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Sellafield Ltd

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CHALLENGE: Standardised Robotics Control Architecture

Sellafield Ltd uses a range of robots on site for remote handling and inspection – each of which has its own unique programming language and interface. Sellafield are seeking to move towards a robot control system that can provide a modularised ‘plug-and-play’ hardware reconfiguration solution.

Can you answer the challenge to create a standardised robotics control architecture which in the future may be used to operate all of Sellafield’s robots?

Introduction

Sellafield Ltd uses a range of robots from different equipment manufacturers to tackle a wide variety of decommissioning activities. Robots offer Sellafield an opportunity for remote handling and inspection which helps to minimize employee exposure to hazardous environments, to increase working time in challenging environments and to reduce the overall cost of decommissioning.

The robots used on site differ in size and complexity. Sellafield operators are trained to program and use a variety of robotic systems. However, the differences in the programming language used by the equipment manufacturers means that the Sellafield workforce must maintain a working knowledge of many different systems. This limits the flexibility of delivery of work due to workforce resourcing requirements. The added complexity can result in more difficult and expensive robotic deployment.

This can have a significant impact in a constrained industry where slight changes may have considerable knock-on effects as illustrated below in this hypothetical scenario:

Scenario

- *Robot A (manufactured by Company A) is used to remove a cylindrical object from a storage container.*
- *The object must be handled in a set sequence of moves to ensure careful handling.*
- *Programming of Robot A to do this takes 10 hours of time by employee Z.*
- *A "safe" test run is carried out to mitigate risks.*
- *Robot A is then used in a real scenario to remove an object from a storage container and the task is repeated for a further 240 objects.*
- *Robot A breaks down and requires repair which is going to take over 1 week.*
    - *This causes a significant delay to other scheduled tasks creating a potential backlog with re-work amounting to an extra 18 days of work in addition to the time taken to fix robot A. This is hugely costly for Sellafield.*
- *A second robot manufactured by company B is available and can be transported to the work area for immediate operation to continue the movement of objects from the storage container.*
- *The second robot (Robot B) is normally used in a different part of plant and has not been used by employee Z before.*
- *Robot B is loaded with the same program which was used to control Robot A.*
    - *Robot B doesn't understand the full code and re-programming is required which takes employee Z an additional 3 hours*
    - *Routines written to ensure safe working in this area of plant are not compatible with Robot B, however this can be overcome with an additional 2 hours of programming.*
- *Robot B has to be tested to carry out the same operation and approved to carry out the task, taking an additional day.*
- *Robot B is approved and carries out the work satisfactorily but does not complete the task in the window of opportunity and the storage container is returned.*
- *Due to knock-on effects of delay, the work is rescheduled to be completed in 3 months' time.*

By using a modular and reconfigurable system architecture, the robotic control software would be able to communicate with interchangeable robotic devices without changing the robotic deployment's task logic. This would both reduce the complexity of robotic task logic development and reduce downtime should a robotic device need to be replaced.

Current Practice

Sellafield are relatively early in their exciting journey with robotics technologies. There are several key challenges in the application of robotics across the Sellafield site as borne out of current practices:

- Robots are not transferable
    - Robots can become dedicated equipment remaining in one area
    - Robotic deployments are typically purpose-built (thus bespoke) for each project, resulting in little to no re-use of components between new and already-deployed robotic installations

    - Robots are unutilised for much of the time
    - There is no standardisation of hardware and software, nor any established development procedures to design new deployments against
- Workforce resource
    - Specialised staff are involved in programming only robots they know
    - There are capacity and capability issues when staff are off work due to sickness or annual leave – the workforce may not be transferable
    - It is more expensive to train the workforce to operate and program multiple systems
    - There may be a reduction in shared learning across the Sellafield site

Opportunity

Sellafield are seeking to move towards a reconfigurable system architecture that can provide a modularised 'plug-and-play' hardware reconfiguration solution, alongside standardised hardware and standard software libraries. Sellafield are looking for applicants to demonstrate their capability to:

- develop robot task logic that is common to any compatible robot to ensure familiarity by the workforce across all platforms
    - improve the efficiency of using robots on site
    - increase the resourcing flexibility of workforce
- ensure compatibility of operation across platforms within the bounds of a common operation envelope
    - reduce time taken to program or re-program robots
    - reduce resource requirements to change over robots for common tasks
    - improve the confidence in safe operation of robots
- A successful solution may have the potential to extend across the Nuclear Decommissioning Authority estate
- The challenge is open to any organisation who feel they can meet the challenge aims
- In the event that Sellafield Ltd progresses to a future procurement opportunity for the implementation of standardised robotics control architecture, the learning gathered from this market knowledge PIN will be shared to all potential suppliers noting that commercially sensitive information will not be included.

There will be a webinar on the 7th September to explain this Game Changers challenge process, the funding available to support development of solutions and the anticipated next steps.

There is an expectation that successful applicants will participate in 2 activity days in Cumbria. The first will be a setup day and the second will be a demonstration day which will involve completing two discrete challenges. Further details of these challenge demonstration days are available below.

Key dates and next steps in the process are listed in the table below:

Event	Date	Notes
Challenge statement webinar	7th September 2020	See Game Changers website for details (https://www.gamechangers.technology/)
Application period closes	18th September 2020	-
Successful candidates notified	25th September 2020	-
Challenge demonstration days (1 & 2)	Schedule starts from 19th October 2020	Taking place at PaR Systems in Cumbria

This robotics challenge deviates from the normal Game Changers challenge process outlined on our website in that funding will be limited to developing solutions for participation in the demonstration day only. There will be no follow-on Proof of Concept funding awarded through Game Changers as would normally be expected. Sellafield do however reserve the right to work directly with the overall winning Game Changers applicant on a longer term basis to develop a bespoke Sellafield robot software architecture. This will be outside the scope of Game Changers.

The outcome of the Game Changers Challenge will determine whether a full procurement exercise will follow.

Benefits to Sellafield

It is expected that a solution will bring benefits to Sellafield's decommissioning programme, including:

- Allowing a greater flexibility in the utilisation of robots across the Sellafield site
    - When a robotic deployment is no-longer required, equipment can be dismantled and stored, ready for a diverse range of future tasks
    - Increase in cross-deployment hardware and software compatibility
- Allowing hot swapping of robots
    - A homogenised set of shared reserve equipment allowing for rapid changes of equipment, especially in cases of breakdowns/replacement
- Access to a set of pre-tested, verified and approved standardised robotic equipment, speeding up design and deployment, consequently reducing overall costs and risk
- Validation of robotic systems to enable quick safety-case development
- Enabling focused and standardised development of robotic functionality
- Improved operator safety
- Operators will become more familiar with robots as a result of common interface
    - Less variation between deployed hardware and software components
    - Allowing for standardised training and easier operator onboarding between different deployments
- Opportunities for the workforce to be upskilled in robot operation and programming
- Decommissioning is faster
- Simplifies the process of using robots across the Sellafield site
- Easier collaboration with academic and other third-party entities via known, predictable and fully validated software interfaces
    - A modular robotic architecture would have the flexibility to be re-configured as required, and any new or improved modular components produced could be added into the architecture's software library.
- Improving the confidence in safe operation of robots by operators and managers (making robotics business as usual)

Constraints

Solutions must:

- Demonstrate simplicity of use
- Be capable of safe operation within a working envelope
- Demonstrate how the software deals with connection to the hardware
- Demonstrate repeatability
- Be capable of being made secure
- Be capable of future updates without losing legacy capability

Solutions must not:

- Be co-dependant or have any shared dependence with another interface (i.e. the operator must only see one interface system)
- Reference external libraries that cannot be stored locally

Challenge Aims

For those applicants progressing beyond the initial submission and who are awarded feasibility funding, Challenge 1 and Challenge 2 are outlined below:

Challenge 1 (CS1) - Setup day

Applicants are requested to bring their own robot to demonstrate a specific task (e.g. move to a specific position and draw a circle). On the day of the demonstration the panel will observe the first task (move to a specific position and draw a circle) and then ask the applicant to modify the task (e.g. change from drawing a circle to drawing a square). The applicant will be observed and judged on the process of changing the task's logic.

- This will take place on the same day as the setup day for Challenge 2
- The setup day will take place around 1 week before the Challenge 2 demonstration day
- A list of potential tasks will be communicated to the applicant to demonstrate on the setup day

Challenge 2 (CS2) - Demo day

Choosing from four robot platforms and a list of predefined tasks, the judging panel will ask the applicant to demonstrate their ability to carry out the same chosen tasks on two different robot platforms.

- The applicant will be given details about the robot platforms prior to the demonstration day and will be able to carry out trials on all robot platforms on the setup day
- The applicant will be asked to carry out two demonstrations with differing levels of complexity during the demonstration day
- A list of predefined tasks will be provided to the successful applicants
- The two chosen robot platforms and chosen tasks will be announced to the applicant on the demonstration day
- Switching between robotics platforms should demonstrate the applicant's ability to perform the task without (significant) adjustment or intervention
- The judging panel will need to see the code used in the solution as part of the judging process

More detailed information, including scope of the tasks, judging criteria themes and logistical information about each challenge will be provided in advance of Challenge 1 and Challenge 2 to successful applicants.

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What next?

Game Changers are hosting an online briefing webinar for this challenge on 7th September 2020. Registration is via Eventbrite and details can be found on the Game Changers website www.gamechangers.technology.

If you have ideas or innovations which can be applied to address this challenge we invite you to join us.

Applications for the challenge can be submitted using the Game Changers online application form www.application.gamechangers.technology. The closing date is 12pm on 18th September 2020.

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