



The European Coordination Hub for Open Robotics Development



E++ 4th Review Meeting

WP3 - Experiments

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The BioRobotics Institute

Scuola Superiore Sant'Anna, Pisa, Italy

Luxembourg, February 21, 2018



Objectives of WP3 - Experiments



Experiments

- **Regulatory framework** governing the experiments based on ECHORD
- **Implementation and improvement** of the process
- **Close cooperation with Quality Management (WP1)**

Objectives of WP3 - Experiments



Summary WP3 - Experiments

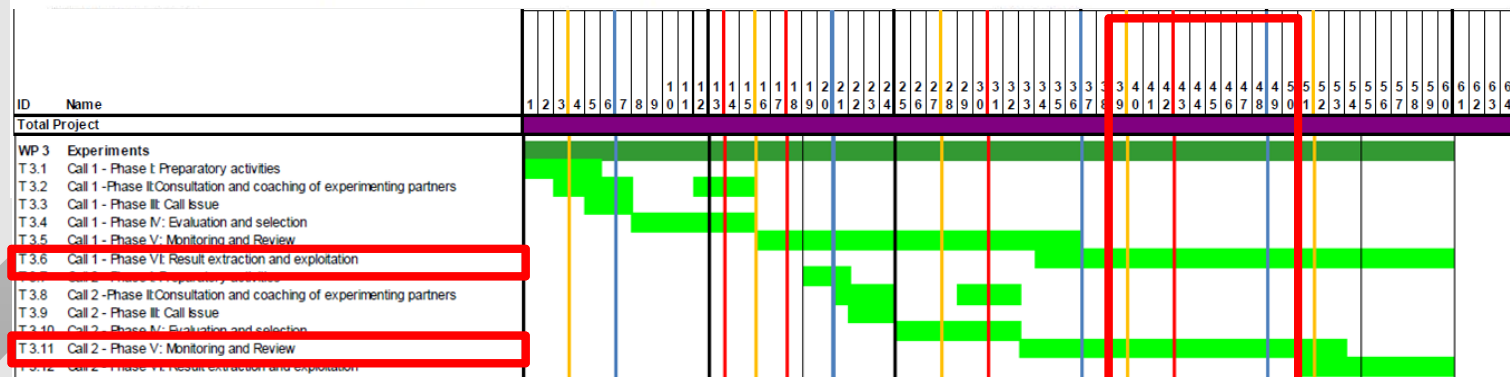


Experiments

Person-Months per Participant		
Participant number ¹⁰	Participant short name ¹¹	Person-months per participant
1	TUM	27.00
2	SSSA	45.00
3	UWE	0.50
4	UNIVERSITAT POLITECN	10.50
5	CEA	0.00
Total		83.00

1.3.3 Timing of work packages and their components

M39-M50



Main achievements during the 4th period (WP3)



Experiments

Outcome of Call 1:

- Experiments reviewers evaluation very positive overall (with few exceptions)
- Exploitation:
 - Cumulated sales of robotic products over year 2017 in excess of €1 million and more to come
 - Looking back on technical developments in Call 1 (TRL evaluation workshop)

Monitoring of Call 2:

- Coming to a conclusion by the end of summer
- Technical quality very comparable to that in Call 1
- Some products already emerging

Follow-up of previous review

- **Recommendation R3:** *After further rapid analysis consider how to best support experiments through a Booster program focusing on Business Development training and perhaps based on which experiments will most benefit, and quick to implement since time is short.*

Experiment Booster programme

- **Recommendation R4:** *please re-examine the TRL step changes claimed by the experiments, especially those that claim a starting point of TRL1 or 2, in order to better align with existing practice and thus to obtain maximum credibility and impact when presenting outside the project.*

- **Call1 Experiments:** “E++ Experiments TRL evaluation Workshop” Munich, January 30th 2018
- **Call2 Experiments:** TRL evaluation will be performed by external experts (reviewers)

Deliverables of the reporting Period

- **D 3.5.4** 4th six-monthly report on experiment progress and on reviews
- **D 3.5.5** 5th six-monthly report on experiment progress and on reviews

Milestones of the reporting Period

- No milestones planned



Experiments

Overview of tasks for WP3



Experiments

SECOND CALL

- Task 3.11: Call 2- Phase V: Monitoring and review

FIRST CALL

- Task 3.6: Call 1- Phase VI: Result extraction and exploitation

Overview of tasks for WP3



Experiments

SECOND CALL

- Task 3.11: Call 2- Phase V: Monitoring and review



Task 3.5: Call 1- Phase V

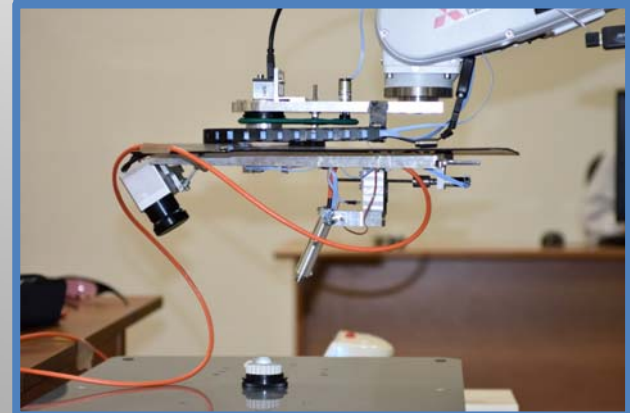
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TUM, SSSA, UPC

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- Call 1 Experiments were also active during the RP, due to extensions
 - LA-ROSES
 - EXOTrainer
- **Each Experiment has been concluded with a final review:**
 - **Reviewers:**
 - External expert
 - Technical Moderator
 - **Demonstration** of the technology developed
 - **Discussion** about Experiment's achievement with the Experimenters (in particular in terms of KPIs, as tracked by the detailed traffic light system)



Task 3.5: Call 1- Phase V

Monitoring and Review

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- Call 1 reviews occurred in the **previous RP (RP3)**:
 - DexBuddy
 - MODUL
 - MOTORE++
 - Pickit
 - SAPARO
 - MARS
- Call 1 reviews occurred in the **current RP (RP4)**:
 - TIREBOT
 - LINARM++
 - LA ROSES
 - GAROTICS
 - 3DSSC
 - 2F
 - DEBUR
 - COHROS
 - EXOTRAINER

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- Call 1 Experiments final outcome

	Milestone	Deliverable	Technical KPIs	Impact KPIs	Dissemination KPIs
TIREBOT	●	●	●	●	●
MOTORE++	●	●	●	●	●
LINARM++	●	●	●	●	●
LA ROSES	●	●	●	●	●
GAROTICS	●	●	●	●	●
MARS	●	●	●	●	●
PICKIT	●	●	●	●	●
SAPARO	●	●	●	●	●
3DSSC	●	●	●	●	●
2F	●	●	●	●	●
DEBUR	●	●	●	●	●
COHROS	●	●	●	●	●
DEXBUDDY	●	●	●	●	●
EXOTRAINER	●	●	●	●	●
MODUL	●	●	●	●	●

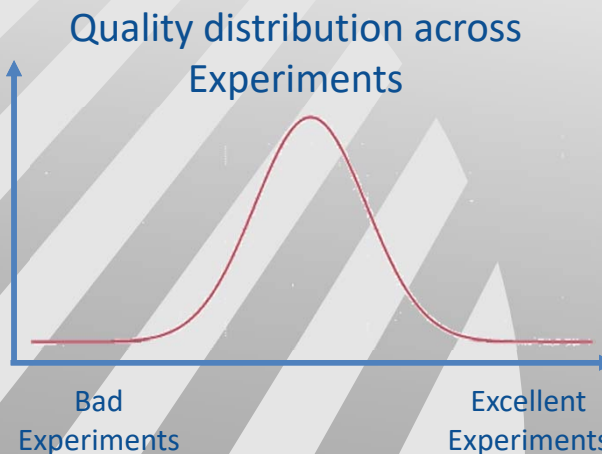
Task 3.5: Call 1- Phase V

Monitoring and Review

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- Call 1 Experiments final outcome
 - The **monitoring works**: through the monitoring we are able to assess the situation and anticipate the situation.
 - The **quality is reflected in the monitoring tools** showed in the table

	Milesto ne	Delivera ble	Technic al KPIs	Impact KPIs	Dissemi nation KPIs
LA ROSES	●	●	●	●	●
DEXBUDDY	●	●	●	●	●



	Milesto ne	Delivera ble	Technic al KPIs	Impact KPIs	Dissemi nation KPIs
MOTORE++	●	●	●	●	●
MODUL	●	●	●	●	●

Task 3.5: Call 2- Phase V

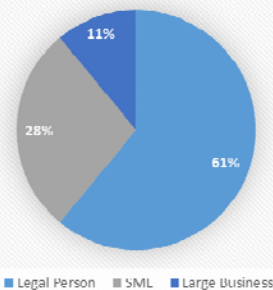
Monitoring and Review

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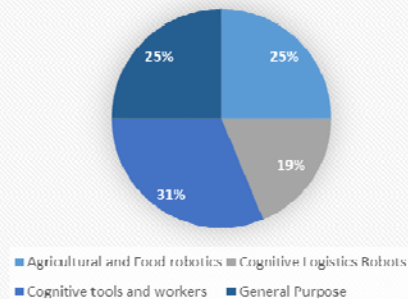
Call II Experiments

- **16** running Experiments
- **47** funded organizations
- Starting date: June 2016 or September 2016
- Expected end: November 2017 or February 2018

Organizations distribution



Scenario distribution



1	INJEROBOT	Agricultural and Food robotics
2	FlexSight	Cognitive Logistics Robots
3	SAGA	Agricultural and Food robotics
4	MAX ES	Cognitive Logistics Robots
5	AAWSBE1	Cognitive tools and workers
6	WIRES	Cognitive tools and workers
7	Keraal	General Purpose
8	SAFERUN	Cognitive tools and workers
9	DUALARMWORKER	Cognitive tools and workers
10	RadioRoSo	Cognitive tools and workers
11	HOMEREHAB	General Purpose
12	FASTKIT	Cognitive Logistics Robots
13	CoCoMaps	General Purpose
14	GRAPE	Agricultural and Food robotics
15	CATCH	Agricultural and Food robotics
16	HyQ-REAL	General Purpose

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Monitoring and Review



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General Monitoring Activities

- Monitoring activities are structured around a **Key Performance Indicator (KPI)** roadmap
- For each Experiment, Core Partners have negotiated with Experimenters **one set of KPIs per Experiment**
 - **Technical** KPIs
 - **Impact** KPIs
 - **Dissemination** KPIs
- Achievement of KPIs → completion of the Experiment's objectives
- The **monitoring process** is then structured around **timely achievement of these KPIs**



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Monitoring and Review



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General Monitoring Activities

- Each Experiment is overseen by a team of **two dedicated Moderators**

SSSA

TUM

UPC



Experiment	Technical Moderator	Management Moderator
AAWSBE1	SSSA - Manuele Bonaccorsi	SSSA - Manuele Bonaccorsi
CATCH	UPC - Herminio Martínez-García	SSSA - Raffaele Esposito
CoCoMaps	TUM - Adam Schmidt	TUM - Adam Schmidt
DUALARMWORKER	SSSA - Annagiulia Morachioli	UPC - Ana Maria Puig Pey Claveria
FASTKIT	TUM - Yannick Morel	TUM - Yannick Morel
FlexSight	SSSA - Raffaele Limosani	UPC - Ana Maria Puig Pey Claveria
GRAPE	UPC - Antoni Grau	SSSA - Stefano Betti
HOMEREHAB	TUM - Adam Schmidt	TUM - Adam Schmidt
HyQ-REAL	TUM - Yannick Morel	SSSA - Laura Fiorini
INJEROBOT	UPC - Antoni Grau	SSSA - Alessandra Moschetti
Keraal	SSSA - Abdul Butt	SSSA - Abdul Butt
MAX-ES	TUM - Adam Schmidt	UPC - Ana Maria Puig Pey Claveria
RadioRoSo	TUM - Y. Morel, UPC – A. Grau	SSSA - Clementina Cruceli
SAFERUN	TUM - Yannick Morel	UPC - Ana Maria Puig Pey Claveria
SAGA	SSSA - Alessandro Manzi	TUM - Yannick Morel
WIRES	SSSA - Ilaria Strazzulla	TUM - Adam Schmidt

Task 3.5: Call 2- Phase V

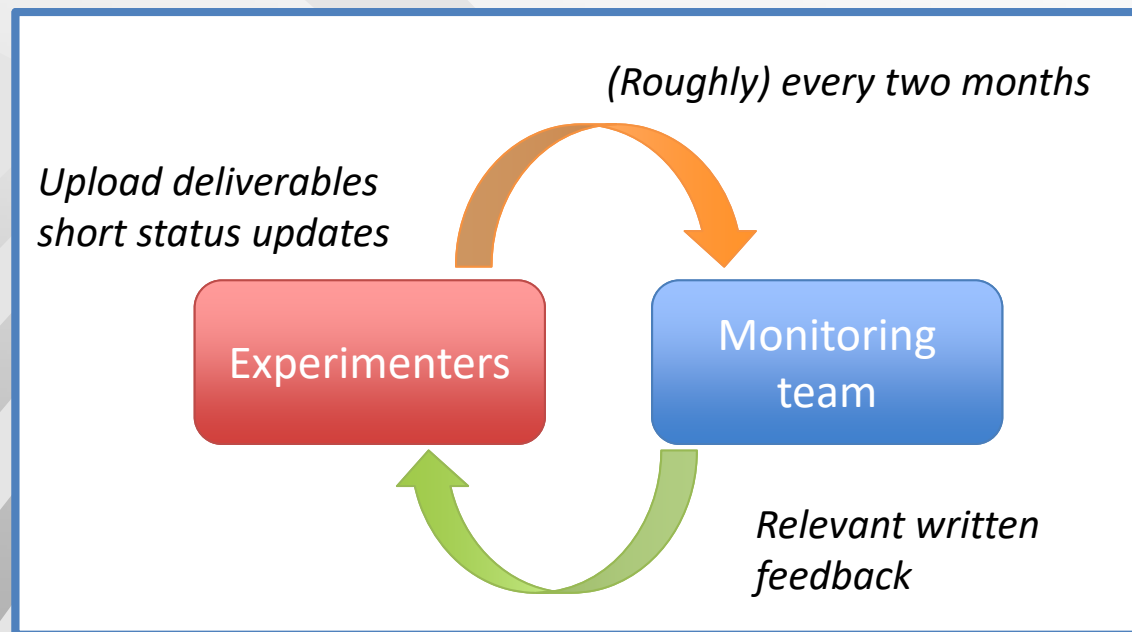
Monitoring and Review

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General Monitoring Activities

- **Interactions** between monitoring team and Experimenters:
 - two-monthly **Skype monitoring calls**
 - **follow-up question/answers** through emails



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General Monitoring Activities *every six months*

General overview (D354 and D355)

- High-level overview
- One page overview of the entire activities
- Easy to track, all the information visible in one look

- One or more activities planned in the period resulted in positive outcome
- One or more activities planned in the period resulted slightly under expectation
- One or more activities planned in the period resulted significantly below expectations
- No action foreseen in the selected period

	Self-Assessment	Milestone	Deliverable	Technical KPIs	Impact KPIs	Dissemination KPIs
DUALARMWORKER	●	●	●	●	●	●
Injerobot	●	●	●	●	●	●
SAGA	●	●	●	●	●	●
Flexsight	●	●	●	●	●	●
Max Es	●	●	●	●	●	●
AAWSBE1	●	●	●	●	●	●
Wires	●	●	●	●	●	●
Keraal	●	●	●	●	●	●
Saferun	●	●	●	●	●	●
Radoroso	●	●	●	●	●	●
Homerehab	●	●	●	●	●	●
Fastkit	●	●	●	●	●	●
Cocomaps	●	●	●	●	●	●
Grape	●	●	●	●	●	●
Catch	●	●	●	●	●	●
Hyq-Real	●	●	●	●	●	●

Task 3.5: Call 2- Phase V

Monitoring and Review



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General Monitoring Activities *every six months*

Detailed traffic lights (QM reports)

- Low-level, high detail
- Useful in tracking down the specific problems

DUALARMWORKER

tKPIs	#1 Time to plan a dual arm trajectory	#2 Trials to obtain a suitable solution	#3 Deviation with the respect to ideal trajectory	#4 Weight carrying capability
	●	●	●	●

iKPIs	#1 Station Recurring Cost Reduction	#2 Number of Airbus operations as potential users of the dual-arm	#3 Open Source Software Modules release	#4 Automation in different industrial sectors	#5 Commercial exploitation of dual-arm planning libraries
	●	●	●	●	●

Milestones	#1 Dual-arm closed kinematics chain planning algorithm selected		#2 First prototype implemented		#3 final prototype implemented	
	●		●		●	

Deliverables	#D4.1 Story Board	#D1.1 Pilot case scenario definition	#D2.1 Intermediate report on dual arm motion planning algorithm	#D2.2 Library for dual arm closed kinematics chain motion planning	#D3.1 Prototype of the first demonstrator
	●	●	●	●	●
	#D2.3 Library of dual arm constrained automatic programming	#D2.4 Library of dual arm online collision detection and avoidance	#D3.2 Prototype of the second demonstrator	#D4.2 Multi-media Report	
	●	●	●	●	

Dissemination	#1 Website of experiment	#2 Press release I	#3 Press release II	#4 Multimedia report	#5 Networking with associations (AER-ATP)	#6 Networking with associations (GDR ROBOTIQUE CNRS)
	●	●	●	●	●	●
	#7 Networking with associations (Hisparob)	#8 Attendance to trade fairs (INNOROBO)	#9 Attendance to scientific conferences (AIM 17)	#10 Social media		
	●	●	●	●		

Task 3.5: Call 2- Phase V

Monitoring and Review – Illustrative examples

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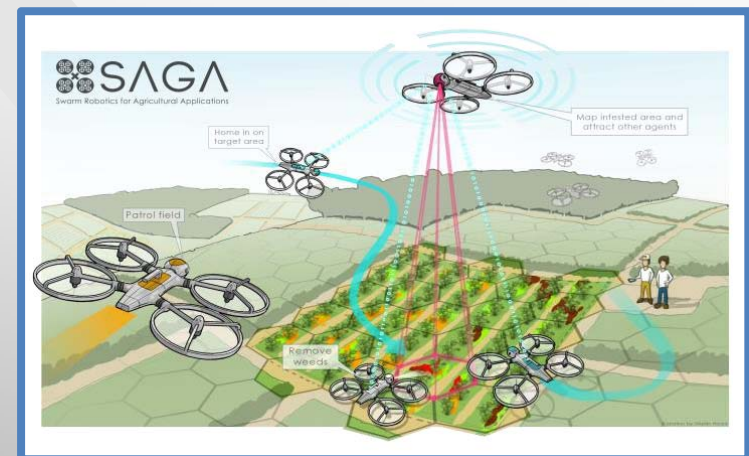
Narrowing the scope facilitates reaching market

SAGA

- Goal of the experiment: to prove the applicability of **swarm robotics to precision farming**
- By exploiting swarm robotics principles, a **group of small UAVs** has been deployed to collectively monitor a field and cooperatively map the presence of weed
- An **existing multi-rotor UAV enhanced with on-board camera and vision processing, radio communication systems** and suitable protocols to support safe swarm operations.
- The experiment developed **on-board vision routines** capable of supporting local navigation and discerning weeds from cultivated plants.
- Collectively, the robots will **build a map of the field with semantic tags associated with different areas**, so as to convey precise information about the presence and amount of weed in the different parts of the field



WAGENINGEN
UNIVERSITY & RESEARCH



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Monitoring and Review – Illustrative examples

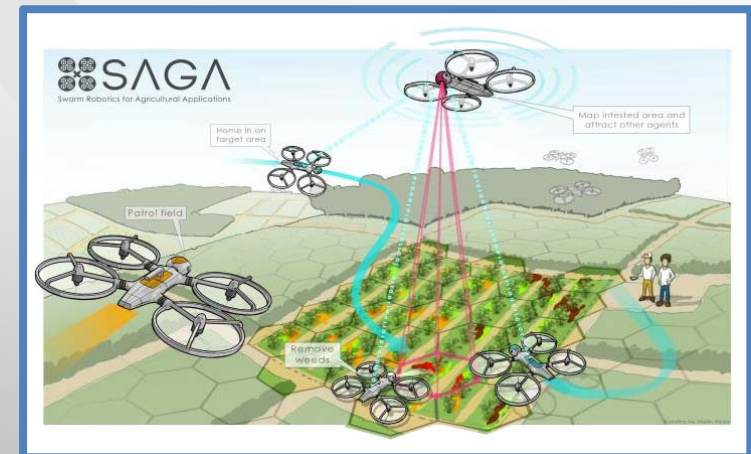
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Narrowing the scope facilitates reaching market

SAGA

- Ambitious experiment
- They did a lot of work on a complicated system to develop
- Technology Transfer happened: it is a success for E++
 - Cooperative control
 - Vision processing
- **Lessons learned:**
 - Complex system, narrow audience, difficult to reach market
 - They took a building block of the system and they sell that as a stand alone product (same as MODUL) → it is a trend of some experiment
 - Building block: less specialized, larger audience, easier to reach market



SAGA shown later

Task 3.5: Call 2- Phase V

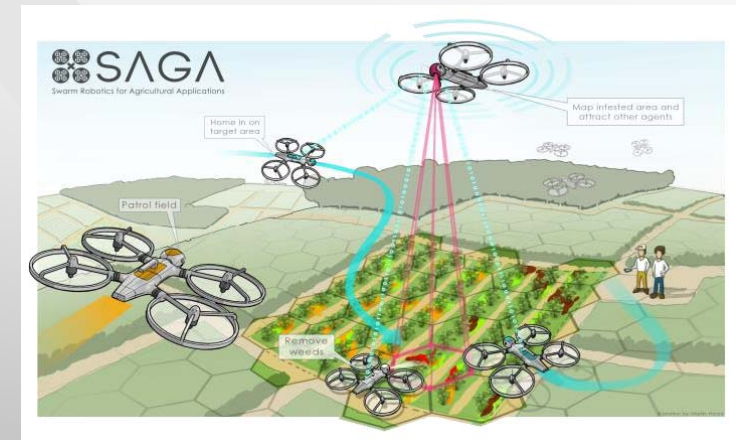
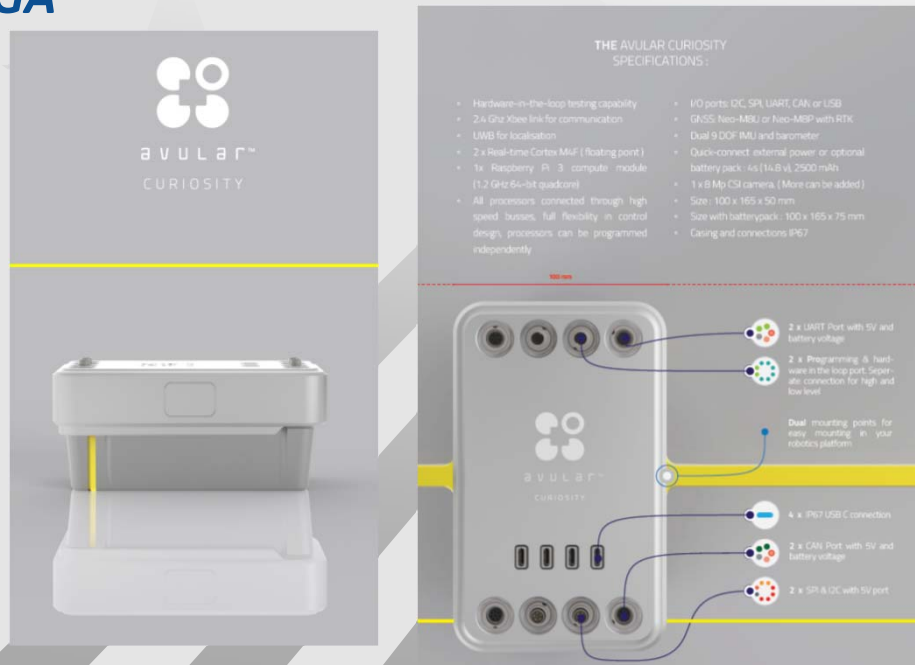
Monitoring and Review

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Some interesting stories about Call II Experiments

SAGA



SAGA shown later

Call 2 Experiments

SAGA

- Too ambitious to be an experiment
- They did a lot of work
- Too complicated,
- TT happened: it is a success
 - Cooperative control, Technology from CNR to avular
 - Vision processing from wageningen to avular
- It is impossible to find a market since the final system is too complicated
- They took a building block of the system and they sell that as a stand alone product (same as MODUL)→it is a trend of some experiment
- building block: less specialized, more easy to sell



Task 3.5: Call 2- Phase V

Monitoring and Review – Illustrative examples

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Instruments synergies to the benefit to E++ beneficiaries



GRAPE

- GRAPE project aims at creating the enabling technologies to **develop vineyard robots** that can increase the cost effectiveness of their products.
- The project addresses the market of **instruments for biological control** by developing the tools to execute (semi) autonomous vineyard monitoring and farming tasks with **Unmanned Ground Vehicles** and, therefore, reducing the environmental impact with respect to traditional chemical control.



Task 3.5: Call 2- Phase V

Monitoring and Review – Illustrative examples

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Instruments synergies to the benefit to E++ beneficiaries



GRAPE

Testing phase in real environment:

Castellani Winery

January 5 – 9, 2018



Task 3.5: Call 2- Phase V

Monitoring and Review – Illustrative examples

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Monitoring helps in focusing on objectives



MOOG

HyQ-REAL

- Significant deviation at the beginning of the Experiment
- Extensive negotiation between the monitoring team and the experimenters
- Outcome:
 - Constructive discussion
 - Inclusion of experimenters needs in the workplan (from gas to batteries)
 - Experiment scope of work in line with the original proposal (improvements in the design of the robot, more integrated and professional product)
- Building block product (same story as SAGA, MODUL): actuator



Task 3.5: Call 2- Phase V

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Measured ambition, high TRL, high impact

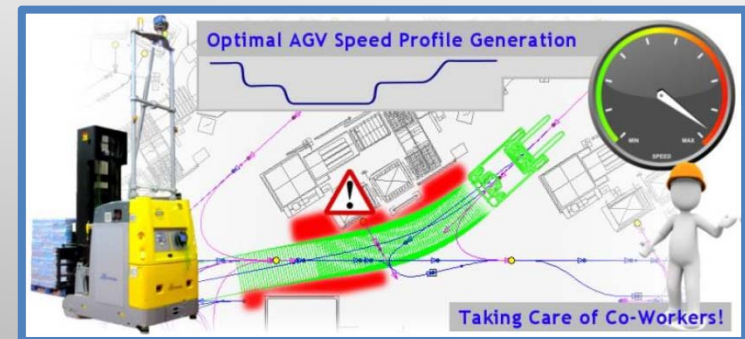
SAFERUN - Secure and fast real-time planner for autonomous vehicles

- Scope well in line with the E++ Experiment instrument
- The problem addressed is a **need expressed by the industrial partners Elettric80**
- Different kind of success:
 - Not a stand alone product
 - Integrated within the product and processes of the industrial partner (software)
 - Meaningful positive impact on business practices

DIPARTIMENTO
DI INGEGNERIA
DELL' INFORMAZIONE

ELETTIC80

PreGel
Your passion. Our ingredients.



SAFERUN shown later

Task 3.5: Call 2- Phase V

Monitoring and Review

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Experiments Schedule Management and Extension Requests

Experiment	Expected end	Requested end	Motivations	Status
HOMERHAB	Nov. 2017	Feb. 2018 (3 months)	Clinical trials	Granted
HyQ-REAL	Feb. 2018	June 2018 (4 months)	Delay in HW acquisition	Granted
SAGA	Nov. 2017	March 2018 (4 months)	Flight certification	Granted
WIRES	Nov. 2017	March 2018 (4 months)	Difficulty of integration	Granted
MAX-ES	Feb. 2018	June 2018 (4 months)	Final UGV delivered late	Positive outlook
Keraal	Feb. 2018	June 2018 (4 months)	Clinical trials	Positive outlook
FlexSight	Feb. 2018	June 2018 (4 months)	Dissemination	Discussed
CoCoMaps	Feb. 2018	June 2018 (4 months)	Delay in HW acquisition	Negative outlook

Grant of extension requests is assessed on a case-by-case basis.

Difficulty in timely scheduling of clinical trials

Delay in getting 3D metal printed hydraulic Intelligent Servo Actuators (ISAs)

Flight certification problems

Task 3.5: Call 2- Phase V

Monitoring and Review

Experiments Schedule Management and Extension Requests

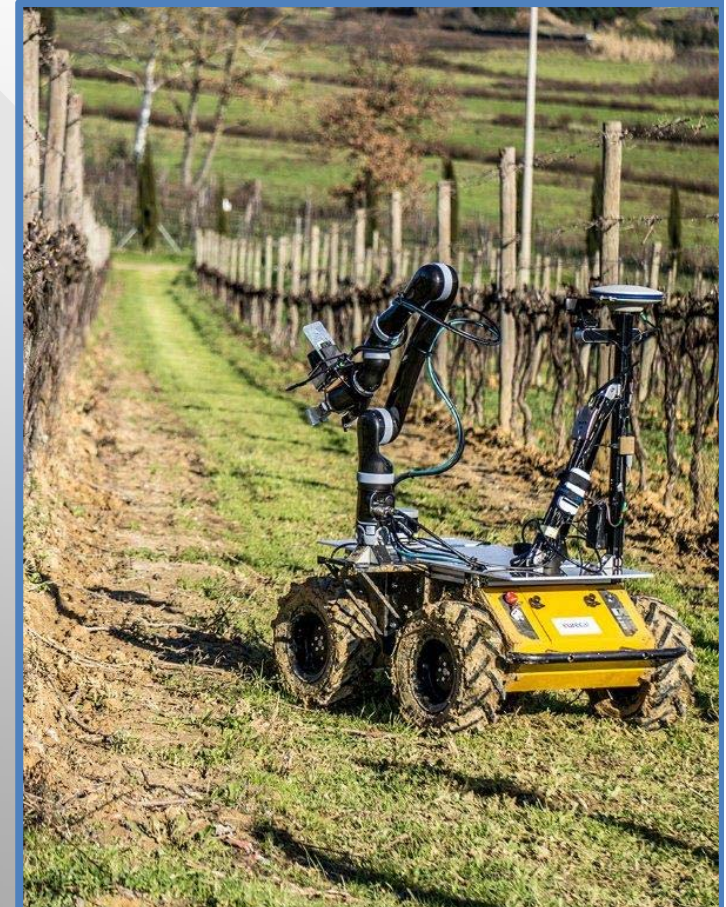
Extension request procedure:

- Experimenters are requested to send a **signed request letter**
- **Assessment of the request** is performed
- In the case that the extension is granted, the monitoring team negotiates an **amended KPI document with the Experimenters**
- Project management **notifies the Project Officer.**



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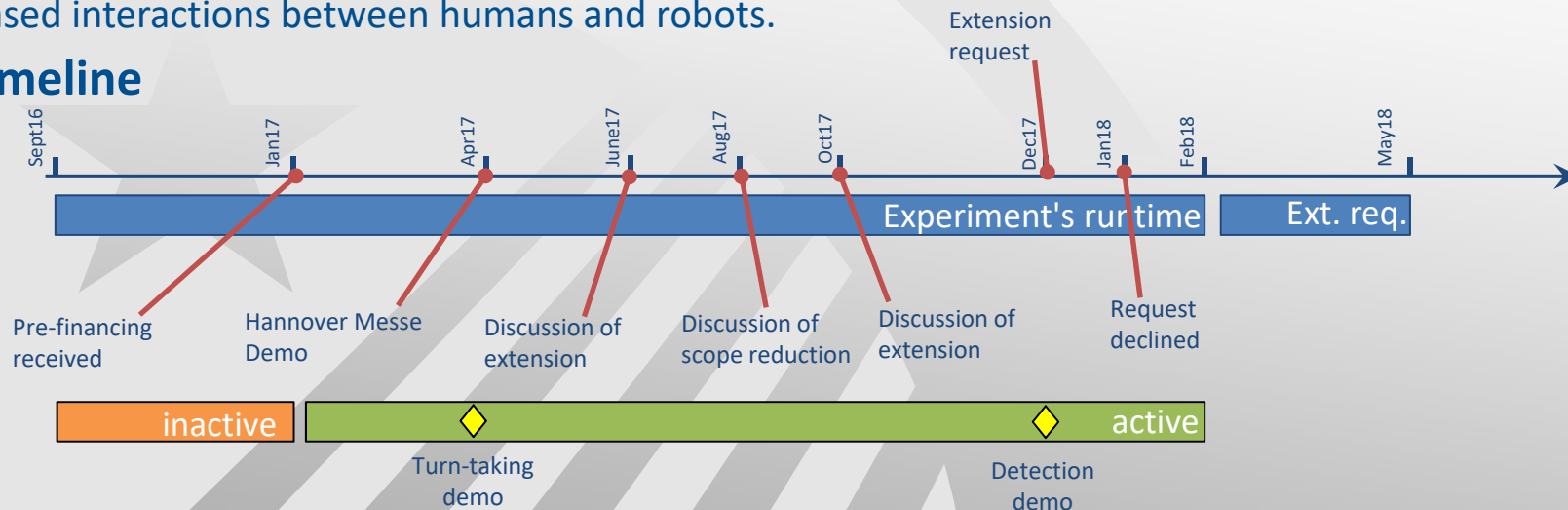
Monitoring and Review

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Extension Request: CoCoMaps

The **CocoMaps** Experiment's objective is the development of software supporting natural, speech-based interactions between humans and robots.

Timeline



- Progress has been assessed based on **continuous discussion** over 2017, **Turn-taking demo** (Apr17, Hannover), human **Detection demo** (Dec17/Jan18).
- **Limited progress** observed over the 12 months of 2017 (40MM),
- **Extension cost/benefit:** 6-7MM / no expected measurable improvement.

Task 3.5: Call 2- Phase V

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Extension Request: CoCoMaps

The **CocoMaps** Experiment's objective is the development of software supporting natural, speech-based interactions between humans and robots.



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Task 3.5: Call 2- Phase V

Monitoring and Review



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Management of Underperforming Experiments

- Most Experiments are in a **very good status**
- **Corrective measures** applied if problems occurred
- Monitoring is **very effective** as a tool to detect deviations.
 - **False positives:** lack of (or problems in) communication from the Experimenter was misconstrued as a lack of efforts invested and of progress
 - **Real deviations:**
 - The ECHORD++ **online platform's** overall status traffic light
 - A **monitoring call** is then scheduled rapidly thereafter
 1. To present detected deviations
 2. To request explanations
 3. To prepare a mitigation plan



Task 3.5: Call 2- Phase V

Monitoring and Review

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Sharing of Best Practices in Monitoring

- **Core Partners take their monitoring and reviewing responsibilities very seriously**, and efforts are invested in sharing best practices, as well as to ensure, smooth, homogeneous monitoring and reviewing quality across all experiments
- **Sharing of best practices** is important due to occurred turnover
- **Regular events** are held for Technical Moderators:
 - to provide a status update to the group about the Experiment(s)
 - to discuss procedures, problems, and tips, tricks, or insights they may have gleaned.
- **Monitoring call** in Spring 2017.
- An **in-person meeting** in Peccioli (August 2017)



Task 3.5: Call 2- Phase V

Monitoring and Review

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Preparation of final review: addressing R4

Recommendation R4: *please re-examine the TRL step changes claimed by the experiments, especially those that claim a starting point of TRL1 or 2, in order to better align with existing practice and thus to obtain maximum credibility and impact when presenting outside the project.*

TRL evaluation will be expected of **the external expert acting as reviewer:**

Experiment start	Experiment end
Initial TRL from: <ul style="list-style-type: none">• Deliverables• Experiment Proposal• Experiment's KPI document	Final TRL from: <ul style="list-style-type: none">• Final report (Experimenters declare the gained TRL)• Direct access to live demo of the prototype developed

Expert will assess TRL at the conclusion of the Experiment

Overview of tasks for WP3



Experiments

SECOND CALL

- Task 3.11: Call 2- Phase V: Monitoring and review

FIRST CALL

- Task 3.6: Call 1- Phase VI: Result extraction and exploitation



Yannick Morel