

European Robotics Challenges – A retrospective analysis towards a better challenge design in the future

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What is EuRoC about?



Motivation:

- The **European manufacturing industry** needs **competitive solutions** to keep global leadership in products and services
- **Collaboration** and cross-fertilisation between the **industrial** and the **research** community should be strengthened → synergies across these will speed up the process of bringing **innovative technologies** from research labs to industrial end-users
- **EuRoC** wants to act as an **enabler** in this context

Procedure:

- Three industry-relevant challenges were launched in April 2014 with open calls for Challengers, Technology Developers, System Integrators and End Users
- Each of the challenges is divided into three stages of increasing complexity
- The project will end in December 2017 with **one EuRoC** winner team

EuRoC a Challenge

About the three challenges:



**Reconfigurable Interactive
Manufacturing Cell**



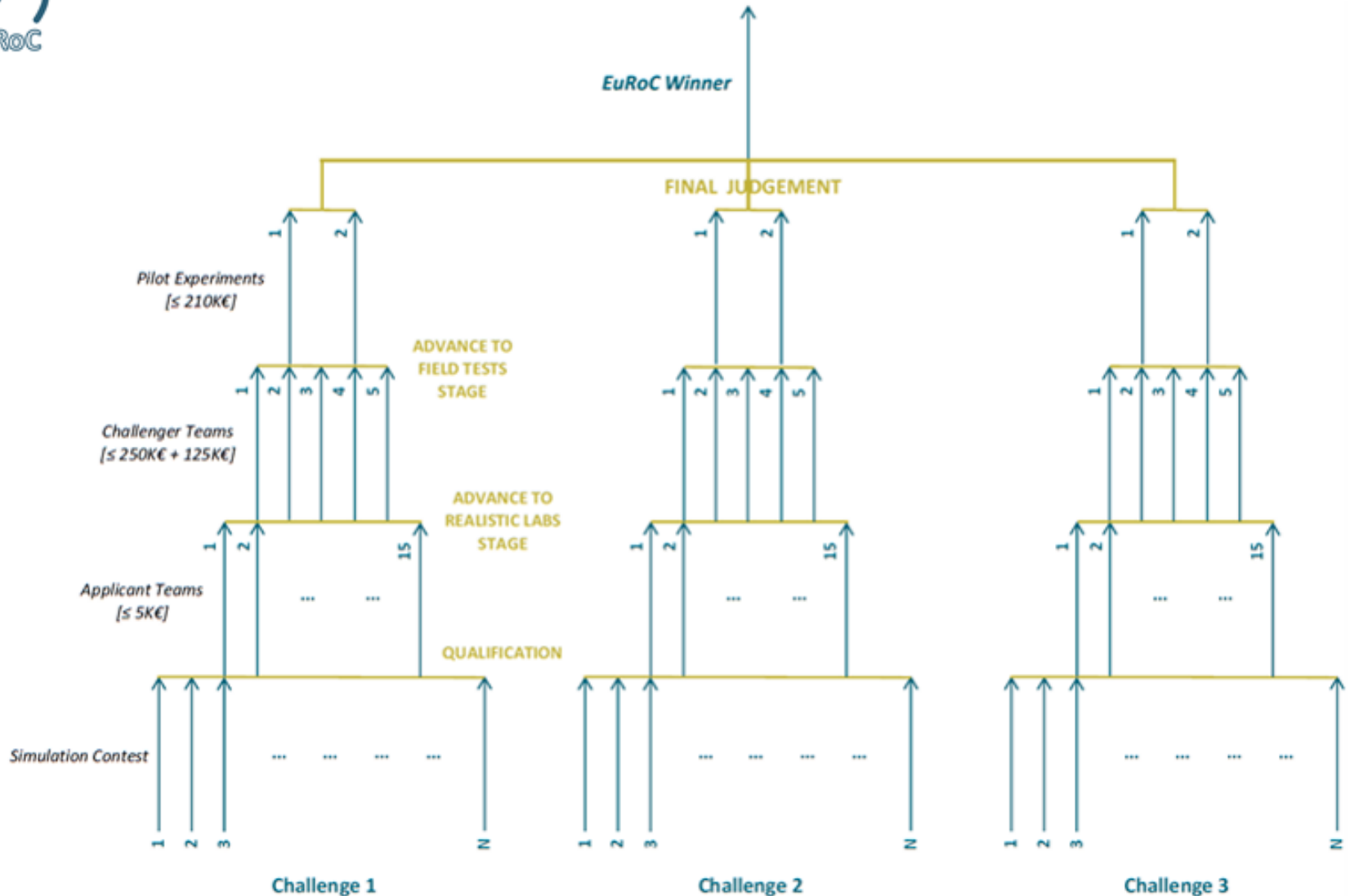
**Shop Floor Logistics
and Manipulation**



**Plant Inspection
and Servicing**

- Each challenge involves whole **manufacturing supply chains** within their field, while favouring **technology transfer** from academia to industry
- All registered Challengers from each challenge will undergo **benchmarking exercises** in the form of a Simulation Contest during **Stage I: Qualifying**
- Selected Challengers from each challenge then team up with partners from the industry and **share existing resources** at three top European platforms in **Stage II: Realistic Labs**
- In **Stage III: Field Tests**, Challenger teams must **ensure sustainability** and **adaptability** to end users

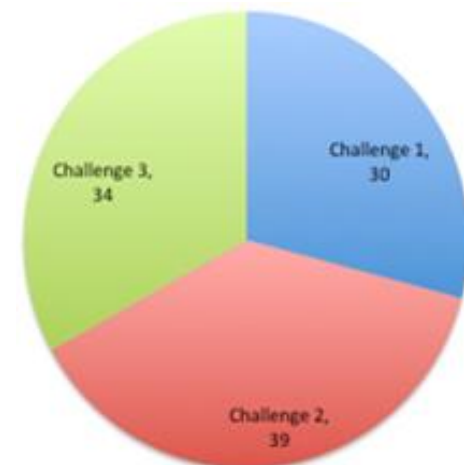
EuRoC a Competition



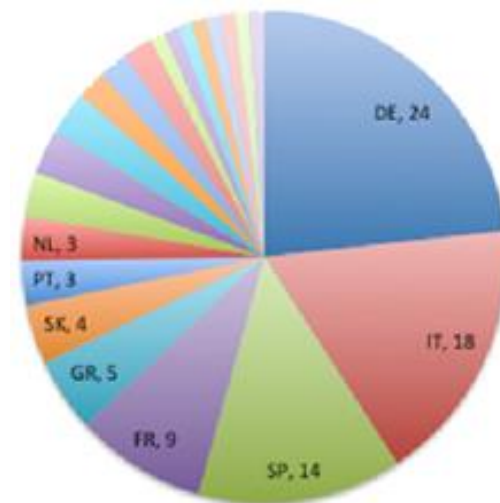
The Call for Challengers



- **Challengers** = Research Organizations, companies or even private persons, which fulfill the eligibility criteria, and are willing to tackle the **EuRoC** challenges
- The [Call](#) was opened on April 1st 2014, and closed on June 30th 2014
- Campaigns for the promotion of the challenge program:
 - Publication of the Call Announcement on the **EuRoC** website
 - Presentations at relevant networking events
 - Featuring of **EuRoC** in numerous relevant Challenge Bulletins
 - LinkedIn advertising campaign
 - Organization of the **EuRoC** Info Days with presentations and Q&A
 - Direct contact with potential challengers
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- **Results:** [103 applications](#) from **22 different countries**

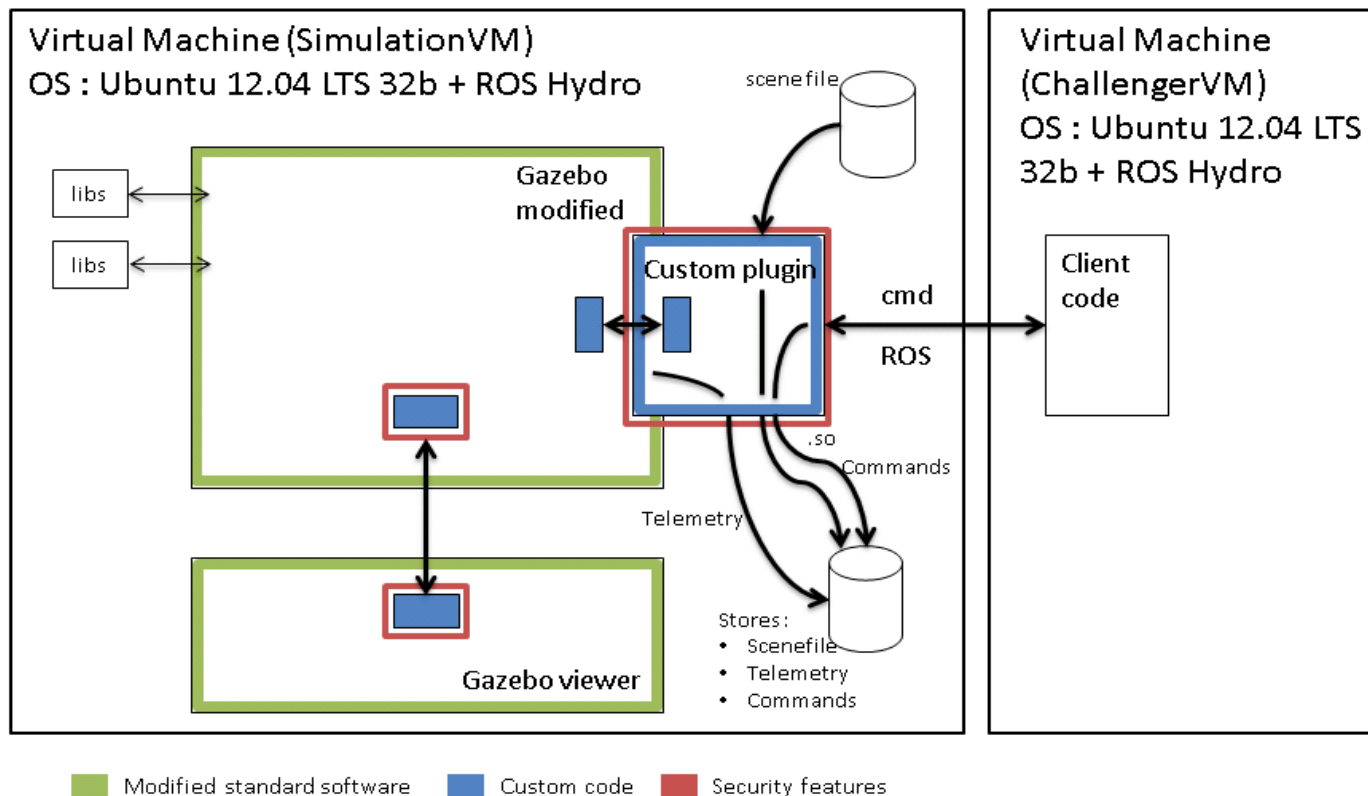


Distribution of applicants



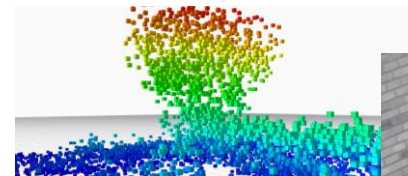
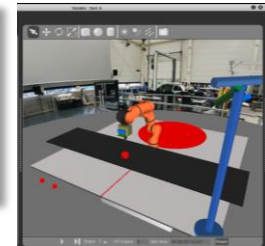
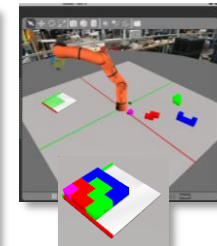
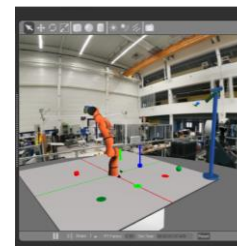
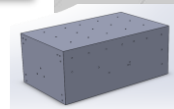
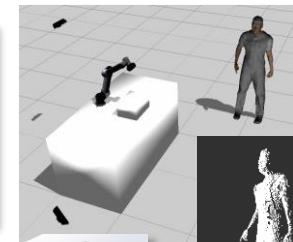
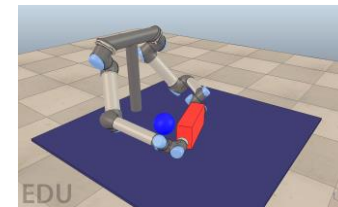
Distribution of countries

Simulation Technology



Simulation Scenarios

- Challenge 1:
 - Track 1: Focus on perception and human robot interaction
 - Track 2: Focus on dual arm and force/torque control (dynamic simulation)
- Challenge 2:
 - Focus on pick&place with uncertainty, planning, mobile manipulation
- Challenge 3:
 - Track 1: Vision based localization and reconstruction
 - Track 2: State estimation, control and navigation



Stage I: The Simulation Contest



Support

- **Online Evaluation:** Teams were allowed to submit interim solutions to be automatically evaluated.
- **Score Dashboard:** interim results were published on a dashboard.
- **Mailing-Lists:** mailing list for posing questions
- **Forum:** Forum for posting questions and receiving technical assistance

Final Submission:

- Same tasks as during online evaluation but different scenarios, models, etc.

Results

- On 2014-11-12 EuRoC received 49 solution submitted in the 3 challenges.
- Only 41 did advance to match making
 - Challenge 1: 11 teams
 - Challenge 2: 15 teams
 - Challenge 3: 15 teams

TASK 4					
TASK	SUB-TASKS	BENCHMARK	METRICS	SCORING INTERVALS	POINTS GIVEN (MAX SCORE 30 POINTS)
Cooperative transportation of a rigid object tightly grasped by two robotic arms in the presence of known obstacles (object already grasped)	1. Coordinated motion planning and control	1.1 Positioning accuracy	1.1A Deviation of object position with respect to the planned position (at steady state): E_p [mm]. This deviation is compared to the repeatability of the robots: R [mm]	$E_p > 100 R$	0
				$100 R < E_p < 50 R$	4
				$E_p < 50 R$	6
				$E_p < 100 R$	0
				$100 R < E_p < 50 R$	4
				$E_p < 50 R$	6
Total 22 points					
Total 30 points					



Rank	Team Name	Total Score
1	TUM Flyers	90.5
2	UNIZG-FER	82.5
2	Eiffel Team	82.5
4	NimbRo Copter	77.0
5	RPG	75.0

The Call for Technology Developers, System Integrators and End Users



About the Call:

- **End Users** = Manufacturing companies who can provide use cases for the Challenger teams
- **Technology Developers** = Companies or research organizations developing innovative technologies and looking for an application of their technology in the industrial robotics domain
- **System Integrators** = Companies that specialize in either bringing together robotic components/subsystems or developing and commissioning whole robotic systems
- The [Call](#) was opened on April 1st 2014, and closed on November 30th 2014
- Campaigns for the promotion of the challenge program:
 - Publication of the Call Announcements on the [EuRoC](#) website
 - Presentations at relevant networking events
 - Featuring of [EuRoC](#) in numerous relevant Challenge Bulletins
 - LinkedIn advertising campaign
 - Organization of the [EuRoC](#) Info Days with presentations and Q&A
 - Organization of several Webinars
 - Contact with official EU National Contact Points and dissemination of materials through their networks
 - Encouraging of Challenger teams to contact companies they are in touch with directly
 -

The Call for Technology Developers, System Integrators and End Users



Results:

Technology Developers:

- **20 applications** in total (some for more than one challenge!)
 - Challenge 1: 10 applications
 - Challenge 2: 8 applications
 - Challenge 3: 10 applications

End Users:

- **77 use cases** in total
 - Challenge 1: 26 use cases
 - Challenge 2: 18 use cases
 - Challenge 3: 33 use cases

System Integrators:

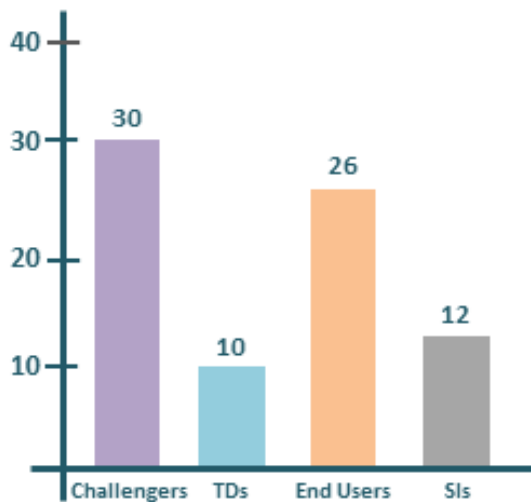
- **12 applications** in total for Challenge 1

The Call for Technology Developers, System Integrators and End Users

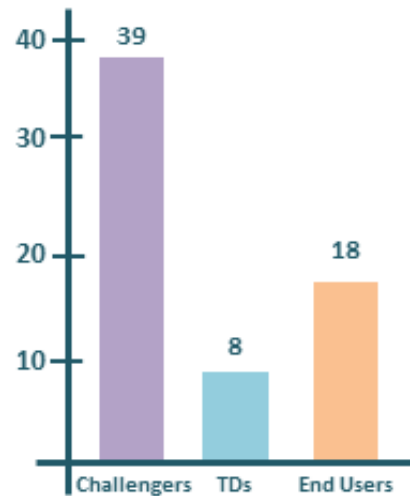


Comparison of applicant numbers per challenge:

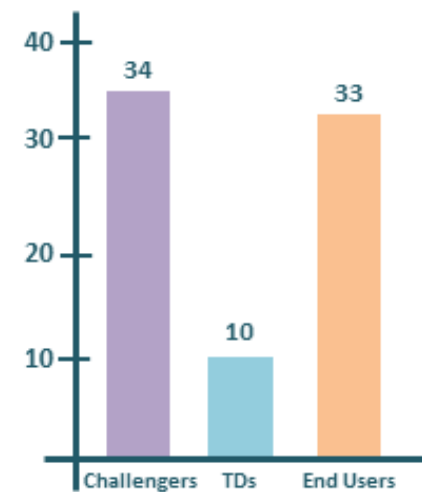
● Challenge 1:



● Challenge 2:



● Challenge 3:



The Matchmaking process for Stage II

Stage I – Qualifying: Simulation Contest

Challenge 1: 11 Challengers

Challenge 2: 15 Challengers

Challenge 3: 11 Challengers

Match-making
+ Proposals

Challenge 1: 10 Challengers

Challenge 2: 12 Challengers

Challenge 3: 14 Challengers

Evaluation
and selection
of Proposals

Stage II – Realistic Labs: Benchmarking, Freestyle and Showcase

- **Matchmaking** e.g. during a Brokerage Workshop in December organized by the **EuRoC Consortium**
- The resulting teams submitted proposals 36 proposals by February 09th 2015, which are currently being evaluated and rated by independent experts

Tuesday, 2014-12-16:

Time	Meeting 1	Meeting 2	Meeting 3
15:30-15:45	FZI (CH) & IMA (EU)	DTI (CH) & Loccioni (EU)	CATEC-AyR (CH) & CT Ingenieros (SI)
15:45-16:00	PIROS (CH) & Forteq (EU)	Ghepard (CH) & Opel (EU)	ITRxcell (CH) & EMA (EU)
16:00-16:15	Butfit1 (CH) & Zodiac (EU)	Nimbro Man. (CH) & SITEC (EU)	AGAS1 (CH) & Element 6 (EU)
16:15-16:30	FZI (CH) & Bühler (EU)	DTI (CH) & STAM (SI)	LMS1 (CH) & ICPE (EU)
16:30-16:45	PIROS (CH) & EMA (EU)	Team IfU (CH) & MRK Systeme (SI)	Optoforce (TD) & Philips (SI)



MM (SI) & IMA (EU)
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) & SPINEA (EU)

Outlook Stage III



- Realistic Labs:
 - Go into the labs and solve three tasks:
 - Benchmarking:
 - mandatory task for all teams
 - benchmarking of algorithms, approaches
 - Free-Style:
 - Show what you can
 - Bragging rights
 - Show-Casing
 - prototypical implementation of use case



Strengths

- Involvement of the entire value chain
- Simulation Contest as a Gateway
 - „Pre-selection of candidates by contest increases chance of actual proposals [going through] based on problem solving skills [of contestant, and not her/his proposal writing skills]“
- Gathering of Use Cases, Technology and Expertise Descriptions
- Match-making
 - Quote End-User „We get the research partner on a silver platter“
 - Quote Challenger „It is like being in a three star restaurant and getting a menu of use cases to choose from.“
- Support by Core-Consortium
- Low-Threshold for participation/High Threshold for Advancement

Weaknesses

- Simulation Technology:
 - There were some problems with regard to the simulation infrastructure
- Level of Difficulty:
 - There were inconsistency wrt to level of difficulty of simulation tasks across the three challenges

Opportunities

- Networking
 - There was a lot of networking done, which resulted in a couple of FoF and ICT proposals.
- Market Research:
 - Submitted use cases reflected real needs by manufacturing companies.
- Educational Impact
 - Involvement of students to solve simulation tasks.
 - Providing simulation environment and tasks as educational tools for universities.
- Dissemination of Technologies
 - Enforcing the usage of the same simulation environment (Gazebo) and ROS as middleware reinforced the market penetration of these tools in research.

Threats

- Time Table
 - The time table for implementing EuRoC is very ambitious
- Resources for Use Cases
 - The use cases selected are very challenging and might require more resources than budgeted

Lessons Learned



- Improve time table for challenges:
 - Relax time table by introducing more buffers between stages and phases
 - Allocate more time and resources to design of the challenges
 - Rules
 - Benchmarks
 - Simulation environment
- Simulation Introduction Day
 - Either a hosted event or a training webinar to familiarize challengers with simulation environment and tasks
- Better dissemination to industry
 - More cohosted national events and less newsletters

**Feedback on how to improve EuRoC and/or
suggestions for new challenge topics welcome!**

Send suggestions to project-office@robotics-challenges.eu