Global Navigation Satellite System Road Pricing in the Greater Toronto Area

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Abstract

This paper discusses the prospects of overcoming the hurdles to implementing a policy of road pricing in the Greater Toronto Area (GTA) via Global Navigation Satellite System (GNSS) technology. The paper begins by outlining some of the theories and issues surrounding road pricing implementation. Next, the experiences of three other jurisdictions with implementing road pricing are analyzed, followed by an analysis of the debate in the GTA and the merits of GNSS tolling compared to other policy options. The two main hurdles to GNSS road pricing in the GTA, costs of the system and privacy concerns, are identified and examined. Suggestions to overcome these hurdles are offered and evaluated. The paper concludes with an analysis of how such an implementation strategy would affect the issues of road pricing acceptance and governance.

Foreword

The plan of study is about political economy and the policy changes necessary for an appropriate response to public energy-related problems. The main demand-related transportation problem is traffic congestion. When the demand for roads outstrips supply, time and fuel efficiency during travel decreases. Road pricing is a policy tool that directly affects the energy economy but rather than being applied to the energy production system, it's applied to the energy demand side. It increases the resiliency of an urban transportation problem by providing a financial incentive to motorists to increase the proportion to which alternative modes of travel are used.

The major paper helps to fulfill the requirements of the MES degree by partially achieving the learning objectives of the Plan of Study. These objectives include:

- to learn how politics has, and how it can continue to, affect the management of an energy transition
- to learn the economic and behavioural barriers to significant energy-related policy change
- to understand the contributions various actors make towards policy change
- to understand the strategic approaches governments take towards energy policy problems
- to understand the technical solutions for an energy transition
- to understand the financial solutions for an energy transition

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1.0 Introduction

It has often been argued that the Greater Toronto Area's (GTA) has transportation system is unsustainable. A study by HDR Corporation on the costs of road congestion in the GTA stated that "delay, diminished productivity, wasted energy, environmental degradation and a diminished standard of living…threaten the region's viability as a decent place to live, visit and conduct business" (HDR Corporation, 2008). The study concluded that if the region's transportation patterns follow business as usual, the reduction in GDP due to excess congestion would increase from $2.7 billion in 2006 to $7.2 billion in 2031 – an increase of 167 percent (HDR Corporation, 2008). In Ontario, transportation accounts for the highest demand for energy in the province, and passenger vehicles represent 73 per cent of the greenhouse gas emissions from road transportation (Miller, 2010). It is clear that an important policy objective in the GTA should be to reduce the dependence on automobiles for transportation services. This paper looks at one public policy option, road pricing, as a mechanism to solve automobile dependency.

In response to the GTA's automobile dependency, the Province of Ontario started the "Smart Commute" program that advises employers on how to promote carpooling, transit, cycling walking and teleworking as alternative commute methods to a private automobile (www.smartcommute.ca, 2011). Metrolinx, the region's transportation authority adopted "The Big Move" or its Regional Transportation Plan (Regional Transportation Plan) in 2008. The plan calls for building over 1200 kilometres of rapid transit, essentially tripling existing services (Metrolinx, 2010). This project is estimated to cost $50 billion in capital over 25 years and approximately $1.5 billion per year in ongoing operation and maintenance (Metrolinx, 2010). Fulfilling long-term funding requirements for "The Big Move" would be an ever-growing strain on provincial and local budgets if their existing structures do not change. Moreover, new public

transit infrastructure represents only the pull factor of a policy to reduce automobile dependency. As Glaister and Graham argue, no big move can be planned in isolation from push factors (Glaister & Graham, 2006).

History suggests that push factors such as road pricing proposals are very unpopular for a variety of reasons, and the case of the GTA is no exception. A common theme in the current transportation debate in the GTA is whether or not road pricing should be implemented for the purpose of subsidizing public transit (Toronto Board of Trade, 2010). It may be that public transit subsidies need not be very extensive if by reducing automobile dependency in turn makes public transit become more competitive (Gilbert, 2010). In any case, this paper will not discuss public transit, crucial to alleviating automobile dependency as it is. Instead, this paper will focus only on how to provide solutions to traffic congestion and implement road pricing in the GTA, despite the concept's lack of popularity.

1.1 Externalities and User Fees

The concept of road pricing comes from the economic theory of externalities (J. N. Buxbaum, 2009). When the market fails to balance the levels of supply and demand, some of the costs of product are not included in their price, and are externalized. Externalities from an unbalanced market for road use include congestion and harmful emissions. One could strike a balance if access to the supply is manually limited by, for example, banning the use of vehicles with licence plates that end in an even number for half the week, and banning odd number plates for the second half. This, however, is not a practical approach for an urban transportation system. Instead, most products and services supplied in the marketplace rely on pricing to align

demand with supply. If demand exceeds supply, prices will rise, and some customers (motorists) will choose not to buy (drive). In the case of transportation services, supply from the public is limited and often is exceeded by private demand. When there is no charge on a motorist for entering a highway, the motorist does not consider that he or she is imposing a cost on others. Buxbaum argues that the under-pricing of roads results in a market failure called congestion (J. N. Buxbaum, 2009). He argues further that assigning a price to the use of a road seeks to correct this market failure by, for example, reducing demand for low value trips and therefore reducing the supply shortage.

1.2 Efficiency and Equity

In a public policy context, it has been argued, by Kitchen for example, that user fees achieve economic efficiency in the provision of goods and services that have private characteristics (Kitchen, 2011). Goods and services that have private characteristics are those where one person's consumption means that this good/service is not available to anyone else. Roads should be considered to have private characteristics because the space occupied by one vehicle cannot be shared with another vehicle (Kitchen, 2011).

Traditionally, roads have been "priced" with a tax of motor fuels. Fruits and Pozdena argue that since fuel taxes are not fully related to the burden vehicles place on society, externalities have progressed (Fruits and Pozdena, 2008). Moreover, if governments successfully manage to discourage fossil fuel consumption, these taxes will not be able to pay for roads in the long run.

Restructuring transportation markets with direct user fees is not simple. Buxbaum suggests that maximizing efficiency can conflict with equity concerns when choosing a road

pricing design and rate structure (J. N. Buxbaum & Ortiz, 2009). The choices involve: (1) which types of roads will be priced such as upon entrance to major roads and highways, upon entering an urban core, or all roads in a jurisdiction; (2) how will prices vary such as with certain days of the week, times, locations, congestion levels; (3) will anyone receive discounts to such road use such as low income individuals; (4) and where will the revenues go such as into general government coffers, transportation infrastructure, or rebates in the form of tax breaks? The certain disagreements that occur over answers to these policy questions is one reason why so many more road pricing proposals have been rejected than implemented.

1.3 Political Will and Policy Change

A potential policy change (i.e. implementing road pricing) has less chance of success if it arouses negative emotions and can be attached to a politician (Westen, 2007). To avoid negative reactions toward traffic congestion, policymakers talk about fixing the GTA's transportation system by implementing Metrolinx's Regional Transportation Plan, but do not talk about how the plan will be financed. While the Regional Transportation Plan's demand for public resources is great, the predicted changes in travel behaviour implied by it are even greater. Where the change in population is about the same for the periods 1986-2006 and 2006-2031, transit origins during the morning peak are predicted to increase by 132 per cent compared to an increase of only 11 per cent for the period 1986 to 2006 (Soberman, 2010). Such an unprecedented change requires unprecedented measures that take into account the human interest in maximizing personal gains.

This paper proposes a road pricing system for the GTA based on Global Navigation Satellite Systems (GNSS) technology with an On-Board Unit in each vehicle. The road pricing system could toll vehicle use throughout the entire region based on any pricing options desired. Such a scheme has yet to be introduced, perhaps because it is dismissed by opponents as being too expensive and intrusive (Anable and Boardman, 2005). But by tolling all roads and levying fees for direct road use, it is possible to minimize negative externalities and maximize the efficiency of the GTA's transportation system.

Politics, human behavior, and specific circumstances surrounding the GTA present serious hurdles in path to implementing GNSS road pricing: managing the cost and privacy concerns surrounding the technology, achieving acceptance of the policy among stakeholders, and solving the issues of how to govern the revenues. This paper will discuss approaches to overcome these hurdles, approaches that require the distinct abilities GNSS technology possesses.

1.4 Methodology

The research consisted of collecting qualitative data in newspaper articles, journal articles and blogs. The paper begins with an analysis of the experiences three different jurisdictions had attempting to implement road pricing. Lessons are drawn from these experiences to help inform the further discussion. The same method is then applied to the experience of the GTA, while arguing the merits of GNSS road pricing to this specific case. The remainder of the paper focuses on the main hurdles in the path toward implementing GNSS road pricing in the GTA, and evaluates ways to overcome them.

2.0 Past Developments in the GTA and Other Jurisdictions

This chapter will discuss the experiences of three jurisdictions attempting to implement road pricing: the tolling of high occupancy vehicle lanes in San Diego County, the attempt to pass road pricing legislation in the Netherlands, and the testing of a mileage fee in the State of Oregon. Most information regarding these jurisdictions' experiences was found by analysing their respective newspapers, though government documents and academic journals were also used. Each of the three sections of this chapter will give an account of the events and make sense of them in a political economic framework. Lessons for the GTA will then be drawn from this discussion.

2.1 San Diego County

San Diego's experience with road pricing began with the need to accommodate a large increase in population and commuters to and from the City of San Diego. By the late 1980s, traffic congestion was exacerbating. Ramp meters at some freeway entrances were making drivers wait up to ten minutes during rush hour (Curran-Downey, 1994). The number of miles driven each weekday in the county had increased by 7 percent a year -- twice the rate of the population growth. However, it was an increase in air pollution that prompted the County to tackle its transportation problems (Weisburg, 1991a). In 1988, the State of California passed the Clean Air Act which mandated a reduction in the sources of air pollution contributing to smog (Weisburg, 1991a). San Diego County had to bring its average vehicle ridership up to 1.5 persons during the peak-period commute from 1.2 at the time, and substantially reduce vehicle trips and miles traveled by 1997 so that the rate of growth did not exceed that of the population (ibid).

One government agency, the Air Pollution Control District (APCD), was mandated in 1988 to develop a plan to meet these legislative requirements. In addition, the regional planning agency, San Diego Association of Governments took the initiative and developed an alternative plan for the County in 1991 (Weisburg, 1991a). The Air Pollution Control District plan was very robust, proposing to force businesses to eliminate free parking to their employees and directly taxing businesses to fund an expansion of mass transit (Weisburg, 1991b). The San Diego Association of Governments, comprised of elected officials, opposed these strict proposals, and advocated for a 'less prescriptive approach' (ibid). Even though the Air Pollution Control District had the final say over the official plan, it negotiated with the San Diego Association of Governments in an attempt to reach an agreement. It was in the San Diego Association of Governments' interest to convince the Air Pollution Control District and the county in general, that it was not afraid to take bold measures to alleviate congestion and improve public transit.

The major area of congestion in the county was Interstate 15, connecting the county suburbs to the City of San Diego. By 1988, eight miles of high occupancy vehicle lanes were made to help with the "war on the single occupant vehicle" but failed to attract many carpools (TRB, 2009). In 1991 Jan Goldsmith, mayor of a County suburb and a member of the San Diego Association of Governments, suggested lifting restrictions on the high occupancy vehicle lanes for single occupant drivers who are willing to pay. Goldsmith was interested in raising money for mass transit improvements (Goldsmith, 1996). The San Diego Association of Governments' board applied for funding from a federal congestion pricing program of the Intermodal Surface

Transportation Efficiency Act, adopted by the U.S. Congress in 1991 (ibid). The funding was to test the idea of charging solo drivers who wish to use the car pool lanes on Interstate 15. The San Diego Association of Governments thought the funds collected could be used to expand mass transit on I-15 (ibid).

Implementing this law required legislation from the State of California. By 1993, Goldsmith was a Republican State Assemblyman, representing eastern San Diego County, and the author of a bill to convert the I-15 high occupancy vehicle lanes into High Occupancy Toll lanes. He presented Bill 713 as "a creative way of raising some transit funds for an underutilized corridor without raising taxes" (Mendel, 1993). Bill 713 became law. It required that the I-15 express lanes ensure "free-flow" conditions for high occupancy vehicles at all times, unrestricted, free access to the lanes by high occupancy vehicles, the use of revenue only to transit and high occupancy vehicle improvements for the I-15 corridor (Supernak et al, 2002). In January 1995, the San Diego Association of Governments received a $7.96 million federal grant from Intermodal Surface Transportation Efficiency Act's program to pay for half of the projects costs, and the other half came from the toll revenues and California's gasoline tax (Supernak et al, 2002).

The tolls began in the form of monthly permits; a limited number of colour coded hang tags affixed to the rear-view mirror for unlimited use of the lanes per month. San Diego Association of Governments slowly increased the monthly permit fee to test the effect on motorists' willingness to pay. The demand for these permits grew and as supply followed, prices went up (Arner, 1997). The findings from this test influenced the pricing structure that San

Diego Association of Governments deployed after only several months of operation. San Diego Association of Governments launched an all-electronic variable toll collection system called "FasTrak" where subscribers pay for each trip on the I-15 High Occupancy Toll lanes. The rate varies in real time, depending on the number of cars using the High Occupancy Toll lanes (Supernak et al, 2002).

Opposition to the High Occupancy Toll lanes project occurred both before and after Bill 713 became law. During debate in the California Legislature, advocacy groups such as the Sierra Club and the Professional Engineers of California Government argued that carpooling was being discouraged and highways were becoming privatized leaving less work for the public sector (Mendel, 1993). These advocates failed to convince enough lawmakers.

As the months and years went on, the High Occupancy Toll lanes were successfully accommodating more vehicles. The population and the economy, however, were still growing, so I-15 congestion was still a problem. A group upset with congestion launched a campaign to open the High Occupancy Toll lanes to all traffic. Called Project NOEL for "No Exclusive Lanes", the campaign was joined by the San Diego Taxpayers Association (Berhman, 1997), and involved themselves in the election to replace Goldsmith (who was being forced out by term limits) in his district. The notable contest was in the Republican primary where many candidates sympathized with Project NOEL and viewed traffic congestion as government encroachment on people's lives (Braun, 1998). Fortunately for the High Occupancy Toll lanes, the winner was a moderate Republican endorsed by Goldsmith. This was evidence that the original and most

prominent proponent of congestion pricing in San Diego County did not suffer political repercussions for his actions.

Though politics did not substantially interfere with the High Occupancy Toll lanes development, opposition remained. This opposition persisted on the issue of equity and the argument that rich people can speed past the poor who remain stuck in traffic. Discrediting this argument was the fact that High Occupancy Toll lanes had many different types of users; people at all income levels were using the lanes when saving time was important to them (Poole Jr., 2001). Furthermore, the toll revenues went to an express bus services that also used the High Occupancy Toll lanes, enticing some drivers to take public transit along I-15. Finally, carpoolers on the I-15 did not believe that the pricing program affected them adversely, because the original law required the lanes to constantly be free-flowing (ibid).

Today, as the leading agency, the San Diego Association of Governments plans to quadruple the area of High Occupancy Toll lanes on I-15. It has done so in part because nearly every public opinion study about the High Occupancy Toll lanes between 1996 and 2005 has revealed broad support for the congestion pricing concept and for expanding it in Southern California (TRB, 2009). Some of the support can be attributed to the specific characteristics of the High Occupancy Toll lanes project instead of some unique cultural qualities in San Diego County. First, the tolls paid went exclusively to servicing the lanes and the bus service on them. There was little perception that these user fees were an additional tax. Second, the lanes were previously exclusive to high occupancy vehicles. Drivers did not see the policy as taking away

previously free lanes (Harrington et al, 2001). San Diego County's High Occupancy Toll lanes were one of the first and few success stories of congestion pricing.

2.2 The Netherlands

The country of the Netherlands has some of the highest economic activity in Europe, and one of the world's largest population densities. The Randstad, an agglomeration of the Netherlands four largest cities, is one of the largest in Europe. Two-thirds of the Randstad's area is the "Green Heart", an area of 160,000 hectares of agricultural land protected against urban uses, including roads since 1958 (Carter-Whitney, 2010). Furthermore, the Netherlands also has a rigid housing market, due to the "Green Heart" that poses barriers for people who want to move closer to their jobs (Kozluk, 2010). It should therefore be no surprise that the country has major traffic congestion problems. Over the last 20 years, despite its relative small size, the average commuting distance has increased by 45% and as a result, Dutch workers spend more time commuting than those in other European countries (Kozluk, 2010). Despite these push factors, the car is the dominant mode of transportation (Van der Waard, 2008).

The Dutch government has tried to respond to this issue with road pricing measures many times, but these efforts have produced limited results due to a variety of political and technological reasons (Custers & Kuiper, 2010). In 1999 the government planned to build toll booths on all access and exit roads in the Randstad to charge rush hour driving fees. These driving fees were to be in addition to the tax on purchasing automobiles and fuel taxes, which were considered high. The new revenues were to follow the path of the existing transportation revenues and be put into the government's general budget and not allocated for reducing

congestion (Smith, 2009). The Royal Dutch Touring Club (ANWB, the Automobile Association of the Netherlands), already feeling that the revenues from taxes on fuel and automobile purchases should be earmarked for transportation projects, saw this policy as unfair, and campaigned heavily against road pricing. Its campaign, along with low public acceptance, caused the policy to stall (ibid).

In 2005, the government created a panel called the "Nouwen Platform". It was comprised of business leaders, academics, and government officials to make recommendations on how to proceed with transportation financing (Van der Waard, 2008). The panel mostly focused on alternatives to the current tax system. By this time, Global Navigational Satellite Systems and On-Board Unit technology had progressed to the point that their use in road pricing pilot projects was practical (Grush, 2010a). The panel advised the government to use this technology to create a kilometre charge to replace the taxes on vehicles purchases and ownership (ex. The vehicle purchase tax was 40% of the net list price). The new kilometre charge would apply to the use of all roads in the country and vary depending on location, time of day, and emissions (Van der Waard, 2008).

In, 2006, the Netherlands had a national election. It resulted in the formation of a center-left coalition government headed by the Christian Democratic Appeal and followed by the Labour Party, and the Christian Union. The Minister of Transportation, Camiel Eurlings, was a member of the Christian Democratic Appeal. Eurlings approved of the recommendations made by the Nouwen Platform. He was also in favour of fully hypothecating the "kilometre pricing" revenues into an infrastructure fund, so that all the taxes paid for using the transportation system

would be used to improve the system (Keken, 2009). By 2007, Eurlings went on a mission to communicate the benefits of this €4 billion plan to the Dutch people. He argued that half of drivers would end up paying less in vehicle charges in the new financing design, but the costs of the On Board Units that would have to be installed in every vehicle would mainly be borne by motorists. Over privacy concerns, Eurlings promised that information collected about motoring habits would be 'legally and technically' protected and would not be accessible to other government agencies. However, if the "security of the state" was at risk, or in the case of "prevention, detection and prosecution of criminal activity", the police or the national intelligence agency could (virtually) spy into cars (Keken, 2009). Regardless of whether or not his mission was succeeding with the public, Eurlings still managed to start a 100,000-driver pilot project and won the approval of the governing coalition's cabinet over an implementation timeline, with all cars being subject to the charge by 2012 (Wright, 2009). However, the Dutch legislature still had to approve the proposal in order to pave the way for implementation.

Around the same time, the Automobile Association of the Netherlands, who viewed "kilometre pricing" as a fair way to charge for mobility (Smith, 2009), surveyed 200,000 members and non-members about their opinions on the new policy (Graaf, 2010). The Automobile Association of the Netherlands interpreted the survey's results and concluded that there was a significant level of distrust among the public towards the government on whether the policy could be implemented fairly and successfully (Haighton, 2010). More specifically, survey participants felt that they will be paying more and that their privacy will be infringed – a sentiment exacerbated by the new security measures taken since 9/11. Further undermining the

government's credibility was its failure to finish major transportation projects on time and on budget (ibid).

Simultaneously, the coalition government had been considering extending the Dutch military mission in Afghanistan at the request of the United States. The Labour Party ardently opposed extending the mission, and withdrew from the coalition in February 2010, thereby dissolving the government and triggering an election (Grush, 2010a). Public opinion was strongly against the coalition's leading party, the Christian Democratic Appeal, and a month later, Eurlings resigned as Transport minister and announced he would not run in the upcoming election (Ron, 2010). The Ministry's new leaders, sensing a lack of political support for the kilometre charge, suspended all of its implementation activities (Ministerie van Verkeer en Waterstaat, 2010). After the election, the new coalition, headed by the Netherlands right wing parties, decided to not implement the kilometre charge, and instead shift taxes towards fuel and away from vehicle registration and purchases (Grush, 2010a). Ironically, the new coalition used the phrase "kilometre pricing" to describe their policy of increased fuel taxes, the same phrase their political opponents used to promote its own policy in the past.

The fact that the kilometre charge was a policy promoted by the previous government could have been reason enough for the new government, with its new ideology, to cancel it. However, the reasons explicitly given (that this very complicated policy was poorly communicated to the point that a majority of the public found it controversial and unacceptable) were reiterated by two supporters of the kilometre charge: the Automobile Association of the Netherlands and the Dutch trade association of car manufacturers

(http://www.kilometerheffingnederland.com/, 2010). Even if the Labour Party had not left the coalition, its leading party, the Christian Democratic Appeal, had become unpopular and would have faced an election eventually. The period from 2006 to 2010 was not long enough for the government, and Minister Eurlings, to develop and communicate a policy to a point that it would be in the interests of the new government to carry on the work without interruption. It would appear that a restructuring of transport finances would take much longer than four years. This is the sentiment of the next jurisdiction, whose story at present, may be only half way through.

2.3 State of Oregon

The State of Oregon has almost as many registered drivers and vehicles as it does population. In 2007, drivers travelled in state a total of 34.8 billion miles (Starr, 2010). Accommodating these drivers has been very expensive, causing huge difficulties for the state government to keep revenues in line with costs.

The state has a unique transportation policy that uses its constitution to fully hypothecate gas taxes and other road revenues for the purposes of building and maintaining transportation infrastructure (Starr, 2010). In the mid-1990s the tax rates were proving to be insufficient for the Oregon's transportation needs. The gas tax had not been raised since 1991 (Lednicer, 1999). A gas tax increase had failed in 1997. By 1999 the pressure was on in the Republican-controlled state legislature to attempt another gas tax increase. During these deliberations, some lawmakers advocated for the Department of Transportation to provide the legislature with a detailed list of construction projects every two years, as a way to instil some accountability to a gas tax increase (ibid). In July of 1999, the State passed a five cent increase

in the gas tax, but three months later, efforts were already underway to repeal it. The Oregon-Idaho chapter of the American Automobile Association, viewing the tax increase as unfair, pressed to put the issue on a ballot initiative for the primary election in the spring of 2000. The ballot initiative was successfully created with the help of many Republicans who voted for the tax in the first place, and the tax increase was defeated by a margin of 7-to-1 (Charles, 2000).

After the ballot initiative, it became clear to many in Oregon that the chances of increasing the gas tax in the near future were very slim. However, at the same time the State still needed to improve its infrastructure (ibid). This fact was not lost on Democratic Governor Kitzhaber, who alluded to some important policy shifts in late 2000: that transportation demand management should be part of the debate, that the state should explore other ways of paying for road construction and repair without raising taxes, and that gas taxes (at the time paying for 70% of the transportation costs) were an unstable source of revenue (Lednicer, 2000). At the same time, a right-wing think tank from California released a paper that was reported on by the Oregon media. The paper advocated tolling cars to pay for roads and refunding drivers the appropriate amount of gas tax (Samuel, 2000). Six months later, Republican State Senator Bruce Starr, Chairman of the Transportation Committee, put forward a bill (passed not long after) that would create a task force to study alternatives to the gas tax (The Oregonian, 2001).

The "Road User Fee Task Force" was created under the Oregon Department of Transportation's direction. The title of the task force acknowledged the perception that Oregonians were feeling over-taxed, and the phrase "user fee" was meant to show that it was working on something different than taxes (Zoner, 2002). The law required the Road User Fee

Task Force to be composed of four members of the state legislature, four stakeholders (road user representatives, telecommunications industry, research community), appointed by the governor, one city and one county official (Whitty, 2007) By 2002, the Road User Fee Task Force held public hearings to report the hypothetical user fee options being considered: highway tolls, rush hour surcharges, and a satellite-based tolling system. The expected backlash from the hearings' attendees about these proposals was rebutted by Starr who explained that the problem was 10-20 years away when most vehicles are high mileage and some using alternative fuels (Stewart, 2002). Some transportation officials in Oregon's largest city, Portland, were critics that argued that current efforts would best be put into raising the gas tax immediately since vehicle miles traveled in the city were increasing (ibid). Despite the critiques, the 2002 Oregon gubernational election transferred power from Kitzhaber, who was forced out by term limits, to his fellow Democrat, Ted Kulongoski. Though the Republican candidate tried to make taxes a major election issue, the proposed road user fees was not one of them (Esteve, 2002).

The Road User Fee Task Force continued its work and contracted with Oregon State University to develop "cost and qualitative functionality parameters for data and fee collection" (Whitty, 2007). By 2004, the University had developed a system using GPS satellite signals to gauge a fee based on the amount of miles driven in Oregon. The calculation and collection of the fee would occur at the vehicle's fueling station (Hortsch, 2004). By the middle of 2006, a Portland-area pilot project had begun. It involved almost 300 volunteer drivers who were paid $300 each to carry a GPS device in their car and fuel up at two participating gas stations (Mayer, 2006). The GPS recorded how many miles were traveled inside and outside Oregon, to ensure that only driving in the state was charged. The GPS also recorded miles traveled in the Portland

area during morning and afternoon rush hours, so the concept of congestion pricing could be tested. When a volunteer's car pulled into the gas station, a radio transmitter sent the mileage data to a reader in the gas pump. The mileage fee was added to the gas bill, and the gas tax was subtracted (Starr, 2010). During the pilot project, the gubernational election in the fall of 2006 was held, and gave Kulongoski another victory. The issue of paying for roads was a major issue, though the Road User Fee Task Force's work was not. Kulongoski argued for the need to replace the gas tax, but stopped short of endorsing any specific proposal (Mayer, 2006).

A year later, the Portland pilot project had finished. Though there were some glitches with the technology, the overall mileage fee concept proved to work (Mayer, 2007). Kulongoski's 2009-11 budgets included $10 million to continue experiments on the technology. He was able to avoid the concerns about privacy protection and fee increases by stressing that such a mileage fee would not be ready for another ten years, and that these issues still need to be worked out (Walsh, 2009). The fact that the proportion of the Oregon Department of Transportation's road budget from the gas tax had decreased from 70% to 60% over the last ten years gave credibility to the governor's argument that alternative revenues were needed (ibid). After reaching his consecutive term limit as governor, Kulongoski was succeeded by his predecessor, Kitzhaber, in the 2010 election.

For over a decade the Oregon Government has retained its objective to seek a long-term gas tax alternative. Its mileage fee concept is similar to the proposed kilometre charge in the Netherlands. Oregon however, is far away from implementing this objective partly because it is hoping that vehicle manufacturers will begin including GPS technology in every vehicle,

embedding the cost to users/consumers (Whitty, 2007) (the Dutch Government was planning to require that all vehicle owners pay directly for most of this cost). Oregon has managed so far to keep the mileage fee proposal away from being an election issue, but public concerns such as fairness, privacy, and perceptions of a large and costly bureaucracy, are likely to become voters' concerns at some future point in time. At that time, the government will not be able to forever alleviate these concerns by saying "implementation will not occur for another ten years".

2.4 The Greater Toronto Area

It could be argued that the modern transportation planning debate in the GTA began in the early 1970s when urban residents revolted in opposition to the construction of inner city expressways. The argument was that their land should not be paved over in order to allow more suburban commuters to bring their cars downtown (Vaughan, 1992). In the early 1990s, the need to reduce automobile dependency was already recognized by the federal government. Through the departments of energy, transportation, and environment, the government gave grants to organizations such as the Canadian Urban Institute to develop land use and transportation planning strategies to meet this need (ibid). At the provincial level in the early 1990s, an NDP government was planning to build highway 407 north of Toronto, and pay for it using tolls via gantries that would scan license plates. The government created a crown corporation to administer this project, as well as to explore the possibility of using this concept to finance future transportation infrastructure projects (Barber, 2005). The tolled 407 highway was built relatively quickly, and temporarily alleviated congestion on surrounding highways until more vehicles entered the system. In the 1995 provincial election, the Progressive Conservatives took power from the NDP, and later sold the 407 to a private company. With this sale, the new owners

sought to raise the tolls to maximize profits, as opposed to achieving socially optimal congestion levels. The increased fees irritated frequent users who were told by the previous government that the tolls would go to pay only for the highway itself (Borins, 2004).

By the late 1990s, the work to solve the issues continued at the provincial level with the creation of the Greater Toronto Services Board, a body made up of the mayors of the GTA and some councillors of Metro Toronto. Supported by the region's chambers of commerce, the Board's objective was to create a transportation plan for the region by the end of the decade. The Toronto Board of Trade urged the provincial government to give the Greater Toronto Services Board power to override municipal objections to future transportation initiatives, as well as to borrow and disburse for major projects (Toronto Star, 2001). Unfortunately, the Province avoided making this decision by taking over responsibility for regional transportation planning. The Greater Toronto Services Board, which had been studying congestion pricing options, was dissolved by its provincial creators soon after (James, 2001).

Perhaps anticipating the fate of the Greater Toronto Services Board, the City of Toronto simultaneously proposed an official plan to massively expand the transit system and pay for it with either road tolls, vehicle registration fees, or parking levies (Maloney, 2000). This was an indication that the City could no longer expect its provincial government to provide substantial funds for transportation. This resulted in only minor transit improvements and no reform of transportation financing that would address congestion.

In the 2003 provincial election, the Liberal Party won power from the Progressive Conservatives. However, a serious plan to improve the transportation system was not developed until years later with the creation of the Greater Toronto Transportation Authority (later renamed Metrolinx). It did not take long after its creation for Metrolinx to create its Regional Transportation Plan (Regional Transportation Plan), consisting mainly of a series of linked transit projects. However, a long term financing plan was not included, and the Province was questioned about from where the money would come. Prior to the 2007 election, the Province stated that it did not support road tolls as part of a financing plan, and deferred such decisions to 2013 (Manahan, 2008). Metrolinx officially supported the decision to defer, contending that the public would be more receptive to new "revenue tools" once there are transit projects physically in place (ibid). Unfortunately, the global economic recession delayed some of the Regional Transportation Plan's projects, and the inability of the Province to provide transit funding became more apparent. In 2009, the Transportation Minister alluded to the lack of provincial funds by not ruling out road tolls as a possible future solution, saying Ontario citizens need to have an "intelligent conversation" about transit funding (Kalinowski, 2009). This "conversation" did not take place before, or during the 2011 provincial election campaign, and it is unclear where and when it will start.

3.0 GNSS Road Pricing Technology

During the private and public deliberations about road pricing in Ontario, a local company called Skymeter was working on a technology called "Financial-grade GPS", a type of GNSS that meets the requirements of financial transactions and has been proven by the California Department of Transportation (www.tollroadsnews.com, 2009). Skymeter can use On-board Units and satellites (without gantries) to meter vehicle use according to time, distance, and place. An On-board Unit would record vehicle travel data, send it wirelessly to a "pricing proxy" to calculate a bill which is then sent to a tolling operator (Kalinowski, 2010). Working in Toronto, the company, and others like it, have already been testing the technology in small projects around the world and could be part of a future congestion pricing scheme that is appropriate considering the physical characteristics of the GTA.

There are varieties of GNSS metering technology being developed by different companies. The technology that was to be used by the Netherlands, for example, uses the GNSS signal to determine reference points or 'waypoints' in order to gather the route information (Custers & Kuiper, 2010). For each trip an automobile takes, the waypoints are compared with a digital map that has all the pricing information for the different roads, and the trajectories travelled on each road is added together per price category. The cost for each trip is then added for a total fee amount, and then transmitted to a central office for billing, fee collection and processing (ibid). With this form or road pricing, distance-based congestion tolls could be applied throughout the GTA's transportation network on any routes that suffer routine congestion, and rates could vary depending on the time, the specific route, and even a vehicle's emissions levels (Sorensen, 2010).

The prices of satellite technologies can vary enormously. On-board Units, transponders, smart cards and toll facilities can have high implementation costs until they achieve economies of scale. However, they are convenient for users and also allow for easy price adjustments (Victoria Transport Policy Institute, 2010). Financial-grade GPS is relatively more expensive than the other communications technologies, yet they have much wider applications. Many drivers already use a GPS product in their car, and if such systems can be installed during vehicle manufacturing, the costs can decrease significantly (Sorensen & Taylor, 2006). This is one of the methods by which Oregon's DOT hopes to pay for its mileage fee infrastructure.

4.0 Policy Options for Alleviating Congestion in the GTA

Although this paper advocates for a GNSS-based road pricing option in the GTA, this chapter discusses the other various policy options that have been proposed for the GTA. The discussion will be based on the compatibility of each option towards the specific transportation problems faced by the GTA.

4.1 Gas Taxes

Gas taxes, either raising current forms or creating local or regional forms, have been suggested as an alternative to tolling roads in order to solve the GTA's transportation problems (Toronto Board of Trade, 2010). Increasing the tax or adding a new one and charging it at the pump is a relatively simple policy that is inexpensive to implement and administer. It is a fee with which consumers are already familiar, and can theoretically generate large amounts of revenue for infrastructure (ibid). However, there are several deficiencies when it comes to the idea of more gas taxes to help the GTA, because of the change in markets and policy goals.

To begin with, the gas tax rate does not vary based on levels of congestion or location or time of day. Even if a higher gas tax would give an incentive to drive less, there would not be an incentive to avoid driving on congested roads, hence the perception that roads are 'free' (Peters, 2008). Moreover, the gas tax may not be as effective at reducing vehicle miles travelled as it used to be. This is so because, as the price of fuel has risen over the years, studies have shown that the price elasticity is shrinking (von Haefen, 2011). This means that drivers are no longer reducing their road use as much as fuel prices are increasing. It is likely that most drivers have a minimum amount of distance to drive regularly (such as the distance to work and back), a distance no fuel price increase can easily shorten. Furthermore, vehicles using alternative fuels

are becoming more affordable and are beginning to find niche markets in urban areas. This means that even if fuel prices continue to rise considerably, vehicle miles travelled may still rise over the long term, causing further congestion (Grush, 2011a).

Lastly, but still very important, is the deficiency of the gas tax due to the ongoing improvements in vehicle fuel efficiency. By both government and market forces, the fuel efficiency of motor vehicles has steadily increased in the last few decades (Peters, 2008). As less gas is consumed by these vehicles, there will be less tax revenue to fund transportation services. In Oregon, this has been apparent for years, as the auto fleet's increasing fuel efficiency has reduced per-mile fuel-tax revenues by about $10 billion since 1985 (Landauer, 2002). Mills estimates that average fuel efficiency for light and medium weight vehicles will increase by approximately 25% in the next 25 years (Mills, 2010). This indicates that the gas tax may be a sub-par revenue generator, considering the rigorous attention needed to improve the GTA's transportation system.

It is clear that an alternative to the gas tax is needed and some form of directly pricing road use, in a way that is sensitive to the scarcity of peak road capacity. Such a form of road pricing could address congestion, while indirectly raising substantial amounts of revenue for transportation infrastructure. It is expected that opponents to such a policy would argue that voters would not accept new charges. If that is the case, then voters would not accept higher gas taxes either. It is true that, for example, the introduction of the HST has affected Ontario public opinion polls and caused fewer respondents to approve of taxes in the province (Neuman, 2011).

Voters, more or less, did however, accept this tax by re-electing the government that implemented it, and it is impossible to know what voters will accept in the future.

4.2 Options to Charge Directly for Road Use

There is no doubt that implementing road pricing in the GTA will take a lot of work. This work could begin with choosing what type of road pricing would be best for the region. Electronic road pricing has become the dominant pricing method in new and emerging schemes. As of 2006, there were over 90 implemented or proposed electronic road pricing projects around the world, including highway tolls (like the GTA's Highway 407) and cordon tolls. Maphangoh has argued for a cordon-based pricing system as a form of road pricing in Toronto. In cordon-based pricing, vehicles are charged upon entering a particular area, usually a central urban area that normally experiences high levels of congestion (Maphangoh, 2004). Cordon tolls have been implemented in cities such as London and Stockholm but there are reasons why it would not be appropriate for the GTA.

The GTA is surrounded by the Ontario Greenbelt, almost two million acres of permanently protected land established in 2005 (Carter-Whitney & Esakin, 2010). The Greenbelt was created in response to the rise of urban sprawl in the GTA. From 1986 to 2001, approximately 75% of the growth population and employment has occurred in the regions surrounding the City of Toronto (IBI Group, 2007). Transportation demand trends show that trips from the suburbs to Toronto has increased 45%, but more importantly, trips from Toronto to the suburbs, between the suburbs and within the suburbs has increased 127% (ibid). This increase in economic activity and the associated sprawl, along with other land use and transportation planning decisions, has shaped the travel patterns of the GTA's vehicles to create

congestion that is largely decentralized (City of Toronto, 2000). By contrast with Toronto, London's congestion is mainly centralized in the core, providing an appropriate place to create a cordon.

A cordon surrounding Toronto would only target some of the GTA's congestion. Another problem with implementing cordon tolls is the need to build perimeter gantries for entry and exit points around the core. This challenge was relatively small in Stockholm, whose core is on a large island, requiring gantries to be built only on the bridges connecting the city to the suburbs (Schuitema et al, 2010). By contrast, Toronto has many routes that vehicles can take to enter the downtown, making the building of perimeter gantries unreasonably difficult. Lastly, studies have shown that by creating a cordon and making travel outside it cheaper, businesses are given an incentive to move from inside the cordon to outside (Anas, 2010). Encouraging sprawl through cordon pricing would therefore contradict the policy goals sought-after with the creation of the Greenbelt.

The decision-making process involves not only choosing where to charge drivers but also how to charge drivers. In some cases, certain charging methods can allow decision-makers to choose from a larger set of options.

4.3 Technology Options

Many of the underlying technologies to support electronic road pricing have matured in recent years. This has enabled governments to adjust fees based on vehicle characteristics and travel characteristics, and implement other kinds of road pricing projects such as automated weight-distance truck tolls, and distance-based user fees spanning entire road networks (Sorensen & Taylor, 2006).

Within the realm of electronic road pricing, communications technologies have also greatly matured. Such technologies include electronic transponders that are placed inside a vehicle and are counted each time the vehicle passes a roadside sensor, and smart cards, which are placed inside the transponder, and are charged with a certain dollar value (Sorensen & Taylor, 2006). Less than ten years ago, 407ETR began to use a technology called Radio Frequency Identification to toll the highway because its products were benefiting from economies of scale and the prices had significantly dropped. The Radio Frequency Identification receivers, in fixed locations, capture driver information from the Radio Frequency Identification transponders inside the vehicles as they drive by. This streamlined the billing process, reduced operation costs and allowed the company to charge users less (www.407etr.com).

Radio Frequency Identification is currently used in countless road pricing systems around the world, but the problem with Radio Frequency Identification lies with its need to install large gantries over roads (Grush, 2010b). The need for overhead gantries means only certain roads can be tolled. Unless gantries are built over every single road, drivers will take a non-tolled route. This creates an element of inflexibility that weakens the incentive to change a motorist's behaviour. Congestion can regularly occur in many places in the GTA, from the Toronto's suburban thoroughfares to the streets of downtown Ajax, to Highway 401. Negative externalities are produced in all of these places of congestion, and therefore should be equal policy targets. Simply tolling some areas known for heavy traffic can just push congestion somewhere else. Pricing these new congested areas by building new infrastructure would cost more in time and money. Traffic congestion is a "wicked problem" in that, attempting to solve it

can reveal or create other problems (Grush, 2010c). The road pricing design that the GTA should adopt should be one that minimizes that amount of new problems it reveals or creates.

4.4 Area-wide & Distance-based Pricing

In 2003, Germany implemented a tolling system for trucks using satellite technology, similar to what many cellphone companies use. Trucks are required to have a certified agency install a government-purchased On-board Unit, and are tolled when using major German highways, according to distance traveled, number of axles, and vehicle emissions rating, and enforced by gantries (TRB, 2009). The toll rate is determined by calculating the costs that trucks incur through extra wear and tear on roads, and the revenue is collected by the same agency that installed the On-board Unit. The German government at the time lauded the policy because such a tolling system was without precedent, and therefore was thought to potentially boost German innovation (Victoria Transport Policy Institute, 2011). The technology being used was created in the previous decade and was not perfect. Yet satellite technology has benefited from years of research and development since then. Improved satellite technology, with the ability to toll all roads, could be considerably more appropriate for the GTA than the other options mentioned above.

4.5 Implementing GNSS Road Pricing in the GTA

Up until the present, much of the public discourse on road pricing in the GTA has spawned from the need to provide massive amounts of funding for public transit (Grush, 2008). Fortunately, a GTA-wide road pricing policy that targets congestion via GNSS and On-board Units can provide sufficient revenue negating the need for the existing transportation funding

methods. Such a policy, however, cannot be implemented in the short term. The experience from the Netherlands suggests that even a few years may be too short a period to properly develop a policy that is politically acceptable. The experience from Oregon suggests that such technologies can benefit from lots of testing and exposure in the public eye, especially when privacy concerns remain strong. For these reasons, it is sensible to expect that such a pricing system could not be fully implemented in the GTA for at least ten years. This is not good news for automobile commuters, but short term congestion reduction policies could also be implemented as long as they do not interfere with the long-term plan. For current and future transit users, this rough timeline could compliment what Metrolinx has calculated will be the total costs for capital, operation and maintenance, and rehabilitation in the Regional Transportation Plan and beyond. In the "Draft Investment Strategy", Metrolinx estimates that peak annual costs will occur around 2028, and remain high in the years beyond compared to the period of 2008-2018 (Metrolinx, 2008). In this earlier period, funds for transportation services could be acquired by borrowing against future revenues from road pricing. Soberman argues that the best way to fund transit is through guaranteed streams over predictable time periods (Soberman, 2010). This means that if a new revenue generating mechanism is supported by a legislative commitment, Metrolinx could take out loans or issue bonds for short term funding (ibid).

5.0 Hurdles and the Options to Overcome them

The phrase "legislative commitment" in the last section is not only an important one in this paper; it represents the goal of this paper. The remainder of the paper will discuss the major hurdles that exist on the path to achieving a legislative commitment to GNSS pricing in the GTA. Those hurdles are: managing the cost, privacy concerns caused by the technology, gaining acceptance to the direct pricing of roads and gaining an agreement between all GTA governments on the policy priorities. The following chapters will assess the extent of these hurdles, and provides strategies to overcome them.

5.1 Hurdle # 1: Privacy Concerns

In the earlier discussion about the Netherlands' recent road pricing experience, it was mentioned that one of the reasons for public opposition to the policy was the fear that the government would use the technology to encroach on private lives. It could be argued that since the rise of national security priorities over international and domestic terrorism concerns, citizens have become apprehensive about the potential of their respective governments to spy on them. Moreover, the rapid technological innovation of smart phones and social networking has created the perception that invading someone's privacy is much easier than it used to be.

Despite the credibility (or lack thereof) of the possibility of a Canadian government's interest in tracking the movements of its motorists, GNSS On-board Units could technically provide information about where and when a vehicle has travelled. The American Civil Liberties Association believes that because the technology is capable of providing information, both law enforcement and intelligence agencies will obtain and use the information (NewsHour with Jim Lehrer, 2009).

It is quite reasonable for people to want their movements and driving history to be kept private, even if it is also true that other types of personal information are given to credit card, insurance, and cell phone companies (Whitty, 2007). In the telecommunications industry, the strong aversion to privacy invasion led to the creation of the International Working Group on Data Protection in Telecommunications. Mindful of how citizens can distrust their governments in general, let alone distrust the advocacy of road pricing, the Working Group created guidelines to protect privacy for road pricing systems designers:

- "The anonymity of the driver can and should be preserved by using the so-called smartclient or anonymous proxy approaches that keep personal data of the drivers under their sole control and do not require off-board location record-keeping."
- "Road pricing systems can and should be designed so that the detailed trip data are fully and permanently deleted from the system after the charges have been settled in order to prevent the creation of movement profiles or the potential for function-creep."
- "Processing of personal data for other purposes (e.g. pay-as you drive insurance or behavioural- based marketing), should only be possible with clear and unambiguous consent from the individual."
- "In terms of enforcement, the system should not ascertain the identity of the driver or owner of a vehicle unless there is evidence that the driver has committed something which is defined as a violation of the road pricing system." (IWGDPT, 2009)

It is the case that many road pricing technologies, such as Radio Frequency Identification, require roadside equipment that in some way identifies and records the presence and location of a vehicle as it passes by and charges an account associated with that vehicle (Grush, 2010b). GNSS devices do have the ability to show the precise location of a vehicle on a

map (just like the GPS products now common on dashboards). However, not all GNSS On-board Units are alike. Some kinds of units are more likely to store information (such as a vehicle's precise location) in the vehicle itself. This would alter the On-board Unit's relationship with a central administration office, and thus address the privacy concerns.

GNSS On-board Units differ in their level of autonomy, meaning how much information is processed in the On-board Unit and whether the data is stored and analyzed in the On-board Unit or in the central office, and whether the same occurs for each stage of the billing process (Custers & Kuiper, 2010). The basic issue in the debate over privacy in GNSS On-board Units is the fact that even though detailed travel data about a vehicle are not accessible to third parties, there has to be access for the vehicle owner/user for transparency reasons, and for the supervising authority for enforcement reasons (Grush, 2010b).

5.2 On-board Units Options and their Privacy Assessments

To address the privacy concerns, there are four options. Option one is a "Thin" On-board Unit. The Thin On-board Unit contains only the ability to determine the location and an electronic identity (probably the license plate). The waypoints, along with the identity of the vehicle, are transmitted to the central office, where the information is extracted and processed for pricing. The road segments are priced at the central office using a price table and aggregated per category. The price tables are centrally stored and can easily be modified for all drivers at the same time (Custers & Kuiper, 2010). Under this option, all data are transferred to the central office immediately after collection. The user cannot see what is happening with his or her data inside the On-board Unit.

Option one has drawbacks but there are ways to address them. For example, to make the process more transparent, an arrangement could be created where users could log onto a personal page and check their route data. Were this done, encrypted data would be sent to the central office which creates a privacy concern if people there are able to view it. Encrypting data would solve provide employees of the central office only with access to data they needed to know for their tasks (Custers & Kuiper, 2010).

The second option to address privacy concerns is the "Slim" On-board Unit. The Slim On-board Unit collects a series of positions and aggregates these to a route using a digital route map. Instead of 25 separate waypoints on one route, the On-board Unit notes only that a road was used by a vehicle between a particular starting point and an endpoint. The amount of information to be transferred is reduced considerably. The route information is transferred to the central office together with the vehicle identity. This is done periodically, or at the end of each trip. The road segments are aggregated and priced in the central office (Custers & Kuiper, 2010).

The Slim On-board Unit results in much less data sent to the central office than the Thin On-board Unit discussed above. Nevertheless, for enforcement purposes, the registration of waypoints still needs to be stored in the On-board Unit to enable comparison checks with the central office (Custers & Kuiper, 2010). In short, privacy concerns are alleviated but not eliminated.

The third option is the "Smart" On-board Unit. The Smart On-board Unit, the type of product created at Skymeter, has a digital route map onboard. It processes a series of location targets to a route. The road use is calculated on a per road basis. The information is transferred

in the same way as the Slim and Thin On-board Units, to a central office. The pricing and fee collection takes place at the central office (Custers & Kuiper, 2010).

In the third option, location data does not leave the vehicle. It cannot be used information for other purposes, such as browsing the data for patterns. However, its advantage may also be a disadvantage. The use of the Smart On-board Unit may hinder the ability to predict traffic jams or provide information for road maintenance organizations. Furthermore, any errors cannot be rectified by the central office straightaway. The vehicle may have to visit a service location to get information corrected (Custers & Kuiper, 2010). However, with option four, a market for multiple services can be created. Private operators can offer additional applications, beyond that of metering road use (to be discussed further, later in the chapter).

The fourth option is the "Thick" On-board Unit. The Thick On-board Unit encompasses all functions in the metering process, starting with the location determination, processing a series of location determinations to a route and calculating the price. Like the Smart On-board Unit, the Thick On-board Unit has a digital route map onboard. It contains pricing data. A fee is determined for each trip. The main difference between the Smart and the Thick On-board Unit is that the Thick On-board Unit has a payment option. There is a digital purse onboard with a balance that can be charged (Custers & Kuiper, 2010).

The Thick On-board Unit does not provide central access to vehicle location data, thus alleviating the privacy concerns. The onboard payment option provides more sense of privacy for the user, as users may check all payments directly. The Thick On-board Unit does create an issue with regard to enforcement however. The Thick On-board Unit is more susceptible to fraud. In

this connection, it is useful to note that cell phone service providers have not added payment options to their devices (Custers & Kuiper, 2010).

None of the above options is perfect but some have more shortcomings than others when it comes to privacy concerns. However, other measures can be taken to reduce privacy concerns. They include making the data anonymous at several stages of the metering process; that is, anonymous until the bill has to be sent to a specific individual. Legal measures could also be enacted that determine what data are collected and processed, how data making occurs, and by whom (Custers & Kuiper, 2010).

The Smart and Thick On-board Units are the preferred options, not just because of likeliness to overcome privacy concerns, but also to overcome the hurdle of how to pay for them.

5.3 Hurdle # 2: Costs of the GNSS and On-board Unit Infrastructure

One could argue that, while GNSS-based road pricing can be effective, the current prices of the infrastructure (mainly the On-board Units) are much too high. Average prices for Smart and Thick On-board Units are around $150 dollars each (Grush, 2011b). For the government to equip every vehicle in the GTA with an On-board Unit would cost hundreds of millions of dollars. This is money Ontario governments cannot easily allocate, especially for a controversial road pricing program. It is likely that the hurdle of cost contributed to the demise of the program in the Netherlands. Then can GNSS-based road pricing be implemented? In the United States, an effort to answer this question is being made by the Transportation Research Board. The Board hired Paul Sorensen from the Rand Corporation to report on the best ways to develop system trials for mileage-based road pricing.

In the Rand Corporation report, consideration of "vehicle miles travelled fees" was said to be motivated by the recent "erosion" of fuel tax revenue. Tax rates have failed to be raised to offset the effects of inflation and improved fuel economy (Sorensen, 2010). Though relatively simple vehicle miles travelled fee systems can be designed to solely provide a stable source of revenue, more sophisticated systems can also achieve additional policy goals such as reducing congestion and harmful emissions, and providing a range of value-added services for the driver through the Smart or Thick On-board Units (ibid). The mentioning of the last policy goal, providing value-added services, is what makes Sorensen's road pricing document different than most others. Only in recent years, with the improvement of GNSS and On-board Unit technology, has this policy goal of providing value added services become possible.

There are several possible value added services.

Motorists with a GNSS On-board Unit in their vehicle could have the benefit of a pay-as-you-drive insurance policy. Automobile insurance payments are made annually and monthly. Insurance premiums are currently determined by address, driving record, gender, self-declaration of average distance traveled, and possibly other demographic variables, but almost never by the most important indicator of risk - actual distance traveled.

The concept of Pay As You Drive car insurance stems from the argument that the cost structure of owning a car is designed so that most of the fixed costs are paid upfront. Drivers must purchase the car itself, pay a yearly registration fee, and pay a fixed monthly amount in insurance (Victoria Transport Policy Institute, 2010). By contrast, the cost of driving each kilometre is relatively very low. There is little financial disincentive to drive because of insurance premiums (Greenberg, 2009). Using GNSS technology, Pay As You Drive car insurance could prorate premiums by mileage. Mileage then becomes a variable cost, giving

drivers an incentive to drive less, or rewarding lower mileage drivers with perhaps as much as several hundred dollars per year (Sorensen, 2010).

A study by the Brookings Institution found that, if all car insurance was converted to Pay As You Drive, the reduction in crash claims would be disproportionately lower. In addition, there would be billions of dollars saved in "social benefits", and sixty-four percent of households would experience savings, amounting to an average of $270 per vehicle (Greenberg, 2009). The Brookings Institute study assumes a given price for driving. This price may not be one that targets congestion specifically unless of course, prices vary according to time and place.

Pay As You Drive insurance is unlikely to be mandated under provincial or federal law, but it can be promoted as an excellent compliment to pricing congestion. Moreover, Pay As You Drive insurance could be applied to distance travelled only (like most applications to date), or applied to time and location of travel reflecting the fact that collisions, thefts, and the like are more probably in certain areas than in others (Sorensen, 2010).

Another value added services relates to parking. Underpriced parking is common, a principled cause of undersupply. It is a contributor to traffic congestion. Drivers circle streets repeatedly to find an available spot (Grush, 2010c). Advanced (ie Smart and Thick) On-board Units could locate nearby vacant parking spots and also determine the specific location in which a vehicle is parked, thus allowing for automated parking payments.

In many circumstances, the act of payment of street-curb parking is far more painful to drivers than is the actual expenditure itself, especially when one has to worry about being fined by parking enforcement or paying more than the time parked required. With automated parking

payments, drivers would avoid fines and pay only for the time they occupy the parking space (Sorensen, 2010).

Another value added services involves "peer-to-peer car sharing". Peer-to-peer car-sharing involves having automobile owners sharing their cars with neighbours without having to physically exchange keys or buy a car-storage depot (Grush, 2011c). In order for this to work, there must be mutual trust between owner and renter. The necessary ingredient is trust as this is a private transaction. Trust can come from GNSS Thick On-board Units that measure driving behaviour and the associated fees, calculate the fees and send electronic bills (ibid).

Finally, GNSS On-board Unit technology can make GPS navigation more sophisticated, suggesting travel routes based on real time traffic conditions, construction detours, accidents or any other alerts. It could also provide an internet connection, safety features such as alerting the driver of school zones or hazardous patches of roadway, or provide warnings of imminent potential collisions due to merging or suddenly stopping vehicles (Sorensen, 2010).

It is because GNSS On-board Units have extensive value added capabilities, the costs of purchasing them and installing them in every vehicle can be quite high.

In his report, Sorensen outlines three possible ways to deploy the On-board Unit infrastructure into vehicles in order to begin levying vehicle miles travelled fees. The first approach requires that all vehicles be retrofitted with the On-board Unit. This approach was considered by the Dutch government in their kilometre charging scheme. The high degree of public opposition in the Netherlands to this approach probably contributed to the demise of the scheme. The second approach mandates auto manufacturers to install the On-board Units into new vehicles. This second approach was considered by the Oregon Department of Transportation during the mileage fee trials in Oregon. Oregon has found there are drawbacks to this type of

deployment. First, in order to minimize the length of time to replace the entire vehicle fleet with a new one containing On-board Units, the public policy decision to mandate manufacturers to install On-board Units (and thus introducing vehicle miles travelled fees) would have to happen as soon as possible. Such a clear policy decision would first require sufficient public support. The Oregon experience suggests that public support is not easily guaranteed. Second, GNSS technology has evolved rapidly in recent years and will probably continue to do so, suggesting that it might be premature to settle on a standardized type of On-board Unit for all vehicles in the near term (Sorensen, 2010).

One could argue that using "thinner" and less expensive types of On-board Units, such as those used in the Oregon trial, would better help overcome the cost hurdle, it is in fact misleading. Grush contends that the operational costs of GNSS tolling can actually be less using with Thick or Smart types of On-board Units. Even though the cost of the physical product is higher, the telecommunication and central administration costs of the Thick system are much lower (Grush, 2011b).

5.4 Voluntary Opt In Approach

A third infrastructure-deployment approach involves a voluntary opt-in. By installing the On-board Unit in one's vehicle, road users would pay optional fees initially. Oregon used a voluntary opt in approach in their first mileage fee trials. It did so by paying a few hundred volunteers to test the technology. In addition to the benefits of the Oregon trial, a volunteer opt in approach would provide greater incentive by offering a range of value-added services (Sorensen, 2010). To add credibility to the voluntary opt in, on May 11, 2011 the New York

City Department of Transportation formally issued a Request for Expressions of Interest, inviting companies to give insights about ways to provide "driver benefits through in-vehicle and communications technologies, software applications and related components to afford a range of services such as customized information on travel choices and cost; real-time travel conditions; personalized feedback on recent trip-making, and to support pay-as-you-drive insurance and integration of social networking and crowd sourcing" (NYCDOT, 2011). New York City made this request in the hopes to help travelers make better use of its extensive multimodal transportation systems and in the process improve the overall efficiency of system operations (NYCDOT, 2011).

In vehicle miles travelled-fee trials in the United States, the approach has been to contract with a single firm or consortium for them to provide the technology and infrastructure. A single provider system provides for competition during the bidding phase however motivation for continued efforts to innovate and reduce costs is often lost once the single provider contract has been awarded.

To resolve the problems associated with a single provider, the voluntary opt-in approach could employ the concept of interoperability. Multiple firms could continually compete in a market for the provision of metering and billing services. Third parties could compete to provide value added applications. Interoperability all would likely drive down costs and stimulate innovation (Sorensen, 2010). Governments can still shape the market. They would do so by setting technology standards with a minimal set of functional requirements. Such standards might include accurate meter capability (according to time, distance and place), protecting data

through during storage and transmission. With a volunteer opt in system motorists would have a wide variety of choices: technology vendors, services providers, and additional value-added services described above (Sorensen, 2010). Meanwhile, under the voluntary opt in system, drivers could choose any variation on the basic fee structure, even a flat rate. Drivers could also choose to receive discounts and convenient payment methods if they opt for a "thicker" On-board Unit, reducing operating costs, in exchange giving up a degree of privacy.

Sorensen envisions what initially is an informal trial of the voluntary opt in approach. In such a case, the market is created and regulated by the government. However, a voluntary opt in approach, as opposed to mandated one, would reduce costs to the government. It would demonstrate the effectiveness of the GNSS On-board Unit technology. As the amount of volunteers increase, a legislative commitment to GNSS road pricing would become more viable.

This voluntary opt in approach, however, is not without its drawbacks. An informal, market-based trial has never been tried before. Governments have no experience from which to draw. The informal aspect would mean that the government did not have full control over the trial. A degree of co-management between the public and private sectors would be necessary. Competing interests could lead to conflict (Sorensen, 2010). Lastly, it is possible that drivers may not be interested in a voluntary opt in. They may not want to be part of any vehicle miles travelled fee program. They may not care for value added services, because they already have free parking options. A lack of volunteers may make firms fearful of investing into a brand new market, and the informal trial would be weak.

To address these drawbacks, Sorensen suggests creating two vehicle miles travelled programs; one voluntary for passenger vehicles, the other mandatory for commercial vehicles (Sorensen, 2010). Grush suggests that the introduction of vehicle miles travelled fees could be

put off for a few years until the market for the other value added services is viable. Grush's suggestion requires that government be involved in an initial stage. Selling a few licences to firms to enter the market in exchange for their contracted responsibility to protect privacy and provide accurate vehicle miles travelled data (Grush, 2010d). In this way, firms would have a degree of market protection, encouraging them to invest significantly in the market for applications.

Another way to reduce costs by creating incentives for drivers to volunteer is parking reform. Parking reform is already being promoted by Ontario's Ministry of Transportation, as evidence by their 2011 release of guidelines (drawn from other jurisdictions) for municipalities to improve their public transit systems. In the guidelines, the Ministry of Transportation encourages municipalities to:

- encourage employers to reduce the amount of free parking for employees
- reduce parking availability and increase fees in municipal lots and streets, and
- implement more dynamic parking rates (i.e. based on time of day) to achieve desired levels of demand (MTO, 2011).

It is possible that the Ministry of Transportation is making these suggestions as a way of addressing the regional transportation problems. Charging motorists for parking spots at work is an easy way to alter drivers' behaviour without too much negative backlash. Drivers are already accustomed to paying for parking, unlike road tolls (Victoria Transport Policy Institute, 2011). In Toronto, a large payment disparity exists between on-street and off-street (garage) parking. This disparity causes drivers to repeatedly circle around city blocks seeking cheap spots. The result is

unnecessary congestion. Parking management also requires physical meters and manual enforcement staff. It is only financially viable to conduct in areas of high demand (Grush, 2010c). Licensing parking authorities to collect fees through GNSS On-board Units would reduce operating costs to parking management.

The voluntary opt in approach is based on the presumption that volunteers will join when the costs of value added services decreases. Furthermore, if the number of opt ins increases, parking management can be reformed even further. Parking authorities can expand their metering to areas with lower demand. In its guideline report, The Ministry of Transportation also encourages municipalities to "leverage parking assets into revenue" meaning there is potential revenue to be collected for every non-charged parking space (MTO, 2011). GNSS On-board Unit technology can eventually allow parking authorities to expand their metering in low demand areas while reducing their overall expenses (Grush, 2010e).

A voluntary opt in approach can use private money to finance the GNSS infrastructure. This approach, can also demonstrate the effectiveness of the technology and its ability to protect privacy and provide value added services to motorists. Reformed parking management can create greater incentives for motorists to join the GNSS On-board Unit market, driving costs down further.

6.0 Analysis

6.1 Analysis of the Arguments Against Road Pricing

As time goes on, the government will have a chance to implement GTA-wide or province-wide GNSS tolling in order to finance the transportation system and manage congestion. Implementation legislation will require sufficient acceptance of GNSS tolling by Ontario politicians and their constituents. During the public debate about such legislation, it is expected that the opponents of road pricing will make the arguments they have made in the past.

The only modern experience the GTA has with accepting a road pricing scheme was the building of Highway 407 north of Toronto as a toll route in the 1990s. The Ministry of Transportation proposed implementing tolls on the new highway as a method of paying for its construction and removing these same tolls upon completion (Borins & Mylvaganam, 2004). Though the Ministry of Transportation feared that the Ontario Treasury Board would not permit them to divert the tolls away from the general revenues, the Premier at the time, Bob Rae, approved the idea in 1993. A crown corporation was created to administer and accelerate Highway 407's construction. The initiative won the approval of one of the largest transportation stakeholders, the Canadian Automobile Association, largely because the aim was to expand road capacity (ibid).

When the Conservatives took power in 1995 in Ontario, there was opposition to the idea of having a crown corporation involved in transportation financing and policy development. As an alternative, the Conservative government proposed privatizing Highway 407. It contended that the tolls would probably decrease in this scenario. The Canadian Automobile Association was opposed to privatization. It accused the government of breaking its promise to remove the

tolls when construction was completed. It correctly predicted that the tolls would actually rise with privatization.

Since the privatization of Highway 407, the Canadian Automobile Association has been one of the most consistent organized opponents to road pricing in the GTA (Kitchen, 2008). Most Toronto newspaper articles on the subject support the Canadian Automobile Association's position that motorists are already overburdened by fuel taxes and other fees. Because money is not fully allocated for transportation, motorists should not have to pay in tolls (Theobald, 2003).

The history of transportation funding will show that the amount revenue from driving related taxes is currently insufficient. Early in the twentieth century, cities used property taxes to fund improvements to their local transportation system such as widening streets and installing traffic signals. City property taxes made sense because these transportation measures linked homes and businesses raising the value of them. As time went on, the population grew and the automobile could travel farther distances. There became a demand for freeway systems. However, cities were not rich enough to build freeways nor was this appropriate because freeways affect property values across entire regions (Brown, Morris & Taylor, 2009). The revenue raised was insufficient, and a gas tax was added instead. A gas tax was simple and cheap to administer. It was successful because revenues were resilient even in tough economic times when fuel consumption continued to rise (ibid). However, despite large gas tax revenues, the costs of roads were still growing, and they were paid for by general government funds (Toljagic, 2009). When public transit services were introduced, they were paid for in much the same manner, except also with fares paid by transit riders. While the taxes drivers pay on fuel are not dedicated to transportation, the total costs of road and transit services continue to grow, and cannot be fully funded by gas and property taxes.

I would argue that the Canadian Automobile Association's argument that drivers already pay enough for roads is incorrect. However earmarking all the gas tax revenue to fund all transportation services would provide some government transparency. In order for the Ontario Treasury Board to approve earmarking the gas tax, the effect on the provincial budget would have to be neutral. Other provincial transfers to municipalities might have to be reduced, or some public services might have to be downloaded. At the same time, municipalities would be less dependent on property taxes for transportation because the gas tax would yield a greater share of the funding. Therefore, the effect on municipal budgets could also be neutral. If GNSS road pricing were to be introduced, rates could be set so that the tax shift was revenue positive for both the Province and the GTA (the relationship between money and governance will be discussed later in the analysis).

There are precedents for earmarking gas taxes. The State of Oregon took action thirty years ago when a constitutional amendment was passed that limited the use of fuel taxes to transportation purposes. The Province of Manitoba passed a similar law with the Gas Tax Accountability Act in 2004 (Gaudet, 2008). It is often claimed that drivers in Ontario are displeased with the current state of taxes (Neuman, 2010). A gas tax may be one of the more despised taxes in Ontario because it has not been increased since 1992 (Ministry of Finance, 2011). Fortunately, GNSS tolling can replace the gas tax in the future.

Another prominent argument against road pricing is based on the issue of fairness. In the past, road pricing proposals involved charging for the use of only some roads or entering a cordon. Opponents claimed that the burden of paying for roads would be unevenly distributed if one of the options discussed above would be implemented. Yet one could argue that this is

already the case for the drivers of fuel-efficient or alternative vehicles. They do not pay much gas tax. With GNSS road pricing, the argument of unfairness would not hold because what drivers would pay would be in proportion to extent of their road use (Grush, 2010b).

Road pricing opponents can also claim that road pricing is a regressive policy because it hurts low-income individuals more than others. Opponents say that a mileage charge would take up a greater proportion of a poor person's budget than that of a middle or high income individual (Schweitzer, 2011). This is true but the argument suggests that regressive pricing should be avoided, even when so many goods and services in our society already have the same regressive price structures. Heat, electricity, even a loaf of bread all cost the same regardless of someone's income.

Some policymakers in jurisdictions that practice road pricing have established discounts on the charges for some drivers that were argued to deserve it. This is not the best option because firstly, it goes against the user-pay logic and second, there are different types of equity that can and should be addressed but are not. Viegas argues that there is a distinction between "Horizontal equity" which means having equal opportunities no matter where you live, and protecting those in worse conditions, and "Longitudinal equity" which means the comparison of conditions between present and past, for each citizen individually, and for social groups based on gains and losses (Viegas, 2001). Providing discounts would bring only horizontal equity, because the road pricing revenue would be taken out of the transportation sector and put into something else, leaving a less-than-optimally funded transportation system for future generations.

Creating a Credit System

Rationing road use using a credit-based system can be a way to price roads while providing both horizontal and longitudinal equity. Veigas states that while traditional forms of rationing scarce goods are often associated with high transaction costs and administrative abuse, electronic road pricing can avoid these costs (Viegas, 2001). GNSS tolling, an advanced form of electronic road pricing, can be especially effective at delivering what Gulipallia and Kockelman call "mobility credits" that can be put on a smart card and inserted into an On-board Unit (Gulipallia & Kockelman, 2008).

Mobility credits could be distributed on a monthly or annual basis from the road pricing billing service operator(s) to every resident of a jurisdiction as opposed to each vehicle. If the credits are made to be completely tradable, say through an online exchange system, people can sell them to others (Viegas, 2001). Exchangeable credit would compound the road pricing signals in three ways: First, the motorist who buys such credits would directly subsidize some-other person to use a non-automotive alternative – or at least to use their automobile on uncongested roads and at uncongested times. Second, the value of not driving would now be rewarded, as opposed to only having the act of driving taxed. And third, if a cap was put on the number of credits available to everyone, the credit market would measure the value of road use, informing the government on how to set the road prices (ibid).

When it comes to disadvantaged people, the cost of the On-board Unit itself could be paid for over time, as is done for cell phones. Initial credits given could help pay as well. For example, disadvantaged motorists can be given initial discounts, as they may need time to adapt their commuting habits to the new road charges. Once they adapt, they could sell their credits to

finance the alternative practice. Those with dependents would receive a proportionate amount of credits as they would likely have to take more trips (daycare, doctor etc.). The whole credit system could be financed via credit transaction charges or via the road pricing scheme itself (Grush, 2007).

The most uninformed, but still prominent argument against road pricing is that roads should be kept free. Roads are in fact not free but are paid for in a variety of ways by both users and non-users. Nevertheless, this argument still has persuasive ability. For example, in the late 1990s, San Diego County's High Occupancy Toll lanes were proving to be so effective at improving the flow of the freeway and optimizing the lanes' level of use that the government was expanding the system. As mentioned in a previous chapter, a political movement had developed demanding that all the lanes should be "free". This movement focused only on two lanes of one freeway, and did not significantly influence the County's politics. However, a political movement against the tolling of all public roads in the GTA could have the potential to affect government policy.

Overcoming the argument that roads should not be tolled in any way, requires effective political communication. Messages that focus on the need to fund public transit or make road use more economically efficient are not going to sound appealing to drivers if they have to pay more. Instead, the differences between "taxes" and "user fees" should be emphasized. The Canadian Taxpayers Federation argues that the most effective way to keep taxes in check is for citizens and business to pay directly for the services they use (Bader, 2008). Using this logic, Myers and Kent claim that the costs of road building and maintenance, traffic management, congestion, road accidents, pollution, free parking, garages, fuel stations, and oil industry subsidies are "over and above" what drivers pay in gas taxes and other fees (Myers & Kent, 1998). Because GNSS

tolling can account for the benefits mentioned above, one political message should be "we're going to make the costs of roads more transparent to those who benefit from them" instead of "we're going to make drivers pay their fair share". As mentioned above, improving the transparency of transportation finance involves a revenue shift from taxes to more comprehensive user fees first through tax rebate methods until a formal replacement is possible.

Currently however, the government is probably not sufficiently trusted to force a shift from fuel taxes to road user fees by promise and mandate. Even if the shift already involved fully hypothecated revenues, it is unlikely the government will gather the courage. Moreover, studies show that simply earmarking revenues is not enough to gain acceptance of road pricing. From a psychological point of view, drivers need to believe that they will benefit greatly from a policy change from the status quo (Schuitema & Steg, 2008). Humans have irrational tendencies in terms of how they value losses versus gains. Charging drivers to use roads is perceived as a loss, and Schade & Schlag posit that people experience losses more intensely than gains of similar magnitude (Schade & Schlag, 1999). For example, if one expects to receive a B grade in a class, they would be more disappointed about receiving a C grade than happy about receiving an A grade. This idea is extended to what is called "Loss Aversion", the fact that people prefer avoiding losses over two times more than acquiring gains (ibid). When it comes to the risks of making certain choices, people are willing to take more risk to avoid losses than to make gains. The implications for road pricing are that people are willing to risk experiencing more congestion than to potentially pay more to experience the gains that have been promised. Therefore, if a driver asks "what's in it for me?" they need to perceive that the answer is twice as powerful as the expected sacrifice. GNSS tolling can provide these gains, but it is critical that this type of policy is properly perceived.

A common, but potentially unproductive message for road pricing advocates is "we are trying to promote alternative modes of transportation". Some opponents of road tolls, hearing this message, perceive that they are being coerced out of their cars and onto a bus. There are probably very few politicians that think private automobile use is intrinsically bad, and so their message should instead be "overuse of automobiles is unsustainable". Messages need to stress the abundance of choices people have. After the government chooses the common standards for mileage data generation and transfer, the rest of the choices are left up to the motorist. They would choose how to comply. They could do so with an On-board Unit that differentiates charges based on time or place. They would also choose the level of sophistication for their On-board Unit and the associated privacy level along with what added services they choose to receive (ibid).

Oregon does not expect such legislation to be written or passed soon. The same goes for GNSS tolling in the GTA, where a voluntary, market-based approach could take many years to be realized. Over these years, the technology will improve and the political messaging can intensify. In jurisdictions where road pricing was on the verge of implementation, studies have shown that people who believe road pricing is coming exhibit much more positive attitudes toward it. The theory to explain this result is called "cognitive dissonance". This theory suggests that when there is an inconsistency between attitudes or behaviours (dissonance), people are motivated to reduce or to eliminate the dissonance because these inconsistencies cause discomfort. The easiest way to do this is to develop a positive attitude (Schade & Baum, 2007). Those with the most severe negative attitudes who are least likely to accept the forces of

cognitive dissonance are likely to be those who are the most automobile-dependent for their commutes. In the GTA, those with the longest commute lengths live in Halton, York, and Durham regions (HDR Corporation, 2008). These regions have poor transit service compared to the rest of the GTA. With GNSS time, distance, and place tolling, some drivers in these regions would pay less than with the gas tax because of their proximity to uncongested roads.

6.2 Analysis of how Road Pricing can be Governed

The GTA is a conurbation consisting of many local jurisdictions that have different needs and interests when it comes to the regional transportation system and other services (Swainson, 2000). It is inevitable that the political attitudes towards GNSS tolling and restructuring the transportation finance system will be different among each municipality. If the road pricing scheme is to be regional in scope, a decision has to be made about how the scheme will be managed. Local opposition to road pricing can block any implementation efforts (King, 2011). Municipalities might not approve of a regional body making decisions for them.

In the GTA, there exists no single unified metropolitan government. Instead, the region consists of several local governments including one large one-tier municipality (the City of Toronto), surrounded by four regional municipalities. These four regional municipalities (York, Peel, Durham and Halton) are the upper tiers of two-tier structures, and each regional municipality contains several lower-tier municipalities. In total, there are 24 lower-tier municipalities in these four regional municipalities, 23 of which form part of the Toronto Region (OECD, 2009).

The current governance structure of the GTA is the result of provincial decisions since the 1970s not to build on the metropolitan model that had been instituted in the 1950s. From

1953 until 1997, Toronto had a two-tiered government structure, whose upper level of government, the Metropolitan Toronto Council (Metro), was responsible for "metropolitan" issues (OECD, 2009). This structure was not updated, however, to take account of the population growth outside the boundaries of Metro. Instead, in 1971, the provincial government created the four new two-tier governments in the suburbs surrounding Metro, or the "905" according to its telephone area-code. After this period, five regional municipalities effectively governed the Toronto region. No single body was responsible for the entire area (OECD, 2009).

In 1998, the provincial government undertook two major operations regarding municipal affairs. The first was the transfer of funding responsibility for several government functions from the Province to the municipalities. The second was the amalgamation process. The Metro Toronto municipalities were merged to create a single government, the City of Toronto. Two developments had a large impact on governance arrangements and intergovernmental relationships in the GTA. Amalgamation required the merger of different government administrations. The provincial government at the time recognized the need to improve regional governance. It created the Greater Toronto Services Board in the same year to work on fighting urban sprawl with land use and transportation planning strategies for the region.

The Greater Toronto Services Board consisted of local politicians throughout the region. It tried to create an official transportation and land use plan for the GTA. Essentially, this meant trying to agree on minimum suburban population densities that would support rapid transit.

It did not take long for major conflicts to appear between the Board's political members. The "905" leaders did not want to limit their abilities to sell land to developers for low-density housing. The Board's Chairman, Alan Tonks (a Toronto politician), resigned over this conflict

(Toronto Star, 2000b). Tonks was replaced by another Toronto politician, Gordon Chong, who moved more aggressively in advocating for sprawl-fighting measures. Chong felt that the Greater Toronto Services Board was merely acting like a seminar for discussing problems. He threatened the Province that if it did not act and give the Greater Toronto Services Board more power to achieve its goals, the Board would disband (Swainson, 2001).

The idea of a stronger Greater Toronto Services Board faced opposition from developers and the broader business community. The developers feared the Greater Toronto Services Board would restrict lucrative suburban developments. The Ontario Chamber of Commerce wanted a non-political board to be in charge (Hall, 2001). Premier Mike Harris was worried that a stronger Greater Toronto Services Board would be perceived by the "905" as another layer of government. In the end, Harris' government dissolved the Board (Urquhart, 2001).

The next provincial government, run by the Liberals, was able to bypass conflict between municipalities on the issues of planning and transportation. It passed the Places To Grow Act in 2005. The Act required municipalities to plan for minimum population and employment densities in existing built-up areas (MOI, 2011). It also passed the Metrolinx Act in 2006, forming a regional transportation authority made up of non-political board members. In turn, Metrolinx created the Regional Transportation Plan. The Metrolinx Act was changed in 2009 to give the agency the responsibility of managing GO Transit (Metrolinx, 2011).

Metrolinx would logically be a large future recipient of the tax revenues for transportation, directly or indirectly, that would otherwise have been received by municipal governments. Because Metrolinx will be placed in a decision-making capacity, some organizations such as the Toronto Board of Trade and the Conference Board of Canada feel that

it would therefore be an ideal Special Purpose Body with the authority to toll roads (Hume, 2008). However, simply changing the Metrolinx Act to give it more powers is easier said than done.

There are a few major shortcomings with the idea of making Metrolinx a Special Purpose Body with new taxing powers. First, there would be a need for accountability, and citizens may demand the Metrolinx Board be democratically elected. However, the Toronto Board of Trade and the Conference Board of Canada feel that governance of a GTA-wide Special Purpose Body would be best achieved through boards comprised of independent individuals answerable to elected officials (Soberman, 2010). If there are decisions pending that would benefit the region but do not compliment the politics of the moment, directly elected board members may be afraid to make them.

Another shortcoming with creating a Special Purpose Body out of Metrolinx is that such a creation would make governance in the GTA overall less efficient. Special Purpose Bodies tend to do everything on their own. The two-tier municipal structure in the 905 creates savings in operations that are not available to Special Purpose Bodys such as sharing certain legal and administrative personnel and facilities (Kitchen, 2008). This extra separated form of government could not only seem inefficient but also too complicated for citizens to understand. If citizens are not sure about who is accountable, they may lose interest in local (and regional) government (ibid). Given that there are many shortcomings and challenges with creating a Special Purpose Body for the GTA, it may instead be best to focus efforts at restructuring the region's municipal governance beyond transportation services.

They shortcomings and challenges associated with creating a Special Purpose Body for the GTA suggest that it may be best to restructure the region's existing municipal governance beyond transportation services. Kitchen claims that over the past two decades, services have "migrated" from the local municipalities to the regional governments, and therefore it is a logical choice for the latter to fully absorb the former (Kitchen, 2008). Another option came up during the days of the Greater Toronto Services Board. Some 905 mayors expressed interests in scrapping the governments of Peel, York, Durham, and Halton if their responsibilities were divided up between the Greater Toronto Services Board and the local municipalities (Toronto Star, 2000a). Both these options could be problematic and unpopular if local autonomy is surrendered or if smaller and more dependent municipalities would have to merge to take care of themselves.

When the Province passed the Places To Grow and Metrolinx Acts, it proved that adding a new layer of regional government was not necessary to coordinate the GTA's land use and transportation planning. The same could be true for GTA transportation finance. Instead of giving Metrolinx the authority to set rates and collect revenue, the Province could authorize it only to spend a percentage of the annual transportation revenues the Province allots. Nor would a new government have to collect toll revenue as well. As explained in earlier chapters, the task of direct toll collection could be taken by private billing service operators with government contracts. The Province could decide on the toll rates and/or which transportation services it wants to fund (after the legislated amount is given to Metrolinx). The toll rates could be set to be revenue positive, meaning local property taxes would no longer bear the brunt of financing transportation infrastructure. This would help resolve one of the main governance challenges, which is inadequate "local fiscal architecture" (OECD, 2009).

GNSS tolling under provincial management would not be without its challenges because GTA municipalities have shown to be stubborn when it comes to regional initiatives. One of the current barriers to cooperation is that municipalities feel they do not have incentives to share their resources without direct benefits (Civic Action, 2011). Local governments might not like the idea of Metrolinx taking away their authority to spend all money dedicated to transportation, and may not view the benefits as being direct. It would be helpful if as the time for implementing GNSS tolling approaches, GTA municipalities would have already experienced a greater degree of cooperation, so that sharing tolling revenues would seem like a logical next step.

Currently, there are forces advocating for greater regional strategic planning in the GTA. In its 2010 Territorial Review of the Toronto Area, the OECD argued at length for the need for the GTA to increase its economic competitiveness through regional cooperation. Though the Review argues that policy coordination and alignment is more likely to be achieved when existing institutions cooperate (as opposed to creating new institutional organizations), they recommend the Province builds off its successes of the Metrolinx and Places to Grow Acts (OECD, 2009).

Regional Linkages and Cooperation

One way to begin is to consider the strong linkage between transportation infrastructure and economic development since, for example, transportation corridors can link companies with the employees and suppliers whom may be based in another municipality (OECD, 2009).

Since there is no regional inter-sectoral institution in the GTA, and there is little appetite for more governments or further amalgamation, a group called Civic Action has tried to fill the role of promoting GTA cooperation (Deans & Tory, 2011). Civic Action is an organization that acts as a platform for collaboration among the GTA's public and private actors. Civic Action has worked for years already to encourage GTA mayors to coordinate policies such as cluster development and integrating immigrants (Civic Action, 2011). There are currently twenty organizations in the GTA working on economic development. Civic Action works to facilitate regular conventions between these organizations and other stakeholders. The latest convention of business, labour, the academic, non-profit and voluntary sectors, called the 2011 Greater Toronto Economic Summit, allowed these actors to discuss the next steps towards increasing regional competitiveness, such as creating a regional investment promotion agency (Civic Action, 2011). Though continuous dialogue is vital, serious political action towards regional integration may not occur until there are direct financial benefits for local governments. Though correcting the fiscal architecture of local governments and developing an efficient and effective regional transportation system are excellent future benefits, the Province will have to offer short term incentives as well.

7.0 Conclusion

Alleviating congestion in the GTA is possible, but introducing the necessary measures involves facing very difficult hurdles. These hurdles include the costs of the tolling infrastructure and privacy concerns about how vehicle travel data is recorded. Choosing to toll all roads with GNSS technology and On-board Units can enlarge these hurdles but at the same time make these hurdles possible to overcome in the long term.

The Ontario government should take steps to dedicate its fuel tax revenues entirely to transportation expenditures, creating transparency with the money it currently takes from drivers. At the same time, the government should create a voluntary opt in program for drivers to purchase the GNSS technology with its associated valued added services. These drivers could pay road user fees in exchange for a fuel tax rebate. The Province can regulate the market for this technology and encourage the reform of parking management to create incentives for drivers to join.

After enough volunteers have joined the program, and after the technology has been proven, the Province could write legislation to shift from fuel taxes to road user fees to pay for transportation services and infrastructure. Such legislation would then be politically viable because the unique advantages of GNSS technology will allow the government to minimize the credibility of opposing arguments. Road pricing would not be in the form of an additional tax, but instead a shift from gas taxes to user fees. The Province can work with its private sector partners to administer the fees and manage the revenues themselves.

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