GRANT CALL FOR IMPROVING PRODUCTIVITY OF RAIL MAINTENANCE WHILE SUSTAINING DESIRED RELIABILITY

1. OVERVIEW

1.1. Today, some 3.5 million trips are made each day on our Mass Rapid Transit (MRT) network for work, school and leisure – this is about 40% of all daily trips made across our entire public transport (PT) system. Our MRT is the backbone of our PT system that is vital to keep our economy going and our people moving. A reliable and resilient rail network is hence central to achieving the "20-minute towns and a 45-minute city" vision of our 2040 Land Transport Master Plan which is key to make our city more livable and our economy more competitive moving forward. With this vision in mind, we have dedicated efforts over the last few years to improve the reliability of our rail system. To this end, we have managed to achieve new records of mean kilometres between failures (MKBF)[1] for our MRT network.

1.2. Currently, the local rail industry employs more than 8,000 rail operations and maintenance workers. About 20% of these workers are today above 55 years old, which means that come 2030, they will likely retire. The challenge of the future labour demand facing the local rail industry is exacerbated as we envisaged that some 15,000 workers will be needed come 2030 to support our expanded rail network operations and maintenance.

1.3. A significant amount of the maintenance works today is still manual and rely heavily on on-site manpower during the short engineering hours in a hot and humid environment. To circumvent the potential maintenance productivity issues of our ageing workers and improve our maintenance efficiency for a better network, there is a fundamental need to innovate and automate these maintenance works. This will allow us to better serve commuters and the society at large while minimising the frequency and duration of repair and replacement work, and the reliance on on-site manpower. In other words, it is now timely to leverage on research and technology to see how we can improve productivity of rail maintenance while sustaining the desired reliability.

[1] Mean kilometres between failures (MKBF) is an international performance indicator for rail reliability. It measures the mean distance travelled before a train fault lasting more than 5 minutes occurs.

2. SCOPE

2.1. LTA is launching a grant call for proposals to leverage on research and technology to improve productivity of rail maintenance work while sustaining desired reliability. Three focus areas (a) Innovate and Automate Permanent Way ("P-way")[2] Maintenance, (b) Innovate and Automate Rolling Stock[3] Maintenance, and (c) Innovate and Automate Mechanical & Electrical (M&E) and Other System Maintenance have been identified. These are elaborated in the sections below.

Focus Area A: Innovate and Automate Permanent Way Maintenance

Requirements

This focus area aims to develop solutions to innovate and automate P-way maintenance, to:

- Minimise the frequency and duration of repair and replacement work
- Minimise reliance on on-site manpower

Applicants should select a specific Challenge listed in the table below to propose innovative solutions to the problem statements. Proposals should address the possible improvements and recommend how the impact would be measured. If a new area is proposed, please attach a support letter from the rail operator on its significance.

S/N	Challenges	Possible Solutions (but not limited to)
1	Currently, when anomalies are detected, temporary fixtures are often applied as "first aid" before proper repair or replacement takes place during engineering hours. Staff will be deployed to the ground to closely monitor the condition during revenue service hours.	• Innovative designs for temporary fixtures that do not deteriorate within 7 days; • Remote monitoring systems that can be easily deployed on site with at least 7-day availability.

[2]Permanent way, or the rail track, comprises of rails, rail fastenings, sleepers and bearers, switches and crossings, ballast, formation and drainage. It also includes the trackside third rail system which provides 750V DC electrification for traction of the MRT system.

[3]Rolling stock refers to a train, which is a combination of train-cars coupled together. The main sub-systems of a train-car includes the car-body, bogie, brakes, propulsion, doors, air-conditioning, auxiliary converter and battery, Train Integrated Management System (TIMS), and communication systems.

2	Measurements of geometry and profile at turnouts and plain lines are done manually.	Automated measuring device with a tolerance of +/- 0.5mm that can be used by one person to measure 1 turnout within 30 minutes.
3	Manual inspection, removal and replacement of embedded fasteners are very challenging.	Automated machine to carry out inspection with a tolerance of +/- 0.5mm, removal and replacement of embedded fasteners in an efficient manner.
4	Challenging to measure 3rd rail wears continuously in an effective and efficient manner.	Automated measuring machine with a tolerance of +/- 0.5mm via a non-contact manner for at least every 0.5m.
5	Challenging to inspect conditions of track foundation and predict its remaining life.	• Innovative method for track foundation inspection; • Characterisation and modelling of track foundation condition to predict its remaining life.
6	Conversion of ballast track to non-ballast track with minimum disruption of revenue service.	Innovative method to convert ballast track to non-ballast track with minimum disruption of revenue service.

Focus Area B: Innovate and Automate Rolling Stock Maintenance

Requirements

This focus area aims to develop solutions to innovate and automate rolling stock maintenance, to:

- Minimise the frequency and duration of maintenance for the whole train
- Minimise reliance on maintenance manpower

Applicants should select a specific Challenge listed in the table below to propose innovative solutions to the problem statements. Proposals should address the possible improvements and recommend how the impact would be measured. If a new area is proposed, please attach a support letter from the rail operator on its significance.

S/N	Challenge	Possible Solutions (but not limited to)
1	Cleaning of train cabin interiors is manpower intensive. Sometimes the cleaning is not thorough and may even damage the train cabin interiors.	Robotic solutions to automate the cleaning work.
2	Current wear rate of the wheels is high.	Innovative designs e.g., steerable boogie to reduce maintenance of wheels.
3	Foreign objects, such as dust, caught in train doors grooves may have obstructed the opening and closing of these doors.	Automate the removal of these foreign objects caught in the door pathway by incorporating new door designs such as an interior door.
4	Automatic mode currently applies under normal train operation. When the train is not under normal operation, human intervention is required. It is not economical to deploy train captains for all driverless trains just to standby for faults.	Optimise procedures or train captain deployment plan so as a train captain can be introduced to a train that needs human intervention in the shortest possible time.

Focus Area C: Innovate and Automate Mechanical & Electrical (M&E) and Other System Maintenance

Requirements

This focus area aims to develop solutions to innovate and automate mechanical & electrical (M&E) and other system maintenance, to:

- Minimise the frequency and duration of inspection and repair work
- Minimise manpower requirement on labour intensive work

Applicants should select a specific Challenge listed in the table below to propose innovative solutions to the problem statements. Proposals should address the possible improvements and recommend how the impact would be measured. If a new area is proposed, please attach a support letter from the rail operator on its significance.

S/N	Area of Interest	Possible Solutions (but not limited to)
1	Maintenance of station lightings, escalators, platform screen doors (PSD), pumps, etc. are time-consuming.	Innovative and cost-effective technologies to predict, optimise and/or reduce frequency and duration of maintenance.
2	Viaduct bearing inspection is currently carried out manually every 5 years (as deterioration of bearings take place slowly over a long period of time). The inspection and replacement are very time-consuming.	Innovative and cost-effective tools and methods for fast inspection and replacement.
3	Existing cables are typically life-ed for in-use or in-service life and scheduled for replacement once the in-use life is due. Such replacement is a massive exercise. It is usually costly and affects many systems.	• Innovative method to replace cables without fiddling with live cables; • Innovative method to determine remaining life span of existing cables; • Innovative tool to automatically detect cable insulation degradation or breakdown.

3. ELIGIBILITY CRITERIA

3.1. This call is open to all R&D organisations in Singapore including publicly funded institutes of higher learning (IHLs), not-for-profit research institutions, public sector agencies, companies and company-affiliated research entities.

3.2. The Lead Principal Investigator will be required to have a minimum time commitment of 9 months per year in Singapore. International parties can participate in the project as Collaborators. All work should be done in Singapore, unless expressly approved by LTA.

4. APPLICATION PROCESS AND EVALUATION CRITERIA

4.1. Proposals will be selected and evaluated based on i) potential for impact, ii) strength of project execution, and iii) technical competency of the team.

4.2. The grant call will be launched on 16 September 2020 (Wednesday), 1200hrs. Interested applicants should submit proposals to the following email address LTA_Innovate@lta.gov.sg by 19 Oct 2020 (Monday), 1200hrs. Only documents in **Word**, **Excel** and **PDF** formats should be submitted.

4.3. Proposals should cover the objectives, proposed approach and project execution plan. The guidelines for drafting the proposal is in Attachment 1.

4.4. Proposals should be submitted together with Offline Call Application Package (Attachment 2) during IGMS downtime.

4.5. LTA will support 100% of the approved qualifying direct costs of a project for IHLs, not-for-profit research institutions and public sector agencies. Companies and company-affiliated research entities will qualify for up to 70% of the approved qualifying direct costs of a project. 20% of indirect costs (costs that that are incurred for common or joint objectives and therefore cannot be identified readily and specifically with a particular project) will only be allowed for IHLs and not-for-profit entities. A list of non-fundable direct cost items is in Attachment 3.

4.6. Funding support will be up to five years but projects with 3 years or shorter duration are preferred. Deliverables are expected to be commensurate with the level of funding requested. LTA may require that funding support will be based on achievement of milestones in a payment schedule.

4.7. Proposal that provide cash or in-kind contributions will be viewed favourably. Multi-disciplinary/organisation teams or teams with industry collaborators are also encouraged to perform holistic analysis and facilitate downstream deployment of the R&D technologies developed. Proposals which involve a trial or pilot with clear plans to deploy / scale-up the solutions developed are highly preferred. Where applicable, technology readiness level (TRL) of the proposed technology should be at least TRL 5 (prototype demonstration in a relevant environment) and above at the end of the project. Appendix 1 shows the definitions of the TRLs.

4.8. The following may be rejected without review:

- Late or incomplete proposals (including proposals that do not follow the guidelines)
- Proposals that do not fall within the scope of the grant call
- Duplicates of proposals submitted to any other funding agencies for simultaneous consideration
- Ineligibility of the Investigators or R&D organisation

4.9. Submission of proposals to LTA shall be construed as consent by the applicants to participate in the evaluation process. Selection of reviewers is at the sole and exclusive discretion of LTA. LTA shall not be liable for the release of information concerning proposals to third parties by individuals involved in the evaluation process.

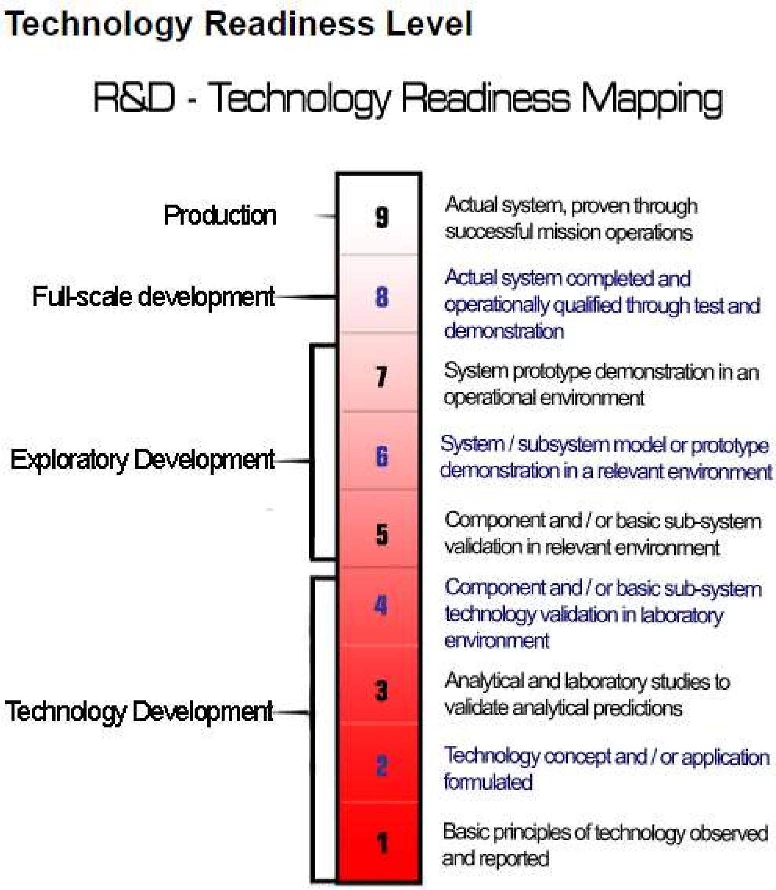
4.10. LTA may require proposals to be revised or combined as it sees fit to enhance outcomes, facilitate integration of approaches, and optimise funding resources. LTA's funding decision will be final.

5. CONTACT INFORMATION

5.1. For further enquiries on this Open Call, please email LTA at LTA_Innovate@lta.gov.sg.

Appendix 1: Technology Readiness Level Chart

A progressive approach, depending on the Technology Readiness Level (TRL) at the point of decision, is used to evaluate test-bedding of new mobility concepts.



<u>Prototype demonstration in a relevant environment (for TRL 5 & 6)</u>
A technology of interest has demonstrated potential to meet certain transport objectives. It will then be pursued for further development at the component level and subsequently tested for operational viability within confined test areas that mimic part of an envisaged operational environment.

<u>Proof-of-Concept (POC) demonstration in an operational environment (for TRL 7)</u>
If a technology of interest has been proven its potential at the component level, its development will be further pursued. In this case, the test-bedding environment will be escalated into the actual operational environment with actual interaction with other road users and commuters. At this stage, we will focus on evaluating the proposed mobility concept, which deploys the technology of interest, for its envisaged benefits and values in meeting the transport objectives.

Full Scale Deployment (FSD) (for TRL 8 & 9)

This level will be considered after a successful Proof-of-Concept (POC) demonstration. However, it may not be a straight-forward process as other considerations like commercial viability, operational sustainability, and other policy considerations (especially when the new mobility concept could be disruptive to existing modes of travel).