MULTI-LANE FREE FLOW ELECTRONIC TOLL COLLECTION

1. **Background.** There are three existing expressways in Sri Lanka: (i) Southern Highway (SH), 126.3 kilometers (km); (ii) Outer Circular Highway (OCH), 18.9 km; and (iii) Colombo–Katunayake Expressway (CKE), 25.8 km. Current toll collection systems for the expressways have been historically developed on a project-by-project basis so the toll collection systems differ among expressways. The SH and the OCH use only manual toll collection (MTC) under a closed tolling system while the CKE provides both MTC and electronic toll collection (ETC) under an open tolling system. The SH and the OCH, and the CKE are not physically connected. However, once the rest of the OCH section is completed, the three expressways will be interconnected. The planned Central Expressway leading to the OCH will also join the network. Furthermore, the New Kelani Bridge (NKB), funded and implemented by the Japan International Cooperation Agency (JICA), links the CKE to the proposed toll elevated highway. The proposed South Asia Subregional Economic Cooperation (SASEC) Port Access Elevated Highway (PAEH) will form part of the expressway network. A modern and unified toll collection system will need to be introduced for the entire expressway network.

2. **Current toll collection system.** The current MTC being used in the SH and the OCH provides rather primitive systems with manually issued tickets at the entrances with a bar code printed on paper, and with cash payment at the exits based on travel distance and vehicle types recorded in the bar code.[1] All collected data are uploaded to the central service via general packet radio service (GPRS) for generation of toll reports.[2] There are several issues with the MTC: (i) no automatic vehicle classification system, (ii) disruption of ticket issuance and validation caused by the slow and narrow bandwidth GPRS communication system, and (iii) no end-to-end reconciliation reports produced from the system reports.

3. On the other hand, the CKE has an ETC system that uses radio-frequency identification (RFID) passive technology at 920–925 megahertz. However, the current ETC is a very limited system that requires ETC customers to slow down and to maintain proper distance between vehicles at the ETC lane for accurate detection and smooth operation of the system. The ETC system is directly connected to the Bank of Ceylon (BOC); BOC customers can automatically top up their ETC account or do it manually at BOC branches. However, users who do not have a BOC account can top up only through fund transfer or interbank payment system. In summary, the current ETC system has several shortcomings: (i) poor reliability of vehicle detection, (ii) possible multiple charging by detection of vehicles from adjacent lanes, (iii) limited maximum speed at 20 km per hour at the toll plaza, (iv) old and nearly life-expired in-lane equipment, and (v) limited method of payment.

4. **New toll collection system**. The expressways will be made into a closed expressway network; therefore, only a single payment on the network is a practical requirement. Due to the incompatibility of integrating the two different toll collection systems, a new toll collection system or one of the existing systems should be introduced to the entire expressway network. However, given the limitations of the current ETC system on the CKE, the Road Development Authority (RDA) does not recommend extending this system to cover the whole expressway network. The RDA prefers adopting a more advanced ETC system to meet all new future requirements in Sri Lanka. The core requirements for such future system are as follows: (i) all expressways are included within a closed system for toll collection; (ii) all expressways are subject to toll collection;

[1] Toll rates applied to SH and OCH are different based on different calculation basis.
[2] The GPRS is a packet-based wireless communication system providing data rates of 56–114 kilobits per second. This is recognized as 2.5G network services.

(iii) only one payment is required at the exit for expressway users during each journey within the network of tolled roads; and (iv) the capacity at toll points needs to be increased to efficiently accommodate future traffic demand. The PAEH and the NKB sections, which are urban highways, will expect higher traffic demand but have limited space for the construction of toll plazas. As such, the PAEH and the NKB sections will not have MTC; only an appropriate type of ETC will be considered.

5. Table 1 below compares toll collection options in terms of vehicle capacity in-lane. Considering the constraints to the PAEH and the NKB and the toll efficiency requirement for the short- and high-demand sections, the multi-lane free flow electronic toll collection (MLFF-ETC) is deemed to provide an optimal toll collection system for the expressway network. In addition to the advantages of vehicle speed and of no space requirement for toll plazas, the MLFF-ETC would also reduce the operational cost, provide benefit and convenience to road users through the cashless method of payment, and lessen greenhouse gas emission.

Table 1: Toll Option and Capacity

Toll Option	Toll Capacity (vehicle per hour)	Toll Plaza
Manual	130–240 (15 seconds per vehicle)	Required
ANPR	600–950 (4–6 seconds per vehicle)	Required
ETC in toll plaza	1,200–1,800 (2–3 seconds per vehicle)	Required
MLFF ETC	Only limited by road capacity	Not required

ANPR = automatic number plate recognition, ETC = electronic toll collection, MLFF = multi-lane free flow.
Source: Asian Development Bank.

6. It is to be noted that the procurement and installation of the MLFF-ETC will take nearly 3 years to complete; therefore, the current MTC and ETC will be used temporarily before the MLFF-ETC is in place. A transition arrangement also needs to be considered for users without required on-board units at the beginning of the MLFF-ETC operation.[3]

7. **Technical features of MLFF-ETC.** The MLFF-ETC is one of the most advanced but already proven ETC technologies that allow vehicles to drive through tolling points at high speeds without stopping or slowing down for the toll payment. The MLFF-ETC has been adopted in many countries such as Australia; Austria; Ireland; South Africa; United Kingdom; and the United States; and is going to be introduced in Indonesia, Malaysia, and other Asian countries.

8. The proposed MLFF-ETC for Sri Lanka expressways comprises four main components: (i) passive RFID tags for vehicles; (ii) construction of gantries at tolling points (over main lines or ramps); (iii) vehicle identification and classification devices equipped with the gantries (i.e., RFID readers, automatic number plate recognition [ANPR] cameras, and communication system); and (iv) a back-office system for charging, billing, and enforcement functions.[4] A vehicle approaching a tolling point will be detected and identified once within the signal communication zone between the passive RFID tag onboard and RFID readers. Visual information of the vehicle will be captured by the ANPR cameras to supplement the vehicle identification and classification. The information will be sent to the back office to connect with the vehicle owner's registered information, to create the bill, and to charge the toll to the account.

[3] For example, in some countries, vehicles without on-board units are allowed to drive through tolling points; however, toll payments will be charged later after the vehicle plate number is confirmed with ANPR cameras.

[4] There are several types of on-board units to be used for the MLFF-ETC. The passive RFID has significant advantage in the lower cost of tags ($1–$2 per tag) compared with other active tags such as dedicated short-range communication (DSRC) ($10–$20 per unit). Read rate accuracy is more than 99% regardless of the types of on-board units.

9. The Department of Motor Traffic (DMT) is in the process of installing an RFID tag for all newly registered vehicles in Sri Lanka. This RFID tag will contain a copy of the vehicle registration data, which are saved in the DMT's vehicle registration database system. The RFID tag can be utilized for toll collection, which will make it easier to link the information obtained at roadside to the vehicle owner's registered information in the back-office system. Since the cost of passive RFID tags is not expensive, the tags can be distributed to vehicle owners without charge. Increase in the number of travelers with the RFID tags will be a key to success in the installation of the MLFF-ETC. Thus, the passive RFID tags will have comparative advantages over the other on-board units.

10. A major advantage of ETC over manual toll collection is that it provides the opportunity for cashless or almost cashless operation. The passive RFID tags issued to users are linked to a specific account into which the user either loads a credit balance in advance (pre-pay) or for which the user receives a monthly invoice for the amount due. There are several well-established methods of payment available in Sri Lanka: bank transfer, prepaid cards, debit cards, and credit cards. As the smart phone users have rapidly increased in Sri Lanka, so-called e-payments through mobile phone applications are becoming more popular. The MLFF-ETC could provide payment channel mix leveraging the existing method of payment platform, in consideration of both operating costs and user acceptance of the system. As the RFID tags are connected to the vehicle registration, it would be an option, subject to further discussions with relevant authorities, not to allow vehicle owners to take the annual revenue license or to transfer the vehicle registration if they have unpaid balance to the toll charges.