The S2R Joint Undertaking considers that proposals with a duration of 30 months would allow this topic to be addressed appropriately. Nevertheless this does not preclude submission and selection of proposals with another duration.

**COMPLEMENTARITY**

As specified in section 2.3.1 of AWP 2020, in order to facilitate the contribution to the achievement of the S2R JU objectives, the options regarding 'complementary grants' of the S2R JU Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R JU Grant Agreements.

The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics:

- S2R-CFM IP3-01-2019: Intelligent asset management finalisation

**EXPECTED IMPACT**

Actions will contribute to achieve an increase of the attractiveness and competitiveness of the railway transport in Europe through an efficient, safe, intelligent infrastructure maintenance approach. Expected impacts in detail are:

- Balanced, controlled, cost and risk-effective interventions in between railway services and maintenance.
- Increase operational reliability by 30% through less service disruption, improving users railway attractiveness.
- Optimize maintenance execution by 30% through the multi-objective decisions' optimization tools.
- Life cycle costs reduction by 20%.

**Type of Action: Research and Innovation Action (RIA)**

### 4.2.8 S2R-OC-IP3-03-2020: Advanced tools and equipment: collaborative robots & wearable mobile machines (TD3.8)

**SPECIFIC CHALLENGE**

As described in the MAAP, for TD 3.8 one of the focal areas is new and advanced working methods, tools and equipment and logistics solutions, supporting the LEAN execution of intelligent maintenance processes. For this topic two work streams are defined with each a specific challenge:

- Work stream 1: the challenge is to move forward the research on robotics and make robotic principles rapidly applicable for the rail sector using existing plant (machines and equipment) as a starting point. Currently the primary method of plant control are human operators. This creates a significant risk of incidents caused by human error. There is a great reliance upon compliance and individual competence, which is not always robust. Giving existing plant a

level of autonomy and intelligence using the robotic principles, could help to avoid incidents where plant strikes other plant, plant strikes an individual or plant strikes a piece of infrastructure. Introducing this level of autonomy should make the collaboration between current plant and machine operations and personnel on the track around the plant possible. On top of that, some of the tools being used in the track are heavy and, using these tools, requires physical effort that will cause damage to the human body over time. Introducing robotics principles moving and using these tools can be seen as part of the challenge.

- Work stream 2: the challenge is to equip railway workers who handle heavy tasks with load carrying exoskeletons to minimize muscular fatigues. Long term benefit by avoiding health issues are the main driver. Many workers performing heavy physical tasks are affected by musculoskeletal disorders, leading to a huge annual cost. Exoskeletons have the capacity to decrease the number of musculoskeletal injuries and increase quality of life at work, thereby reducing costs for a company in the long run.
  The developments around exoskeletons are rapid meaning that these can now offer partial, passive, or agile support with a decreased price tag. Exoskeletons designed for performing manual labour tasks in industrial environments are now commercially available. For successful use in the rail sector, extra requirements come related to the more robust environment come into place. For this work stream, the challenge is to address these requirements and present a successful demonstration.

**SCOPE:**

Proposals should complementing the IAMS development, and activities within the S2R JU programme, especially within the S2R-CFM-IP3-01-2020. These activities are described globally in the S2R MAAP – TD3.8 and the S2R-CFM-IP3-01-2020 topic description.

Within S2R JU IP3 work is being undertaken to develop a generic robotic platform to support future inspection and execution of maintenance actions (In2Smart - GA 730569). Especially work stream 1 fits in the same context as described above to develop and test new automated and smart working tools and equipment, demonstrating that existing tools/equipment can be transferred easily into robots letting these to make decisions.

For this work stream the idea for this call is to use the principles developed for this robot platform, such as a central control unit using ROS – Robot Operating System (an open-source, meta-operating system for robotics), to give current plant equipment and on track machines (OTM) a level of autonomy or transfer it to a cobot (collaborative robot), in order to physically interact with humans in a shared workspace. Also the aspect of moving tools and equipment to the place of execution can be included. This can either be moving autonomously or creating the tool of equipment as an add-on to, for example, excavator.

To summarize: making existing plant/equipment multi-purpose and autonomous using ROS and other robotics principles.

Expected result of the action is standalone demonstration of an improved existing plant (machines and equipment) by integrating robot technology (ROS) giving it a level of autonomy and/or the capability to move without being directly operated by humans. Interaction with humans, avoiding, is in an imported feature to be included.

Possible examples of current plant equipment and OTM are:

- Rail Excavator,
- other multi-purpose rail equipment and tools for reprofiling and deburring tools, weld trimmers etc.

For work stream 2 the idea is to deliver an exoskeleton which can be used outside in the rail track performing a set of different maintenance task. Since the working conditions are robust, the exoskeletons have to made suitable for these outside situations. The exoskeletons have to be made ready for heavy duty use. The weather conditions are one: water resistance is obvious. But also the use under different extreme temperatures (indicatively -20 + 50 Celcius degree). An exact level of protection expressed in the International Protection Marking, IEC standard 60529, should be part of the requirements definition, but probably IP67 or higher.

Track workers perform often a variety of tasks and move from one spot to another. Idea is that the exoskeletons can be used during a whole shift and are suitable for multiple tasks and moving between tasks. This requires special attention to comfort, such as weight and possibility turning assistance off. Tasks can include work bending over, sitting on haunches or raising arms above shoulders.

Concerning safety: the exoskeleton should not introduce new safety issues for the users, existing safety issues should be addressed. This means that integration with existing required Personal Protective Equipment (PPE) is part of the complexity. Weight of the exe-skeleton should be below 10Kg.

In order to reach the required high TRL, it is necessary to make choices around the scope. Therefor a focus for the type of exoskeleton, active/passive of hybrid, and application (which tasks) in the sense which part of the body is supported, might be necessary. Proposal should include a clear use case specifying the type of support the exoskeletons will give (arms, legs or (lower) back) type of exoskeleton and which range of tasks

This both work-streams the work is expected to deliver a TRL 5/6 prototype.

An indicative scheduling for both work-streams of the deliverables is suggested below[60]:

M8: General requirements : scope definition of proposed use case (including the choice of existing equipment to be used as an example work stream 1 and set of tasks for work stream 2) defined and agreed;

M14: First results presented as demonstrator

The S2R Joint Undertaking considers that proposals with a duration of 30 months would allow this topic to be addressed appropriately. Nevertheless this does not preclude submission and selection of proposals with another duration.

**COMPLEMENTARITY**

As specified in section 2.3.1 of AWP 2020, in order to facilitate the contribution to the achievement of the S2R JU objectives, the options regarding 'complementary grants' of the S2R JU Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R JU Grant Agreements.

The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics:

[60] The scheduling of the deliverables is provided to facilitate the complementarity with the CFM actions and it is not binding. Additionally, each deliverable may have some flexibility in the scheduling

- S2R-CFM IP3-01-2019: Intelligent asset management finalisation

**EXPECTED IMPACT**

Actions will contribute to achieve an increase of the attractiveness and competitiveness of the railway transport in Europe through an efficient, safe, intelligent infrastructure maintenance approach. Expected specific impacts for work stream 1 are:

- improvement workers safety and working conditions;
- Cost reduction of the working methods by improving time needed (up to 20% reduction compared to state-of-the art methods);
- Improved quality, higher accuracy, of the results produced by the improved working method.

For work stream 2:

- improvement workers working conditions and safety;
- reduction of physical, static load;
- Sustainable employability of employees.

**Type of Action: Research and Innovation Action (RIA)**

### 4.2.9 S2R-OC-IP4-01-2020: Supporting the implementation of the IP4 ecosystem

**SPECIFIC CHALLENGE**

IP4 is defining a consistent bench of services covering all the steps of multi-modal journeys and providing a seamless passenger's experience. A long term CFM project (COHESIVE) started in 2017 is consolidating incrementally the various building blocks developed in the IP4 projects and then demonstrating the added value of the IP4 developments[61]. To be effective and to pave the way of an easy deployment, these demonstrations must take into account the constraints of a real environment. The specific challenge of this Open Call aims to provide this environment, and requires the following steps:

- Define relevant use-cases together with the CFM project members
- Provide real data supporting the implementation of the use-cases
- Clarify the adequate business rules needed to implement these use-cases
- Support when requested -in the field- demonstrations
- Collect the needs and expectations of future users of the solutions in order for Travel Service Providers to manage the offer of the travelers.

**SCOPE**

The action addresses the "non-technical" part of the ITD4.7 in the S2R MAAP. The overall integration of a great number of travel services and modes all over IP4 is the only way to demonstrate added value on the market. The technical part (complex software integration) of ITD4.7 is developed by the CFM project COHESIVE, but performing relevant demonstrations require the involvement of additional

[61] https://shift2rail.org/research-development/ip4/