EGRRS Session at DigiDecom 2021

Summary of the EGRRS Dedicated Contribution at the DigiDecom 2021 DIGITAL

Online Event Focusing on Innovation within Nuclear Decommissioning

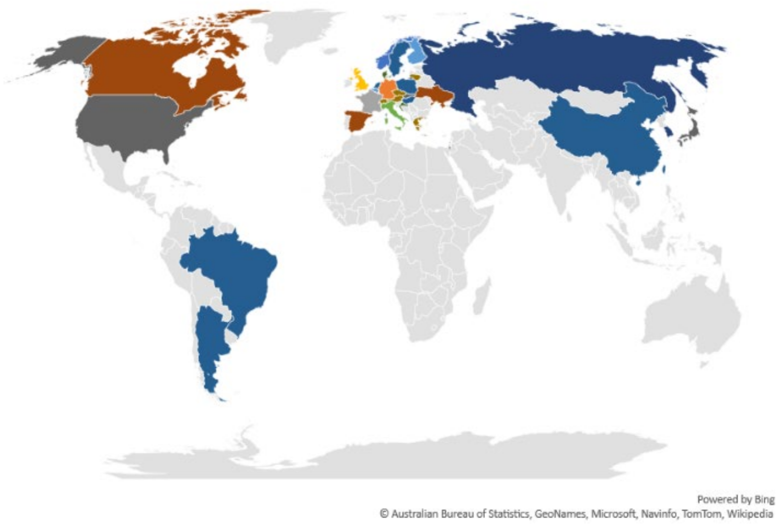
25 March 2021

BACKGROUND - DigiDecom

The *DigiDecom*® Workshop series was initiated in 2017, and has continued with annual events since its initiation, typically gathering around a 100 (and in 2021 more than 200) international experts every year, representing a wide range of the stakeholder community. The DigiDecom workshops' primary aim is to engage participants in highly interactive discussions and debates, focusing on past and foreseen challenges for decommissioning and opportunities for the application of innovative solutions (with a focus on digital and robotic technologies) to improve current practices from a holistic (systemic) perspective that considers technical as well as human, societal, organisational and other aspects.

The main partner organisations for the DigiDecom Workshop events are the Nuclear Energy Agency (NEA), the International Atomic Energy Agency (IAEA) and the Electric Power Research Institute (EPRI). In 2021, the French Alternative Energies and Atomic Energy Commission (CEA) and the Technical Research Centre of Finland (VTT) were also co-organising partners of the DigiDecom Workshop.

In 2021, DigiDecom was organised online, with more than 200 participants attending from 34 countries representing decision makers, R&D, implementers, suppliers, regulators, users and other parties.



DigiDecom 2021 included a full day session (the last day) fully dedicated to support the work of the NEA Expert Group on the Application of Robotics and Remote Systems in the Nuclear Back-end (EGRRS). Details are provided below.

SUMMARY OF THE EGRRS DAY ON DigiDecom 2021

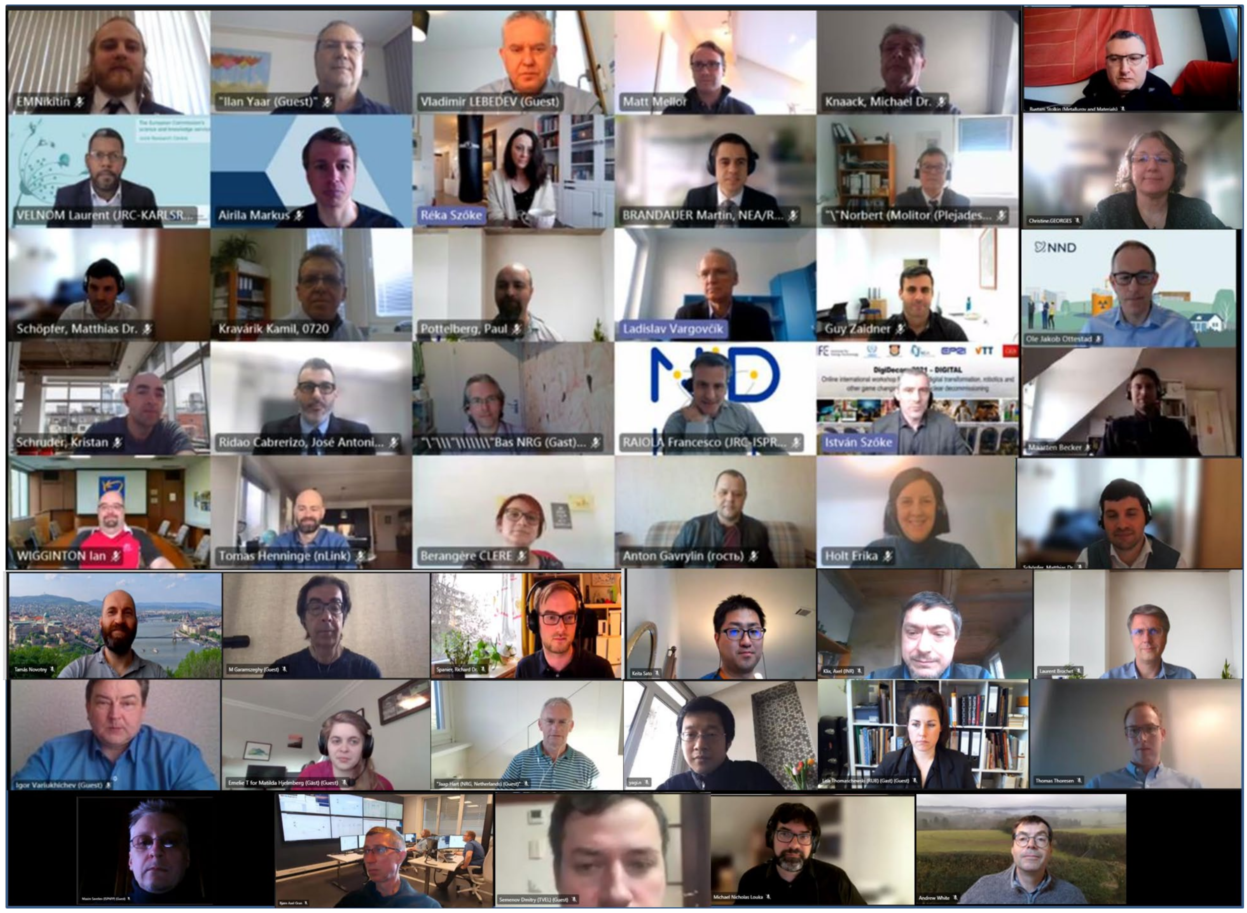
Host: *Institute for Energy Technology IFE (Norway)*

Chairs: *Vladimir LEBEDEV and Martin BRANDAUER (NEA)*

Participants: *126 persons were registered for the EGRRS full day session*

List of participants is available at www.ife.no/DigiDecom2021

Sponsored by: *IFE, the Research Council of Norway, and Createc (United Kingdom)*



OBJECTIVES

The aim of the EGRRS session of the DigiDecom 2021 Workshop was to initiate a broad international dialogue between interested parties to identify the different factors influencing the development of robotic and remote systems (RRS) for radioactive waste management, decommissioning and legacy management (the "back-end" of the nuclear fuel cycle) and to discuss possible solutions that can be developed through international collaborations.

ORGANISATION

The EGRRS day on DigiDecom 2021 had two parts:

1. *Topical Session* with invited speakers
2. *Breakout Session* dividing the audience into four topical groups, followed by a plenary where short summaries were provided from each group moderator

Topical Session

The session started with a topical session with presentations, invited by EGRRS, on:

- Robotics and Remote Systems applications in Decommissioning and Radioactive Waste Management - NEA EGRRS
- Robotics and 3-D gamma mapping technologies for supporting nuclear decommission
- Digital innovation for robotics applications in decommissioning
- Modular UGV and humanoid robot platform-based technology – prospects for application in nuclear decommissioning
- Robotics research and applications by Florida International University (FIU)
- The use of robotics and remote equipment in international projects implemented at Chernobyl Nuclear Power Plant
- Economic drivers for robotic and remote systems in decommissioning (including FREMES example)
- Robotic fragmentation of large equipment at decommissioning of nuclear power plants.

Breakout Session

The session dedicated to EGRRS continued with four parallel group discussions, moderated by EGRRS members and invited international experts, discussing innovation needs and possible solutions related to robotics applications in decommissioning from four different perspectives.

Group 1 Implementation barriers based on experience with application of robotics

Moderators: Rick Reid (EPRI), Leonel Lagos and Laurent Velnom (EC)

Group 2 Safety and security requirements for robotics applications in decommissioning

Moderators: Michael Knaack and Matthias Schoepfer (TüV Nord)

Group 3 Digitalisation and robotics – how can they strengthen/enable each other?

Moderators: Rustam Stolkin, István Szőke and Matt Mellor

Group 4 Economic benefit drivers for robotics applications in the nuclear

Moderators: Eduard Nikitin and Norbert Molitor

Each of the four group discussions was summarised by the group moderators reflecting on lessons learnt / status quo, barriers, enablers, needs and opportunities for application of RRS in the nuclear back-end.

OUTCOMES

Summary of Group 1: Implementation barriers based on experience with application of robotics

Moderators: Richard Reid, Leonel Lagos and Laurent Velnom.

To address the implementation barriers to RRS systems in the nuclear back-end field it is required to both access the current status of activities, reports and main actors in the area but also to identify the barriers and impediments that hinder the application of RRS systems.

Discussion background

- identified challenges in the areas of the application of RRS regarding the environmental, societal, economic, regulatory and organisational impacts;
- participants were invited to complete two surveys by the NEA Expert Group:

  Status of current technologies and uses/define terminology

  Barriers /impediments

Experience feedback

The reported implemented solutions reveal highly technically focused innovative solutions designed to overcome many of the main challenges encountered in nuclear back-end such as distance, high radiation, industrial safety or device control and remote situational awareness.

The state-of-the-art solutions, however, still lack end-user confidence regarding namely equipment reliability, the performance in high contamination fields, performances in an industrial environment vs. R&D, and preparedness for retrieving malfunctioning equipment. In particular, significant challenges remain around issues such as the lifetime of RRS in high radiation fields, or the capabilities and reliability of RRS in traversing rough environments e.g. rubble-strewn explosion zones at the Fukushima Daiichi site, or the survivability of complex electronics in these extremely high radiation environments.

Key enabling aspects for industrial use of RRS such as a definition of international standards or robust definition of maintenance requirements, need to be improved.

Finally, human factors should be more considered in terms of personal training definition and requirements to gain better workforce acceptance, and also the development of effective interfaces between human experts and complex robotic systems. Additional co-ordination between end users, government agencies and academia needs to be achieved in order to better train the future workforce.

Barriers and impediments

During the discussion, a recurring topic was the lack of real industrial transfer solutions for advanced R&D systems for robotic systems, including maintenance or service, spare parts and supply aspects. For instance, decontamination/maintenance of (robot) equipment in high radiation fields might lead to considerable exposure of workers, and this must be considered carefully.

From R&D to industrial operations / market there is a missing step which could include specific funding schemes and a technical enhancement phase for suitable adaptation to industrial environments, contrary to the typical ad hoc approaches that are currently common.

Needs

- In order to increase the acceptability by practitioners – trust / workforce to buy in, higher investment in training and education for increased implementation should be considered.
- Standards for qualification tests should be increased for better acceptance.
- The licensing challenges should be considered part of the barrier workstream. Work should be carried out on harmonising the approaches for their qualification (both for hardware and software) to meet the required safety integrity target in the intended application.
- Guidance should be developed for radiation hardening of systems intended for longer term use in high radiation environments. This is particularly important for modification of commercial off-the-shelf (COTS) equipment.

Opportunities

Possibly a different communication about the introduction of new RRS technologies would bring better acceptance. To set the human factor as a key enabler should improve implementation success and broader application.

- Address the attractiveness for younger generations e.g. gaming-like interface technologies, and use of robotics for a new category of worker with remote systems. Develop a strategy for government agencies, academia, and end users (industry) to engage and train the next generation of workers.
- Implementation strategy must include more relations with unions or at another level, regulators to move from “replace the human worker” to “support the worker to be safer and more productive” policy and change cultural biases.

Summary of Group 2: Safety and security requirements for robotics application in decommissioning

Moderators: Michael Knaack, Matthias Schöpfer

Lessons learnt

Lessons from past applications are heavily based on the paradigm that digitalisation technologies are for capturing data, while robots are using this data. However, mobile robots are changing this paradigm, with the emergence of better positioning solutions. Considering R&D as an integral part of decommissioning and waste management programmes would avoid the strong current trend for reverse engineering existing solutions.

Enablers

Improving trust and confidence in emerging technology through pilot deployments and long-term collaborative actions for competence/knowledge building was identified as key for adoption of RRS. This can include training programmes, technology showcasing, programmes for sharing of lessons, and support by the regulator for communicating a positive message. Certifications for RRS for nuclear applications would also enhance international deployments. Technology providers have a higher chance of not being dependent only on the nuclear market. Finally, a solutions-to-problems approach to RRS adoption is expected to facilitate the emergence of multipurpose solutions addressing groups of tasks related to the nuclear back-end.

Barriers

More intelligent systems are emerging with higher integration of RRS with digital systems, including AI. However, nuclear sector specific risks (including radiological) require special qualification of solutions. Other important barriers mentioned include the lack of standard ways for working with robots and the image of emerging RRS solutions among decision makers and investors (to be addressed by promotion among the younger generations). In addition, positioning in GPS-denied environments and the need for global positioning systems was mentioned as a technical challenge.

Needs

Needs identified by the participants included indoor positions systems, solutions for deploying sensors across large areas and solutions enabling dynamic change between levels of autonomy. Standard ways for application of RSS must be industrialised and the application of robots should be integrated into workflows.

Opportunities

- Modular solutions based on moving robot platforms were discussed. Comments from the audience pointed out that both fleets of robots designed for specific purposes and multipurpose systems have a strong potential. Robot systems can also provide input data for BIM systems. Such systems could facilitate planning of new activities (including 3-D modelling of robot missions) and monitoring the status of the implementation of ongoing tasks. It was mentioned that stationary robots can also be improved through integration with digital systems, and data that can be used for robotics procedures can also enhance human missions.

Summary of Group 3: Digitalisation and robotics – how can they strengthen/enable each other?

Moderators: Rustam Stolkin, István Szőke and Matt Mellor

Existing technology – lessons learnt

- The status quo is heavily based on the paradigm that digitalisation technologies are for capturing data, while robots are using this data. However, it has been demonstrated that robots can also play a key role in generating data to be used in digital support systems.
- Currently, mostly stationary robots are utilised. However, non-stationary robots are being increasingly applied.
- A robust positioning solution for robots is not available, but this challenge is being increasingly solved. Solutions include use of point clouds for detecting surfaces the robot can act on and determining the location of the robot. Precision of positioning is hard to quantify currently.
- There is a trend for reverse engineering existing solutions. Part of the reason for this is that the nuclear sector recognises R&D as a stand-alone activity, rather than an integral part of the strategy.

Barriers

- The main barrier to the application of robots is related to risks that are specific to the nuclear sector (e.g. radiological risks). A key challenge is qualification of solutions for specific use cases in the nuclear sector.
- Integration of robots with complementary digital systems is shifting the ratio between capabilities for action and perception. Traditional machines were not connected with AI that helps the robot understand the environment. Emerging, more intelligent systems are foreseen to be useful in the nuclear sector, but applicability needs to be evaluated case by case.
- There are bits and pieces available for establishing a standard way for application of robots and standard interfaces to operating robots. However, most solutions are developed among roboticists for their own use.
- Application of robots in GPS-denied environments (e.g. indoors) is a problem. Universal positioning system is required to ensure that robots and digital models are aligned. There is no standard way for solving this problem at present.
- Nuclear is not so famous in terms of innovation and robotics among the young generation. The same applies for investors. Nuclear is regarded as one of the most difficult businesses.

Enablers

- A roadmap is required to build trust / confidence for robotics and other related disruptive technologies (e.g. embodied AI). This can include:
    - pilot deployments in lower safety critical applications, and
    - clarification of what the long-term aspirations are for performing targeted activities for building competence/knowledge, collaboration among stakeholders and a framework to enabling different stakeholders (including the regulator).

- Higher adoption of robots can be achieved by 1) training that creates awareness, 2) showcasing new technology, and 3) better sharing of lessons learnt.
- A positive "message" from the regulator is required on the use of AI (including embodied AI i.e. robots): "Use AI if confident that the safety case can be sufficiently built".
- Technology/service providers have a higher chance of success if working not exclusively in the nuclear sector.
- Certification of robotic technology for specific use cases (or more generally for application in the nuclear sector?) would increase technology adoption. This model is, however, vulnerable to ruling out useful technology based on evaluation of applicability against a multitude of requirements.
- The problems and solutions must be the focus, not robots. Develop solutions (e.g. robots) that solve a group of problems in nuclear decommissioning. This strategy could be replicated across several projects.
    - elicit what the specific benefits of non-stationary solutions are e.g. what class of problems do these solve; for instance, in the context of characterisation, sensors are needed that are movable across large areas;
    - use cases could be categorised based on required levels of autonomy.

Needs/opportunities

- New indoor positioning systems: Real Time Locating System (RTLS) infrastructure, UWB 3-D localisation, …
- Fleet of robots composed of heterogeneous platforms fit for various purposes.
- Modular solutions where various modules can be integrated into moving platforms.
- Systems that provide a solution for having movable sensors across large areas. This use-case is not duplicated anywhere.
- Solutions for enabling dynamic change between levels of autonomy. Specifically, solutions for handing control or autonomous solutions back to humans. This requires further research into interaction between human and robot.
- Stationary robots can also be improved by integration with digital systems. What digitalisation is required depends on the intended application. For instance, a digital model of a facility can support better planning/control of processes (e.g. robotic) within the facility.
- Robots can be purpose-built or multipurpose. Both have potential in the nuclear sector.
- Standard ways for application and operation of robots must be industrialised.
- Better integration of robots into workflows is required with focus on mainstream use.
- Data that can be used for robotics procedures can also enhance human missions.
- Robots can provide data for enriching content in BIM systems and to keep information in BIM systems up to date. Such systems could facilitate planning of new activities. Another example is monitoring the status of the implementation of ongoing tasks based on data from robots working in the field. Robots can also provide task-specific data (typical task parameters) that could be stored in specific databases.

- BIM based systems could be used for simulating robot missions for supporting mission planning (and control). Such systems could also simulate the function of sensors e.g. those mounted on robots.

Summary of Group 4: Economic benefit drivers for robotics applications in the nuclear

Moderators: Eduard Nikitin and Norbert Molitor

Economic drivers and trends highlighted

The EGRRS's proposal for identifying economic benefit drivers had positive feedback from the audience. In the group discussion, participants provided a list of areas recommended for EGRRS to focus on in the global analysis of international trends:

- Digitalisation and AI
  - Machine learning, specifically deep learning techniques.
  - Mixed Reality (XR) (including virtual and augmented reality) for easier to understand, online real-time information.
  - Upgrading conventional standard equipment with, for instance, specific apps and modifications should be investigated.
  - Economics of scale: global implementation of digital twins may provide significant economic improvements.
  - Digitalisation for lifetime management of radioactive waste may decrease global costs.
- Multitasks
  - There is a need for more functions provided by RRS. There is an international trend towards multi-task systems.
  - Modularisation can make it easy to equip universal robotic systems with different instruments providing specific functions required by the nuclear back-end.
- Standardisation
  - Use of conventional interfaces and standardisation of non-conventional interfaces is an important driver of cost decrease.
  - International standardisation of regulation and legislation, relevant for application of RSS, is expected.
- Risk management
  - Recovery of broken robots and new wastes generated by robots (like contaminated oil from hydraulic leak) must be considered.
  - Application of digital and robotics solutions is expected to improve planning and risk assessment for nuclear back-end activities.
  - Corrosion/wear should be considered when designing future robotics.
  - Risk management / risk analysis should be performed before construction (of robots).

- Lean production / lean decommissioning: Robotics and digital solutions may be key success factors for enabling lean decommissioning concepts.

Session chair's notes

Chairs: Vladimir LEBEDEV and Martin BRANDAUER

Martin BRANDAUER collected impressions throughout the dedicated EGRRS session at DigiDecom 2021 reflecting on needs, drivers, new/improved tools and gaps. These are provided below.

Needs and drivers:

- Reliability/maintainability of robots is a challenge, which includes retrievability strategies.
- Licensing challenges are part of the barriers in the workstream; harmonisation on the approaches for their qualification (both for hardware and software) to meet the required safety integrity targets is important.
- Radiation hardening is key for high activity areas (taking into account effects on electronics).
- Human-machine interphase (interaction) with robots and AI is a challenge and a driver requiring attention.
- Full scale mock-up is key (real boundary conditions).
- Providing an economic value to risk makes it possible to reflect them in a cost-benefit analysis.
- Attractiveness of working in the nuclear fields increased with these new technologies (rejuvenation of aged workforce).
- Whole life cycle of the systems needs to be kept in mind for the RRS application (including intervention as well as decontamination and disposal of RRS).
- Fast-paced security industry is providing solutions to security gaps identified in the past; AI is being applied for security improvements.
- Standardisation improves safety.
- Human element is quite important in the system (training, operation, safety, etc.).
- Safety case (broken down into different safety case aspects) for robots is important: iteration between licensing and development; provide certification for wider tasks by modularisation; reasonableness of paperwork should be kept in mind.
- Strong interphase between digital environments (BIM) and robots (generation, exchange and usage of data); robots can decrease the resources BIM usually implies (constant updates, regular inspections).
- Digitalisation tools allow knowledge management and data keeping over the whole life cycle. Provides potential for optimisation on many levels (e.g. workflow, cost).
- Trust building for robotics, including in AI and the human-machine interface, is required; lower safety critical application approach has been mentioned.
- Bridge applications and developments to be applicable in different fields is important part of business case for companies/supply chain.

New/improved tools:

Radiation hardening attracted a lot of interest during the session. Following contributions have been collected on the topic:

- Lessons learnt show that many robots will have a useful lifetime in many nuclear applications without the need of specific hardening.
- Typical COTS technology will often withstand lifetime doses of around 100 Sv. COTS motors will often withstand 0.5 mGy or more.
- Decommissioning of reprocesing plant or legacy waste retrieval have levels up to 300 Sv/ H, so electronics are put outside of the working area and the limits of operability are the wires length.
- Existing systems (e.g. PaR power manipulators) used for decades in reprocessing plants can be suitable for "robotisation" using current technologies.
- Semiconductors can be taken up to 10 000 Sv with special components, based on participant experience. Others have achieved much more, but the costs mount. 1F (Fukushima) sensor pack example deployed on the end of an inspection devise to reach inside Primary Containment Vessel (PCV). Spec is 10KGy lifetime, 1kGy per hour max rate. So the lifetime is known to be quite short – but it is adequate to the purpose which is a brief inspection.
- Other effects of radiation of different energies need to be considered for long time exposure (e.g. neutrons).
- Underwater COTS applications for shielding purposes exist; the example of the robot called AZURO, funded by the German Federal Ministry of Education and Research (BMBF), was referenced.
- Exposure minimisation can be achieved by new technologies (less exposure path planning).
- Regarding irretrievability, US applications have to be tethered as per DOE requirements, so that they can be retrieved in case something goes wrong, including a cable management system.

Regarding new technologies: electric motors providing more accuracy (even above 200 kg payload), decreasing risk of hydraulic leakage.

- Further examples mentioned:
    - Chernobyl Nuclear Power Plant: robots capable of replacing a person on the roof of the shelter exist, performing work of fragmentation of structures as well as manipulating these structures on the main crane system. It is recognised, however, that this includes many challenges.
    - Belgian Dessel case: development of a fast-moving belt system for 3-dimensional characterisation (activity distribution) and sorting of large quantities of soil for clearance purposes.

Identified gaps:

Database (open access) for benchmarking was suggested, making sure there is collaboration with international entities; an open-source Wiki has been suggested, reflecting technologies, case studies, etc.

- "Reinvention of the wheel" is being observed; technologies from other fields can be used (e.g. space, oil and gas) and closer collaboration is required, also in the nuclear field.
- A characteristic of nuclear robotics in general is that every system is unique, but every system has 30-90% in common with most other systems – modularity is essential, with a multi-task capability approach.
- Tools monitoring the health of on-board electronic would be useful (radiation hardening by software). There is existing technology that allows predictive maintenance which would likely extend the dose range that can be explore without having to do radiation hardening.
- Regular inspections (many data types, e.g. radiation, RFID, QR-codes, scanning) with integration in BIM could be pursued with robotic systems.
- There is a need to deliver the raw and results data to the inspection authority in a harmonised format.
- Transfer of data referenced to the communication system between the robot and the operator requires for e.g. an extra tender robot (example mentioned 2.4 GHz connection wasn't possible); encryption was mentioned for wired and wireless connections; also, indoor positioning for strongly changing environments is a challenge.
- There are different understandings in the community for terms such as "robots", "BIM", etc.; a "glossary" would be useful.
- Including the regulators and connecting developers, implementers and operators with regulators is crucial for licensing; also bridge end user with developers.
- Technology transfer from advanced R&D technologies to implementation is a challenge; → raising the TRL levels.
- Training and education is important, including breaking cultural barriers.

Summary

The following key messages could be identified:

- State-of-the-art RRS applied outside the nuclear sector are improving industrial safety, providing better control and interaction with the technology within the workflow. However, applicability of these systems in the nuclear sector (especially high radiation areas) must be verified.
- International standards, technological maturity (benchmarking and testing), robust definition of maintenance requirements (including retrievability), as well as better consideration of human factors can enable application of RRS in the nuclear sector.
- Radiation hardening is a topic of great interest. Solutions do exist. However, balancing cost of radiation hardened systems and overall cost-benefit is key. Hence, regular replacement of (non-hardened) systems as well as robotisation of existing remote systems[1] are also options to be considered.

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1. E.g., adding actuators at the master-side of a master-slave-system, allowing conventional mechanical remote systems to be enhanced by digital and improved control interface.

- Trust, confidence and acceptability need to be improved among stakeholders. Co-ordination among end users, government agencies, R&D, as well as education and training entities is crucial. Pilot deployments and long-term collaborative actions for competence/knowledge building were identified as key enables for adoption of RRS.
- Defining the *principles for demonstrating safety* of robot applications could be considered. This could include graded requirements *dependent on the level of complexity* of the intended application (i.e. increasingly stringent requirements with increasing complexity of the planned work), *types of application field* (e.g. nuclear power plants, reprocessing facilities; based on different associated risks), as well as *safety criticality* (e.g. release potential under normal conditions and disturbances).
- In terms of security, wired connections are preferred due to lower vulnerability. However, there is a fast-paced development of advanced industrial solutions for improving security, including components relying on advanced information technology. These new solutions can be applied to enable fail-safe systems for parts or the whole RSS. Hence, wireless remote-controlled systems can be as secure as wired systems with the application of suitable data encryption solutions.
- Risk analysis of robot systems should consider the whole life cycle, including maintenance and disposal of robots. Nuclear sector specific risks (including radiological) might require special qualification of solutions.
- Deep learning, extended reality (XR) for providing real-time information (in activities using RRS), and digital twins were identified as the most important technologies impacting economic benefits for robot applications. Digitalisation for the global management of radioactive waste (from cradle to grave) could decrease overall costs. More intelligent systems are emerging with higher integration of RRS with digital systems, including AI-enabled systems.
- Indoor position systems, solutions for deploying sensors across large areas and solutions enabling dynamic change between levels of autonomy have been identified as key needs. Standard ways to apply RSS must be industrialised (modularisation for specific and multipurpose applications) and better integrated into workflows.

Conclusions

Strong safety requirements, responding to the specific conditions in manipulating radioactive components and materials, contributed to the development of what are today referred to as robots. Further developments and specific implementations of the technology have been revolutionising industries where lower safety and security concerns spawned a new generation of robots and co-bots that are more cost efficient and rather different from the heavy-duty machines which must be strictly segregated from human workers. New mobile, modular, collaborative and autonomous solutions are emerging in several application areas. Now robotics, through these new solutions, is circling back into the nuclear industry where applying these technologies requires special attention due to the same reasons that started robotics development. The nuclear industry, in collaboration with some other industries where robots are subjected to special conditions that may impact on their performance, is foreseen to facilitate the emergence of a new breed of modern robots that will change the way the nuclear back-end is addressed. These modern robotic systems are foreseen to combine the results of nuclear robotics altered by R&D described previously, with the results of years of parallel developments in the digitalisation of the nuclear back-end.

The NEA EGRRS will continue, through a range of initiatives, to facilitate international sharing of good practices and the provision of guidance for current applications and prospective RRS systems for decommissioning and radioactive waste management.

AGENDA OF THE EGRRS DAY ON DigiDecom 2021

Thursday - 25 March: Innovation needs, solutions and initiatives related to digitalisation as well as robotics and remote systems in decommissioning

Chairs: Vladimir Lebedev (NEA) and Martin Brandauer (NEA)

Participants were invited to participate in two surveys of the NEA Expert Group on the Application of Robotics and Remote Systems in the Nuclear Back-end (EGRRS):

1. **STATUS OF CURRENT TECHNOLOGIES AND USES / DEFINE TERMINOLOGY**
2. **BARRIERS / IMPEDIMENTS**

A participation in advance of the meeting would be appreciated.

11:30 – 12:00 (CET)
Participants admission

11:50 – 12:00

Opening remarks by session Chairs

12:00 – 12:20 (CET)
Robotics and remote systems applications in the decommissioning and radioactive waste management - the NEA EGRRS

Rustam Stolkin, University of Birmingham and NEA-EGRRS Chair, United Kingdom

12:20 – 12:40

Robotics and 3D gamma mapping technologies for supporting nuclear decommission

Matt Mellor - CREATEC, United Kingdom

12:40 – 13:00

Digital innovation for robotics applications in decommissioning

István Szőke - IFE, Norway (member of EGRRS)

13:00 – 13:20

Modular UGV and humanoid robot platform-based technology – prospects for application in nuclear decommissioning

Nasser Ukla – IFE, Tomas Henninge – nLink, Bernt Øivind Børnich/ Egil Utheim – Halodi robotics, Norway

13:20 – 13:40

Robotics research and applications by Florida International University (FIU)

Leonel Lagos, FIU, United States

13:40 – 14:00 The use of robotics and remote equipment in international projects implemented at Chernobyl Nuclear Power Plant Norbert Molitor – PLEJADES GmbH, Germany, Valeriy Seyda, Sergiy Kondratenko – Chernobyl Nuclear Power Plant, Ukraine and Cécile Javelle – PLEJADES GmbH, Germany
14:00 – 14:20 Economic drivers for robotic and remote systems in decommissioning (incl. FREMES example) Eduard Nikitin, ROSATOM, Russia, and Norbert Molitor, PLEJADES GmbH, Germany
14:20 – 14:40 Robotic fragmentation of large equipment at decommissioning of nuclear power plants Ladislav Vargovcik, Jozef Varga, Jan Semjon – TUKE, Slovak Republic
20 min break

15:00 – 16:00 Discussion of innovation needs and possible solutions related to robotics applications in decommissioning **Chairs** present the objectives of the group sessions and the required background information **Moderators** shortly present the topic of their group and some food for thought Breakout to groups: Group 1 Status and trends for robotics applications for decommissioning Moderators provide a teaser presentation Moderators: Rick Reid, EPRI, United States, and Leonel Lagos, FIU, United States Group 2 Barriers and impediments for robotics applications for decommissioning Moderators provide a short teaser presentation Moderators: Laurent Velnom, EC Group 3 Safety and security requirements for robotics applications for decommissioning Moderators provide a short teaser presentation Moderators: Michael Knaack, Matthias Schoepfer TüV Nord, Germany Group 4 Digitalisation and robotics – how can they strengthen/enable each other? Moderators provide a short teaser presentation Moderators: Rustam Stolkin, István Szőke and Matt Mellor Group 5 Economic benefit drivers for robotics applications in the nuclear sector Moderators provide a short teaser presentation Moderators: Eduard Nikitin and Norbert Molitor
16:00 – 16:45 Short summaries from the group discussions presented in plenary by the moderators (5 min each) and plenary discussion (20-30 min) Moderators and session Chairs
16:45 – 17:00 Final remarks of the session Chairs Vladimir Lebedev and Martin Brandauer, NEA

FURTHER INFORMATION

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WEBPAGES

The Nuclear Energy Agency:

- http://www.oecd-nea.org/

The Division of Radioactive Waste Management and Decommissioning:

- http://www.oecd-nea.org/rwm/

Institutt for Energiteknikk (IFE)

- www.ife.no

Link to the workshop:

- www.ife.no/DigiDecom2021