Draft Specifications Document
For
RFID Tag and Transceiver
For
Nationwide ETC System

Apex Committee for ETC Implementation
Ministry of Road Transport and Highways
Government of India
New Delhi

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Abbreviations

AVC	Automatic Vehicle Classification
AVI	Automatic Vehicle Identification
CCH	Central Clearing House
EPC	Electronic Product code
ETC	Electronic Toll Collection
GUI	Graphical User Interface
ISO	International Standards Organization
kbps	Kilobits per second – a unit of speed of data communication
LED	Light Emitting Diode – a visual indicator
MHz	Megahertz – a unit of frequency of a signal
MIS	Management Information System
MOP	Method of Payment
OHLS	Over Head Lane Sign
RFID	Radio Frequency Identification
TID	Tag Identification – written into the Tag and locked by the manufacturer
TL	Traffic Light
TLC	Toll Lane Controller
UFD	User Fare Display
UHF	Ultra-High Frequency

Contents

1   Scope of Document

This document provides the Specifications for Radio Frequency Identification (RFID) Transceiver, RFID Tag and a solution for automatic identification of vehicles in a secure and reliable manner from a distance – which is a key component for implementation of Nationwide RFID, based Electronic Toll Collection System (ETC).

The security risks faced in such a scenario when using RFID Tags include business risk such as cloning or counterfeiting and intelligence risk such as skimming license numbers, vehicle identification numbers, or other personally identifiable information off of Tags.

Taking all these into consideration, an Automatic Vehicle Identification (AVI) application has to be developed using a combination of RFID Tags and Transceivers and providing the data as input to an ETC client application in the toll plazas in India.

The scope summary therefore is:-
   a)   Supplying the Tags
   b)   Commissioning of Tags
   c)   Supply and commissioning of Transceivers at the Toll Plazas
   d)   Interfacing AVI with ETC Client Software on the Lane Controller

2 Solution Development

2.1 Introduction

The solution developed is solely for the purpose of non-stop ETC and hence the functionality is limited to Tag authentication and data protection for the purpose of toll charge collection for the appropriate class of vehicle.

The system design approach has been to make the Tag and Transceiver a commodity that can be procured at competitive rates from vendors and the application controlled mainly by the client software that will be developed as a standard for non-stop ETC in the country.

It is to be clearly understood that this AVI system is not a substitute for existing Automatic Vehicle Classification (AVC) systems that may exist in many Toll plazas in the country.

2.2 Functional Requirements

The AVI system has been designed to address the following functional requirements, namely:

a) Multiple levels of security and authentication process

    i. Security of Tag issuance

    ii. The Tags should be non-transferable physically, once affixed to a vehicle

    iii. Mechanisms to authenticate Tags in the system:
        Authentication based on TID, EPCglobal compliant code & initiation code

b) Speed and accuracy of Reading the Tags at the required speed in a non- stop scenario.

c) The AVI must be able to operate as a stand-alone system independent of the toll collection system.

d) The AVI must be provided with a dual data stream to transfer its data to :

    i. ETC Client in the Lane controller

    ii. A separate AVI Data Management System located at the toll plaza.

e) AVI Configuration

The AVI shall be a stand-alone system with its own Tags, Transceivers, power supply, power backup (additional power backup over and above the toll plaza uninterrupted power supply), memory, enclosure etc. The AVI equipments shall be located in the Toll Lane as per the recommended Toll plaza geometry.

f) Automatic Vehicle Detection and Identification

The AVI shall detect the passage of every vehicle that passes in the reading range of the Transceiver. The RFID Tag on the vehicle is identified, authenticated and the information stored in the Tag is relayed on to the ETC client application in the Lane controller as well as to the AVI data management system.

g) AVI system functions

The AVI system shall perform the following:

I.   For each passing vehicle fitted with a RFID Tag, the Transceiver shall read the contents of Tags issued for the purpose of ETC and pass on the information to the TLC.

II.   The information passed by the Transceiver to the TLC shall include the contents of the Tag ID memory and EPC memory.

III.   ETC Client in the TLC shall process the information received from the Transceiver to validate the Tag ID, EPC memory contents comprising of EPC Code, the Vehicle registration no, the Vehicle class and the initiation code against those stored in the database at the time of Tag commissioning/initiation.

The transaction comprising of Time Stamp, amount charged, TLC identification as well as the contents of the Tag shall be recorded in the data management server.

3   Equipment specifications for Nation-Wide RFID based ETC System Components

3.1   Specifications for RFID Transceiver

3.1.1   General

Sr.	Parameter	Particular
1	Frequency	UHF 865 MHZ to 867 MHZ *
2	Communication	Ethernet/ Serial communication (EIA standard RS 232 C)
3	RF Power maximum	1 W – transmitted & 4 W – EIRP (Equivalent Isotropically Radiated Power) *
4	Reading distance	With the Transceiver mounted typically at a height of 6 m above the road surface, the coverage of the antenna shall not exceed a diameter of 3.6m.
5	Antenna	Circularly Polarized
6	Protocol	EPC Gen 2, ISO 18000-6C and shall comply with the general conformance requirements of the standard
7	Visual diagnostics	The Transceiver shall have LED indicators for sense, transmit Fault and Power which shall be visible clearly to the operator on ground while the system is operational.

*is in the wireless license free band for RFID use in India. Typical existing product(s) for 'RFID- based-ETC' operates in the 865 MHz – 868 MHz band.

3.1.2   Environmental

Sr.	Parameter	Particular
1	Enclosure	Light weight enclosure for the RFID Transceiver and circularly polarized antenna
2	Environmental	IP 66 or better
3	Relative Humidity	100% Condensing
4	Operating Temperature	-20°C to 55°C
5	Storage Temperature	-40°C to 85°C

3.1.3   Operating Characteristics

Sr.	Parameter	Particulars
1	Air Interface & Adaptive Noise Features	The Transceiver technology employed should have the capability to optimize read rates for the vehicle identification application and adapt to instantaneous noise and interference level
2	Application capability	1. Should have read reliability exceeding 99.9% in the distance range specified. 2. Diagnostic and Reporting Tools
3.	Upgradeability	The firmware should be upgradable to support future protocols.
4	Transaction Capability	Reading of Tag & EPC memory for at least 10 Tags per second

3.2   Specifications for RFID Tag

The Tags shall be essentially non-transferable RFID transponders designed to be used in conjunction with compatible Transceivers and are meant to identify the vehicle for ETC application.

3.2.1   General

Sr.	Parameter	Particular
1	Power	Tags are Passive
2	Frequency	UHF 860 MHZ to 960 MHZ as per EPC Gen 2 standards
3	Data Transfer Rate	At least 512 kbps
4	Protocol	EPC Gen 2, ISO 18000-6C
5	Dimensions (including the substrate/ backing)	Maximum area occupied on the windshield shall be 50 Sq. cm.
6	Material	Plastic substrate with printed antenna
7	Physical printing of Tag ID on the Tag	The Tag ID shall be physically printed on the Tag using the Hexadecimal numbering system and shall be adequately clear for easy visual recognition

3.2.2   Environmental

Sr.	Parameter	Particular
1	Relative Humidity	95% Condensing
2	Operating Temperature	-20°C to 55°C
3	Storage Temperature	-40°C to 100°C

3.2.3   Installation

Sr.	Parameter	Particular
1	Location	The RFID Tag shall be installed at a fixed location on the inside of the Windshield of the vehicle. *
2	Installation mechanism	The RFID Tag shall have a self-adhesive backing with which it can be fixed to inside of the windshield. The adhesive shall be such that - It allows reliable and accurate reading of the Tag by the Transceiver located at a specified distance. - The RFID chip and/ or the antenna get irreparably damaged when an attempt is made to remove the installed Tag from the windshield by any means. After such an attempt the Tag shall become inoperable.

*location to be optimized for each class of vehicle during trials

3.2.4   Memory

Sr.	Parameters	Particulars
1	Tag Memory (minimum)	Unique Tag ID – 64 bits, EPC memory – 240 bits
2	Data Retention	10 Years minimum

4   AVI Processes

4.1   Tag Commissioning

4.1.1   Each Tag will be required to have a non-changeable Tag ID, a unique EPCglobal Tag data standard Compliant code, both of which must be read by the Transceiver.

4.1.2   At the time of personalization, the POS module shall read the unique Tag ID and allocate an EPC code & a randomly generated initiation code. It shall then write the EPC code, Vehicle registration number, vehicle class code and the initiation code in the EPC memory area using the software module provided by NIC. The Tag ID, EPC code, Vehicle registration no., the vehicle class code and initiation code shall also be stored in the database.

4.2   Tag initiation

4.2.1   Tag initiation will be a process carried out during Tag commissioning and when the original owner suspects a cloning of the RFID Tag.

4.2.2   The Tag initiation software shall generate a random initiation code and read Tag ID, EPC code, vehicle registration no and vehicle class code from the Tag mounted on the windshield. After due verification from the central database, the values (initiation code) shall be updated on the Tag as well as on the database. Old initiation code and EPC code shall be blacklisted for 'catching' the clone.

4.3   Automatic Vehicle Identification at Toll Point

4.3.1   The communication sequence between the Transceiver and Tag shall conform to ISO 18000-6C.

4.3.2   The Transceiver shall retrieve the Tag and EPC memory contents for those Tags whose EPC code satisfies the mask stored in the Transceiver for a matching entry. The EPC code shall be used to index into the database from where the Tag ID, Vehicle registration no., the Vehicle class code and the initiation code will be retrieved from the database and verified against the corresponding values read from the Tag.

5 Data format

5.1 Schematic
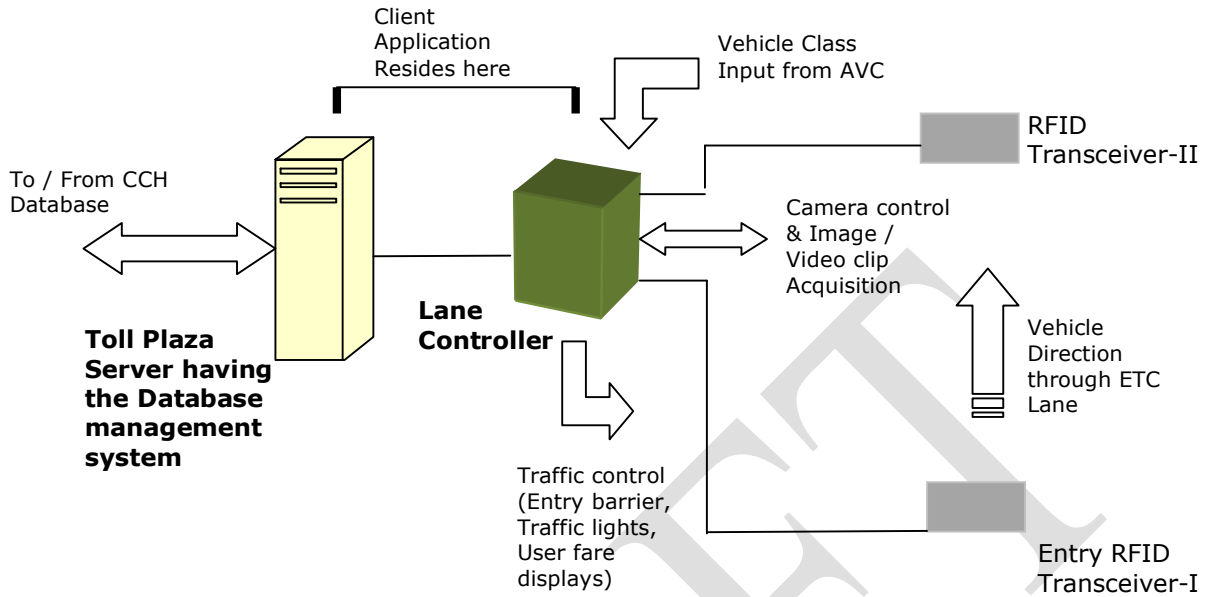
5.2 Data downloaded from Central Database into Data Management System (Toll Plaza Server) and each lane controller

Sr	Data	Size and format	No. of Values of Data Parameter to be stored in the Data Management System	Remarks
1	Tag ID (The Tag ID on the Tag is only 8 bytes long but extra memory has been provided in the database)	20 Bytes per vehicle	5,000,000	Written into the Database during Tag commissioning
2	EPC Code	12 Bytes per vehicle	5,000,000	Written into the Database during Tag commissioning
3	Vehicle Registration number	12 Bytes per vehicle	5,000,000	Written into the Database during Tag commissioning
4	Vehicle Class code	2 Bytes per vehicle	5,000,000	Written into the Database during Tag commissioning
5	Initiation code	4 Bytes per vehicle	5,000,000	3 bytes random no and 1 Byte checksum on Item nos. 2 to 5

6	Tag Status (Valid, Exempt, Blacklisted)	1 Byte per vehicle	5,000,000	

The above data is downloaded from the central Data base at User-settable time intervals varying between 15 min to 8 hours.

5.3   Toll Tariff tables downloaded from Central Database into Data Management System (Toll Plaza Server) and each lane controller

This table contains the approved toll tariff records for the toll plaza. The toll tariff can be based on vehicle class, lane type, time of day and shall be applicable from a given start date only. The table will contain all the toll tariff records – the old, current and future. Any discounting for local road users must be done by the clearing house. The table is likely to be updated each time the toll tariff is revised (typically about once in 2 years).

Sr	Data	Size and format	No. of Values of Data Parameter to be stored in the Data Management System	Remarks
1	Vehicle Class Code	2 Bytes	As many required	
2	Lane Type	20 Bytes	As many required	Valid Values will be 'Cash Lane', 'ETC Lane', 'Premium cash lane...
3	Valid from Date	20 Bytes	As many required	Date of start of applicability of toll fare
4	Time Interval from	20 Bytes	As many required	Can be used for time differential toll charges
5	Time Interval till	20 Bytes	As many required	Can be used for time differential toll charges
6	Toll Amount	10 Bytes	As many required	

5.4   Transaction Data generated by client application for ETC vehicle

Transactions generated (described under section 2.2.g.III in this document) by the client application is transferred to the Central Clearing House database. Each Transaction consists of the following items:

Sr	Data	Data Size	Remarks
1	Date and Time Stamp	20 Bytes	Time stamp of the vehicle passing through the toll plaza
2	Tag ID	20 Bytes	As read from the vehicle and verified against the database

3	EPC Code	12 Bytes	As read from the vehicle and verified against the database
4	Vehicle Registration number	12 Bytes	As read from the vehicle and verified against the database
5	Vehicle Class code	2 Bytes	As read from the vehicle and verified against the database
6	Initiation code	4 Bytes	As read from the vehicle and verified against the database
7	Tag Status (Valid, Exempt, Blacklisted)	1 Byte	As read from the toll plaza replica of the CCH database
8	Toll Amount	10 Bytes	Non-Discounted. Any discount on this shall be implemented by the Clearing house
9	Vehicle Image	100 kb	

Transactions shall be uploaded into the central Database at User settable time intervals varying between 5 minutes to 8 Hours (Vehicle image need not be uploaded to the Central database to minimize the network bandwidth).

The Data management system (Toll Plaza server) shall have the capacity to store at least **280,000** such transactions per lane.

5.5   Data in Central Database for ETC vehicle

Replica of this data (Item 1 to 6) shall be available at the toll plaza. The replica shall be made for only valid Tags including those that are blacklisted.

Sr	Data	Size and format
1	Tag ID (The Tag ID on the Tag is only 8 bytes long but extra memory has been provided in the database)	20 Bytes
2	EPC Code	12 Bytes
3	Vehicle Registration number	12 Bytes
4	Vehicle Class code	2 Bytes
5	Tag Status (Valid, Exempt, Blacklisted)	1 Byte
6	Initiation code	4 Bytes
7	Tag Registration Date	20 Bytes
8	Vehicle Owner details consisting of name, address, phone numbers, bank account details, credit card details, balance details (when paid, amount paid and current balance), valid-upto details	a) Name – 90 Bytes (including first, middle and Surname) b) Address – Free format Phone numbers –Landline and Mobile telephone numbers – 15 bytes each E-mail address – Free format

(when the information is going to be not considered)	d) Bank Account details: Account No -12 Bytes, Bank Name – 10 Bytes, Branch Name – 12 Bytes IFSC Code – 12 Bytes e) Credit Card Details: Credit card No – 16 Bytes, Type of Card (Visa/ Master Card/…) – 11 Bytes, Issuing Bank – 10 Bytes 'Valid up to' Date – 20 Bytes f) Balance Details: Date paid – 20 Bytes, Amount paid – 10 Bytes, Current balance – 10 bytes g) 'Valid up to' Date – 20 Bytes