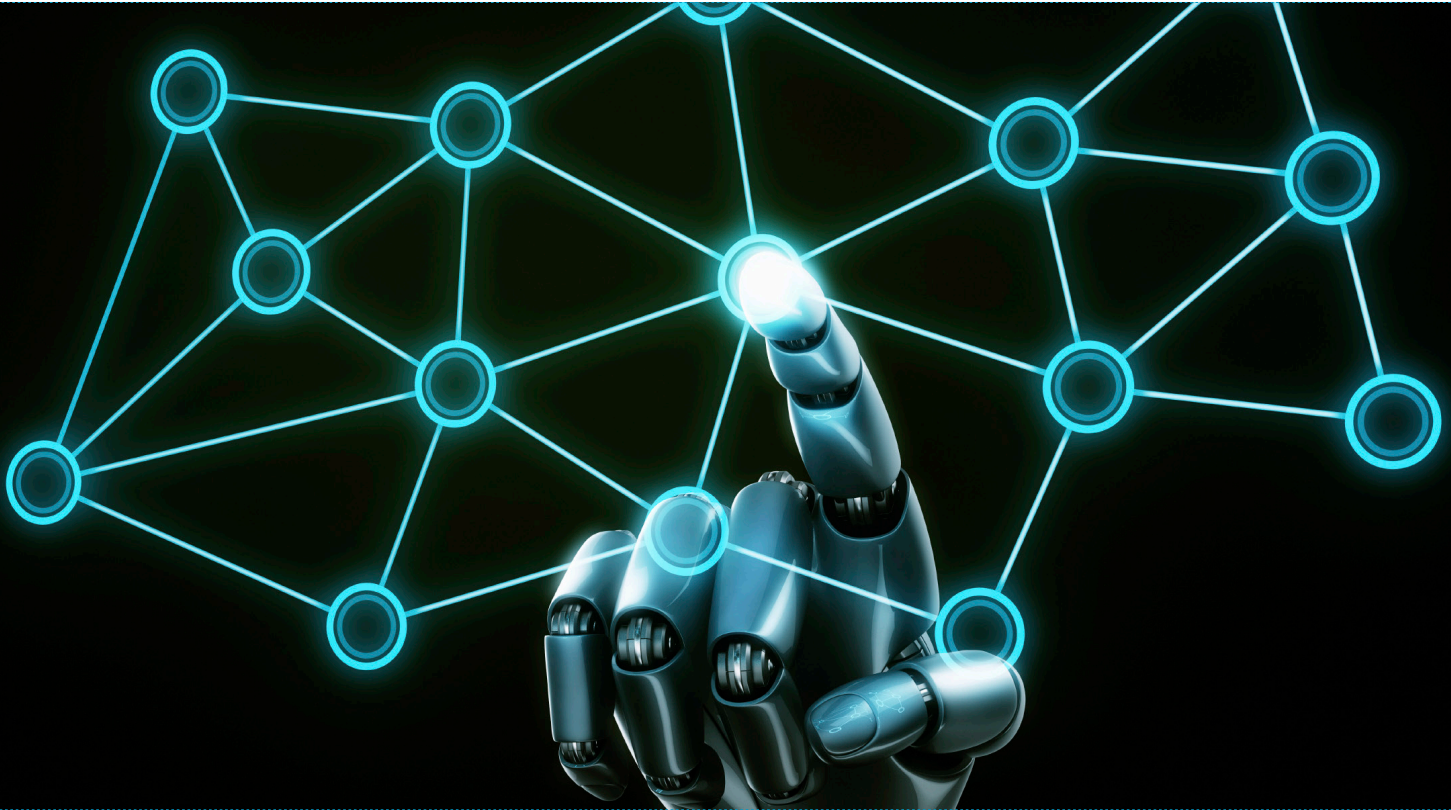# R5-COP

Reconfigurable ROS-based Resilient Reasoning Robotic Cooperating Systems

EXECUTIVE *summary*

R5-COP focuses on agile manufacturing paradigms and specifically on modular robotic systems. Based on existing and newly developed methods for the formal modelling of hardware and software components, R5-COP will support model-based design, engineering, validation and fast commissioning. Using existing interface and middleware standards, R5-COP will be a strong facilitator of the integration of components from various suppliers.

CONTRIBUTION *to SRA*

The R5-COP project will provide a platform and toolset containing methods, algorithms, prototypes and living lab solutions for cross-domain reusability, scalability and open interface standards for robotic and autonomous systems. It will contribute to the ARTEMIS Repository by connecting to other ASP and AIPP initiatives, to ensure long-term sustainability and impact on society. Key results will be demonstrated in a set of showcases, displaying high relevance to industrial and manufacturing issues and cross-domain applicability. Regarding interoperability, R5-COP will also contribute to establishing a standard for robust, reliable reconfigurable robot systems, using common interfaces in a certification and safety context, which

entails conformity to both domain-specific and international domain-independent standards, thereby fostering a significant increase in market potential.

MARKET INNOVATION *& impact*

R5-COP focuses on agile manufacturing paradigms and specifically on modular robotic systems to overcome the shortcomings of existing solutions, by firstly identifying and extending suitable existing methods and, where required, developing new ones to formally model hardware and software components. Furthermore, the use of existing interface and middleware standards such as ROS will strongly facilitate the integration of components from various suppliers. Such a modular approach is not only flexible, but will also reduce design, setup and maintenance costs. Given the level of human/robot cooperation, robustness and safety will be assured by dedicated verification and validation methodologies. The formal specification framework will support component suppliers in efficiently verifying and certifying their modules. This project will identify and develop reconfigurable key hardware and software components, employing living labs to show the feasibility and capability in manufacturing and service demonstrator environments.

RELEVANCE & CONTRIBUTIONS *to Call 2013*

The R5-COP project addresses the ARTEMIS Sub Programmes ASP4 ("Embedded Systems for manufacturing and process automation"), ASP1 ("Methods and processes for safety-relevant Embedded Systems") and ASP5 ("Computing platforms for Embedded Systems").

In terms of ASP4, it specifically addresses:

> improved methods and technologies for automation model life cycle management,
> online real-time quality assurance of measurement data,
> robustness of sensor and actuator technology, e.g., calibration, energy harvesting and disposability,
> automation system human/user interface context awareness and information timing,
> automated device configuration.

Due to the delicate nature of robot and automation systems, there is a strong focus on safety and security. Hence, the project also specifically addresses core ASP1 topics:

> requirement management,
> architecture modelling and exploration,
> analysis methods,
> component-based design, particularly building reliable systems out of unreliable components.

Technology-wise, R5-COP is closely tied to work in the field of ASP5, especially with respect to complex distributed heterogeneous systems supporting real-time awareness, safety protection and Cyber-Physical properties, such as complex real-time sensor-data fusion. The project aims to target ASP5's main goal of enabling an increase of cross-domain re-use and interoperation, thus leading to lower costs of ownership and wider applicability.

R5-COP also covers aspects of ASP8 ("Human-centred design of Embedded Systems") with respect to the human-centred design of human-machine interfaces, object recognition, scene analysis, real-time image processing and cognitive assistance. It is motivated by usage scenarios from ASP2, ASP3 and ASP6.

R&D INNOVATION *and technical excellence*

The main objective of the R5-COP project is to provide the means for fast and flexible adaption of robots to quickly changing environments and conditions, to enable safe and direct human/robot cooperation and interaction on an industrial scale. To overcome the shortcomings of existing robotic solutions, it focuses on the following objectives:

> Enabling fast and flexible re-composition of software and hardware components of robotic systems, while ensuring robust and safe operation, through the modular design of the components with formalised specifications and standardised interfaces.
> Enabling standardised yet simple design and implementation of software components, through using ROS Industrial for software deployment and SDKs for software development.
> Enabling standardised yet flexible (re)configuration, using ontologies of configurable components for modelling hardware and modelling applications on an app or skill level.
> Ensuring robust perception, using advanced reconfigurable sensor systems modules.
> Supporting component and system certification for safe human/robot cooperation, using dedicated V&V techniques.
> Identifying, modelling, developing and evaluating key hardware and software components, using dedicated use cases from industrial and service domains.

PROJECT *partners*

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START
1 February 2014

DURATION
36 months

TOTAL INVESTMENT
€ 13.02 M

PARTICIPATING ORGANISATIONS
30

NUMBER OF COUNTRIES
12