

DELIVERING USAGE BASED ROAD PRICING

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ABSTRACT

Governments are increasingly interested in usage based road pricing. Typically the interest is in charging based on distance travelled. But delivering a workable distance-based charging scheme on a national scale potentially for all vehicles on all roads is a very challenging proposition, not least because of the problems posed by occasional users and safeguarding privacy. The paper explores the issues and presents the argument for re-considering time as a possible basis of charging that accurately reflects usage. It goes on to explain how delivering such a scheme could be considerably simpler than a distance-based charging scheme of comparable scale and it compares and contrasts the likely behavioural responses of users being charged under distance and time scenarios.

INTRODUCTION

By definition the movement of vehicles is a function of distance and time. This means that in theory distance and/or time could be used as the basis of usage based road pricing. The relative suitability of these parameters for this end is dependent on the underlying objectives of usage-based road pricing itself, and the extent to which the chosen parameter can actually be implemented as a workable road pricing scheme on the scale required. So while it may be suitable, for example, for charging heavy vehicles for the use of motorway networks in order to charge transit traffic effectively, or to internalise the costs of road infrastructure maintenance, it does not follow that it will be equally suitable as a basis for charging all vehicles using all roads on a national scale.

GOVERNMENTAL OBJECTIVES OF USAGE BASED ROAD PRICING

Increasingly governments are interested in usage based road pricing, but there are many motivations and objectives for doing so. The trend towards gradual improvement in vehicle fuel economy has been forecast by many governments to lead to a reduction in the effectiveness of fuel duty as a tool for constraining traffic growth and for delivering general tax revenues. There is also a growing interest in achieving the effective internalisation of external costs of road transport activities through road pricing that is very specifically related to road use in certain places and at certain times. In Europe, a variety of national and international developments are stimulating interest too. For example, there is a need to finance the development of road infrastructure in the new Accession Countries. Some countries need to manage growing levels of congestion on strategic road networks. Others need tools for managing growing transit traffic stimulated by the inexorable liberalisation of movement of people, services and goods within the European Union.

INTEREST IN DISTANCE-BASED ROAD PRICING

So, although there is currently a tremendous diversity of objectives for usage based road pricing, typically current government interest is in charging based on distance travelled. For some this interest may be based on a rigorous assessment of the comparative suitability of distance and/or time as the basis of usage-based road pricing to meet their specific objectives.

However, there are also many external drivers causing governments to consider distance-based road pricing which may distract from a thorough consideration of the relative merits of alternative approaches. With specific reference to the European context, this includes:

- The implementation of national distance-based charging schemes for heavy vehicles in (such as in Germany, Austria and Switzerland);
- The recent Directive on interoperable electronic fee collection, which requires GNSS as a core technological ingredient for in-vehicle equipment of future road pricing schemes in Europe even though it is currently barely used in this context today; and
- The apparent gradual deployment of Cellular Network (CN) connectivity and GNSS-capable systems into vehicles associated with wider roll-out of Intelligent Transport Systems (ITS) applications;
- The interest of the private sector in seeking to establish commercial linkages between GNSS systems used for navigation, insurance and location-based services, for example, and government interest in usage-based road pricing;
- Pressures to include road pricing as a key component in the emerging business case for the new Global Navigation Satellite System (GNSS), Galileo; and
- The recent amendment to the Eurovignette Directive.

APPROACH TO & POTENTIAL EFFECTS OF DISTANCE-BASED CHARGING

Approaches

The alternative approaches to implementing distance-based charging have been well-rehearsed in technical papers and presentations to the international ITS community over many years, so they will not be elaborated here.

Potential Effects in Terms of Likely User Responses

If a user is intent on minimising the level of charges incurred in the context of a distance-based charging scheme, then they will need to take the shortest route. This could encourage driving in the most congested areas (e.g. directly through urban centres) or on less suitable roads for a given vehicle type because these form part of the shortest route. Depending on the extent of congestion experienced, this strategy may be moderated by consideration of the user's perception of the value of their time relative to the charges incurred, i.e. they may divert from the shortest route in order to save time.

KEY CHALLENGES FOR DELIVERING DISTANCE BASED CHARGING

There are many key challenges for implementation of distance based charging nationally, to all vehicles. Just three key aspects are considered here.

Dealing with occasional users

The challenge here is to deliver the full potential of what is apparently possible with a national distance based charging scheme, yet which can be applied without discrimination (either way) to national and visiting vehicles. When it comes to a vehicle visiting a scheme within the European Union, for example any disbenefit to the visitor (e.g. cost, delay, interference with the vehicle) must be proportionate to the charges they are likely to incur, it cannot become an undue constraint to their free movement and it cannot represent the re-imposition of border controls. This constrains what is possible by way of equipping vehicles and hence specifying in vehicle equipment, or requiring visitors to pre-register their intended use of the road network. This in turn affects the basis of the scheme used for nationals too, ensuring that they too are not subject to discrimination of the grounds of their nationality.

Installation and unit cost of in-vehicle equipment

There are many more vehicles in an “all vehicles” scheme. The unit cost of in-vehicle equipment will affect the total procurement cost and financing it can become a significant obstacle to implementation. The greater logistical challenge of deploying equipment (on a retrofit basis) in all vehicles nationwide means it is likely to take years to equip all vehicles with in-vehicle equipment that requires any degree of connectivity to existing in-vehicle power supply, systems or sensors. The logistical, warranty and liability issues associated with connecting new equipment to privately-owned vehicles of varying age, condition, make and model is a major programme risk. Deploying expensive in-vehicle equipment only to then not use it for several years while other vehicles are equipped has a significant impact on the business case. Yet phasing implementation may be considered discriminatory or inequitable, or may adversely affect economic efficiency during the period when some or in the scheme and some are not. It may also be challenging to take account of the potential cost of equipment installed on visiting vehicles if this equipment is not recovered on departure.

User Acceptance: Privacy

Finally, an all vehicle scheme will, of necessity, encompass private individuals as vehicle owners and users. There are key issues to be considered regarding the overall acceptability of schemes in terms of ensuring user privacy and the perception of any compromise of user privacy by virtue of the introduction of the scheme. Distance based charging schemes generally involve the determination of location over time. Convincing users that the location information will not be used for other purposes – governmental or commercial – and will not be disclosed to other private individuals (e.g. family members) is a real challenge for policy-makers and may prevent them from being able to introduce a scheme covering all vehicles in the first place. This challenge reflects a fundamental issue relating to the declining level of trust in government per se.

POSSIBLE APPROACH TO AND EFFECTS OF TIME-BASED CHARGING

Possible Approach

In considering time-based charging of all vehicles as a potential alternative to distance based charging, the following potential approach will be considered. An in-vehicle device is developed based on a conventional 5.8GHz DSRC tolling tag and containing in addition a timing device or clock, vibration sensors capable of determining whether the engine is switched on or off and accelerometers capable of determining whether vehicle is moving or stationary. With appropriate roadside infrastructure the device would be capable of occasional

short range communication of charging data and some location-specific support for variation in charging rates (e.g. identification of presence on motorway). Such a device could potentially implement charges based on a number of options, but specifically including when the vehicle is moving, but not when stationary (e.g. if in congested traffic or waiting at traffic lights). Hence it could be used to charge on a basis that is largely analogous to distance based charging and need not apply charges when drivers can do nothing about how long they are travelling (e.g. when queuing). The latter was shown to be a particularly important consideration in the context of previous research in Cambridge on congestion pricing.

Potential Effects in Terms of Likely User Responses

If a user is intent on minimising the level of charges incurred in the context of a time-based charging scheme, then in principle they will need to take the quickest route and adopt the fastest driving style for the road conditions encountered on the way. This could encourage driving at excessive speeds, unsafe overtaking manoeuvres, and so on. More helpfully it could also result in drivers diverting or changing time of travel to avoid delays and congestion.

But in practice how likely is it that the particularly undesirable behaviours will occur? It is a well-established principle that different users / trip purpose combinations lead to very different values of travel time. If the difference in cost of travel time between different user / trip purpose combinations are genuine, then such an economic incentive towards unacceptable driving behaviour already exists for some relative to others (most likely at a greater cost per hour than would be considered for road pricing purposes). If this differential economic incentive is material in terms of influencing driving style, then user type / trip purpose combinations ought already to be being highlighted by the road safety community as major influences on accident risk or accident severity. Yet this is not the case, suggesting that the primary motivations for such undesirable driving behaviour today are not primarily about the cost of the journey.

Overall this suggests that charging on the basis of time need not necessarily result in any more undesirable user behavioural responses than that associated with distance-based charging. This aspect of time-based charging would certainly benefit from further research to establish more precisely the degree of any likely behavioural effects in practice.

DELIVERABILITY CONSIDERATIONS

The approach to time-based charging described above would not require the device to be connected to the vehicle's power supply, or to external antennae. Potentially it could operate supported by a battery for many years. This means the device potentially could be retrofitted to the vehicle by the owner / driver and reduces vastly the logistical challenges associated with roll-out to all vehicles, reducing cost and speeding up implementation time. The simplified technical functionality associated with time-based charging as opposed to distance-based charging also means the supply cost of the device is likely to be considerably cheaper.

This means that for the vast majority of vehicles the time-based charging solution described above would be likely to overcome the problems described in the section on challenges to distance-based charging implementation. The lower cost and ease of installation also makes it

feasible to contemplate providing such devices to visitors quickly and easily. The lack of connectivity to the vehicle avoids logistical, liability and warranty issues.

Finally, since charging for use on the basis of time does not require the determination of location, the privacy concerns of users cease to be a major issue in considering the likely public acceptability of any such scheme.

So although such a time-base charging solution might be more rudimentary than a distance-based charging solution, when implemented on a large scale (such as in all vehicles) the technical capability of the latter system may be compromised significantly by issues associated with dealing with occasional users, installation and unit costs of equipment - indeed the implementation challenges may prevent delivery of a scheme altogether.

CONCLUSION

Delivery of distance-based charging on a national scale (in terms of application to all vehicles), is hugely challenging and results in significant compromise in terms of how this technological potential can be applied in practice. Indeed it can prevent implementation altogether. Although time-based charging may be a more rudimentary reflection of use of the road network by vehicles, it is possible to identify at least one possible mechanism by which it could be applied to all vehicles on a national scale. Such an approach need not necessarily lead to the charging of vehicles while they are stationary. Time-based usage charging is unlikely to be inhibited by concerns for safeguarding privacy of users and on the face of it seems unlikely to lead to any more undesirable user behaviour than a distance-based charging solution. However the latter issue would merit further research to establish more clearly the likely responses of users.

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