International Bridge, Tunnel, and Turnpike Association

North American Toll Interoperability Program

Electronic Toll Collection Protocol

Requirements Document

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1 Introduction

During the summer of 2012 the International Bridge, Tunnel, and Turnpike Association's Interoperability Committee formed a "Technical Subgroup" in order to begin discussions of requirements for tolling interoperability in North America. The goal was to establish a set of requirements for protocol(s) to be used by in-lane equipment and tags/transponders that would provide interoperability for participating members of the traveling public and also meet the technical and business needs of the toll operators.

The IBTTA requirements initiative is meant to serve as a basis upon which further planning and design work can move the industry toward compliance with MAP-21, a federal law signed into law in 2012, which calls for a nationally interoperable system by July of 2016.

There are roughly six separate radio frequency-based "protocols" used in North America to collect toll from participating travelers. These protocols, while all based on radio communication in the same band of spectrum (902-928 MHz), are not compatible with each other.

The aggressive schedule for MAP-21 eliminates the possibility of moving away from RF-based identification systems. In addition, the industry has a large investment in the installed base of equipment. For these reasons, the Technical Subgroup (TSG) has focused its efforts on requirements for RF-based systems, since it is very likely that only protocols currently in use are feasible candidates for use across all of North America within the MAP-21 schedule.

This document is intended to be the formal statement of the requirements for any protocol selected to be a candidate for serving as a "National Protocol". The goal is to get agreement on these requirements so that a decision can be made about which protocol(s) will be tested and eventually selected for the final interoperable system.

2 Nature/Scope of this Document

The intention of the IBTTA is to specify the requirements for Radio Frequency Identification (RFID) protocols that could be used to meet the needs for an interoperable toll network of North American toll operators. This effort focuses on those needs by determining the requirements rather than on specific existing or proposed technologies or products. The requirements for the ETC Protocols are described in terms of on-board units ("OBUs") and roadside equipment ("RSEs"). These are used as generic terms and are not intended to indicate the use of a specific technology.

IBTTA recognizes that many hardware components, software modules, and operational issues are involved in an overall program to implement an Electronic Toll Collection (ETC) system. The technical requirements herein, however, deal specifically with the system component that provides the ability to automatically and in real-time communicate a unique identifier and other data stored in an OBU traveling with a vehicle passing through a toll lane/zone. Other equipment in the toll lane and/or back office then determines the toll assigned to that vehicle.

The Technical Subgroup (TSG) focused on technical requirements without regard to possible costs to implement compliant equipment and/or changes that might be required to other aspects of the overall toll collection process.

The primary purpose is to define requirements for Protocols, not Products. To the extent possible, this document is limited to protocol requirements that are intended to serve as the NTP. However, since the selected protocol(s) must be able to operate in tolling environments (which are the result of significant investment) some requirements that go beyond just protocol needs are included. These additional requirements are intended to ensure the selected protocols are properly defined and to guide the testing program that will follow agreement on requirements.

2.1 Abbreviations, Definitions and Terminology

For the purposes of this requirements document, the term "ETC Protocol" shall be used to refer to an RF-based identification methodology which uses roadside and vehicle based equipment to communicate certain data elements between those two locations.

The term Onboard Unit (OBU) shall be used to refer to the vehicle-based device.

The term Roadside Equipment (RSE) shall be used to refer to all of the equipment necessary at the roadside in order to carry out the functions defined herein

Following is a list of other abbreviations used in this document:

AVC - Automatic Vehicle Classification
DMV - Department of Motor Vehicles: Not intended to refer to any particular state's DMV but the corresponding agency in all relevant states or provinces.
ETC - Electronic Toll Collection
FCC - Federal Communications Commission

GPS - Global Positioning System
ID – Identification
IBTTA -International Bridge Tunnel and Turnpike Association
I/O - Input/output
MHz - Megahertz
NEMA - National Electrical Manufacturers Association
NTP – National Toll Protocol (interoperable protocol as specified by IBTTA)
OBU - On-board Unit
ORT - Open Road Tolling
Protocol – A method of communication based on sending and receiving messages
RF - Radio Frequency
ETC Protocol – Radio Frequency Identification Protocol
RSE - Roadside Equipment
TCP/IP – Transmission Control Protocol/Internet Protocol
VES - Violation Enforcement System

3 ETC Protocol Requirements

3.1 Single and Multi-Protocol Requirements

The requirements herein apply to NTP RSE and OBU devices intended to operate in single and multi-protocol environments. Single protocol NTP environments are considered to only operate with the use of the NTP specified protocol, where as multi-protocol environments are intended operate with both the NTP protocol and the existing protocol(s) of a toll operator.

The requirements herein apply only to the performance of the RSE and OBU devices operating in the NTP mode in a dual-protocol environment. It is recognized that toll operators may have existing protocol(s), functionality, and performance requirements different from those specified in this NTP document. It is not the intent of this document to make changes to the requirements of any toll operator, but rather to define the performance capability of the NTP devices that may be used by a toll operator to support interoperability. It is the expectation that the NTP devices will meet the requirements of this document, while simultaneously meeting local toll operator requirements for one of the following other protocols in use. The local toll operator protocols are commonly known as one or more of the following:

- Allegro
- ASTM v6
- ATA
- ISO 18000 6C (63)
- SeGo (eGo Plus)
- TDM (IAG)
- Title 21

For a dual-protocol environment, the performance of the local (non-NTP) protocol cannot be degraded by the addition of the NTP protocol by more than 60%, based on the average number of 'handshakes' obtained by the existing protocol.

3.2 Organization of the Requirements

The requirements have been organized into the following categories:

- Legal and Safety Requirements (Section 3.3)
- "Open Protocol" Requirement (Section 3.4)
- Functional Requirements (Section 3.5)
- Operational Requirements (Section 3.6)
- Performance Requirements (Section 3.7)
- OBU Data Requirements (Section 3.8)
- Environmental Requirements (Section 3.9)

3.3 Legal and Safety Requirements

3.3.1 Regulatory Compliance and Licensing

The ETC Protocol, when incorporated into tolling equipment, shall comply with applicable federal, province, state and local licensing and regulations for the technology in question.

3.3.2 Spectrum Usage

The OBUs and RSEs utilizing the protocol shall operate in such FCC allocated radio frequencies as appropriate for this application.

3.3.3 FCC Licensing

All ETC equipment using the protocol shall comply with all FCC requirements. OBUs shall not require an operating license. RSE's shall operate and require a license to provide protection from interference. If there are different levels of license available (primary, secondary, other), the ETC Protocol shall be eligible for no less than a secondary license.

3.3.4 Resistance to Interference

Equipment utilizing the ETC Protocol shall be able to be made resistant to electromagnetic interference or noise, electrical interference, and mechanical interference that may typically be found in a toll plaza environment from sources such as, but not limited to, wireless data and voice services, satellite radio signals, GPS devices, vehicle electronics, ignition systems, electrical appliances, lightning (except for direct hits), other toll registration equipment in and/or near toll booths, power tools, power lines, power transformers, mobile and portable communications radios, cellular telephones, walkie talkies, VES equipment, security systems, lighting, speed radar sources and detectors, refrigeration units, windshield wipers, detuned engines, defrosters, and any moving parts. Resistance to direct, in-band signals of significant signal strength is not included in these requirements.

3.3.5 Safety

Equipment utilizing the ETC Protocol shall be able to meet or exceed all applicable safety and environmental requirements related to the technology and its applications in addition to any requirements listed herein. The equipment shall not pose either a short-term safety risk or a long-term health risk to drivers, toll collector, technicians, and other people who may frequently be in the vicinity of the equipment in operation. All RSE components shall be able to operate continuously and still meet all pertinent specifications stated herein. RSE components must be installed per the manufacturers' installation guidelines.

All transactions shall be automatic without any involvement of the driver, except with a possible exception of moving an external switch on a "switchable tag". The OBU devices shall allow for the placement of safety labels as required by prevailing laws, regulations, and standards of the State in which they are issued.

3.4 "Open Protocol" Requirements

3.4.1 Definition of "Open Protocol"

Any protocol chosen for North American interoperability of electronic toll collection (ETC) equipment which includes, but is not limited to, the readers and transponders necessary to identify the ETC account associated with a vehicle passing through a tolling point must satisfy the following criteria:

- The protocol shall include specifications and operational information that:
  - are documented, published for all to use, and readily available on a royalty-free or a fair and reasonable basis;
  - describe the parameters necessary to allow anyone to manufacture readers, transponders and other ETC equipment that can be independently certified as meeting the published specifications. Adequacy of this documentation will be subject to a peer review process;
  - do not withhold any detail necessary for interoperable implementation; and
  - contain no unreasonable constraints on re-use or modification.
- A continuing obligation from the owner and/or licensor of the protocol to offer all persons the unrestricted right to implement, use, and exercise other rights with respect to all technology and intellectual property necessary to implement the protocol (including the right to use, make, have made, market, import, offer to sell, and sell, and to otherwise directly or indirectly distribute ETC equipment that implements the protocol's specifications) under:
  - a royalty-free and otherwise reasonable and non-discriminatory license; or
  - a license that contains Fair, Reasonable and Non-Discriminatory (FRAND) terms and conditions that do not unduly restrict competition.

3.4.2 Compliance with Published Specifications

Equipment utilizing a candidate ETC Protocol shall fully comply with the published specifications referenced in Section 3.4.1.

3.5 Functional Requirements

3.5.1 Basic Functions

Devices using the ETC Protocol shall be able to establish a communication link between the roadside and vehicle in order to determine the unique identifier and other associated data stored in an OBU contained in or attached to the vehicle and communicate these data to the lane/zone controller. Other communication functions are described below.

3.5.2 Roadside Equipment (RSE) Requirements

The RSE is defined as encompassing all toll plaza equipment (e.g., antennas, similar devices, cables, readers and any electronics modules) utilized to communicate with the OBU and to process data for communication to the existing lane or zone controllers.

Equipment utilizing the ETC Protocol may use different RSE configurations for different purposes (single lane, multi-lane, open road tolling, etc.) but they all shall meet the requirements stated herein except if explicitly stated otherwise.

3.5.2.1 Operational Environment

The ETC Protocol shall support the ability of equipment to operate in both traditional plaza environments and open road tolling environments. Current environments include traditional plazas with at least 28 lane and open road environments with at least 6 lanes of live traffic and 2 shoulder lanes. Protocols should support as many lanes as needed, without any logical maximum limit.

In a multi-lane environment the Protocol shall support methods to avoid adjacent lane interference (if desired).

3.5.2.2 Equipment Location

The in-lane equipment shall typically be located outdoors attached to pipes, posts, toll booths, canopy support columns or other suitable means of support. RSE electronic components shall typically be located outdoors in suitable weatherproof enclosures but may be located indoors (e.g., inside toll booths, the toll plaza tunnel, or the toll plaza building) at the discretion of the Operator.

3.5.2.3 Overhead Equipment

IBTTA Members have a variety of canopy layouts and clearances. Equipment using the ETC Protocol shall meet the accuracy requirements herein for all antenna mounted heights between 13.5 feet and 20 feet.

3.5.2.4 Security

Security requirements shall include features typically deployed with the protocol by toll operators in North America.

3.6 Operational Requirements

3.6.1 Operational Modes and Environments

Equipment utilizing the ETC Protocol shall be required to operate in numerous operational modes and environments. These operational modes include various combinations of the following attributes:

- Payment models
    - Entry or Exit payment only
    - Closed (entry and exit) payment;
    - HOV/HOT facilities
- Toll collection sites
    - Toll plazas
    - Open road tolling sites;
- Lane toll collection configurations
    - *ETC*-only
    - *ETC* with automatic coin machine
    - *ETC* with automatic coin/cash/credit card machine
    - *ETC* with staffed booth
    - *ETC* with automatic coin machine and staffed booth
    - *ETC* with tandem booth (the lane supports two vehicles paying at the
    - same time);
- Lane speeds
    - High-speed
    - Low-speed
    - Stopped, no gate
    - Stopped and gated
    - High-speed gated
    - Low-speed, no gate; and
- Traffic flow characteristics
    - Free flow
    - Bumper to bumper
    - Tailgating
    - Stop and go
    - Backing up
    - Lane Straddling

3.6.2 Definitions

3.6.2.1 Lane Types

The ETC Protocol shall support both conventional toll plaza lanes as well as high-speed open road tolling lanes. These lane types may be stand-alone configurations or adjacent to other lane types. Lanes in traditional plazas may vary from 10 to 15 feet in width and up to 20 feet in height. Open Road Tolling Lanes may vary from 11 to 12 feet in width and up to 20 feet in height.

- Open Road Tolling Lanes

  An open road tolling lane is a lane where a toll is collected but there are no toll booths or other toll collection equipment beyond that needed for electronic toll collection, allowing the vehicle to continue at highway speeds at any lateral position across the provided lanes or shoulder. An entry open road tolling lane in a closed system is a lane where the entry into the system is identified but there are no toll booths or other toll collection equipment beyond that needed for electronic toll collection, allowing the vehicle to continue at highway speeds at any lateral position across the provided lanes or shoulder.

- Traditional Toll Plaza Lanes

  A traditional toll lane is part of a toll plaza where tolls may be collected by toll collectors in booths, automatic coin machines, and/or electronically. Lanes dedicated to electronic toll collection in a toll plaza environment are considered toll lanes even if they do not require the vehicle to slow down. An entry lane in a closed system is part of a toll plaza where the entry into the system is identified.

- Reversible Lanes

  A reversible lane is a lane where tolls may be collected from vehicles traveling in either direction during different periods of the day.

- Express Lanes

  Express lanes are dedicated ETC lanes which permit higher speeds than toll lanes and may have some lane delineation and equipment installed around the lane.

- High Speed Lanes

  High speed lanes are lanes where the vehicle may pass through the toll collection site at or near highway speeds. These may be present in open road tolling and toll plaza sites.

- Low Speed Lanes

Low speed lanes are lanes where the vehicle must slow down well below highway speeds while passing through the toll collection site. These are typically found in toll plazas to enhance safety.

- Gated Lanes

  Gated lanes are lanes in a toll plaza where a gate is used to prevent passage of vehicles until the lane/zone controller provides confirmation that a valid ETC, cash or credit transaction has occurred.

- Dedicated Lanes

  A dedicated lane is a lane where only one form of payment is accepted such as a lane where only OBU-equipped vehicles can pass without triggering a violation enforcement system. A dedicated lane may be gated to control violations.

- Mixed Mode Lanes

  A mixed mode lane is a lane where multiple forms of payment are accepted. For example, it could consist of any combination of manual toll collection, Automatic Coin machines as well as ETC.

- Tandem Lanes

  A tandem lane is a lane configured such that two tollbooths are situated one in front of the other, allowing two vehicles in the same lane to make payments at the same time.

- High Occupancy Toll (HOT) Lanes

  HOT lanes are limited-access, normally barrier-separated, highway lanes that provide free or reduced cost access to qualifying High Occupancy Vehicles (HOVs), and also provide access to other paying vehicles not meeting passenger occupancy requirements.

3.6.2.2 Lane/Zone Controller

The term “lane controller” or “zone controller” refers to all hardware and software necessary to interface with the RSE to receive the OBU-stored data.

3.6.2.3 Properly Mounted/Presented OBU

A properly mounted/presented OBU is an OBU that has been mounted/presented in accordance with the Manufacturer’s specifications and tolerances. When an OBU is properly mounted or presented in accordance with the specifications the OBU data shall be communicated to or captured by the RSE.

3.6.2.4 Read

A read is defined as the transfer of data stored in an OBU contained in or attached to a vehicle as specified herein to the RSE for subsequent transmission to the lane/zone controller as the result of the passage of the equipped vehicle through the Capture Zone.

3.6.2.5 Write

A write is the ability of the RSE to transmit and store new or modified data to/on an OBU for later access or further modification.

3.6.2.6 Capture Zone

The Capture Zone is defined as a volumetric space within which the system performs any vehicle identification, communications, and transactions.

The ETC Protocol shall support the ability of RSE's to utilize Capture Zones that ensure that the required capture rate, at a minimum, is achievable under all traffic conditions, speeds, conditions of congestion (e.g., bumper-to-bumper, stop and go, free flowing), environmental conditions and mixes of vehicle types which occur at the reading location.

3.6.2.7 Capture Compatibility

Capture Compatible OBUs are any OBUs which have the same "over the air" characteristics and some commonly recognizable data fields, such that the RSE can conduct transactions (reads and/or writes) with the OBU in a manner similar to those conducted for OBUs which are actually issued by the Operator. OBUs issued by the Operator are, by default, Capture-Compatible OBUs.

3.6.2.8 OBU Capture

OBU Capture is defined as the RSE's successful completion of a transaction with an OBU where a transaction is a successful "read" and "write" (where applicable). A successful 'read' is achieved when the ETC Protocol is able to correctly determine the fixed identification data (e.g. read only fields) as well as the variable data associated with a vehicle that may have been set by a prior lane/zone controller and RSE (write fields). A successful 'read' and 'write' are achieved when the variable data fields are demonstrated to have been correctly updated so that they are available to RSEs at other tolling points.

3.6.2.9 Reporting Zone

The Reporting Zone is defined as a linear portion of the lane within which a vehicle will be present when the RSE reports the result of an interaction with an OBU to the lane/zone controller. The Reporting Zone is important in that current lane/zone controller algorithms make assumptions about the location of OBUs for association with vehicles that are detected using other roadside equipment. In keeping with the preference to maintain existing lane/zone

controllers and algorithms, the ETC Protocol should support reporting zones similar to what is in current practice.

Reporting Zones shall be designed to ensure that the required capture rate, at a minimum, is achievable under all traffic conditions, speeds, conditions of congestion (e.g., bumper-to-bumper, stop and go, free flowing), and mixes of vehicle types which occur at the reading location.

3.6.2.9.1 Toll Lanes

The ETC Protocol timing shall support the ability to limit the Toll Lane Reporting Zone length for each lane type so as to permit no more than the properly mounted/presented OBU of one vehicle to be present in this space at a given time. The Reporting Zone shall be shaped such that it enables an upstream system (i.e. lane controller) to perform unambiguous correlation between each vehicle with a properly mounted/presented OBU. This includes the requirement that transactions reported by the RSE shall be done so in the same order as the vehicles passing through the toll lane.

3.6.2.9.2 Open Road Tolling

The ETC Protocol timing shall support the ability to limit the Reporting Zone such that it enables an upstream system (i.e. lane controller) to perform unambiguous correlation of each vehicle with a properly mounted/presented OBU and the OBU in/on that vehicle. This includes the requirement that transactions reported by the RSE shall be done so in the same order as the vehicles passing through the Reporting Zone. This also includes the requirement to be able to report the lateral location of the vehicle to the extent necessary for upstream systems (i.e. lane controller) to perform unambiguous correlation between an identified OBU and the vehicles detected in the zone.

3.6.2.10 On-Board Unit Requirements

Any OBU or other vehicle-based Equipment included in the ETC Protocol shall conform to the requirements of this Section.

3.6.2.10.1 OBU Types

OBU Models will fall into two general OBU types. Those OBU types are ones that are suitable for mounting/presentation on/from the “interior” of the vehicle and those that are suitable for mounting on the “exterior” of the vehicle. An interior OBU type is defined as an OBU whose mounting/presentation location is within the passenger compartment of the vehicle. An exterior OBU is defined as an OBU whose mounting location is outside the vehicle’s passenger compartment.

These two types of OBUs can further be categorized as to the mounting/presentation requirement, battery and non-battery powered, feedback, and switchability. The following is a list of definitions for these items.

"Permanent mount" is a method of attachment for the OBU that if the OBU is removed from its mounting will result in it becoming permanently unusable.

"Transferable OBU" is an OBU that can be easily moved from one vehicle and mounted/presented from another vehicle.

"Battery powered" is defined to mean an OBU that operates using the power provided by a battery.

"Switchable" is defined as an OBU that is equipped with a user-operable switch that can be used by vehicle operator to indicate occupancy of the vehicle. The position of the switch is communicated to the RSE for use in determining occupancy-based tolling benefits.

"Feedback" OBU's are OBU's that perform a function that indicates to the vehicle operator/occupants the result of a trip past a tolling point. This feedback can be visual or audible.

3.6.2.10.2 Required OBU and Optional OBU Types

The ETC Protocol shall be required to support, at a minimum, the following OBU Types:

- Interior Transferable
- Interior Permanent Mount
- Interior "Switchable"
- Interior "Feedback"
- Exterior Mount

3.6.2.10.3 General OBU Requirements

All OBUs shall meet the following general requirements.

3.6.2.10.3.1 Consumer Product Safety

All components used in the OBU should be approved for use in consumer products in terms of safety. The OBU shall not give off dangerous substances at any time including when damaged.

3.6.2.10.4 Interior OBU Requirements

The following requirements regarding interior-mounted/presented OBUs shall be applicable to all types of interior-mounted/presented OBUs in all vehicles.

3.6.2.10.4.1 Location

The preferred mounting location for interior-mounted OBUs is within the passenger compartment of the vehicle on the windshield either at the base of or behind the rear view mirror.

Mounting/presentation locations are acceptable where interior OBUs will operate per these specifications and alternate mounting locations required due to performance reasons.

Alternate mounting/presentation locations shall not violate any state or province DMV (or Operator state or province equivalent) and Vehicle Code regulations.

Any alternate or additional mounting/presentation locations shall not conflict with existing vehicle registration stickers or vehicle inspection stickers and decals which are typically located in the lower left or lower right corner of the windshield.

The OBU location shall not obstruct with the driver's view of the road.

OBU mounting locations shall accommodate all vehicle types.

3.6.2.10.4.2 Size

Interior OBUs shall be small enough that it can be mounted so that it shall not obstruct the driver's field of vision.

3.6.2.10.4.3 Exterior OBU Requirements

Interior OBUs may not provide adequate performance for some situations. In these situations the exterior OBUs shall be utilized. Exterior OBUs shall be mounted anywhere except inside the passenger compartment and under the vehicle. All exterior OBUs shall meet the following specifications.

3.6.2.10.4.4 Location

Exterior OBUs shall be designed for installation on surfaces outside of the passenger compartment of motor vehicles. The preferred location for exterior OBUs on passenger vehicles is the front bumper combined with the license plate mounting. Exterior mounting locations shall not violate any state or province DMV and Vehicle Code regulations. Commercial vehicles may have OBUs mounted in a greater variety of locations such as on the roof. OBUs shall be located where a motorist could perform the OBU installation, using common tools. Mounting/presentation locations shall not impact read/write accuracy.

Any alternate or additional mounting/presentation locations shall not conflict with existing vehicle registration stickers or vehicle inspection stickers and decals which are typically located in the lower left or lower right corner of the windshield.

3.6.2.10.4.5 Attachment

When mounted, OBUs shall not obscure the license plate numbering (numbers and letters) information. OBUs shall be readily moved using common tools when the owner replaces his or her vehicle. The mounting method for OBU's developed to be removable and re-usable shall

allow removal without risk of damage to the OBU or vehicle. The attachment methods shall be sufficient to prevent inadvertent displacement or projectile motion in case of rough road surfaces or accident.

3.7 Performance Requirements

3.7.1 OBU Capture, Read Accuracy and Write Accuracy

3.7.1.1 Applicability of Accuracy Requirements

The accuracy requirements which follow are for all vehicles equipped with an OBU at the specified mounting/presentation location. The requirements shall be valid for all motor vehicle types and for all properly mounted/presented Capture Compatible OBUs. The requirements apply to all lane types defined herein.

The accuracy requirements apply to every individual lane installation and not to the aggregate system.

3.7.1.2 Read Rate Performance

For properly equipped vehicles passing completely through the Capture Zone, the RFID subsystem shall successfully perform a 'read' transaction (see 'read' definition in 3.6.2.4) at least 99.90 percent of the time.

3.7.1.3 Write Rate Performance

For properly equipped vehicles passing completely through the Capture Zone, the RFID subsystem shall successfully perform a 'read' and 'write' transaction (see 'read' and 'write' definition in 3.6.2.5) at least 99.80 percent of the time.

3.8 Protocol Data Requirements

3.8.1 Protocol Data Storage Requirements

3.8.1.1 Data Field Programmability

OBUs utilizing the protocol shall have fixed and variable data fields. Fixed data fields transmitted to the lane/zone controller by the RSE shall include two types of data fields: those which are factory programmed and those which are Participating Operator programmable, as specified herein. The factory programmable data fields shall be set at the factory and shall not be able to be changed by programming Equipment supplied to any Participating Operator.

Participating Operator programmable data fields shall be such that they can be changed multiple times via programmer Equipment. Typically, these fields are used to associate a vehicle class with each vehicle OBU.

The tables below present a "first cut" of the memory mapping for each storage area within the OBUs. Note that the number of bits for each field is labeled "Proposed". The intent is to identify the minimum data elements that are required. The mapping may be somewhat protocol-dependent and will be finalized later in the NIOP process.

3.8.1.2 Fixed Data Storage – Minimum Requirements

Read

ID	Name	Proposed # bits	# Possible values	Description	Comments
R1	VersionID	4	16	NTP version	Used to track to which version the memory map conforms
R2	Agency ID	12	4,096	Operator or Agency code for the tag issuer, which provides a unique identifier for each tag issuer	This new field combines the previously separate StateID and AgencyID fields
R3	Serial Number	26	67,108,864	A unique value for the tag, to differentiate it from all other tags issued by the tag issuer	
	R1 +R2+R3 SUBTOTAL	**42**	**274,877,906,944**		
R5	Vehicle Class/Profile	11	2,048	For toll systems that cannot determine class at the lane Vehicle Type: 5 bits (TBD: 32 possible values) Vehicle Axles: 4 bits (0-15) Vehicle Weight: 1 bit (<7k lbs / >=7k lbs) Vehicle rear tires: 1 bit (single/dual)	
	Read TOTAL	**53**			

READ OR WRITE*

WR1	Vehicle Occupancy	3	8	For HOV declaration, for use in HOT/managed lanes Config: TBD	000: Not a switchable tag 001: SOV 010: HOV2 011: HOV3 100: Reserved for future use 101: Reserved for future use 110: Reserved for future use 111: Reserved for future use
	Read or Write TOTAL	**3**			

*Depending on switching method, this could be a read or write solution

Write

ID	Name	Proposed # bits	# Possible values	Description	
W1	Agency ID	12	4,096	This provides a unique identifier for each toll operator	The Agency ID of whoever is writing to the tag
W2	Scratch pad	40	1,099,511,627,776	This section is free for agencies to use as they wish. Possible usage would be Plaza ID: 7 bits Lane ID: 5 bits Date/Time: 25 bits (seconds since Jan 01 00:00:00) Occupancy: 3 bits	This can be increased if there is no performance impact. The displayed value represents the minimum requirement
	Write TOTAL	**52**			

TOTAL BITS RQD	**108**

3.9 Environmental Requirements

The ETC Protocol shall support operation in varying climatic and electromagnetic conditions found in and around toll plazas and roadways in North America. The toll facilities require continuous operation, 24 hours a day, 7 days a week.

The ETC Protocol shall meet the accuracy requirements herein under worst case conditions including the following:

- Vehicles traveling up to 100 mph;
- "Stop and go traffic" with continuous intermittent acceleration and deceleration between 0 and 15 miles per hour;
- Vehicles tailgating;
- Different mixes of all vehicle types encountered on North American roads including but not limited to cars, trucks, tractor-trailers, recreation vehicles, motorcycles, buses, and delivery vans;
- Vehicles arriving simultaneously at every toll lane in a plaza or open road tolling site;
- Vehicles changing and/or straddling lanes (where applicable);
- Environmental conditions that may be encountered in North America including but not limited to:
  - Rain : ¼ inch of rain per minute
  - Fog : 10 feet visibility
  - Ice : ¼ inch thickness between the OBU and the RSE
  - Heavy or Blowing Snow : 2 inches of snow per hour
  - All forms of driving precipitation (sleet, hail, blizzard, etc.)
  - Mud, Dust, Sand, and any other debris or contaminant as might be found in toll lanes or open road tolling sites; and

3.9.1 OBU Environmental Requirements

The ETC Protocol shall support OBUs able to operate as specified without degradation in performance and accuracy under the following environmental conditions, radio frequency emissions, mechanical or electrical interference, and lightning (except for direct hits). The environmental extremes are derived in part from SAE J1211, "Recommended Environmental Practices for Electronic Equipment Design" or other recognized test bodies, and verification programs relevant to the device.

All interior OBUs shall be able to be subjected to and operated in 95 percent humidity, non-condensing environments. All exterior OBUs shall operate in 100% humidity, condensing environments. All OBUs shall be designed to be resistant to penetration of fluids, dust, etc., including automotive fluids, salt spray, and fuels, whether through the design of the OBU case or the mounting of the OBU.

All OBUs shall withstand thermal shocks and gradients associated with dashboard or window mounting and temperature gradients of up to 20º F per minute and continue to meet the environmental requirements herein.

3.9.1.1 Internal OBU Environmental

Interior OBUs shall be designed for operation from -40º F to +185º F.

The OBUs shall operate as specified while undergoing the recommended shock and vibration of SAE J1211 for the proposed mounting/presentation location.

All OBUs shall comply with any and all current U.S. and international safety standards to permit unrestricted shipment by mail and commercial carriers with appropriate documentation and in the recommended packaging.

3.9.1.2 External OBU Environmental

Exterior OBUs shall be designed for operation from -40º F to +150º F. Exterior OBUs shall withstand ice, snow, steam, dirt, mud, any solutions used in the lanes, as well as stones and other projectiles such as sand particles and gravel. Exterior OBUs shall operate as specified under all environmental conditions that will be experienced in this environment including radio frequency emissions, mechanical or electrical interference, and lightning (except for direct hits).

3.9.1.3 Interference Susceptibility

OBU Models mounted/presented in accordance with manufacturers' specifications and within the specified tolerances shall not have their performance affected by the nearby presence of common objects such as beverage cans, cell phones, sunglasses, cigarette packs, etc.

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