

## LTA Call for Solutions – Enhancing Traffic & Road Operations Using On-board Bus Cameras

### Responses to CFS Queries

#### Video Footage

1. Could a text file be provided with the metadata (such as GPS coordinates and timestamps) from the existing footage shared during the Technical Briefing?

The GPS coordinates and date/time stamp are tagged to the video footage. LTA will work with the selected participant(s) on data annotation during the POC stage.

2. Would it be possible to get camera footage from all cameras (other than the 4 cameras)?

There are a total of 5 exterior-facing cameras (4 of which LTA have provided footages). The last camera located at the rear of the bus was omitted, as the camera view is facing directly downwards on the road surface and has a significantly lower resolution which would not serve the purpose of the CFS.

LTA do not provide interior-facing camera footages due to privacy concerns.

3. Can LTA provide a larger and more relevant video sample set? We're particularly interested in videos that exhibit issues defined in the use cases and image quality.

More video footages with the respective issues will be shared during the POC stage.

4. For the POC, is LTA planning to share footage from all five cameras on the bus for each route?

Details of the POC including the video footages to be used will be shared at the POC stage.

5. Who would be responsible for the removal of Personally Identifiable Information (PII) - would this be done via LTA or the vendor?

Removal of PII shall be done as part of the VA processing by the vendor. Do note that traffic violations and illegal parking activities will require the recording of vehicle's licence plate number, which is not considered PII.

#### System Architecture

6. In the Problem Statement Pg 1 it states – “They (the recordings in the bus) can be retrieved manually from the on-board recorder”. Does this mean that currently the LTA does not auto transfer real time footage of the 6000 buses X 4 cameras over 4G to your central server?

Each bus has a DVR with an internal HDD where the footages are stored locally. Only upon official requests, the HDD will be pulled from the respective buses at the depot and the relevant segments of the footages will be extracted. Footages are currently not transferred over-the-air.

7. If the above in Q6 is true -- What is the current frequency of extracting the footage from the 6000 buses to transfer to the central server?

Extraction of footages is only done on request basis. Else, all footages will reside locally on every bus DVR.

8. What is the archival period of the daily footage in the on-board recorder of the buses? Is it archived on-board the bus recorder or in a central server?

All footages can be stored on the bus DVR for up to 1 month before they are overwritten with new footages.

9. How does LTA plan to provide access to the video streams? Will the vendor have access to the camera feeds via RTSP (Real Time Streaming Protocol) or some other protocol?

LTA understands that manual extraction of footages from the buses at the depots is cumbersome and limits the scalability of the solution. The aim of this CFS is to explore various architecture options (to be proposed by participants) and identify the optimal solution that can automate the video extraction process and ensure seamless end-to-end workflow.

10. Will data and servers be hosted on AWS, GCP, or on-premises infrastructure?

Refer to response for Q9.

11. Is there a need for a dedicated 4G transceiver, or is the use of an existing network required for posting detected violations?

Refer to response for Q9.

12. Is integration with an NVR (Network Video Recorder) required?

Integration with the existing DVR is required for eventual scaling but not for the POC.

13. Are the videos from the camera uploaded to the server via 4G network connection?

CCTV video footage is currently stored in HDDs on board public buses.

14. If the videos are uploaded via 4G network connection, which type of video server is used?

Refer to response for Q13.

15. Is our AI to be run only at the Central LTA Server after LTA has transferred the footage from the On-board recorder to the central server? Or can our AI run within the Bus On-board recorder (i.e. Edge computing)? Are we allowed to propose either/both options?

The participant may propose either/both options for LTA's review.

16. Is LTA open to replacing cameras on buses with higher fidelity cameras? The current video footage provided limits the scope of video analytics possible.

The footages provided are from 1080p cameras, and participants shall propose their solution based on the provided resolution.

The participants could state the limitation of the current cameras' resolution in meeting the CFS solution.

17. Besides the camera and GNSS, are there any additional CPUs or MCUs installed on the bus?

The participant will not be able to make use of any existing onboard processor and shall propose all hardware and software required for the POC.

18. Is the GNSS data (longitude and latitude) integrated into the video by the camera itself, or is it processed separately by an additional CPU or MCU?

The location coordinates will be tagged to the image by the onboard DVR.

19. Given that LTA prefers not to have In-Vehicle Unit for processing, what mechanism will be used to retrieve and transmit video data from the DVR on-board the bus to the backend system or end system, in line with the centralised video processing approach?

LTA has no preference over the location of the processing unit. We are looking for optimal solutions that are minimally intrusive with minimal fixtures and impact to bus operation.

20. In the envisioned architecture shown in the Technical Briefing, is the edge box (connected to the cameras and GPS and equipped with 4G) part of existing infrastructure, or is it expected to be provided by participant?

There is currently no edge box in-bus to serve this function and any edge box shall be proposed by the participant.

21. Does the edge box need to be physically located on the bus, or can it be at a remote site with an internet connection, such as in the cloud?

The participant shall propose the system architecture as part of the technical solution for LTA's review.

22. Are there any limitation on the size and type of edge devices that can be installed on buses? Can the devices tap power from the bus?

The participant shall propose and provide the size and power requirements of the edge devices for LTA's review.

23. Can the video streams stored in the edge box be accessed over the internet using the 4G connection?

The participant shall propose suitable communications media that adhere to the Government Instruction Manual for Infocomm Technology and Smart Systems Management standards (ICT&SS) and Authority's security guidelines to ensure data security.

24. Are there any cybersecurity requirements that need to be met during the POC for cloud-based solutions?

Yes. The design shall adhere to the Government Instruction Manual for Infocomm Technology and Smart Systems Management standards (ICT&SS) and Authority's security guidelines to ensure data security.

25. Will LTA be consolidating all the hardware / computing requirements required to support our solution (including - AI/ML/LLM) during the POC?

All hardware and software required for the POC shall be provided by the participant.

26. Can we add new cameras to the vehicle? Or can we only use existing CCTV camera footage?

The participant shall make use of the existing bus camera footage to meet the requirements.

27. If LTA is open to Edge Computing, are we allowed to propose (as an alternate solution), our own proprietary AI cameras which have AI pre-loaded onto it. This will work on a model where the AI Camera can detect the violation and then transmit the violation only (e.g. 10 sec clip) to the central server via 4G. If yes, could you provide specifications on the protocol, mounting height, and other installation requirements for the cameras?

Refer to response for Q26.

28. Are there any specific power limitations or requirements for adding additional computing engines to the buses?

The participant shall propose the power requirements for their solution for LTA's review.

## GPS

29. Where is the location of GPS unit on the bus?

The GPS unit is located inside the bus.

30. What is the GPS precision accuracy on board the current buses?

The GPS precision accuracy is ~10m.

31. Do all cameras maintain the same GPS positioning accuracy?

Yes.

32. Is the quality of the rendered coordinates the best GPS trace available or do the buses have a secondary GPS that can also be shared?

The participant shall use the CCTV GPS where feasible.

33. Will GPS logger access for the buses be provided during Pilot?

The GPS data is integrated with the video footage, as such, GPS logger access is not required and will not be provided during the POC.

34. Can we obtain the specifications of the cameras used? We're especially interested in understanding the GPS accuracy and video camera specs.

See question 30 for the GPS accuracy. Please refer to the footage provided for the resolution and fps.

## Detection Use Cases

35. Can LTA provide example photos of each defect type mentioned in the annex of the problem statement to help us identify what constitutes a defect?

LTA can provide sample photos of each defect type during the POC stage.

36. Can LTA provide more details on the guidelines for the traffic violations and illegal parking activities?

The enforcement use cases, along with their requirements for detection, are detailed in the CFS writeup.

37. Could you specify if there is an existing validation model or standard to be followed?

There is currently no existing validation model or standard to be followed for all use cases except for road infrastructure defects.

38. Will there be any last-mile validation required before detected events are issued or confirmed?

Last-mile validation may be required for some of the use cases.

39. For optimal asset mapping on the dashboard, will LTA be providing the GIS (Geographic Information System) location files during Pilot for the following or are we expected to map the same ourselves:

- Bus Stops
- Fire Hydrants
- BRTS Corridors
- Junctions
- Gantry
- Underpasses/Tunnels/Flyovers
- Carpark Lots/Entrances
- Service Roads
- Authorized Billboards etc.

LTA is able to provide the location files only for LTA-owned assets such as bus stops.

40. Is there a set of guidelines outlining how the reported issues and priorities are determined? For instance, how are the severity levels set for smaller or more significant road quality issues, large or small construction areas, and so on?

As a general guideline, defects or non-compliances that pose safety risks to road users will be rated as higher priority. More details will be shared during the POC stage.

41. How should the results be presented to LTA? Are you looking for a web app with ticketing support and progress tracking for reported incidents over multiple trips/days, or a pdf report with no data persistence between different days?

LTA is open to proposals that facilitate clear data presentation and ease of data extraction for analysis purposes.

### Intellectual Property

42. It is noted that annotated data and videos collection will remain the IP of LTA. Can we confirm that the IP for the any software code and AI models will remain with technology partner?

While the IP for software code and AI models will remain with the technology partner, LTA shall remain vested and have the rights to use and/or modify the foreground IP software code and AI models for the purpose of this project.

43. Can LTA confirm the following understanding regarding IP? All Background IP, including any enhancements, modifications or additions to such IP, is and shall remain the exclusive property of the Party owning it. IPs that subsist in the Services, AI Software (including the Application and Documentation, including

any enhancements, modifications or additions to such IP), and Jointly Developed Products shall vest in and be owned by the Supplier (in production stage after successful PoC).

Refer to response for Q42.

#### Administrative

44. Is the funding of overheads for Institutes of Higher Learning supported for this call?

No, overheads will not be supported for this call.

45. Is the funding of Principal Investigator (PI)/Co-PI supported for this call?

LTA will not be able to fund the salaries of the PI/Co-PI. These manpower expenditures, if any, may be considered as part of the participant's in-kind contribution to the project cost.

46. Can the deadline for submissions be extended?

LTA has extended the submission deadline by 2 weeks from 21 Nov 2024 to 5 Dec 2024.