ITALIA winner of the grant "*20 talenti per l'Italia*", Working Capital 2012

Resilient quadrocopter: software perspective

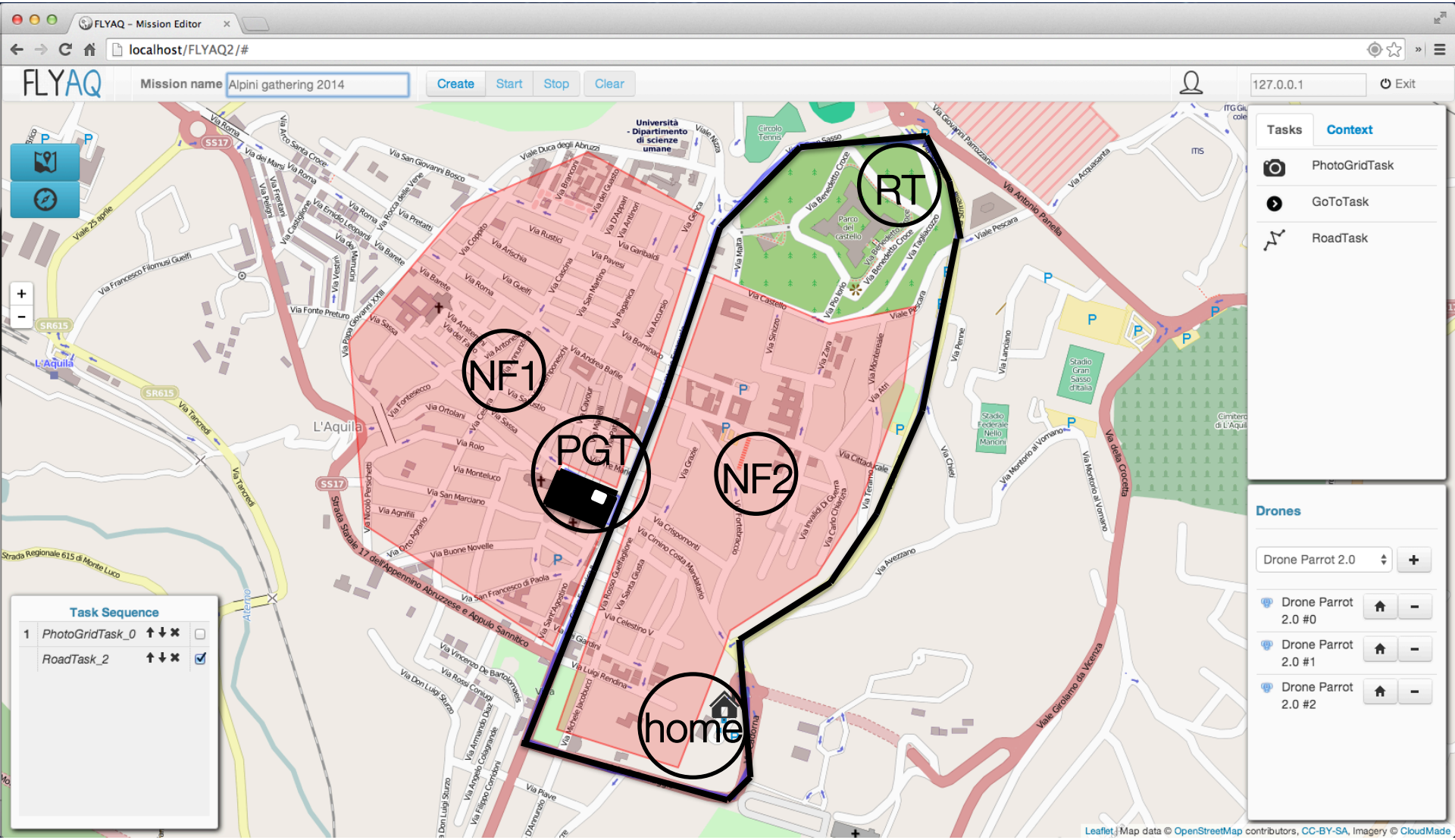
- Up-front specification
  - Goal of the missioN provided by means of the Monitoring Mission Language (MML)
- Sub-specification
  - Quadrotor Behaviour Language (QBL), intermediate language
    - Set of movements: e.g., take off, land, go to a specific geographical point
    - Set of actions like: taking a picture, starting or stopping a video streaming session, sending a message to the ground station, and sending a message to another drone

Run-time control of the mission execution

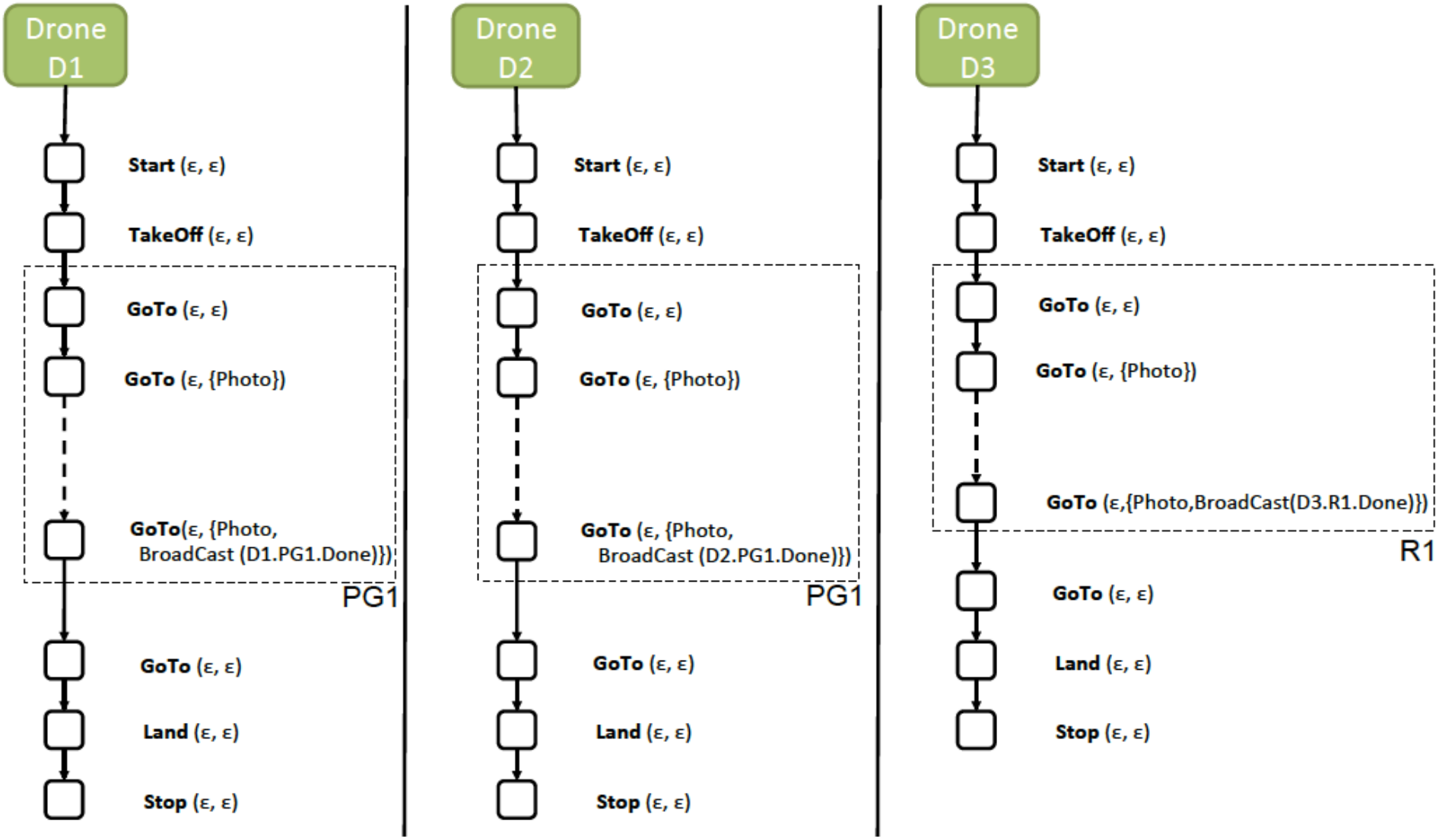


Public Event Mission scenario

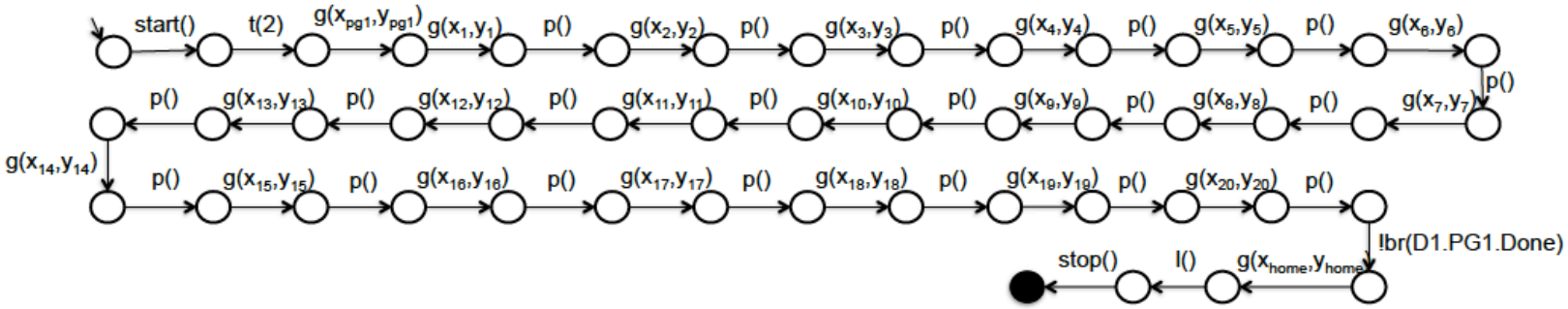
http://www.laquila2015.it/



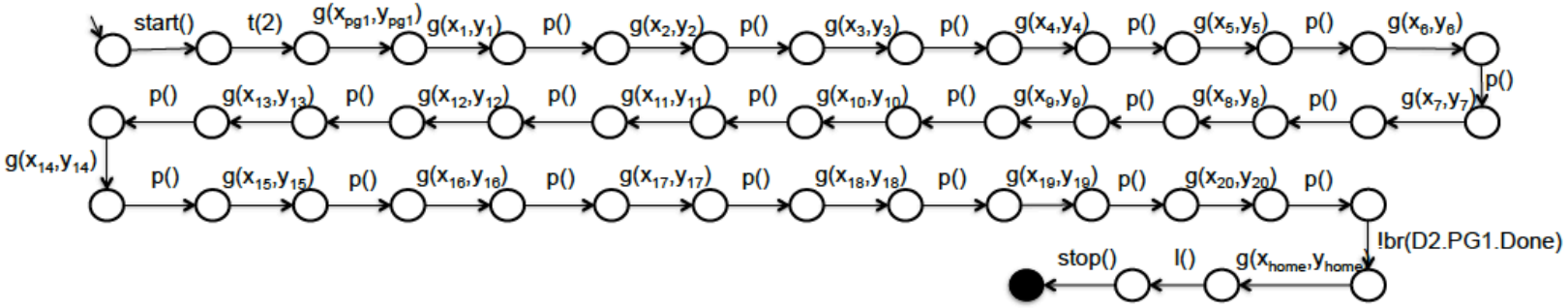
Behavioural model of the Alpini event monitoring mission



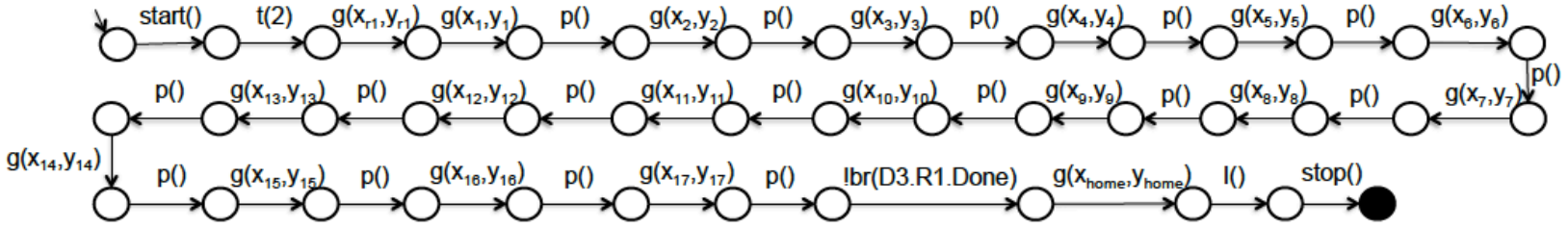
Sub-specifications



(a) Sub-specification of drone D1



(b) Sub-specification of drone D2



(c) Sub-specification of drone D3

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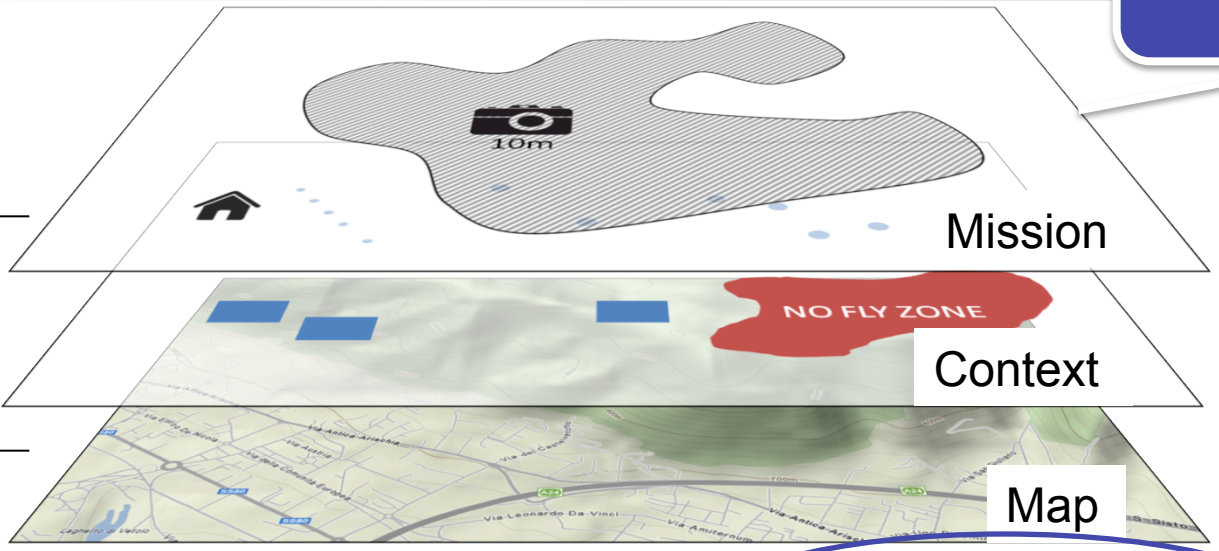
this layer is extensible



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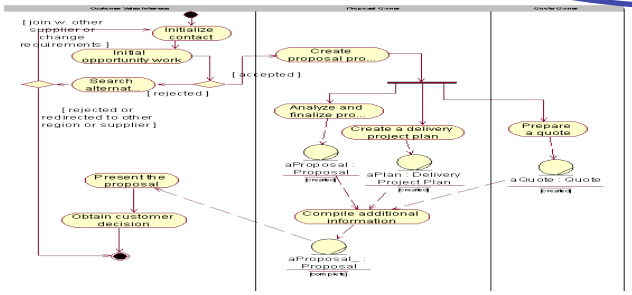
QBL



Drone behavior specification

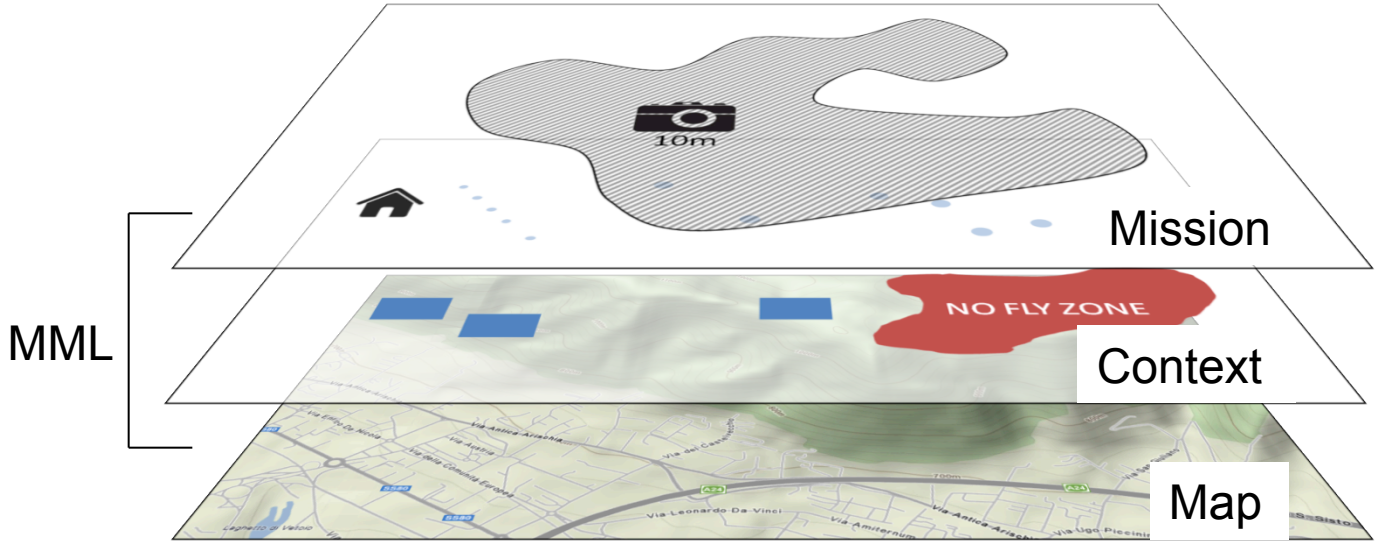
- no automatic support
- completely demanded to the platform extender

*supported by TELECOM ITALIA winner of the grant "*20 talenti per l'Italia*", Working Capital 2012

http://www.flyaq.it/synthesis/

Extended FLYAQ platform

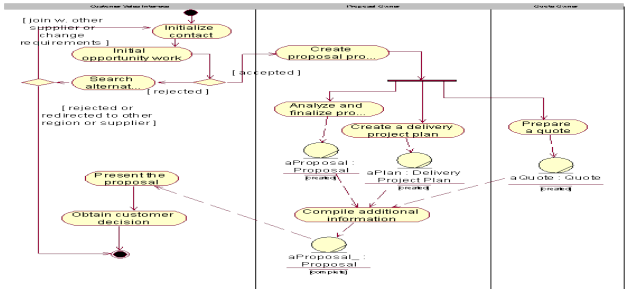
(rif. D. Di Ruscio, I. Malavolta, P. Pelliccione, M. Tivoli)



QBL model automated synthesis (collisions & no-fly zones avoidance)

Quadrotors configuration

QBL



Drone behavior specification

Mission Execution Engine

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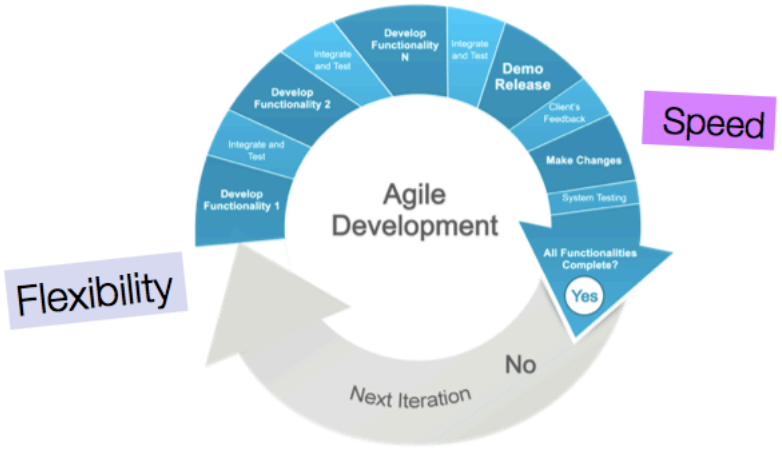
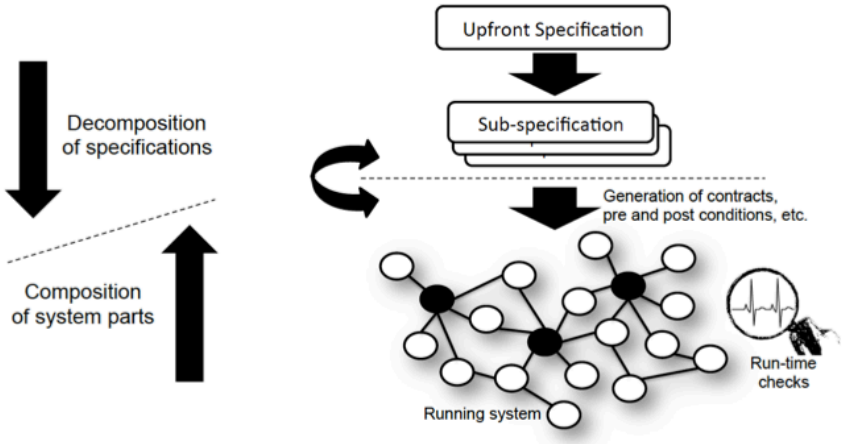
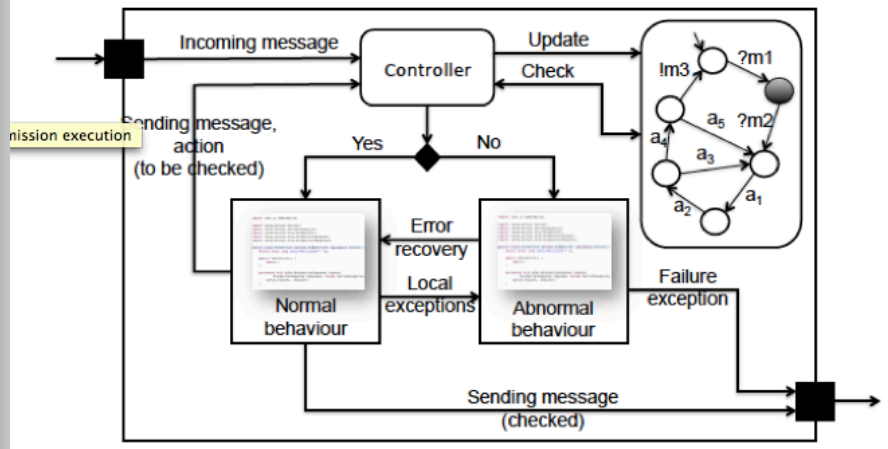


Safety-critical systems

Agility and resilience



Run-time control of the mission execution



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