

**Legislative Council Panel on Transport
Subcommittee on Matters Relating to Railways**

Progress Update on Upgrading Signalling System for Railway Lines

Purpose

This paper briefs Members on the progress of upgrading the signalling system of seven railway lines by the MTR Corporation Limited (“MTRCL”).

Background

2. The MTRCL has continuously invested in service enhancements. In March 2015, the MTRCL announced that \$3.3 billion would be invested in upgrading by phases the signalling systems of seven railway lines (Tsuen Wan Line, Island Line, Kwun Tong Line, Tseung Kwan O Line, Disneyland Resort Line, Tung Chung Line and the Airport Express). Works of the signalling system upgrading include the installation of infrastructure equipment and hardware (e.g. computer equipment, uninterrupted power supply, wires and optical fibers, etc.). They also include furnishing trainsets with new equipment to tie in with the new signalling system. Training will be conducted for staff serving Operations Control Center, train captains and maintenance crew to help them familiarise with the operational and maintenance works under the new system. Furthermore, on-site testing of the new signalling system for the whole line and train operations will be conducted during non-traffic hours to ensure seamless migration from the existing to the new system. The MTRCL had reported the relevant plan and progress to the Subcommittee in December 2017 and February 2019 respectively (please refer to LegCo Paper CB(4)319/17-18(01) and CB(4)468/18-19(05)).

3. The signalling system upgrade is of paramount importance to the MTRCL’s enhancement of the railway services and increase of train frequency in the long run. Upon completion, the overall capacity of Tsuen Wan Line, Island Line, Kwun Tong Line, Tseung Kwan O Line, Disneyland Resort Line, Tung Chung Line and the Airport Express can be increased by about 10%.

4. According to the original plan, the MTRCL commenced the replacement of the signalling system first at Tsuen Wan Line in 2016, and would gradually replace the systems of Island Line, Kwun Tong Line, Tseung Kwan O Line, Disneyland Resort Line, Tung Chung Line and Airport Express. Nonetheless, with a view to implementing the improvement measures recommended by the Investigation Panel (“the Panel”) arising from the incident of the new signalling system testing on Tsuen Wan Line happened on 18 March 2019 (please refer to paragraphs five to eleven below for details), the MTRCL’s contractor Alstom-Thales DUAT Joint Venture (“the Contractor”) has to review the entire signalling system, fix the software issues and go through more rigorous safety tests. And upon the satisfaction of the Independent Safety Assessor appointed by the MTRCL and obtaining the agreement of Electrical and Mechanical Services Department (“EMSD”), on-site dynamic train tests could then be gradually resumed. Given the incident and follow-up actions so required, the overall signalling system upgrade programme would be postponed.

Incident of the new signalling system testing on Tsuen Wan Line happened on 18 March 2019

5. When the MTRCL was conducting a drill for the new signalling system on Tsuen Wan Line during the non-traffic hours on 18 March 2019, an MTR non-passenger train entering Central Station through a crossover collided with another non-passenger train that was departing from Central Station through the same crossover. After the incident, the Corporation had set up an Investigation Panel to look into the cause of the incident and to recommend improvement measures. Concurrently, EMSD had conducted an investigation on the incident. On 5 July 2019, the Government and the MTRCL submitted a paper (LegCo Paper CB(4)1097/18-19(01)) to this Subcommittee, reporting on the investigation findings and suggested improvement measures.

6. The Panel concluded that there were inadequacies on the side of the Contractor in the areas of software development and finetuning, and quality assurance. The Panel considered that the Contractor should be responsible for ensuring the safety of the new signalling system, including the provision of a safe signalling system for tests and drills. Hence, the Panel has made a number of recommendations to the Contractor. The Panel also recommended that the MTRCL should exercise extra vigilance and closely monitor the Contractor to ensure their implementation of relevant measures (details at **Annex 1**). In this connection, the MTRCL has strengthened the monitoring of the Contractor through various means.

7. The Contractor has been implementing improvement measures recommended by the Panel. There are three major areas worthy of attention: (1) designing and developing the software development process and work instructions. Compared to the original development process, the new process aims to provide more detailed requirements on software design and work instructions, as well as more concrete software safety analysis and scenarios for testing; (2) replacing the software design and development team for implementing the development process and work instructions; and (3) strengthening the monitoring and control, enabling both independent safety assessors appointed respectively by the MTRCL and the Contractor to identify any inadequacy in design or implementation as early as possible, and to recommend remedial actions.

Progress on implementing the improvement measures suggested by the Investigation Panel

8. Following the release of the investigation report, the Contractor immediately replaced the design and development team of the software that triggered the incident. The new team will design and develop the software development process and work instructions from a fresh perspective and mindset.

9. The Contractor had addressed such inadequacies based on the Panel's suggestions to enhance the software development and testing process, in order to prevent the recurrence of similar incident. The Contractor has made the following improvements in the software development process and work instructions:

- a) in the process of software development, coding, testing and implementation, the procedures and requirements in each step should be more concrete and detailed as compared to before, thus providing reference to staff to execute it later on, and facilitating monitoring and follow up actions taken by the Contractor, MTRCL and Independent Safety Assessors;
- b) effective and traceable functions have been introduced in the new development process and work instructions to detect any programming errors earlier, to prevent the situation where problems could only be identified during on-site testing stage; and
- c) to reduce the risk of unknown factors during on-site testing, the new development process and work instructions would increase the

scope of operations scenarios for simulation tests, so as to identify problems at an early stage.

10. With a view to enhancing the monitoring of the Contractor's work in implementing the software development process and work instructions, the Contractor has appointed an external Independent Software Assessor for the task; while the MTRCL has expanded the functions of the Independent Safety Assessor from safety assurance of the system before service commencement to cover certification of safety for on-site train tests. This would bring enhanced monitoring, ensuring that the software development has complied with the new process and work instructions.

11. With the efforts over the past year, under the monitoring of the MTRCL, the Contractor has completed the new development process and work instructions for the software, and has also verified a small part of the software under the new process and work instructions. Both Independent Assessors appointed respectively by the MTRCL and the Contractor were satisfied with the results. The next phase would be to test all the remaining functions of the new software according to the development process and work instructions, and to have them gone through all stringent safety tests and scenarios testing. The MTRCL will also continuously implement other improvement measures recommended by the Panel.

Latest timetable of Signalling Upgrade Programme

12. The new signalling system has been progressing in a prudent and incremental manner. Before commencing service, the new signalling system needs to go through multiple safety check and tests, including audit, scenario testing, static testing and gradual dynamic testing.

13. After the incident on 18 March 2019, the MTRCL has immediately suspended all on-site train tests pertinent to the signalling system upgrade programme, hence inevitably postponing the upgrade programme.

14. Taking safety as our top priority, the software verification and rectification process should not be hastened. We need to follow and implement step-by-step every detailed requirement of the new software development process and work instructions. The level of complexity of this task is comparable to re-creating a new software. Hence, the lead time

required for this stage of work would be long. The MTRCL estimates that it would take about a year and a half (till 2021) to complete the entire software verification and rectification. Upon the completion of the software verification and rectification for the new signalling system, repeated testing, and being certified by the Independent Assessors appointed respectively by the MTRCL and the Contractor, and with EMSD's endorsement, the MTRCL could then consider resuming on-site train testing in an incremental manner. The on-site train tests will commence with testing with one train, then multiple trains, and gradually to the whole line. These verification and on-site train tests would require another year and a half for completion. Hence, the signalling upgrade for Tsuen Wan Line would take approximately three years for completion (around 2023).

Other ground works for Signalling Upgrade Programme

15. Apart from software development, signalling upgrade programme includes basic infrastructure and hardware installation (such as computer facilities, cables and optical fiber, etc.) and relevant testing. To expedite the process, whilst revamping the software, the MTRCL has actively implemented the necessary installation of the basic infrastructure and hardware. Please refer to **Annex 2** for details.

16. The MTRCL has completed the installation of station and main trackside signalling equipment, and also static tests on the Island Line, such as train control computer facilities, sector computer equipment, cables, optical fiber, uninterrupted power supply, power supply equipment cubicles, electronic equipment cubicles, tags, WiFi access points, new wires, and new relays, etc. The relevant installation works on Kwun Tong Line have commenced since 2018. More than 70% of the above works has been completed, including installation of train control computer facilities, main trackside signalling equipment, sector computer equipment, cables, optical fiber, uninterrupted power supply, power supply equipment cubicles, electronic equipment cubicles, tags, WiFi access points, new wires, and new relays, etc. Signalling equipment installation tests and static tests on Kwun Tong Line have been frequently conducted during non-traffic hours at night. Furthermore, the MTRCL has started designing the new signalling system of Tseung Kwan O Line and preparing for the installation of basic infrastructure and hardware, including site survey and assessment for signaling equipment installation, and installation design for signalling equipment installation at trackside area and signalling equipment room. After completing the software verification and

rectification of the new signaling system, and repeated testing, and the signalling system of the Tsuen Wan Line replaced, MTRCL will start the testing in Island Line, Kwun Tong Line and Tseung Kwan O Line in the light of the experience in Tsuen Wan Line. For Tung Chung Line, Disneyland Resort Line and Airport Express, relevant planning is also underway.

17. As estimated at this moment, the new signalling system of the Island Line would commence service in about 18 months' time (around 2024/25) following the launch of the new signalling system on Tsuen Wan Line. The new signalling system on Kwun Tong Line and Tseung Kwan O Line will commence service within 24 months (around 2026/27) after the new system on Island Line is launched. The signalling replacement works on other lines will be done in the light of the experience in Tsuen Wan Line. The commencement timetable on various railway lines would hinge on the actual situation and adjustments may be required. The new signalling system for Tung Chung Line, Disneyland Resort Line and Airport Express require re-planning, to tie in with the Tung Chung Line Extension project. Some replacement works would be carried out after the completion of the Tung Chung Line Extension project.

Conclusion

18. The MTRCL understands the expectation of Members and the public on the signalling upgrade programme and apologises for the delay. We understand public concern on the impact to the capacity of train service caused by the delay. According to our observation, the current train service can meet passenger needs. The MTRCL will continue to closely monitor the train capacity, and implement relevant measures (including provision of fare promotions, increase in train frequency and enhance crowd management etc.), to ease crowdedness during peak hour. We will closely monitor the progress of our works in future, and step-by-step complete the signalling upgrade earlier, so that the capacity of the train service can be enhanced. The MTRCL will continue our efforts and timely report to the public on the matter.

MTRCL
June 2020

Extract of “Investigation Panel Report on Train Collision Incident at Central Station (Tsuen Wan Line) during a Drill on New Signalling System at Non-traffic Hours on 18 March 2019”

8. Recommendations

- 8.1 The Panel has made recommendations based upon the causes and the lessons learnt from the incident.
- 8.2 To prevent recurrence of similar incident due to the same causes, the Panel recommended ATDJV to:
- (a) replace the software design and development team causing the software issue;
 - (b) fix the software change issue and confirm with substantiation that there are no wider implications in software development quality;
 - (c) enhance the software coding and testing practices to avoid future programming errors and introduce effective and traceable measures for detection of any programming errors; and
 - (d) develop a full range of effective measures, including but not limited to (i) employing an external Independent Software Assessor to enhance the software development process for Computers A/B and C from its core product; (ii) reviewing, re-checking and demonstrating robustness on its approach with traceable evidence in applying a fail-safe principle; and (iii) conducting risk assessment in its software implementation with support from the Panel’s experts.
- 8.3 To assist ATDJV to address the above, the Panel recommended the MTR Operations Project Team to exercise extra vigilance and strengthen the monitoring on ATDJV’s deliveries to rebuild public confidence as below:
- (a) expand the scope of ISA from safety assurance for passenger service to the inclusion of on-site train related testing certification;
 - (b) upgrade the Training Simulator in Hong Kong to act as a 18 testing simulation tool to perform more scenario simulation tests as far as practicable;

- (c) establish a joint safety Test & Commissioning Panel (MTR/ATDJV together with input from the ISA) to manage the on-site testing; and
- (d) explore together with the Panel's experts on the merits, if any, for staging the development of the Warm-standby Computer C, or any other technically appropriate alternatives proposed by ATDJV.

8.4 Only with the consent obtained from the Government, will train testing of the new signalling system during non-traffic hours be allowed to resume.

Latest Signalling Upgrade Progress on railway lines

| Line | Latest progress |
|--|---|
| Tsuen Wan Line | Installation of station and main trackside signalling equipment completed. Train test suspended due to the incident on 18 March 2019. Currently testing and revamping the new software according to the new development process and work instructions. Initially, the estimated lead time for completing the signalling upgrade is about three years. |
| Island Line | Installation of station and main trackside signalling equipment and static tests already completed. |
| Kwun Tong Line | Completed over 70% of the installation works including signalling equipment at signalling equipment rooms in various stations and at trackside area (train control computer facilities, sector computer equipment, cables, optical fiber, uninterrupted power supply, power supply equipment cubicles, electronic equipment cubicles, tags, WiFi access points, new wires, and new relays). Signalling equipment installation tests and static tests are being conducted during non-traffic hours at night. |
| Tseung Kwan O Line | Already commenced the preparation for installing infrastructure facilities and hardware, including the site survey and assessment for the installation of signaling equipment, and installation design for signalling equipment installation at signalling equipment room and at trackside area. |
| Tung Chung Line, Disneyland Resort Line and Airport Express | Planning in progress. |