

White Paper #2 – The Future of Tolling

All-Electronic Tolling: Saving the Environment, Your Wallet, and Your Time.

Compiled by: [A-to-Be®](#) | [Mobility-Beyond](#)

Executive Summary

All-Electronic Tolling (AET) is an increasingly popular option in the tolling industry, used **56** percent of tolling facilities in the United States as of 2019¹. In the wake of the Covid-19 pandemic, this shift toward AET is only accelerating. Besides the health benefits of reducing physical contact, AET helps operators save money, keep their toll booth operators healthier, reduce greenhouse gas emissions, reduce the safety risks of stopped cars, and perhaps most importantly to their clients, keep vehicle traffic moving.

Despite all of these benefits, **AET presents a few challenges** to operators, including losing on-site customer service from the toll booth operator, having potentially higher leakage rates, the difficulty of collecting payments by mail, and how to include unbanked drivers or those who do not wish to use a transponder.

In this white paper, **we will begin by defining AET, followed by a discussion of the benefits and challenges of AET**, and will propose ways to overcome these challenges, supported by the example of **A-to-Be client Northwest Parkway** in Colorado, which converted their system to AET in 2009 with the help of A-to-Be.

Introduction

All-Electronic Tolling (AET) is not exactly new to the tolling industry anymore, but it's still not universal for a variety of reasons. **AET is growing its share of the tolling market, with 10 percent of road operators recently converting to AET, and another 10 percent planning to convert to AET or Open Road Tolling (ORT) as of 2019.**² Already, AET facilities make up 56 percent of the U.S. tolling market, according to the International Bridge, Tunnel, and Turnpike Association³, and this shift toward AET is accelerating post-pandemic. AET can take many different forms, working with so many types of technology – and that's exactly what makes it a useful tool in the tolling toolbox.

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AET began to appear around the turn of the 21st century, and it was soon on its way to becoming the **predominant tolling option**. At its most basic level, AET is exactly what its name says it is – **all electronic, as opposed to manual or cash-based, tolling**, or systems with mixed-mode applications. Typically, electronic tolling happens using an on-board unit (OBU), also called a transponder, which connects to the driver's toll system account – in fact, **A-to-Be's parent company, Brisa, introduced one of Europe's first AET systems in Portugal, called Via Verde, which is still based on transponders today.** However, we can learn more about the different forms of AET from the way it was introduced and developed in the U.S., like the case of **A-to-Be client Northwest Parkway** in Colorado.

In this white paper, A-to-Be will explore the evolution of this electronic form of tolling concept and its increased sophistication over time due to the emergence of new technologies which are perfect for use not only in AET environments but also for use in Open Road Tolling (ORT)/Express Lanes and/or Road Usage Charge initiatives. Among others, **operators are more and more opting for AET due to its proven capability of avoiding stop-and-go congestion and increasing operational efficiency.** However, **there are several challenges to be considered** when implementing AET, such as interoperability or inclusivity. A-to-Be further explores this, suggesting alternatives to overcome these significant hurdles.

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The evolution of AET

AET grew out of Electronic Toll Collection, or ETC. ETC uses a transponder connected to the driver's tolling system account. Drivers' accounts can be pre-paid or post-paid, and they may or may not be linked to a debit or credit card, depending on the business rules of the toll road administrator. As each car drives through the toll plaza, roadside equipment uses **radio frequency identification (RFID)**, or in some cases and geographies, **dedicated short-range communication (DSRC)**, to register that the car is passing through the toll plaza, read the driver's account details (such as vehicle classification), and to charge the correct toll amount using a back office software system. Early ETC deployments require drivers to slow down to 5 to 20 miles per hour, but the technology does not require a complete stop, despite some lanes having barriers. Even so, **ETC saves drivers time by eliminating the need to exchange cash or hand over a debit or credit card, and it also reduces the potential for classification errors.**

The next iteration of ETC was Open Road Tolling, or ORT (known as Multi-Lane Free Flow, or MLFF, in Europe). ORT allows drivers to pass under gantries at highway speeds, meaning that ORT “plazas” don't have barriers to enforce payment. **ORT lanes do not accept cash, and they use photos and video to audit its own accuracy and to identify the license plates of cars using ORT lanes** without a valid transponder and bill the car's owner later (known as “post-paid”). When using this pay-by-plate system (also called pay-by-mail), the Backoffice System (BOS) of the tolling agency looks up the driver's information in nearby Department of Motor Vehicles (DMV) systems, and invoices the driver by mail. According to a study by KPMG, **more than 43% of U.S. tolling facilities offer ORT on some or all of their lanes**⁴. Some ORT systems have lanes dedicated to cash or card payments in addition to ETC lanes.

AET refers to using only these tolling technologies – ETC and/or ORT – and not using manual toll collection or toll payment machines¹. In summary, **ORT and AET are both methods of ETC** – but they are not the only types of ETC, and ORT is sometimes, but not always, the same as AET.

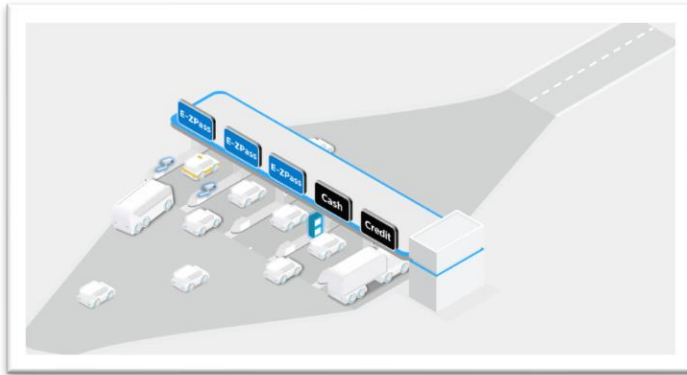


Figure 1: Classic Toll Plaza – combines electronic and manual toll collection

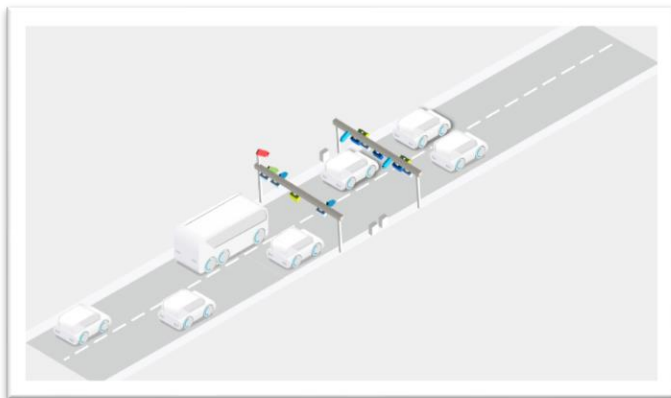


Figure 2: Classic Open Road Tolling – a form of all-electronic toll collection

Additionally, **AET can combine with other technologies to create an even more sophisticated system**. Operators use AET to implement **Managed Lanes**. This approach, used by many tolling agencies, creates a restricted lane within a freeway which drivers can access and exit at various points along the route of travel. These Managed (or Express) Lanes typically move faster than the untolled general purpose lanes, and for that time saving benefit, the patron is charged a toll. Oftentimes, agencies will implement **Dynamic Pricing** in these lane types, where toll rates vary based on the time of day or level of vehicle traffic. This system can also apply to **High Occupancy Vehicle (HOV) and High Occupancy Toll (HOT) lanes**, where vehicles with a minimum number of riders can access the managed lane for free, while cars with fewer occupants must pay a toll. Finally, **AET can be used with satellite (GPS-based) tolling** to facilitate Road Usage Charging (RUC). While this type of tolling is still emerging, it typically uses a combination of an OBU, plus satellites and a mobile app to charge drivers for each mile they travel on certain roads. Some of these systems also use gantries for enforcement purposes.

¹ Some organizations include toll payment machines, or cash-free toll payment machines, as part of All-Electronic Tolling.

Benefits of AET

Operators continue to choose AET because of several distinct advantages, which flow from its two main differences with manned or cash-based toll lanes: **no need for staff, and no need for stopping.**

Removing manual tolling means that operators don't need to staff their toll booths, thus significantly reducing operational costs and removing safety hazards for toll booth operators. This is a key reason driving road operators in Illinois, New York, New Jersey, Kansas, and other states to accelerate their AET plans during the ongoing global pandemic – **moving from manual to all-electronic lanes avoids the need for contact between toll booth workers and drivers and thus avoids the transmission of disease.** Regardless of Covid-19, toll booth operators are typically exposed to vehicle exhaust fumes for hours on end and they may be exposed to safety risks from vehicles while entering and exiting the toll booths. Switching to AET removes these risks. **Road operators can also save money on any new tolling points, which will require a smaller area and less roadside equipment than a manned toll point.** Employees who formerly staffed toll booths can use their customer service experience in remote or walk-in customer service centers.

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Northwest Parkway, for example, decided to convert their system to AET in 2009, and selected A-to-Be to provide the roadside equipment and BOS. Previously, Northwest Parkway collected tolls manually, but they were interested in the cost savings and smoother travel promised by AET. **Today, AET is working well for Northwest Parkway, but they are not stopping there.** One of the technologies they are considering is **smartphone-based payments**, which hopefully will make it easier for local residents and visitors to create an account and enjoy Northwest Parkway.

While some AET systems require drivers to stop (such as those which use a barrier), most allow drivers with transponders to pass under the gantry at or near highway speeds. This has several **benefits:**

- Avoiding congestion. Pausing to pay a toll creates a traffic jam during peak hours. Opening transponder-based and pay-by-plate lanes can alleviate all or part of this congestion.
- Avoiding stop-and-go. Stopping, or even slowing, on a highway creates an environment of significant safety challenges. Distracted drivers can fail to stop or fail to stop soon enough, and they can collide with vehicles stopped to make a payment. While this is rare, it can have dangerous consequences for the drivers, passengers and toll booth attendants, when present.
- Avoiding exhaust fumes. Since no queue forms to pay a toll booth attendant or a payment machine, cars avoid idling and releasing greenhouse gasses while they wait and accelerate.
- Avoiding customer frustration. All of these drawbacks to stopping create a poor customer experience, and AET can help keep drivers moving and happy on their journeys.

“Converting to AET met our expectations,” says Pedro Costa, CEO of Northwest Parkway. “Even though the cost to process video-toll transactions is higher than ETC, using differential pricing you are able to recoup the extra cost. More importantly, our customers like it too, benefiting from the convenience of not having to stop to make a payment. Toll roads main drivers are convenience and safety, and AET improves both.”

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Challenges

However, there are substantive reasons why some road operators haven't embraced AET yet. **One frequent reason is that ETC is not yet universal** – not all drivers have, are able to have, or wish to have a transponder and a tolling account. AET customer accounts are typically linked to a credit or debit card, which requires users to have a bank account. According to the FDIC, about 5.4 percent of U.S. households, or about **17 million people, are unbanked**, although this figure varies by region and is much higher in some areas⁵. Beyond the requirement to have a bank account, **AET users must agree to place the transponder device in their car**. For various reasons, including privacy concerns, some drivers may not be willing to do this. **Plenty of other drivers may use toll roads extremely rarely, and thus may not see the value in paying for a transponder and setting up an account.**

1 "ETC is not yet universal"

2 "Consider what is lost by removing a toll booth operator"

Next, consider what is lost by removing a toll booth operator: customer service and problem-solving on site, plus a measure of enforcement. **A toll booth operator can troubleshoot technological problems, correct vehicle misclassifications, handle drivers without a method of payment, and more.**

Typically, **an AET system will use ALPR to invoice a driver without a transponder** who passes through a tolling point, as well as to perform routine audits. However, **collecting from these invoices is difficult, especially outside of the toll road operator's jurisdiction**. A 2019 study by KPMG found that 64 percent of road operators do not attempt to collect pay-by-plate invoices outside their jurisdiction – and 40 percent do not pursue them even in their own jurisdiction⁶. Often, the cost of collecting the unpaid tolls is greater than the unpaid tolls themselves – and it may not be possible to collect them due to jurisdiction issues. Although the ability to collect tolls outside of the road operator's jurisdiction is improving thanks to agreements between states and agencies, **collecting across jurisdictions is not always easy.**

3 "Collecting across jurisdictions is not always easy"

4 "Customers with a transponder from a different toll road operator which uses a different frequency will not be able to use AET"

Finally, AET shares a challenge with all other electronic toll collection (ETC) methods: **interoperability**. While it may not be a leading reason why some road operators have not yet embraced AET, it is a challenge and a complicating factor. In the U.S., multiple different frequencies of RFID are in use, and **customers with a transponder from a different toll road operator which uses a different frequency will not be able to use AET**, and they will have to pay-by-plate.

Problem-solving

Still, **more than half of all road operators find ways to solve these AET challenges every day⁷**. To address interoperability, **toll road administrators can choose a radio frequency at the beginning of their AET conversion which is interoperable with other nearby systems**. Alternately, they can choose to join one of several regionally interoperable networks, like EZ-Pass, Sunpass or TxTag. Either way, **operators can also consult an interoperability-focused organization**, such as the Alliance for Toll Innovation (formerly the Alliance for Toll Interoperability), which can share best practices.

1 "Toll road administrators can choose a radio frequency at the beginning of their AET conversion"

2 “Accept payments via smartphone”

Another potential solution to interoperability headaches is to **accept payments via smartphone**. Using appropriate equipment, including, but not limited to Bluetooth and license plate recognition technology, and different smartphone capabilities, agencies can collect tolls via a smartphone app. **Since these options would not rely on a specific radio frequency, they could make it could be easier to achieve broad interoperability using phones**. While transponder-based accounts are still far more common than smartphone-based accounts, there are about **10 smartphone toll payment apps** operating in the **U.S.** today.

In order to address the removal of in-person customer service at toll plazas, road operators converting to AET typically **re-imagine their customer service teams**. Frequently, one remote team serves all tolling points, answering calls, text messages or chat as customers encounter challenges, and spending no time on customers who are easily able to pay and proceed on their way. **They can also serve customers at a walk-in center**, so that customers still get in-person service when they need it – just not at tolling plazas.

3 “Road operators converting to AET typically re-imagine their customer service teams”

Minimizing revenue leakage and processing violations are two more challenges when implementing AET. While the cost to collect each toll using AET is less than half of the cost to collect using manual tolling, **processing**

4 “Interoperability agreements make it easy, and smartphone payments may make radio frequencies irrelevant”

“violations,” or customers who use an AET lane without the appropriate transponder, are 72 percent more costly than a transponder-based AET toll⁸. Fortunately, solutions to other AET challenges also help here: **interoperability agreements make it easy for road operators to collect tolls from customers of other systems, and smartphone payments may make radio frequencies irrelevant in the long-term**. Road operators can also structure their agreements with tolling service providers or integrators to include responsibility for pay-by-plate collections, with a maximum allowable amount of revenue leakage.

The most difficult AET challenge to resolve is **inclusivity**, yet even this is not impossible. **Unbanked customers can use pre-paid accounts, which can be paid with cash at walk-in customer service centers**. Those who are not willing to put a transponder in their car **might be open to Bluetooth-enabled smartphone payments**, or they can use **pay-by-plate**. Both of these groups can also be served by leaving one lane that accepts cash, ideally through an **automatic toll payment machine** that accepts cash, credit and debit cards, and even smartphone or smartwatch payments.

5 “Unbanked customers can use pre-paid accounts”

Northwest Parkway also illustrates how toll road operators can work with their clients to solve the challenge of simply changing behavior. After making the decision to convert their system to AET, Pedro Costa says that the next key step in conversion was a **robust plan to communicate the changes to existing Parkway users**. “While we were updating our roadside equipment, **we communicated early and often with the local community** about why they should get a transponder or enroll in our Go-Pass program, how to do so and how to set up their account, and how pay-by-mail would work. We used local media and advertisements, and if we were doing the conversion today, we most likely would also use social media,” said Costa.

Today, AET is working well for Northwest Parkway, but they are not stopping there. “We are always evaluating ways to advance our system,” says Costa. “One of the technologies we are evaluating is **smartphone or bluetooth-based payments**, which we hope will make it easier for drivers to pay for trips using their smartphones.”

The road ahead

“ While the financial, safety, time, health, customer satisfaction and environmental benefits of AET are all appealing, the future of AET is even more exciting.

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While the financial, safety, time, health, customer satisfaction and environmental benefits of AET are all appealing, the future of AET is even more exciting. Through AET, we can envision a future beyond transponders and beyond tolling – where connected cars communicate automatically with sensors as they pass through free-flowing lanes, with rates automatically adjusting to reflect traffic congestion or the time of day, or to protect clean-air and pedestrian-friendly zones in the most advanced cities.

Starting with smartphone payments, we will slowly lose our reliance on RFID or DSRC transponders, allowing true interoperability across the U.S. and even across borders. As 5G becomes widespread and new cars gain the ability to share and receive information with the infrastructure around them, we will even move beyond smartphones, and into an age when the car acts as the transponder, sending and receiving information with tolling sensors, linked through its' operating system to the owner's tolling account, or even directly to their bank account.

As cities continue to grow, AET can also provide the solution to congested roadways, poor air quality, and vehicle-packed historic districts. In this case, we don't have to wait to see the future of AET in action: **Singapore is testing using AET to toll vehicles entering a perimeter around the city center in order to improve air quality, and New York City is set to begin tolling cars entering its central business district in 2022,** in order to manage congestion of vehicle traffic. And in its hometown of **Lisbon, Portugal, A-to-Be recently implemented location-based tolling to limit cars in Lisbon's historic Bairro Alto,** preserving the character of the neighborhood and making it more friendly to pedestrians, while allowing access for residents and business owners.

“ AET can also provide the solution to congested roadways, poor air quality, and vehicle-packed historic districts.

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All of these automatic, **“vehicle-to-X” communications will be verified by video, employing the latest machine vision technologies and license plate recognition algorithms** to read each car's identification and verify its class, and even its occupancy, to sort it into the correct category for tolling, **Road User Charging (RUC)** or using **HOT lanes**. Just recently, **A-to-Be has developed an algorithm that automatically detects the number of occupants in a vehicle, which can be used for enforcement in HOV lanes.**

Summary

The future of tolling is certainly all-electronic – and it does not stop there. Each of these **promising technologies is being developed by tolling integrators and authorities, including A-to-Be**. Building on AET technologies, the industry can unlock a **new era of automatic mobility** that incentivizes drivers to protect the planet through HOT, prioritize air quality and pedestrians through location-based tolling, and to do so in an interoperable way, reducing headaches for road operators and users. **As AET technology progresses, road operators will be able to unleash unprecedented efficiency and financial benefits**, all while aiding benefitting their communities, as well.

In this series called “The Future of Tolling”, A-to-Be examines and reflects on the most innovative tolling that will ensure an efficient and effective toll collection in the long-term aligned with the expected upcoming mobility challenges not only in the US but worldwide. **In the next white paper, we will share a reflection on a different form of electronic tolling: video**. Stay tuned!



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Interested in learning more?

Stay tuned for the next White Paper of this series, where **A-to-Be** will explore a different form of Electronic Tolling – video. Ready for “take three”?



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