CTOC Plan for Transitioning from the Title-21 Protocol to the 6C Protocol

Version 1.1

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Submitted by the CTOC Technical Subcommittee

CTOC

California Toll Operators Committee

Executive Summary

The current "Title-21" Radio Frequency Identification (RFID) protocol was developed over 20 years ago to fulfill the California legislative mandate that one and only one transponder would be necessary for a traveler to pay a toll in California using Electronic Toll Collection (ETC).

Recognizing that requiring travelers to establish multiple accounts (with the same transponder) was not in the best interest of the traveler or the tolling agencies, the California Toll Operators Committee (CTOC) was formed to establish the business rules and agreements necessary for interoperability and reciprocity.

While the Title-21 protocol is an open standard, only two vendors have supplied transponders and readers that implement it. Additionally, there is currently no certification process in place to ensure comprehensive compliance with the specification. This generates concerns about reduced accuracy and has caused some finger-pointing between the vendors.

Through the years, new RFID technologies and protocols have emerged that could address some of the Title-21 protocol's limitations, including the high cost of transponders, the limited number of compliant vendors, and performance issues. One of these protocols, ISO 18000-63 (also known as 6C) is currently in use in several tolling applications in the United States and was identified as a potential and suitable protocol to replace the Title-21 protocol.

As directed by the CTOC Executive Committee in January 2015, this Transition Plan summarizes the main motivators for transitioning to the 6C protocol, key milestones, a possible timeline, and next steps for achieving 6C in California. The Transition Plan incorporates feedback elicited from CTOC members during two workshops held by the CTOC Technical Committee in March 2015.

The 6C protocol has emerged as the leading alternative, offering multiple advantages over the Title-21 protocol. The 6C protocol is an open, non-proprietary standard. The 6C protocol has the following benefits for the CTOC agencies.

- ✓ **Significantly lower transponder costs** compared to other toll protocols. 6C "stickers" do not require a battery and cost between $0.40 and $2.00. The 6C 2-position switchable transponders cost around $10. In comparison, Title-21 transponders cost $10-$15, and Title-21 switchable transponders cost $13-$17.
- ✓ An **established tolling 6C programming standard**, already in use by the 6C Toll Operators Coalition (6C TOC).
- ✓ **Many 6C vendors** are producing 6C transponders for established applications across multiple industries, which increases transponder availability for agencies while ensuring sufficient long-term competition among vendors.

- ✓ **Existing 6C equipment certification testing** is available through OmniAir Certification Services, which ensures compatibility and performance across vendors.
- ✓ **Increased transponder distribution** opportunities with sticker transponders.

Intellectual Property Patents – There are several disputes regarding 6C technology and several agencies have addressed them to their satisfaction. It is important for CTOC members to understand the nature of these disputes and the various resolutions as they undertake a transition to the 6C protocol.

Major Implementation Activities – Transitioning to a new protocol will require CTOC and CTOC agencies to address the following: CTOC (administrative rulemaking, CTOC Technical Specification for Interagency Electronic Data Exchange, certification), transponder procurement, toll system modifications (readers, lane controllers, and Host/CSC systems), administrative changes (e.g. business rules, audits), and public outreach and marketing.

Transition Milestones – With the exception of SANDAG, all CTOC agencies responded that they require an implementation period of 1 to 3 years (through mid-2018) to upgrade their systems to read and process 6C transponders, see Figure 1. SANDAG may need through 2022 to upgrade their AVI, if their vendor does not cooperate on reader firmware upgrades to support the 6C protocol. During this transition period, administrative rulemaking, testing and transponder procurement could begin, and agencies could begin planning outreach and customer education on 6C-related changes (e.g. no beeping, new mounting instructions). This timeline was predicated on general agreement that CTOC would leverage the existing 6C TOC programming standard and equipment certification process.

National Toll Protocol Compliance – The International Bridge, Tunnel, and Turnpike Association's (IBTTA) ongoing effort to develop a National Toll Protocol (NTP), as currently envisioned, does **not** preclude regions (e.g., California) from keeping a local protocol that is not the same as the national protocol. But travelers who want to travel seamlessly in other regions would have to obtain transponders that support the NTP.

Window of Opportunity for Transition & the National Toll Protocol – The timing of the transition to 6C is sensitive due to the current technical limitations of multi-protocol readers—the difficulty of reliably reading two protocols simultaneously, combined with the IBTTA's ongoing effort to develop a NTP. The window of opportunity to complete a transition to 6C with the least disruption to the legacy Title-21 system will close once agencies must implement the NTP. The implementation date of the NTP is likely to be many years out, based on progress to date and outstanding issue regarding back office exchange and governance. But no negative consequences have been identified with transitioning to 6C before the NTP is selected. In fact, the earlier the transition to 6C is made, the earlier CTOC will begin reaping the benefits of 6C, while ensuring that California is prepared for a transition to any protocol IBTTA selects. Conversely, waiting for the NTP to be selected could impede CTOC's ability to transition from Title-21 in the future because currently deployed Automatic Vehicle Identification (AVI) readers can only read reliably any two transponder protocols; therefore all Title-21 protocol transponders will need to be swapped out to 6C at the same time in order to also read the NTP.

Next Steps – The following items are near-term tasks for CTOC to prepare for transition to 6C:

- Proceed with the rulemaking to transition all CTOC toll facilities from the Title-21 protocol to the 6C protocol. The CTOC Technical Committee with Caltrans would draft language to add 6C as an additional protocol and mandate a deadline for all agencies to be capable of reading and processing the 6C protocol. This deadline could be set for mid-2018. Such a date is needed for agencies to begin their individual implementations and transitions to reading and processing 6C. Additional discussions are also needed before a date can be set for phasing out the Title-21 protocol.
- Adopt the 6C TOC's programming standard for 6C as documented in "6C Toll Operators Coalition AVI Transponder Programming Standard", version 2.0.
- Engage OmniAir Certification Service regarding 6C equipment certification.
- Facilitate the modification of Revision G.5 of the CTOC Technical Specification for Interagency Electronic Data Exchange to include changes that enable implementation of 6C. Multiple agencies expressed the immediate need for a finalized version for their upcoming procurements and toll system designs to minimize future change orders.
- Monitor ongoing vendor disputes over intellectual property patents. There are many possibilities for how the claims will be resolved.

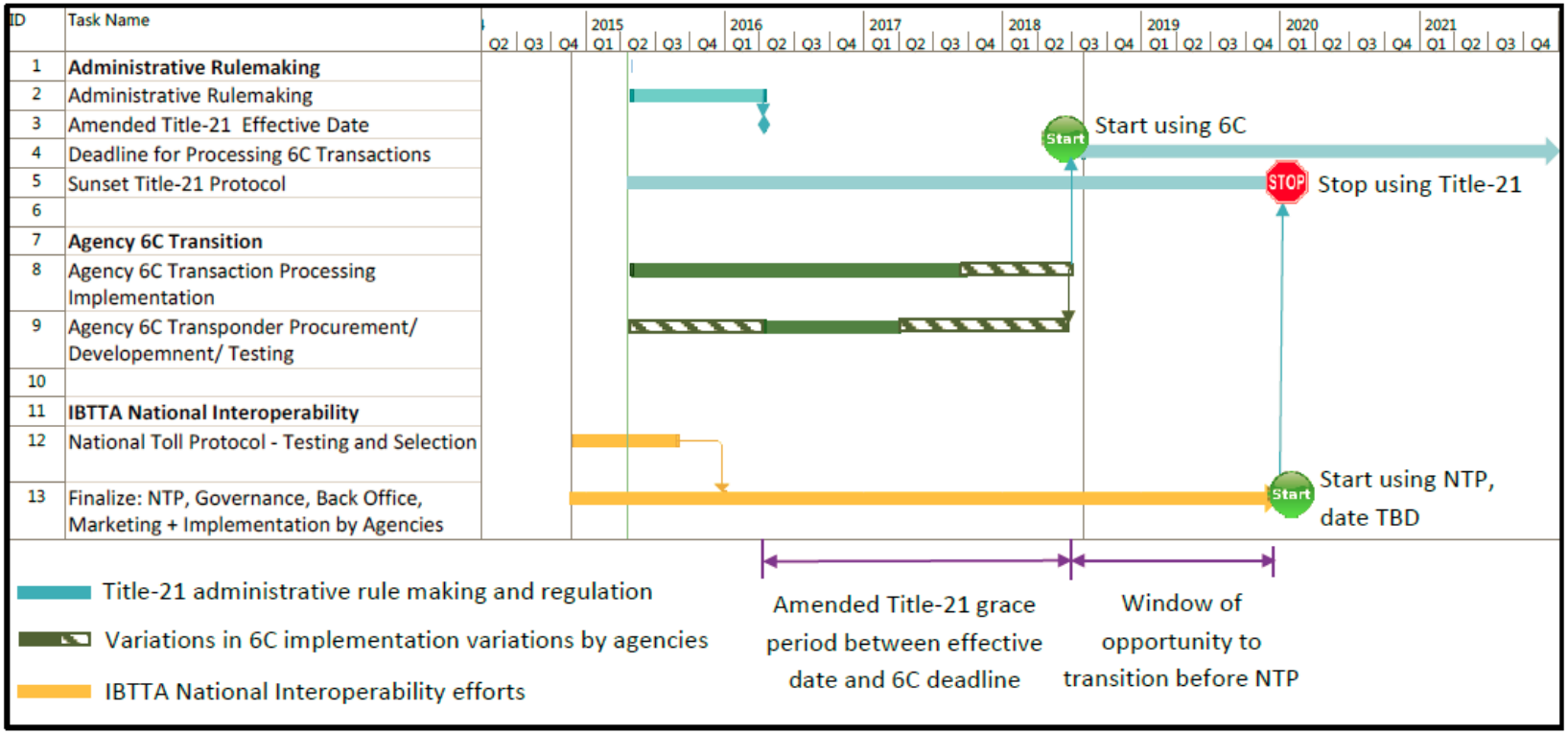

Figure 1 – Potential 6C Transition Timeline

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Revision History

Date	Revision Number	Description
4/20/15	V1.0	
5/30/15	V1.1	Incorporated CTOC Technical Committee Comments

List of California Toll Operations Committee Members

1. Alameda County Transportation Commission (ACTC)
2. Bay Area Toll Authority (BATA)/Metropolitan Transportation Commission (MTC)
3. California Department of Transportation (Caltrans)
4. Golden Gate Bridge, Highway and Transportation District (GGBHTD)
5. Los Angeles County Metropolitan Transportation Authority (LA Metro)
6. Orange County Transportation Authority (OCTA)
7. Riverside County Transportation Commission (RCTC)
8. San Bernardino Association of Governments (SANBAG)
9. San Diego Association of Governments (SANDAG)
10. San Francisco County Transportation Authority (SFCTA)
11. Transportation Corridor Agencies (TCA)
12. Santa Clara Valley Transportation Authority (VTA)

List of Terms

Term	Definition
6C protocol	Officially known as ISO 18000-63, it is the open communications protocol developed by International Organization of Standards for passive UHF transponders and readers.
6C Toll Operator Coalition (TOC)/6C User Group	Used interchangeably to refer to the group formed of toll agencies that developed and maintain the 6C tolling specification.
Administrative rulemaking	Process under the California Office of Administrative Law to modify agency regulations.
California Toll Operators Committee (CTOC)	Collaborative organization composed of California's toll facility operators/owners. CTOC is the primary resource for interoperability and coordination among tolling facilities, and education and advocacy regarding tolling in California.
Customer Service Center	Agency specific or regional tolling call center and back office equipped to handle customer communications.
Technical Specification Rev G.5	CTOC Technical Specification for Interagency Electronic Data Interchange; this is the Interface Control Document for CTOC agencies handling interoperability transactions.
National interoperability	Congressional mandate that all electronic toll collection programs on Federal-aid highways be interoperable by October 1, 2016.
OmniAir Certification Services	A non-profit provider that certifies and oversees labs that perform the testing for tolling protocol certification.
Switchable transponder	Transponders that physically have 2 or 3 settings for users to declare their vehicle occupancy.
Title-21 protocol	The Radio Frequency Identification communications protocol mandated for tolling applications in California under the current Title-21 regulation.

List of Acronyms

ATI	Alliance for Tolling Interoperability
AVI	Automatic Vehicle Identification
CalSTA	California State Transportation Agency
CSC	Customer Service Center
CTOC	California Toll Operators Committee
ETC	Electronic Toll Collection
HOV	High Occupancy Vehicle
IBTTA	International Bridge, Tunnel, and Turnpike Association
ICD	Interface Control Document
ISO	International Organization for Standardization
ISOR	Initial Statement of Reasons
NTP	National Toll Protocol
OAL	Office of Administrative Law
OCS	OmniAir Certification Services
RFID	Radio Frequency Identification
SOV	Single Occupancy Vehicle
SRTA	Georgia State Road and Tollway Authority
UDOT	Utah Department of Transportation
WSDOT	Washington State Department of Transportation

Introduction

The California Toll Operators Committee (CTOC) was formed to facilitate electronic tolling interoperability between toll operators within California. To support interoperability, CTOC ensures that any vehicle only needs to have a single Radio Frequency Identification (RFID) device for electronic tolling to use any tolling facility in California, in accordance with the 1992 California Senate Bill 1523, Chapter 1080, Section 27565. CTOC currently has members from all 12 California toll facility owners and/or operators.

The California regulation for electronic tolling, commonly referred to as Title-21, contains the specifications for transponder and reader communication in the radio frequency range of 902-928 MHz, currently used for Automatic Vehicle Identification (AVI) throughout California. Caltrans oversees and maintains this Title-21 protocol. Title-21 protocol transponders are read-only, and use radio frequency technology that responds to information requests from a reader by reflecting (backscattering) and modulating a signal that is sent from the reader in a manner that uniquely identifies the information on the transponder. The Title-21 protocol uses a battery to power the circuitry and provide the "beep" when a transponder is acknowledged by a reader. The "beep" is not a Title-21 requirement, but instead is an enhancement put in by the manufactures. The beep is triggered by the read/ acknowledgement sequence and is not related to the transponder status.

The Title-21 protocol is an "open" protocol, where any vendors can manufacture equipment as long as they meet requirements published in the Title-21 regulations. The intention of having an open protocol is to prevent a vendor from using proprietary technology, thereby excluding competition and driving up prices. Currently, two companies, 3M (formerly Sirit) and TransCore, supply Title-21 protocol readers and transponders. These companies originally trialed their equipment with Caltrans and have deployed equipment for revenue collection at CTOC agency facilities. Title-21 protocol transponders are available in hard-case forms only and require batteries. CTOC agencies procure three basic transponder types – internal non-switchable, internal 3-position switchable (for occupancy declaration of SOV, HOV-2, HOV3+), and external "bumper mounts", see Figure 1. Besides California, the Title-21 protocol is also used in Colorado (but is being phased-out there) and Vancouver, British Columbia.

Figure 1. Current internal standard, switchable, and bumper mounted Title-21 transponders

Recently, CTOC members have discussed potentially transitioning away from the Title-21 protocol for several reasons. Currently, individual CTOC agencies negotiate their Title-21 protocol transponder procurements with either 3M or TransCore after a competitive bid process. Recent standard transponder purchase prices are $10-$15, while internal switchable transponders range between $13-$17. Generally, higher quantity procurements yielded the lowest unit costs. However, other prevalent transponder protocols, such as 6C, TDM, and SeGo are priced significantly lower (with 6C under $2, TDM about $9, and Sego about $8 for internal transponders). When applied to the current transponder market in California (around 5 million transponders), savings from lower transponder costs alone would be immense.

Although the Title-21 protocol is open, the combination of industry-specific technical requirements, procurement requirements favoring existing deployed equipment, and the limited Title-21 market creates barriers to entry for new vendors. Accordingly, CTOC currently has only two Title-21 protocol equipment vendors. This duopoly has led to procurements with only a single responsive bidder, increased risk of a single supplier situation, less responsiveness from vendors to address performance issues; and higher cost to CTOC agencies.

Additionally, some CTOC agencies have raised questions about in-lane performance of the Title-21 protocol. These agencies are examining compatibility performance between different transponder and reader vendors as a possible cause for higher violation rates after recent lane equipment upgrades. Although Title-21 provides the specifications for AVI equipment, it does not contain a program for certification testing to verify Title-21

compliance. Therefore, it is difficult to identify and to address these performance issues effectively.

Finally, since the Title-21 protocol requires a battery to operate, Title-21 transponders can only be made in hard-cased forms. This allows customers to temporarily and/or improperly mount internal transponders to their windshields. CTOC agencies regularly encounter issues trying to read improperly mounted transponders (e.g., customers throw transponders on the dashboard, hand wave the transponder).

Transitioning from Title-21 Protocol

In the Spring of 2014, CTOC began to formally examine options for transitioning to a different protocol. As was the intent of the original Title-21 regulation, the new protocol must be "open", so as to foster vendor competition and ensure multiple vendor sourcing. Savings from lower transponder costs should offer a compelling business case for transition. The new protocol should provide performance improvements and a formal certification process to ensure all transponders and readers comply with the protocol's standards. Such certification would not replace the specific agency testing with System Integrators to verify functionalities and operations. CTOC also requested Caltrans to assess the process for administrative rulemaking necessary to change the Title-21 regulation, examine transitioning issues and durations for adoption of the new protocol, and determine whether the Title-21 protocol should be sunset.

Progress of Electronic Toll Collection National Interoperability

A key consideration for CTOC's search for a new protocol is the ongoing progress of Electronic Toll Collection (ETC) national interoperability efforts. The Federal MAP-21 mandate for ETC interoperability by October 1, 2016 has tasked the tolling industry with agreeing on a solution. The International Bridge, Tunnel, and Turnpike Association (IBTTA) has taken the lead on ETC interoperability, with an early focus on selection of a single National Toll Protocol (NTP) for transponders and reader equipment. Protocol selection has been narrowed to three options: TDM (used by E-ZPass), TransCore's SeGo (used primarily in Texas, Florida, and other southeastern states), and 6C (used primarily by CO, WA, GA, and UT). The Title-21 protocol is not considered a candidate for being the NTP.

Given the large deployed base of transponders of various protocols around the country (see Figure 2), IBTTA and toll agencies have agreed to allow "local" protocols to be used alongside the eventual selected NTP. Therefore, CTOC can choose to continue to use the Title-21 protocol or another protocol besides the NTP. Although readers that are able to read three protocols simultaneously are in development, currently deployed multiprotocol reader technology in California can only reliably handle two protocols simultaneously for Open Road Tolling.

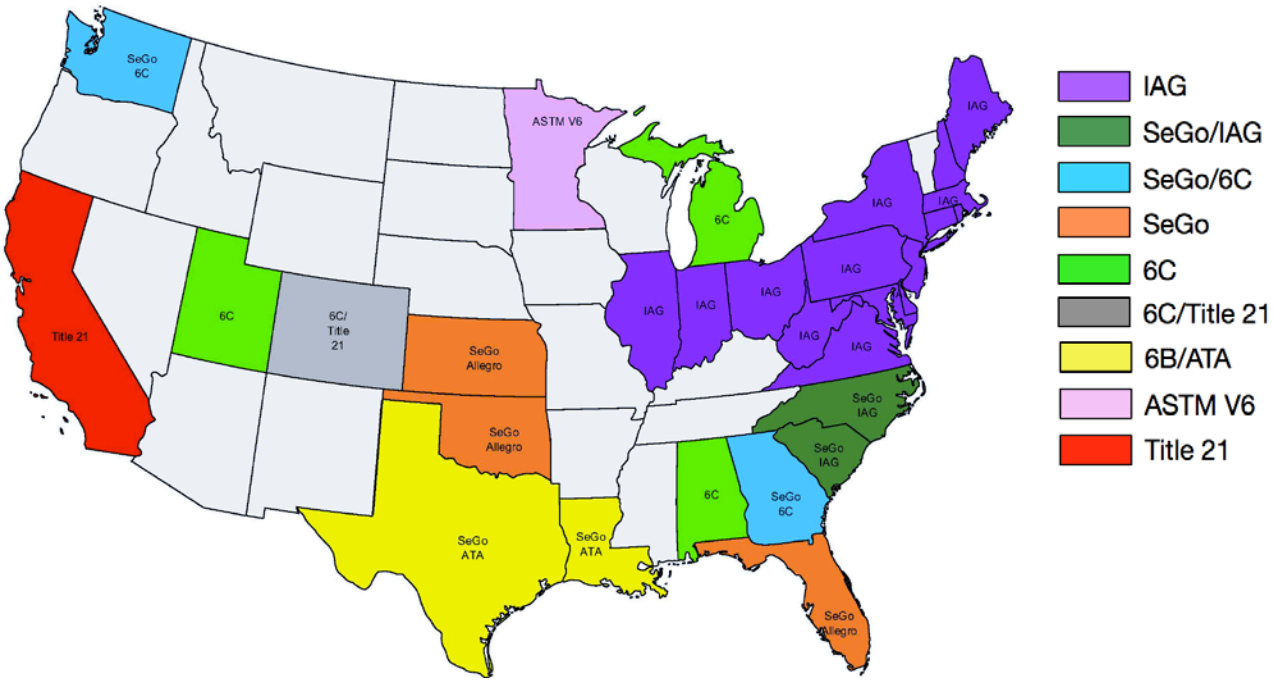

Figure 2. RFID protocols used for tolling nationally

Although timeline for selection and testing of a national protocol is progressing, IBTTA also needs to work on and address back office technical approaches, marketing, and governance in order to support interoperability. Ultimately, many issues still need to be resolved before national interoperability approaches are vetted, approved, and eventually adopted. The probability of resolving these issues before the MAP-21 deadline of October 2016 is very low based on progress to date of the protocol selection process.

Pressure to move toward national interoperability quickly has been tempered by USDOT's ambiguity as to what punitive action it will take if the industry does not meet the deadline. Alternative approaches to ETC interoperability, such as the Alliance for Tolling Interoperability's (ATI) license plate hub, along with multiprotocol transponders, could also reduce pressure to meet the Federal mandated deadline; however it would not supplant IBTTA's efforts to eventually implement NTP.

The bottom line for CTOC is that the tolling industry is unlikely to reach agreement on a NTP approach in the near future. Even if a NTP is selected, California will still have the choice to use the NTP along with its regional protocol.

6C Protocol as an Alternative

As CTOC examined alternatives to the Title-21 protocol, the 6C protocol quickly became a leading choice. 6C transponders have significantly lower costs than TDM (E-ZPass) and TransCore SeGo. In addition, TransCore's SeGo protocol remains a proprietary protocol

and TransCore is the only vendor for those transponders. Furthermore, the 6C protocol has an established 6C programming standard and certification process used by multiple agencies and vendors. The 6C protocol is also used by western toll operators in Washington, Utah, Colorado, and British Columbia, potentially facilitating regional ETC interoperability.

The 6C protocol is based on ISO 18000-63 (formerly known as ISO 18000-Part C). It is an international Radio Frequency Identification (RFID) standard that is open, without any proprietary technology. It is based on the Electronic Product Code Global standard that was originally developed in 2001 to provide a standard methodology to track unique serial numbers on individual objects in the supply chain and later adopted by the International Organization for Standardization (ISO). Widespread usage of the 6C protocol across multiple industries (including retail, security, airlines) lowers transponder and equipment costs through approximately 40 different vendors outside of the tolling industry.

As a passive backscatter RFID technology, the 6C protocol operates in the radio frequency range of 860-960 MHz and does not require a battery to operate. This enables 6C transponders to be available in variety of forms such as hard-case and sticker formats, see Figure 3. The 6C protocol allows for read and writing to transponders, although none of the existing toll agencies use the write functionality for Open Road Tolling. Metalized windows interfere with the ability to read all current protocols, including Title-21 and 6C, so these vehicles would need to use bumper or headlight mounted transponders (as they do today).

Figure 3. Example of 6C protocol forms from Washington State DOT

A tolling version of the 6C standard was created in 2011 by the 6C Toll Operators Committee (6C TOC), called the ISO 18000-6C Tolling AVI Transponder Programming Standard, see Appendix A. The 6C TOC, also known as the 6C user group, is comprised of toll operators who use the 6C protocol in the US and Canada: WSDOT, E-470 (CO), UDOT, SRTA (GA), and TI Corp (BC). In addition to maintaining the standard and managing the facility code assignments, the 6C TOC coordinated with OmniAir Certification Services (OCS) on creation of the 6C certification program. In 2012, OCS created testing procedures

to ensure transponder and reader equipment conform to the tolling 6C protocol. OCS then accredits independent testing labs to perform the actual testing. Currently three 6C tolling vendors – 3M, Neology, and Star Systems– have so far had their products certified. Globally, the 6C protocol is used for tolling in 15 different countries, including Taiwan, Turkey, and Brazil, in over 1,500 toll lanes, although programing standards vary across regions.

Adapting 6C technology for California

A closer examination of the suitability of the 6C protocol as a Title-21 protocol replacement revealed a range of potential benefits and concerns that either affect CTOC agencies as a whole or specific agencies. These 6C protocol benefits and concerns were discussed extensively in two CTOC Technical Subcommittee workshops held in March 2015 and are summarized in the following sections.

Potential 6C Benefits

Substantially lower transponder costs - Depending on the form factor of the 6C transponder and volume pricing, 6C "sticker" transponders bid prices range between $0.40 and $2.00, and 6C 2-position switchable transponders cost approximately $10. (WSDOT is currently paying $10.30 for two-position switchable transponders.) Figure 4 shows a side-by-side comparison of a 6C sticker transponder and a standard Title-21 transponder.

Figure 4. Size comparison between 6C and a Title-21 transponders.

Based on agency-reported Title-21 protocol cost for standard non-switchable transponder, on the conservative side 6C could be 5 times cheaper ($2 for 6C vs $10 for Title-21). On the aggressive side, 6C could be up to 37 times cheaper ($0.40 for 6C vs $15 for Title-21). For switchable transponders, and assuming 3-position are similar in design and cost as WSDOT's, 6C provides a potential saving range of 21% ($10.30 for 6C vs $13 for Title-21) to 39% ($10.30 for 6C vs $17 for Title-21).

With approximately 5 million currently deployed Title-21 transponders, replacement of those transponders as batteries run out (approximately every 5 years) to 6C transponders would save California tens of millions of dollars. Anticipating new toll facilities increasing the demand for transponders makes the savings even more substantial. Most CTOC agencies, especially those that issue transponders, identify cost savings as a major benefit.

Multiple vendors for transponder and readers – Multiple vendors can provide 6C protocol equipment to toll operators and many have equipment deployed for revenue collection in the US and Canada. Vendors who have supplied 6C transponders include 3M, TransCore, Neology, and Star Systems. For 6C AVI readers, vendors include 3M, TransCore, and Kapsch. Of interest to CTOC agencies is that 3M's readers (5204/6204) and TransCore's readers (E6) have both been deployed in multi-protocol settings, reading both 6C and Title-21 protocols in Colorado and British Columbia, respectively. With California's potential market size for tolling equipment purchases, several more 6C equipment vendors have expressed interest in entering the tolling market. Most CTOC agencies felt having multiple vendors was a strong benefit of 6C.

Established equipment certification – Most CTOC agencies felt it was very important to have an existing 6C transponder and reader certification process through OCS. This allows agencies to depend on a base level of compliance to the 6C standard. Certification is important to allow new vendors to enter the tolling market. Agencies understood this certification process is not meant to replace agency-specific functional testing. Some CTOC agencies questioned whether OCS should continue being the certification entity, but most agencies favored keeping OCS in order to reduce implementation delays.

Allows for "sticker" transponder – Since the 6C protocol does not need batteries to operate, 6C transponders can be produced in a variety of sticker forms (as illustrated in Figure 3). If CTOC agencies choose to issue internal sticker or external headlight transponders, potential benefits include:

- ***Better AVI read performance*** – Since drivers have to affix the 6C sticker transponder onto their windshields, this should significantly reduce improper mounting of transponders, hand waving of transponders, throwing transponders on dashboards, etc.
- ***Allows new ways to identify exempt vehicles*** – By forcing transponders to be affixed to a vehicle, and thereby preventing transfers between vehicles, toll operators have the option of issuing non-revenue transponders for exempt vehicles (Clean Air Vehicles, motorcycles, fleet vehicles) without creating potential

widespread abuse of those transponders. Some CTOC agencies, especially those with Express Lanes, noted this could be a major benefit for them.

- ***Allows for new transponder marketing/distribution options*** – Smaller and thinner transponder form factors enable transponders to be potentially marketed like gift cards and dispensable from vending machines. For instance, Georgia was able to leverage gift card distributors to get placement in retail stores as well as handle account management. A couple of CTOC agencies felt this was something they might pursue.

CA has multi-protocol readers - Almost all CA toll facilities, except for SBX and Golden Gate, have existing multi-protocol readers that are capable of supporting 6C and Title 21 protocols. Therefore, most CTOC agencies will not need to replace installed roadside equipment, reducing a large capital expenditure for 6C implementation. Some agencies have identified problems with their existing vendor not wanting to support 6C, ostensibly for business or infringement reasons.

Newer technology and security – Since 6C is a newer protocol technology with a large market, vendors continue to innovate to meet the needs of a wide variety of markets. These improvements, including newer security features, for example, could benefit the toll industry. Most CTOC agencies did not see this as a compelling benefit for them.

West Coast Interoperability – With Washington, Utah, Colorado, and British Columbia already using the 6C protocol, transponder-based interoperability can occur between those states and California. However, this requires negotiating agreements with these states and changes to customer service center processing and other toll system changes. Most CTOC agencies did not find this as great benefit since they do not handle a lot of out of state traffic currently.

Potential 6C Concerns

No existing 3-position switchable transponder – Currently some CTOC agencies are issuing 3-position transponders (where it transmits an RF signal in all settings) to allow drivers to declare the number of occupants in their vehicle for toll-free passage on Express Lanes (SOV, HOV 2, HOV 3+). However, a 3-position switchable 6C transponder does not currently exist. 2-position switchable transponders (SOV and HOV 2+) do exist and are currently being issued by WSDOT and Colorado for new toll facilities opening in 2015 (see Figure 5). Vendors have indicated that the same multiple chip design for a 2-position switchable transponder can be used to create and certify a 3-setting transponder in 6 months (see Figure 6). Currently, 3M is the vendor for the 2-position switchable transponders, but multiple vendors have expressed interest if a larger market like California starts using 6C. Most CTOC agencies were not concerned about the technical feasibility of 3-position transponders, but they were concerned about the time needed for procuring, developing, and testing them.

Figure 5. 2-position switchable 6C transponder from E-470.

Figure 6. Conceptual design of 3-position switchable transponders from Neology.

No Beeping – Currently produced 6C transponders do not beep since these 6C transponders do not need to confirm communication with the reader, nor do they have the power to make a beep. Lack of beeping would necessitate business rule and customer expectation changes for current toll facilities with transponders that beep. Agencies agreed that transponders not beeping is not a significant issue. Adding a battery to power a beeping sound would likely negate cost savings.

Modifications needed for lane and back office equipment – Toll agencies will incur some cost for modifying and testing lane equipment and back office functionalities to accept a new transponder protocol format. Most agencies stated that system changes and modification costs are minimal and would be outweighed by transponder cost savings and other benefits. A couple of agencies are beginning their toll system designs and would like to have commitment to 6C so they can incorporate it into their design now rather than have to make changes later.

Equipment vendor intellectual property infringement – ISO 18000-63 is an international standard, while the 6C TOC programming standard was created and is maintained by toll operators based on the ISO standard. However, there are disagreements amongst 6C vendors about what technologies they use to implement the 6C for tolling. Neology currently has a lawsuit pending against both Kapsch and Star Systems. Prior Neology lawsuits against 3M and Confidex were settled out of court. 6C Toll Operators Coalition agencies that have procured equipment have dealt with this issue using indemnification clauses. With multiple vendors currently offering transponders and

readers, licensing issues between vendors do not seem to have prevented competition or negated 6C pricing advantages over Title-21 or other protocols. Most agencies agreed this issue needs to be monitored and that in spite of the litigious atmosphere, multiple vendors are still offering equipment with significant cost savings over equipment using other protocols.

Write capabilities – There has been discussions about adding "write" capabilities to transponders to aid in express lanes enforcement, since there is no current write requirement in Title-21. The 6C programming standard does allow for write capabilities, but none of the current 6C toll operators use this functionality. Performance implications, especially for high-speed, Open Road Tolling, along with the business needs, should be better understood in order to examine the option of adding the writing functionality. The agencies felt if performance, schedule, or costs were impacted, then they would not implement write capabilities.

Public education and marketing – All the agencies recognized that they will need to educate the public about the transponder change, especially with regards to the elimination of beeping and new mounting instructions for sticker transponders. Agencies felt the cost savings and benefits from the sticker format (e.g., sticker transponders for motorcycles) will help justify the transition to the public.

Impacts to non-tolling Title-21 protocol users – Other non-tolling uses for Title-21 protocol transponders may include use at parking lots, entry gates, and for traffic data probing. In the Bay Area, traffic conditions are no longer monitored by probing Title-21 transponders. The San Francisco International Airport, which uses FasTrak for their parking, will be notified of the change based on their agreement with BATA.

Transitioning to 6C

Once CTOC makes the decision to go from the Title-21 protocol to the 6C protocol, several areas will need to be addressed by the CTOC agencies, including CTOC administrative preparations, transponder procurements, toll system modifications.

CTOC Preparations

Administrative Rulemaking – A key element of the transition will be the administrative rulemaking process through the California Office of Administrative Law (OAL) that Caltrans must undertake in order to change the Title-21 regulation. Caltrans will leverage support from the CTOC agencies for crafting and reviewing the specification language needed for the 6C protocol. The new regulation must avoid unintended performance loopholes, while allowing for flexible implementation (e.g., switchable transponder designs as part of the specification development).

CTOC Technical Specification Revision G.5 – The Interface Control Document, which governs how toll system information is exchanged between CTOC agencies, will need to be modified and approved by the CTOC Technical Subcommittee. At the CTOC transition workshops in March 2015, several agencies expressed the need to have changes made to Rev G5 before July 2015 in order to limit disruption to future toll system designs. An assessment has been conducted and a draft document created that identifies the changes needed to accommodate the 6C protocol; however, the CTOC Technical Subcommittee will wait for the official decision to transition from the CTOC Executive Committee before ratifying the draft. Consideration will be given to the fact that the transponder numbering structure and some additional data in 6C transponders must map as smoothly as practical into the existing transaction and interoperability processes. Doing the necessary translations at the lane and plaza levels will mitigate the work at the customer service centers.

6C Toll Operators Coalition – With the desire to leverage the established 6C TOC programming specification, CTOC will need to continue engaging the 6C TOC. Although 6C TOC voting membership requires agencies to have at least one toll facility using 6C for toll collection, the organization has been welcoming of non-member participation in meetings and information sharing.

OmniAir Certification Services – Most agencies expressed the desire to continue using OCS for equipment certification, however, more direct engagement with OCS will be needed to better understand their testing fee structure and how they engage independent testing labs. There is an opportunity to have a CTOC representative to join their 5 member board.

National interoperability strategy – With the IBTTA National Toll Protocol selection process underway, CTOC will need to continue to coordinate strategies for advocating 6C and monitor the timeline for when implementation of the NTP will occur.

Transponder Procurements

Most agencies identified transponder procurement strategies as a major area of concern. The development of a 3-position switchable transponder and the timing of transitioning to 6C will influence transponder procurements. With respect to the development of 3-position switchable transponders, agencies will need to consider how development cost will be structured in a procurement (separately or reflected in unit cost), and how much control and ownership the agency will have over the appearance of the transponder. In addition, agencies will want to consider joint procurements of switchable transponders, not only to leverage purchasing power, but also to reduce risk with respect to the development of the 3-position switchable transponder. For example, WSDOT and E-470 coordinated on the purchase of 2-position switchable transponders. With a significant price difference between switchable and non-switchable transponders and the number of transponder form choices, each agency will need to examine the right mix of transponders for itself and its customers. Agencies will determine the timing of their transponder

purchases based on when CTOC officially commits to 6C, the development cycle for switchable transponders, and the timeline of the final agency to transition. Agencies' outstanding inventory of Title-21 protocol transponders will not be a major concern, since CTOC agencies only keep up to a 1.5 year supply of transponders on hand.

Toll System Modifications

From an overall system perceptive, the addition of the 6C protocol will mainly impact how 6C transponder information is handled on the roadside and transponder ID management at the Host. Impacts to how systems fundamentally handle transactions processing should be limited compared to introducing products like Pay-by-Plate. The main concern agencies have is timing of confirming the transition to the 6C protocol plus the agreed upon 6C programming standard and revised CTOC Technical Specification Rev G.5, in order to incorporate into upcoming system upgrades or new deployments. As with any system modifications, validation testing of systems will be vital. Figure 7 shows the various parts of toll systems that agencies will need to consider as they assess how to support the 6C protocol.

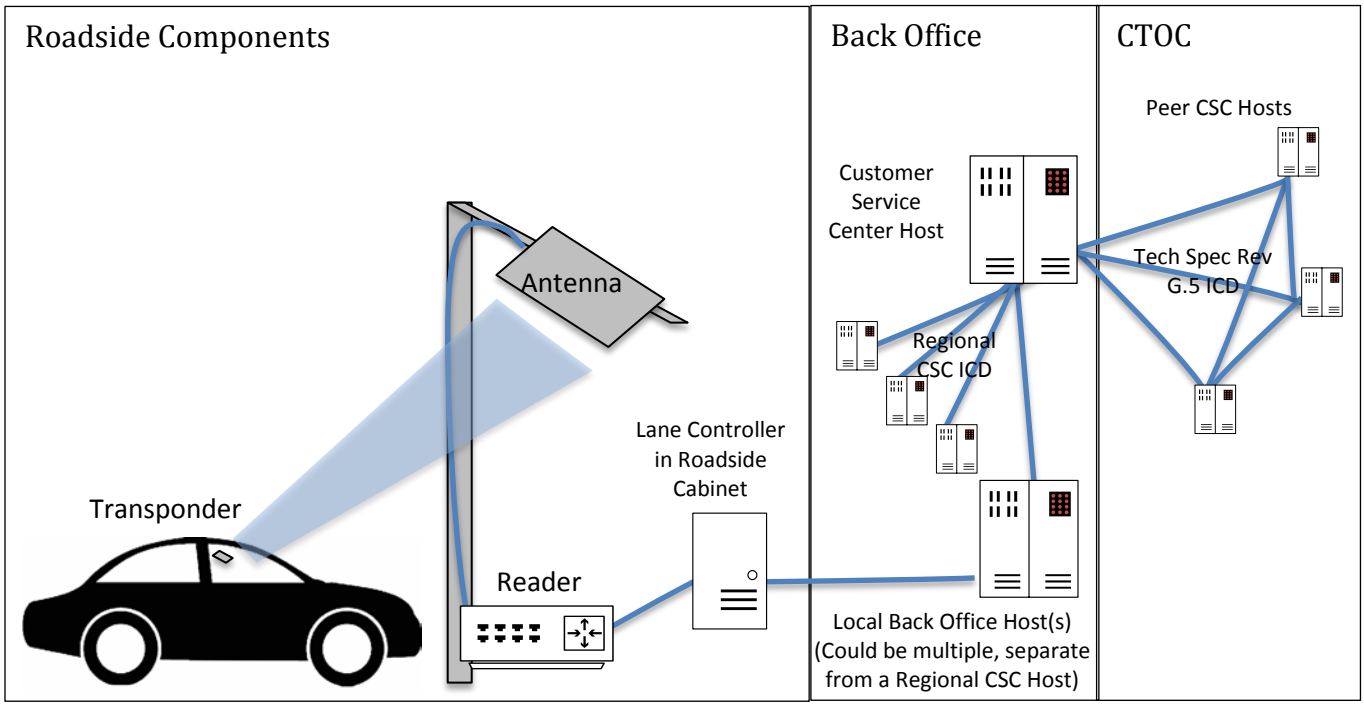

Figure 7. Various toll system elements to assess impacts from 6C

Roadside components – With the exception of SANDAG's South Bay Expressway and the Golden Gate Bridge, California toll facilities already have multi-protocol readers in place that are capable of supporting both the 6C and Title-21 protocols. Even with multi-protocol readers, varying levels of reader updates must be done, such as re-tuning for dual

protocol setups, updating firmware, and potentially refurbishing older readers. Additionally, FCC licensing will need to be obtained at all tolling read points. Lane controller software will need to be modified to properly process 6C messages both from the AVI reader and possibly transponder status file information from toll system back offices. Certification of 6C equipment will only ensure transponders and readers are compliant to the 6C protocol, but agencies will need to test deployment and configuration of 6C equipment on their toll facilities. Many lessons learned regarding tuning, configurations, and testing can be gathered from the dual Title-21 and 6C protocol deployments in Colorado and British Columbia.

Back Office – Back office modification needs depend on how agencies are setup relative to their customer service center (CSC). For agencies that operate their own CSC, modifications needed include how their back office Host communicates to lane controllers, changes to the CTOC Technical Specification Rev G.5, reports, transponder inventory management, databases and transaction handling logic. For the Bay Area, where several different agencies operate their own toll facilities, but they leverage BATA's Regional Customer Service Center, the back office modifications will be more limited to Host handling the 6C protocol data fields, communications to lane controllers, and change to the Regional CSC ICD. Remaining modifications to account management, transponder inventory management, and handling changes to the CTOC Technical Specification Rev G.5 will be the responsibility of the Regional CSC.

CTOC Interagency – Changes to the CTOC Technical Specification Rev G.5 will need to be addressed, and impacts to transaction reconciliation will need to be assessed.

Agency Administration

Most agencies do not anticipate the transition to the 6C protocol to impact existing agency board policies and bond indentures/covenants. With a new 6C sticker transponder form, some agencies may choose to leverage this opportunity to change how their certain customers, e.g. motorcycles and Clean Air Vehicles, are identified and tolled. Furthermore, audits and reconciliation changes will primarily be limited to accounting for the new transponder type and modifying reports to accommodate the longer 6C transponder ID field. Beside system changes, processes at CSCs will need to be modified to differentiate and handle the various transponder types.

Public Outreach and Marketing

Since transponders are very visible touch points with customers, public outreach will be key to making a smooth transition from the Title-21 protocol to 6C protocol transponders. Similar to the launch of Title-21 switchable transponders, public engagement will need to start early and continue throughout the transition. In particular, new transponder designs will need to be vetted for both functionalities and for usability. In addition, CTOC agencies will need to develop new marketing collateral and instructions to

customers. CTOC agencies will want to coordinate messaging to the public, elected officials, and other stakeholders regarding the transition, especially as agencies get ready to deploy 6C transponders and sunset Title-21. A coordinated response will help reduce confusion regarding various protocols, each with multiple forms available. Agencies have preliminarily indicated different approaches to whether they will recall Title-21 transponders. Sufficient time and resources should be allotted for new transponder distribution, customer service training, and responding to an increase in the level of customer inquiries. When the time comes, lessons learned from other regions using 6C are available.

Transition Schedule

Administrative Rulemaking Process

In order to modify the Title-21 regulations to add a new protocol, Caltrans has indicated the entire administrative rulemaking process will take approximately 1 year. The following timeline is based on the CTOC Executive Committee approving for Caltrans to commence work on changing Title-21 on April 24, 2015. Administrative rulemaking can take up to one year to complete and become effective. For a March 1, 2016 approval date/April 1, 2016 effective date (all dates are approximate and subject to change):

- **Late January to early February 2015**: Filing of Rulemaking Calendar with the Office of Administrative Law (OAL). This calendar indicates the regulatory packages that the Department will be pursuing for that year. Submitted by Caltrans on February 13, 2015.
- **May to August 2015**: (1) Drafting of the regulatory text and other documents, including the Notice, Initial Statement of Reasons (ISOR), and the Form 399 and Form 400; (2) Public outreach, including pre-notice workshops, to solicit input on the proposed regulations.
- **August 26, 2015**: Submission of the Notice of Proposed Text to OAL for publication in the Notice Register.
- **September 5, 2015**: Publication in the Notice Register and the commencement of the 45-day public comment period.
- **October 22, 2015**: Close of the 45-day public comment period.
- **October 23-26, 2015**: Public hearing(s) on the proposal.
- **October 27, 2015–January 13, 2016**: Preparation of the final rulemaking file and possible 15-day comment period on changed text.
- **January 14, 2016**: Submission of the final rulemaking file to California State Transportation Agency (CalSTA) for approval to submit to OAL.
- **February 15. 2016**: Filing of the final rulemaking file with OAL for approval.
- **March 1, 2016**: OAL approval date.
- **April 1, 2016**: Effective date of the regulations.
- **TBD time after effective date:** Deadline for CTOC agencies to support the new protocol.

Note that in February of 2015, Caltrans submitted to OAL notice of possible changes to Title-21, but that does not commit Caltrans or CTOC to make any changes during the calendar year. Furthermore, the effective date of the regulation does not need to coincide with the date when CTOC agencies need to be able to support a new protocol.

Transition to 6C Timeline

Figure 8 shows the optimal window of opportunity for CTOC to transition from the Title-21 protocol to the 6C protocol. Transitioning during this period would allow CTOC agencies to realize the 6C cost savings and significantly simplify the transition to the NTP being selected by IBTTA, whether it is 6C or a different protocol. This window is framed on one end by the minimum amount of time it takes for CTOC agencies to transition to 6C and on the other end the earliest that the NTP can be foreseeably adopted and implemented.

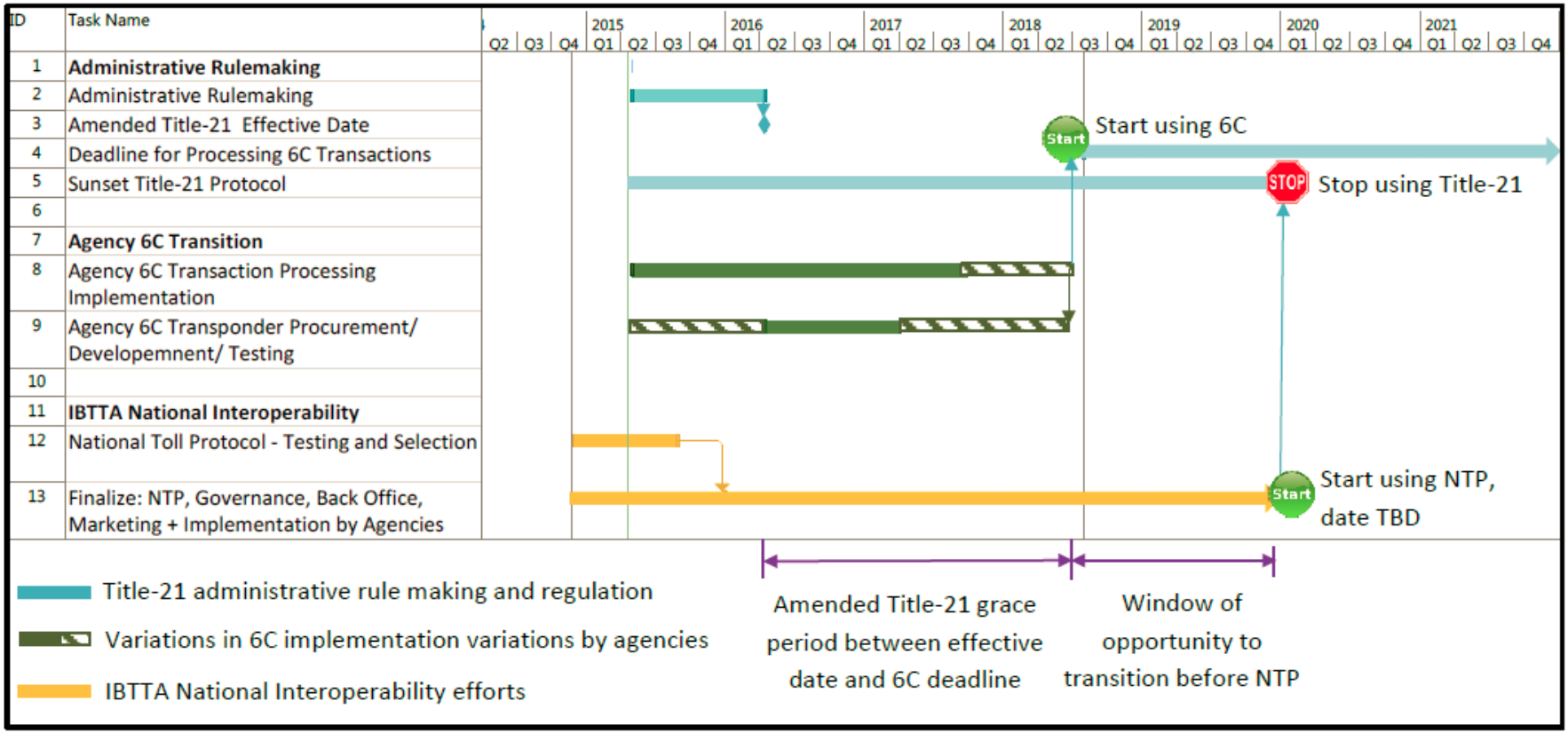

Figure 8. Transition window of opportunity for 6C

According to the feedback gathered from CTOC agencies, it could take 2 ½ to 3 years before California agencies would all be capable of reading and handling 6C transactions. This includes the time needed for the Title-21 administrative ruling change to incorporate the 6C protocol. One exception to-date is SANDAG, which has indicated that it is possible that I-15's readers cannot be changed out until 2022. If they are unable to get their vendor to agree to upgrade their AVI reader firmware, SANDAG will need to change out their roadside equipment. The timeline for when CTOC agencies will start procuring, developing, testing, and issuing 6C transponders varies among CTOC agencies, ranging from 2 – 3 years, but ultimately by 2018. Issuance of 6C transponders is also predicated on the development, test results, and availability of 3-position switchable transponders. From that point forward, CTOC members would be able to support both 6C and Title-21 protocols with multi-protocol readers until the National Toll Protocol is deployed.

With regard to IBTTA's National Interoperability efforts, the process for selecting, testing, and approval of a NTP process will take approximately 2 years, plus a currently undetermined period for developing the necessary back office transaction processing approach. After the selection and adoption of the NTP, toll operators nationwide will need a phase-in period, which could be another unknown period of time, extending the completed national protocol adoption to potentially beyond 2020. Therefore, CTOC agencies will have a number of years after the CTOC implementation of 6C before the National Toll Protocol needs to become effective.

Table 1 summarizes the pros and cons associated with the timing of the possible transitions to 6C and to the National Toll Protocol. The simplest scenario is if CTOC decides to transition to 6C immediately and 6C is also selected as the NTP. CTOC would realize 6C transponder cost savings immediately, have had to only make one transition, and will have more time to phase out Title-21 transponders.

If California adopts 6C but it is not selected as the National Toll Protocol, then CTOC will need to select a date to sunset Title-21 transponders before a National Toll Protocol can be read by all CTOC agencies. In that case, adoption and implementation of 6C well before 2020 would give ample time for CTOC agencies to sunset the Title-21 protocol before needing to switch their multi-protocol readers to read the National Toll Protocol along with 6C.

CTOC could choose to wait until after the National Toll Protocol is implemented before switching the regional toll protocol to something other than Title-21. If CTOC decides to wait to see what protocol is selected as the NTP and 6C is selected, California will only have delayed benefiting from lower transponder costs by a few years. On the other hand, if CTOC waits until there is a selected NTP, but the 6C protocol is not chosen, then CTOC agencies will be responsible for supporting two relatively costly transponder types and will have more difficulty transitioning to a lower transponder cost protocol. Since current multi-protocol readers can only effectively operate with two protocols at any given time for Open Road Tolling and because some CTOC toll facilities, e.g. SANDAG's I-15, do not have

Violation Enforcement Systems to capture license plates to alternatively identify remaining Title-21 protocol customers, all CTOC agencies would need to change out all issued Title-21 protocol transponders at the same time. Alternatively, CTOC agencies could wait until enough Title-21 protocol transponders stopped working before changing to a new local protocol, but this would be many years out.

Table 1. Potential CTOC – National Toll Protocol Scenarios

CTOC Decision	National Toll Protocol Selection	
	6C	**Not 6C**
Transition before NTP Implementation	+ Assured realization of 6C transponder cost savings beginning as early as 2018 + No sunset for Title-21 protocol required allowing a more extended phasing out of any existing investments in Title-21 transponders	+ Assured realization of 6C transponder cost savings beginning as early as 2018 – 2 transitions (6C and NTP) – Sunset for Title-21 protocol required
Wait for NTP Implementation	+ Delayed potential realization of 6C transponder cost savings with only one transition to make + No sunset for Title-21 protocol required, allowing a more extended phasing out of any existing investments in Title-21 transponders	– Potential need to support two costly transponder types – Delayed or unrealized 6C cost savings – Transition from Title-21 protocol to a different regional protocol becomes significantly more difficult with a potential need for a condensed sunset period for Title-21

In summary, the sooner CTOC agencies transition away from the Title-21 protocol, the sooner benefits will be realized. If CTOC decides to wait until the NTP is selected and implemented, it risks whether the NTP will meet local needs (e.g., cost, form choice) Therefore, the best case scenario would be delayed benefits from the desired NTP, but the worst case is the NTP does not meet local needs and transitioning from the Title-21 protocol is complex.

Individual Agency Needs and Challenges

Table 2 summarizes the key constraints, timeline issues, and requirements from CTOC agencies as input to the administrative rulemaking process. Title 21 to 6C Transition Plan Workshops were held in March 2015 for CTOC members to discuss transition issues. For discussion purposes, it was assumed CTOC decided immediately to move forward with the 6C protocol and administrative rulemaking takes one year to be adopted.

The responses to a workshop follow up questionnaire issued to all agencies indicate the following:

- Agencies need a range of 1 to 7 years to upgrade their systems to read and process 6C transponders, with the majority of agencies being able to do so within 2 to 2 ½ years.
- Agencies need sufficient time to test and procure transponders, and to inform customers of the change. The process could take 2 to 2 ½ years and could begin once agencies are confident that the readers will be in place to read the transponders.
- As various system procurements are currently being planned and in process, the sooner the decision is made regarding whether CTOC will be transitioning to 6C, the better. Some agencies need a decision and updated 6C Technical Specification by July 2015 in order to minimize change orders to their procurements.

Table 2. Individual Toll Agency Implementation Constraints, Timeline, and Requirements

Agency	Facilities	Setup	By what date will your agency be able to support reading and processing 6C transponders?	How long will it take your agency to be able to issue 6C transponders to your customers?	What sort of commitments and details does your agency need with regards to CTOC and 6C and by when in order to minimize impacts/optimize your agency's transition to 6C?
BATA/ MTC	Seven Bridges (Antioch, Carquinez, Dumbarton, San Francisco-Oakland Bay Bridge, San Mateo-Hayward, Richmond-San Rafael, Benicia-Martinez) *Under Development* Express Lanes (I-680, I-880, I-80) Scheduled to open 2016	Reader: TransCore E6 Transponder: 3M/SIRIT and TransCore	Back office and CTOC interface changes – 1 year	RFI Procurement Process Form Factor, Certification and Testing: 1 year IFB Procurement Process based on completion of RFI tasks: 8 months Estimated Delivery Lead Time and Customer Materials Update: 6 months Inventory and delivery set-up: 1 month Total: 27 months Replace and retire legacy inventory in circulation: 6 years	None provided

Agency	Facilities	Setup	By what date will your agency be able to support reading and processing 6C transponders?	How long will it take your agency to be able to issue 6C transponders to your customers?	What sort of commitments and details does your agency need with regards to CTOC and 6C and by when in order to minimize impacts/optimize your agency's transition to 6C?
SFCTA	*Under Development* Treasure Island Pricing Program	Transponder: Issued by BATA	Defer to BATA	Defer to BATA	Jan 1, 2018
VTA	SR-237 Express Lanes *Under Development* SR-85 Express Lanes Scheduled to open 2018	Reader: TransCore E6 Transponder: Issued by BATA	Jan 2018 or sooner	Dependent on BATA's date as they provide the transponders to the customers in the Bay Area region.	Dependent on BATA for any new requirements attached to the introduction of 6C as VTA uses BATA's back office to process transactions.
GGBHTD	Golden Gate Bridge	Reader: 3M/SIRIT 915-0006 Transponder: Issued by BATA	Should be able to replace readers in 1–2 years. Going out for a new toll system and hope to have that implemented in 2 years. Need to know within the next 4 months the protocols.	This date is on the same schedule as BATA as they provide transponders on behalf of Golden Gate.	If we had the specifications in the next 4 months we could incorporate it in the upcoming toll system replacement.

Agency	Facilities	Setup	By what date will your agency be able to support reading and processing 6C transponders?	How long will it take your agency to be able to issue 6C transponders to your customers?	What sort of commitments and details does your agency need with regards to CTOC and 6C and by when in order to minimize impacts/optimize your agency's transition to 6C?
ACTC	I-680 Express Lanes *Under Development* I-580 Express Lanes Scheduled to open Fall 2015	Reader: 3M/SIRIT ID5100 Transponder: Provided by BATA	By late 2016 on both the 580 and 680 Express Lanes in Alameda County. The key driver is software and hardware modifications.	Dependent on the BATA/MTC schedule and modifications to the back office systems, followed by public outreach and procurement.	Commitments to protocol and back office processing needs to be available ASAP due to active systems development for the new 580 Express Lanes and forthcoming modifications to the 680 Southbound Express Lane in Alameda County. Further the decisions and design requirements need to be established and accepted by BATA/MTC prior to Alameda CTC's modifications and public outreach plan.

Agency	Facilities	Setup	By what date will your agency be able to support reading and processing 6C transponders?	How long will it take your agency to be able to issue 6C transponders to your customers?	What sort of commitments and details does your agency need with regards to CTOC and 6C and by when in order to minimize impacts/optimize your agency's transition to 6C?
TCA	San Joaquin Hills Toll Road (SR73) Foothill/Eastern Toll Road (SR241, SR261, SR133)	Reader: TransCore E6 Transponder: 3M/SIRIT	9-12 months after an approved specification that defines the protocol is published and TCA's board of directors authorizes the agency to proceed with this change. We do have a risk to this date with our plans to implement a new back office system.	The process of preparing to issue transponders would occur in parallel with the process to support reading 6C transponders. No transponders would be issued prior to verifying that the lane/plaza/host and back-office systems were able to process 6C transactions. We would also approach this based on customer needs and the age of existing inventory as well as looking at benefits for certain account types and fleet accounts.	A technical specification that not only defines the 6C transponder programming standards but also clearly and unambiguously defines the communication protocol between the tag and reader Clear understanding of 6C licensing requirements Revised CTOC Technical Specification that incorporates 6C General Timeline for all other CTOC agency transitions Resolution of national protocol selection and timeline for the implementation of that protocol.

Agency	Facilities	Setup	By what date will your agency be able to support reading and processing 6C transponders?	How long will it take your agency to be able to issue 6C transponders to your customers?	What sort of commitments and details does your agency need with regards to CTOC and 6C and by when in order to minimize impacts/optimize your agency's transition to 6C?
SANDAG	South Bay Expressway (SR-125) I-15 Express Lanes	Reader: 3M/ SIRIT RDR915-0006 Transponders: 3M/SIRIT Reader: TransCore/AM TECH E6 Transponders: 3M/SIRIT & TransCore/AM TECH	SBX: Currently doesn't have multiple protocol reader. Need to have the new Roadside system in place before reading 6C tag. Estimated completion date for this project is June 2018. I-15: Need to change out all the readers to be able to read 6C tag if the vendor won't upgrade the firmware to read 6C protocol. Procurement would then probably start in 2018 with an estimated completion date in 2022.	Will not issue any 6C tags until roadside system is ready. Time for our procurement of our roadside systems will drive this date.	We fully support 6c implementation. Our bottleneck is our roadside reader. For I-15 EL, we rely heavily on vendor's willingness to upgrade firmware for the reader. If the vendor refuses to do so, we need wait for new roadside system to be in place.

Agency	Facilities	Setup	By what date will your agency be able to support reading and processing 6C transponders?	How long will it take your agency to be able to issue 6C transponders to your customers?	What sort of commitments and details does your agency need with regards to CTOC and 6C and by when in order to minimize impacts/optimize your agency's transition to 6C?
LA Metro	I-10 Express Lanes I-110 Express Lanes	Reader: 3M/SIRIT ID5204-001 Transponders: 3M/SIRIT	Lane Update and Testing: 12-15 months Back Office Changes: 3 months* CTOC Interface Change: 3 months* *The Back Office & CTOC estimates do not include requirements as part of the Rev G5 Specification. Changes once the specification is finalized are expected to be significantly more complicated than supporting 6C.	Form Factor and Testing: 1 year Procurement Process: 1 year (could overlap with Form Factor and could be shorter if 3M is a vender and current contracting arrangement is still in place. Current contracting arrangement is estimated to end early 2018. Metro will need to know by early 2017 to go through procurement. Estimated Delivery Lead Time and Customer Materials Update, Marketing/Outreach: 6 months Inventory and delivery set-up: 1 month	• CTOC Executive Committee decision and commitment of at least 2 venders to develop tag and commit to testing and certification process and date of availability • Re-procurement of Lane and Back Office scheduled to begin 2016. o Specification deadline late 2015. (Ideal, but not critical) o Estimated transition to new provider early 2018. (Ideal, but not critical) o Next transponder order needs to be made by late 2015 (critical to gauge replenishment order of Title 21 tags). o Procurement is a long lead-time item
OCTA	SR-91 Express Lanes	Reader: 3M/SIRIT	Upon opening of RCTC SR-91 Express Lanes	OCTA will be issuing the transponders for OCTA and	Need technical spec of 6c to support the

Agency	Facilities	Setup	By what date will your agency be able to support reading and processing 6C transponders?	How long will it take your agency to be able to issue 6C transponders to your customers?	What sort of commitments and details does your agency need with regards to CTOC and 6C and by when in order to minimize impacts/optimize your agency's transition to 6C?
	Under Development SR-91 Express Lanes extension into Riverside County Scheduled to open 2017 I-405 Express Lanes Scheduled to open 2022	ID5204 Transponder: 3M/SIRIT	Jan. 2017 (identifying vehicle to processing transactions and posting to an account or sending to a regional CSC) Reading and processing of 6C transponders would be in coordination with planned opening date. Need to change lane hardware and back office software during the current development phase. Need to be able to include discussion of NEW transponders in marketing / outreach (now thru Jan 2017). Will need to revise business rules and policy. Will need to develop overall transition plan.	RCTC. We would issue transponders to support Jan 2017 opening –(start procurement spring 2016). Need to understand the form factor and allow significant time for testing.	current development cycle (by July 1st 2015). Need procurement and cost information for planning and estimating purposes. Need to have commitment of when other southern California agencies will be able to read/process 6c transponders.

Agency	Facilities	Setup	By what date will your agency be able to support reading and processing 6C transponders?	How long will it take your agency to be able to issue 6C transponders to your customers?	What sort of commitments and details does your agency need with regards to CTOC and 6C and by when in order to minimize impacts/optimize your agency's transition to 6C?
RCTC	*Under Development* SR-91 Express Lanes extension into Riverside County Scheduled to open 2017		Joint response with OCTA	Joint response with OCTA	Joint response with OCTA
SANBAG	*Planning Stage* I-10 Express Lane I-15 Express Lanes		Responses not provided		

Appendix A: 6C Toll Operators Coalition AVI Transponder Programming Standard - Version 2.0

6C TOLL OPERATORS COALITION AVI TRANSPONDER PROGRAMMING STANDARD

REQUIREMENTS AND GUIDANCE DOCUMENT

VERSION 2.0
NOVEMBER 20, 2014

DOCUMENT CONTROL

Originator:	6C Toll Operators Coalition
Report Title:	63 Tolling Operators Coalition AVI Transponder Programming Standard
History:	V 0.1 - Initial Draft Release
	V 0.2 – Updates to “State” portion of EPC field Hash Key changed from 16 to 32 bytes Version Code added to Transponder Serial Number Field
	V 0.3 – Existing System Compatibility section added
	V 0.4 – Transponder and Reader Technical Requirements section added
	V 0.5 – Move Technical Requirements Section
	V 0.6 – Update to Barcode format and EPC/Password validation calculation examples
	V 0.7 – Update to User Memory Password validation calculation example and addition of comment regarding HOT declaration in EPC field
	V 1.0 – Updated Agency Codes (E-470 changed from 1 to 2); Made the Barcode format optional; Prohibited Read protection of User Data Memory; Allowed optional Write protection of User Data Memory; Updated references to the TID length to allow use of all fully serialized ISO 18000-6C standard tags
	V 2.0 – Updated the name of the document; redesigned memory map; convert from EPC Global format to ISO format; security update; changes to permit declarable transponders; updated Barcode format

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1. INTRODUCTION

1.1 Purpose

The purpose of this document is to create and maintain a transponder programming standard based on the ISO 18000-63 (known as 6C) communication protocol for tolling applications that use automatic vehicle identification (AVI). The guidance is intended for tag and reader manufacturers, toll lane vendors, system integrators, back-office providers, and other members of the RFID industry.

This programming standard meets the interoperability requirements developed by IBTTA's Roadside Interoperability Group.

1.2 Scope

This document addresses the following areas of interest:

- Memory Mapping
- Barcode Format
- Transponder Security and Data Integrity Validation
- Transponder Ordering and Delivery (Manifest Information)
- Compatibility with Existing Systems

1.3 Definitions, Acronyms, and Abbreviations

EPC	Electronic Product Code - Gen2 transponder memory bank 01
TID	Transponder Identification Gen2 transponder memory bank 10
UM	User Memory Gen2 transponder memory bank 11
UII	ISO 18000-63 (formerly '6C'), transponder memory bank 01

2. MEMORY MAPPING

The ISO 18000-63 transponder memory is separated into four memory banks:

Bank 00	Reserved
Bank 10	TID
Bank 01	UII
Bank 11	User Memory

2.1 Reserved Memory Specification

The Reserved memory shall be programmed by the tag provider and contents shared with the issuing agency.

2.2 TID Memory Specification

The Transponder Identification (**TID**) memory shall contain a 96 bit (12 byte) unalterable unique chip ID programmed by the chip manufacturer. This field will not be specified to be any particular value, but it is assumed to be unique for all 63 chips, per the ISO 18000-63 standard.

2.3 UII Memory Specification

The UII memory shall contain at least 96 bits; 12 bytes (programmed during transponder manufacturing process). Any memory in excess of 96 bits is undefined and may be used by the issuing agency; however, the additional memory shall not interfere with any of the functionality contained in this document. The UII shall provide read-only access to users. The issuing agency may lock write access permanently or may allow write access by a password known only to the issuing agency.

2.3.1 MEMORY MAP

#	Section	Description	Values
1 - 16	Header 16 bits	• 16 bit **ISO Header**. DSFID	1011 0000 xxxx xxxx
17-21	Reserved 5 bits	• 17 bit **Reserved Space**. These bits are reserved for future use and for interoperability. They shall be ignored.	0 = undefined (default - ignored)

#	Section	Description	Values
22-33	Classification 12 bits	Classification is taken directly from 2.2 E-ZPass – IAG, 256 Bit Style #1, Format #1 and includes:	
		• 1 bit **Classification Code.** The first bit indicates if the tag has been assigned a classification value. If 0 is selected, the following 11 bits shall be ignored.	0 = no class value assigned (default) 1 = class value assigned
		• 5 bit **Vehicle Type Code.** This field indicates the type of vehicle.	00000 = undefined (default) 00001 = automobile 00010 = motorcycle 00011 = pickup truck 00100 = van (seats 1-9) 00101 = minibus (seats 10-15) 00110 = bus (seats 16+) 00111 = recreational vehicle 01000 = truck 01001 = auto transporter (≤ 65') 01010 = auto transporter (>65') 01011 = tractor & trailer (≤48') 01100 = tractor & trailer (>48') 01101 = tractor & dual trailers each (≤28.5') 01110 = tractor & dual trailers each (>28.5') 01111 = tractor & dual trailers each (one ≤28.5' other >28.5') 10000 = undefined 10001 = tractor/mobile home combination 10010-11111 = undefined
		• 4 bit **Vehicle Axles**. This field indicates the number of axles.	0000 = undefined (default) 0001 = undefined 0010 = 2 axles 0011 = 3 axles 0100 = 4 axles 0101 = 5 axles 0110 = 6 axles 0111 = 7 axles 1000 = 8 axles 1001 = 9 axles 1010 = 10 axles 1011 = 11 axles 1100 = 12 axles 1101 = 13 axles 1110 = 14 axles 1111 = 15 axles
		• 1 bit **Vehicle Weight.** This field indicates the weight of vehicle.	0 = ≤ 7,000 lbs (default) 1 = > 7,000 lbs
		• 1 bit **Vehicle Rear Tires.** This field indicates the number of rear tires.	0 = Single rear tires (default) 1 = Dual rear tires

#	Section	Description	Values
34-36	HOV Declaration 3 bits	• 3 bit **Declaration Code.** These three bits indicate the declaration status of the tag. All single mode transponders shall be assigned the default value – 000, unless they are carpool specific tags.	000 = single mode (default) 001 = SOV (non-carpool) 010 = HOV 2+ 011 = HOV 3+ 100 = Carpool (as defined by roadway) 101 = reserved for future use 110 = reserved for future use 111 = reserved for future use
37-40	Version 4 bits	• 4 bit **Version Code**. There are 16 possible values to indicate the version of programming standard used on the tag.	0000 = Ver. 0.9 0001 = Ver. 1.0 0010 = Ver. 2.0 Other = reserved for future use
41-52	Agency 12 bits	• 12 bit **Agency Code**. The Agency Code allows for up to 4,096 agencies. The known agencies are included in the values column. See Appendices A and B for details.	0000 0000 0000 = unassigned (default) 0000 1100 0010 = E-470 (194 decimal) 1001 0000 0001 = TI Corp (2305 decimal) 0000 0100 1101 = WSDOT (77 decimal) 0001 0100 0001 = SRTA (321 decimal) 1001 1110 0001 = BWBA (2529 decimal) 0001 1100 0001 = LSIORB (449 decimal)
53-80	Transponder Serial Number 28 bits	• 28 bit **Transponder Serial Number**. This identifies the particular tag within the agency. There are 268,435,456 values accommodated in this space. The values in this field will be assigned by each agency.	Assigned by agency
81-96	UII Validation (Hash Value) 16 bits	• 16 bit **UII Validation**. This is calculated using the first 80 UII bits and 32 byte key. Example is provided in Section 4.	Assigned at the time of transponder manufacturer. Calculated as per Section 4.

2.4 User Memory Specification

None of the current members of the 6C Toll Operators Coalition Write to their tags, nor do any of them Read the User memory. It is anticipated that this memory bank may be required to accommodate future group members or affiliates. The following general specifications shall apply.

The User memory shall have at least 512 bits (64 bytes) and shall NOT be Read or Write protected.

The User memory bank shall be designated as a temporary data field, where facilities may Read and Write whatever information is necessary, recognizing that the data may be overwritten at any time. For example, the Interoperable Agency Group may choose to use this bank and Write trip start date, time, location, and price as the trip begins and Read this information at the conclusion of the trip. This could be used to compute the correct toll.

Any agency-specific use of User memory outside the specifications in this document should be closely coordinated to reduce the risk of future conflicts.

#	Section	Description	Values
1-11	Agency 12 bits	• 12 bit **Agency Code**. As assigned in the previous section.	Appendix A
12-18	Plaza ID 7 bits	• 7 bit **Plaza ID**. Each operator may choose.	To be defined by agencies using this field.
19-23	Lane ID 5 bits	• 5 bit **Lane ID**. Each operator may choose.	To be defined by agencies using this field.
24-48	Day/Time 25 bits	• 25 bit **Day**. Each operator may choose. (seconds since Jan 01 00:00:00)	To be defined by agencies using this field.
49-51	Occupancy Setting 3 bits	• 3 bit **Occupancy**. Each operator may choose.	To be defined by agencies using this field.
52+	Undefined	• The remaining bits may be defined as individual agency needs arise.	

3. BARCODE FORMAT

3.1 Barcode Format

The transponder barcode shall include only the Agency Code and Transponder Serial Number. It shall be printed using Code 128.

Below the barcode, the Agency Code, the Transponder Serial Number, and a check digit number shall be displayed in the following decimal format. The Agency Code shall NOT include leading zeroes and shall be separated from the Transponder Serial Number (TSN) by a double-space. The TSN shall include the leading zeroes (to fill all ten digits) and shall be separated from the check digit number by a double-space. The check digit shall be calculated using only the last two digits of the Agency Code and all ten digits of the TSN.

AAAA TTTTTTTTTT L

Where:

AAAA = 4 digit Agency Code (leading zeroes not printed)

TTTTTTTTTT = 10 digit Transponder Serial Number (leading zeroes printed)

L = Check digit Luhn (mod10) coded – calculated for **AA** (third and fourth digits only)
TTTTTTTTTT (ten digits)

For example, a WSDOT tag (Agency Code = 77 and TSN = 12) would be written to the tag as follows:

77 0000000012 3

4. SECURITY AND DATA INTEGRITY VALIDATION

4.1 Overview

Transponder security is critical to the toll industry. It is anticipated that as more security features become available they will be evaluated and deployed, as appropriate. The following security measures have been employed.

4.1.1 TID MEMORY BANK

The transponder identification number shall be uniquely assigned by the manufacturer. It shall be readable without a password and unchanged and unique.

4.1.2 UII MEMORY BANK

1. Read Password – The UII memory shall be readable without a password and mapped according to the requirement table in Section 2.3.1.

2. Write Password – The UII memory shall be writable with a password. The issuing agency shall be the only entity authorized to change the encoded bits on the transponder. The password shall be known only to the issuing agency. Further details are contained in Section 4.2

3. UII Authentication/Validation – The UII memory data shall be authenticated with two hashed validation bytes. The UII Validation bytes can be used for transponder data verification and can also provide some level of transponder authentication.

4. Encryption – Under development.

4.1.3 USER MEMORY BANK

1. Read Password – The User memory shall be readable without a password.

2. Write Password – The User memory shall be writable without a password.

3. Authentication/Validation – Authentication and validation shall not be used.

4. Encryption – Under development.

4.2 UII Validation

Below is example of how the UII validation bytes shall be calculated using:

1. The first 10 UII bytes

2. 32 byte key

3. And the transponder TID[1] (length varies - see footnote)

[1] The TID length can vary per the ISO 18000-63 specification. For fully serialized tags, the complete header and serialized portion of the TID (which can be anywhere from 96 - 192 bits, given the allowable serial number length of 48 - 144 bits) will be used for the indicated calculations. Per the standard, the length of a transponder's TID serial number is indicated on each transponder, in bits 20h - 22h of the TID.

For ensuring interagency interoperability and consistency between transponders manufactured by different vendors the open standard SHA1 hashing algorithm shall be used. The hashing sequence shall be:

1. SHA1 Digest with the first 10 UII memory bytes
2. SHA1 Digest with the 32 byte key
3. SHA1 Digest with the TID
4. SHA1 Final. The result is 20 byte hash
5. For UII Validation the first 2 bytes from the 40 byte hash result shall be used.

UII Validation Calculation Example is provided below:

UII 10 byte: **0101CE00010000000101**

Key 32 byte: **C129878320C2D8F31431AD04115865E9FD158736F894E6A9912CD768EF69006D**

TID (12 byte example): **E2003412012EC0FFEE041392**

Result 20 byte: **ECEA433F54993D0947C8425D2F93427DFFBB9D0B**

UII Validation bytes: **ECEA**

The 12 UII bytes shall be encoded as: **0101CE00010000000101ECEA**

5. TRANSPONDER ORDERING AND DELIVERY (MANIFEST INFORMATION)

To facilitate loading of data in back office transponder inventory on transponder delivery, manufacturers should provide a file with comma separated UII memory and TID. Each transponder entry should be on a new line:

12_Byte_UII_Memory,TID (length varies)

0101CE00010000000101CE8C,E2003412012EC0FFEE041392[2]

[2] Note: Values shown are for illustrative purposes only and are not actual/valid EPC or TID values. A 12 byte TID is used for example purposes.

6. COMPATABILITY WITH EXISTING DEPLOYMENTS

6.1 6C Toll Operators Coalition, Version 1.0

ISO 18000-6C Tolling AVI Transponder Programing Standard Version 1.0 was finalized in June 2012. Colorado's and British Columbia's TI Corp follow the standard. This standard is administered by the 6C Toll Operators Coalition. This standard is forward compatible with Version 2.0. See Appendix A for State and Agency Assignments.

6.1.1 E-470 TOLL AUTHORITY, USA

Colorado's E-470 follows this interoperable standard.

6.1.2 TI CORP, CA

British Columbia's TI Corp follows this interoperable standard.

6.1.3 KENTUCKY DEPARTMENT OF TRANSPORTATION, USA

Kentucky's Department of Transportation plans to follow this interoperable standard when they go live in 2015.

6.1.4 INDIANA DEPARTMENT OF TRANSPORTATION, USA

Indiana's Department of Transportation plans to follow this interoperable standard when they go live in 2015.

6.1.5 COLUMBIA, SA

Columbia's Department of Transportation plans to follow this interoperable standard in a series of existing toll facility conversion projects starting in 2015.

6.2 6C Toll Operators Coalition, Version 2.0

As of the publication of this document, ISO 18000-63 Tolling AVI Transponder Programing Standard Version 2.0 remains in draft form. This standard is administered by the 6C Toll Operators Coalition. This standard is backward compatible with Version 1.0. See Appendix A for Agency Assignments.

6.2.1 WASHINGTON STATE DEPARTMENT OF TRANSPORTATION, USA

Washington State Department of Transportation follows this interoperable standard.

6.3 Legacy Systems

6.3.1 STATE ROAD AND TOLLWAY AUTHORITY (SRTA), USA

Georgia's State Road and Tollway Authority (SRTA) had already deployed transponder programming requirements before Version 1.0 was developed and continue to operate their current legacy system.

6.3.2 UTAH DEPARTMENT OF TRANSPORTATION, USA

Utah Department of Transportation had already deployed transponder programming requirements before Version 1.0 was developed and continue to operate their current legacy system.

6.3.3 WASHINGTON STATE DEPARTMENT OF TRANSPORTATION, USA

Washington State Department of Transportation had already deployed transponder programming requirements before Version 1.0 was developed and continue to operate their current legacy system. This legacy standard is being phased out.

See Appendix B for a graphic of the different memory maps.

Appendix B: 6C Toll Operators Coalition MOU

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TOLL DIVISION

Memorandum of Understanding of the 6C Toll Operators Coalition

The **6C Toll Operators Coalition** ("6C Coalition") created on this _ of September 2012 ("Effective Date") is comprised of toll agencies, groups and organizations in the public sector that operate one or more toll facilities in the world using the 6C Standard (each a "Tolling Entity"). This Memorandum of Understanding (the "MOU") shall delineate the parliamentary procedures for the 6C Tolling Users Coalition, standards of conduct, and other issues related to the operation of the 6C Tolling Users Coalition.

I. **GOALS AND OBJECTIVES**. The 6C Coalition is a collaborative organization composed of public sector Toll Facility operators/owners that use the ISO 18000-6C as a primary method for automatic vehicle identification for the purpose of revenue collection on at least on one Toll Facility. The mission of the 6C Coalition is (i) to create and to maintain a uniform programming standard for ISO 18000-6C as used in the tolling industry, (ii) to maintain and control the EPC Header Code used for identifying 6C transponders used within the tolling industry, and (iii) to provide a forum to discuss and address issues and best practices and otherwise exchange lessons learned by the Voting Members' use of ISO 18000-6C in the tolling industry.

II. **DEFINITIONS**.

A. *6C Coalition Representatives* means any individual who is performing official duties on behalf of the 6C Coalition in their various capacities, as Officers, Members of a committee, and/or volunteers.

B. *6C Standard* means the programming details as set forth in the ISO 18000-6C Tolling AVI Transponder Programming Standard, dated June 5, 2012, as may be amended from time to time pursuant to the procedures set forth in this MOU.

C. *Founding Members* means collectively E-470 Public Highway Authority, Georgia State Road & Tollway Authority, Utah Department of Transportation, and Washington State Department of Transportation.

D. *ISO 18000-6C* means the Radio Frequency Identification protocol set forth by International Organization for Standardization.

E. *Members* means collectively the Non-Voting Members and Voting Members.

F. *Qualifying Documents* means individually or collectively ISO 18000-6C Toll Agency Coalition North American Transponder Programming Requirements and this MOU.

G. *Toll Facility (ies)* means any transportation facility that uses the ISO 18000-6C as a material method for automatic vehicle identification for the purpose of toll revenue collection.

H. *Volunteer* means an individual or an organization that agrees to provide services to or on behalf of the 6C Coalition at no cost to the 6C Coalition.

III. **MEMBERS**.

A. Voting Member. Any public sector tolling agency or entity that operates ISO 18000-6C on any Toll Facility is qualified to be a member of the 6C Coalition, provided and only for as long as the President or the President's designee verifies that such tolling agency is using the ISO 18000-6C on at least one of that agency's Toll Facilities.

1. As of the Effective Date, the Founding Members shall be Voting Members and each Founding Member shall remain a Voting Member for so long as such Founding Member continues to meet the criteria required to be a Voting Member.

B. Non-voting Member. Any public sector toll entity (including a group or consortium) may join as a non-voting member provided the agency can successfully evidence to the President of the 6C Coalition or the President's designee their interest in using ISO 18000-6C as the primary method for revenue collection on a Toll Facility. Non-voting Members may provide input to the 6C Coalition on relevant matters from time-to-time. Non-voting Members do not vote, their presence is not counted in determining a quorum or in determining the outcome of a vote, but they have all other rights and privileges of Voting Members.

IV. **ELECTIONS**. Any election held by the Voting Members shall be conducted by written vote or role call voice vote. Nominations shall be received from any Voting Member. Only those individuals receiving a majority of the votes cast shall be elected. If during any ballot no candidate receives a majority of the votes cast, there shall be successive balloting whereby the name of the candidate receiving the least number of votes is removed from the next vote. The term will begin on January 1.

V. **EXECUTIVE COMMITTEE**. The 6C Coalition shall be governed by an Executive Committee with assistance from subcommittees, as needed. The Executive Committee shall be comprised of the President, Vice President, and Secretary (each an "Officer"). Each Executive may designate one alternate to serve in place of the specified designee. The Executive Committee shall provide overall management to the extent necessary to accomplish the Purpose and Mission of 6C Coalition as described in Article I above.

A. Terms. The Officers shall be elected to terms commencing on January 1st with such elections held annually by the President at a meeting held from time to time, and shall hold office until their successors are elected, or until their earlier death, resignation or removal. The term of each Officer shall be two (2) years, unless such Officer no longer is employed by the Tolling Entity that is a Voting Member of the 6C Coalition, and may be re-elected for an unlimited number of terms. Any Officer may be removed, with or without cause, by resolution adopted by a majority of the Voting Members present either in person or via teleconference at a meeting at which a quorum is present and which has been called for that purpose.

B. President. The President shall preside over meetings and shall have and exercise such powers and perform the following duties:

1. the administration of the operations of the 6C Coalition Group,
2. create any committee deemed appropriate to fulfill the objects of the 6C Coalition,
3. notify Members of the existence of a new Member within 30 days after verification required in Section III.A. is complete, and
4. such other duties as may be conferred upon or assigned to him by the Voting Members.

C. Vice President. The Vice President shall have and exercise such powers and perform such duties as may be conferred upon or assigned to him by the Voting Members. The Vice President or the Vice President's designee shall also serve as the EPC Header Code Administrator and in such capacity shall be responsible for ensuring that the EPC Header Code registration remains current. In the absence of the President, the Vice President shall perform the President's duties and exercise the powers of the President.

D. Secretary. The Secretary shall be the keeper of the official 6C programming standard, as it may be revised from time to time pursuant to this MOU, and shall give proper notices of meetings of the members and shall be custodian of the books in which the minutes of such meetings are kept. The Secretary shall also perform such other duties as shall be assigned by the President.

VI. MEETINGS.

A. Annual. The annual meeting of the Members may be held at the office of any of the Voting Members, or as may be determined by the President, and shall be designated in the notice of said meeting, on a business day during the month of July of each year, at 4:00 p.m. EST, or at such other date and hour as may be determined by the President, and the notice for this meeting shall include the time, date and location of the meeting and the purpose of the meeting shall include electing Officers and for the transaction of such other business as may properly be brought before the meeting.

B. Special Meetings. Special meetings of the members for any purpose or purposes, may be held at any place with the option for Members to participate by telephone conference or other wireless-type conference, and may be called by any Voting Member. Such request shall state the purpose or purposes of the proposed meeting. Notice of the purpose or purposes and of the time and place of every meeting of the members shall be in writing and signed by the President or Secretary and a copy thereof shall be served by mail or via email (with confirmation receipt), not less than 5 nor more than 30 days before the meeting, upon each Member. Notice shall be directed to each Member at his last known address or email address, as applicable.

C. Quorum. Each Voting Member shall be entitled to one vote and a majority of the Voting Members presents in person, by telephony, internet conference, or represented by proxy, shall be requisite and constitute a quorum at all meetings of the Members for the transaction of business. Adjournments of any annual or special meeting of Members may be taken without new notice being given, unless a new record date is fixed for the adjourned meeting. When a quorum is present or represented at any meeting, the vote of a majority of the Voting Members present in person or represented by proxy shall decide any question brought before such meeting.

D. Roles. Meetings of the members shall be presided over by the President, or if the President is not present, by the Vice President, but if neither individual is present, the meetings shall be presided over by a chair to be chosen by the President, and if such appointment is not made then by majority vote by the Voting Members at the meeting. The Secretary shall act as Secretary of every meeting, but if the Secretary is not present, the Secretary shall have appointed a temporary substitute and if such appointment is not made a majority vote of the Voting Members present shall choose any person present to act as Secretary of the meeting. Notice of a meeting need not be given to any Member who waives notice and attendance at any meeting shall constitute a waiver of notice.

E. Meeting Procedure. The order of business at all meetings shall be as follows:

i. Calling of meeting to order.
ii. Election of temporary Officers, if necessary.
iii. Presentation of proof of the due calling of the meeting.
iv. Presentation and examination of proxies, if applicable.
v. Settlement of the minutes of the previous meeting.
vi. Reports of Officers and committees, as applicable.
vii. Election of Officers, if an annual meeting, or a meeting called for that purpose.
viii. Unfinished business.

ix. New business.
x. Sponsoring Voting Member presents a proposed change to one of the Qualifying Documents.
xi. If needed, a committee may be formed to perform additional research, which may include additional testing and/or certification efforts.
xii. Results from pre-existing committee will be presented.
xiii. The Voting Members and Non-voting Members will discuss the proposed change.
xiv. The Voting Members will take one of the following actions:
- Pass the proposed change with a three quarters majority of Voting Members present,
- Reject the proposed change if less than a three quarters of Voting Members present, or
- Table the discussion for additional research to be performed.
- Table the discussion for another reason.

xv. Adjournment.

Any action required to be authorized by the Voting Members may be taken in lieu of a meeting, with at least 14 days written notice to all the Members, by the written consent of two-thirds (2/3) of the Voting Members.

VII. Miscellaneous.

A. Amendments. This MOU may be amended only by a vote of two-thirds (2/3) of the Voting Members in attendance, in person, by telephony, or by computer conference at any meeting called for that purpose, after 30 days written notice, including a copy of such proposed amendment, mailed or emailed to each Member at the most current address received the 6C Coalition.

B. Dissolution. This MOU is perpetual unless dissolved as set forth in this section. Any Member may terminate their participation in this MOU on 30 days' written notice to the other Members. The 6C Coalition may dissolve upon a vote of ¾ of the then existing Voting Members.

C. Standard of Conduct. 6C Coalition Representatives must abide by this Standard of Conduct.

i. Each 6C Coalition Representative will:
- Abide by all 6C Coalition rules as well as applicable federal, state and local laws,
- Identify a potential conflict and, as appropriate, remove himself/herself from all discussion and voting on the matter in which a potential conflict of interest may occur,
- Conduct 6C Coalition affairs in good faith and in a professional manner, with honesty, integrity, and due diligence,
- Keep matters confidential if they are designated as such in meeting discussions or in writing,
- Use good judgment in dealing with 6C Coalition volunteers, suppliers and the general public,
- Use any 6C Coalition information and resources appropriately, and
- Return to the 6C Coalition any materials, if requested, at the end of his/her relationship with 6C Coalition.

ii. Each 6C Coalition Representative will not:
- Place (or give the appearance of placing) one's own self-interest or any third-party interest above that of the 6C Coalition,
- Use 6C Coalition staff or resources for personal or third party gain,

- Engage in any outside business, professional or other activities that would adversely affect 6C Coalition, or
- Solicit or accept gifts, gratuities, free trips, honoraria, personal property, or any other item even of nominal value from any person or entity as an inducement to provide special treatment to such donor with respect to matters pertaining to 6C Coalition.

D. Relationship of the Members. Neither this MOU nor the exercise of any actions authorized hereunder shall evidence or establish, or be construed as evidencing or establishing, any partnership, joint venture or similar relationship between or among the Members.

E. Indemnification. Nothing in this MOU is intended to create or imply duties or obligations to, or create or imply rights extending to or for the benefit of third parties not parties to this MOU and/or affect the liability of any Member by imposing any standard with respect to the operation of any Member's Toll Facilities. No Member nor any Officer or volunteer thereof is responsible for any injury, damage or liability occurring by reason of anything done or omitted to be done by 6C Coalition pursuant to or in connection with any work, authority or jurisdiction allocated to 6C Coalition which arises out of or is done pursuant to this MOU. If a claim, suit or action of any name, kind or description, including, but not limited to, tort, contractual, or other theories or assertions of liability, arising out of or alleged to have occurred as a result of anything done or omitted to be done by 6C Coalition is asserted against any Member or any of its Officers or volunteers, the Members shall promptly meet and confer for the purpose of reaching an agreement regarding whether, and to what extent, if at all, to defend, indemnify and hold harmless any Member, officer or employee against whom such claim, suit or action is asserted.

End of Memorandum of Understanding of the 6C Toll Operators Coalition

ACKNOWLEDGMENT

The Undersigned representative of the Tolling Entity listed below agrees that so long as the Tolling Entity is a Member of the 6C Toll Operators Coalition, the Tolling Entity shall comply with the terms of the Memorandum of Understanding of the 6C Toll Operators Coalition, dated September 24, 2012, as the same may be amended from time to time.

The Undersigned representative acknowledges that (s)he has the authority to sign this Acknowledgment on behalf of the Tolling Entity and to bind the Tolling Entity to the terms of the Memorandum of Understating of the 6C Toll Operators Coalition, dated September 24, 2012, as the same may be amended from time to time.

Signature: _____ Date: 9/26/12

Print Name and Title: CRAIG J. STONE, TOLL DIVISION DIRECTOR

Tolling Entity: WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

Signature: _____ Date: October 10, 2012

Print Name and Title: John D. McCuskey / Executive Director

Tolling Entity: E-470 Public Highway Authority

Signature: _____ Date: 11/8/12

Print Name and Title: ROBERT CLAYTON, TRAFFIC MANAGEMENT DIVISION DIRECTOR

Tolling Entity: UTAH DEPARTMENT OF TRANSPORTATION

Signature: _____ Date: 11/21/2012

Print Name and Title: Gene L. Evans / Executive Director

Tolling Entity: State Road + Tollway Authority