

## **Tax or Toll?**

**Garth Clarke, Fellowship President  
Chief Executive, Transport Research Foundation**

Inaugural lecture delivered  
on Tuesday November 21, 2000  
at TRL Limited, Crowthorne

**The Fellowship Chairman, Dr R M Kimber, in the chair**

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**GARTH CLARKE**  
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Garth Clarke began his career as a physicist conducting early research into advanced semiconductors in the 1960s. He then progressed in electronic materials and systems research and became a Director of the central research laboratories of The Plessey Company plc. in the early 1980s. Following the take over of Plessey by GEC and Siemens in 1989 he became Business Development Director of the Business Systems Group in GPT Ltd., one of the UK's most successful telecommunications equipment innovators.

In 1993 he joined the Transport Research Laboratory (TRL) and was then part of the internal management team that put together the successful Transport Research Foundation bid for the Laboratory. TRL was privatised in April 1996 and Garth was appointed Chief Executive on January 1<sup>st</sup> 1997.

Under his guidance TRL has maintained and developed its position as one of the world's leading research centres in the transport field.

**Abstract**

This lecture argues that the current road taxation approach is a blunt control instrument when what is actually required is a more flexible and refined tool. Such a tool should more directly link charges to the value of the service used and the cost of its provision and, as such, would be more acceptable to the user. Flexible charging would also provide a mechanism by which congestion could be reduced, economic growth facilitated and a more inclusive society created.

The effectiveness of the current taxation system in supporting these objectives is limited and, as recent events have shown, the political kick-back can be formidable. It is proposed, therefore, that we should begin to debate whether it would be possible to gain public acceptance for replacing vehicle excise duty and fuel tax with a system that would automatically charge for the use of *all* roads; from farm track to motorway. The objective being to establish a system which would allow governments to use transport policy to more effectively facilitate social and economic development.

The key to success would be to charge for all road use. This would overcome the current problems associated with diversion and 'rat-runs'. Such a system would use a global location device such as GPS combined with a two-way communication device based on mobile telephone technology. Real time information provided by the vehicle to the network operator would improve network efficiency and hence the quality of service provided. It would also generate the data on which a range of value added services could be delivered on a fee-paying basis.

Privacy and enforcement issues are shown to be more easily dealt with than in more conventional gantry-based systems and the need for additional infrastructure is minimised. If we could find a solution to the political and institutional issues over the next ten years, technology would enable us to totally transform our national road transport system for the benefit of our economic, social and environmental well being.

In presenting this lecture the President's objective is to encourage everyone to challenge current thinking and use technology to put us in a position to take an ambitious, if controversial, step forward.



# Tax or Toll?

**Garth Clarke**

Chief Executive

Transport Research Foundation

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## Introduction

My subject this evening is ‘Tax or Toll?’, and the most important word of the three is, as I hope to demonstrate, the shortest one: the ‘or’!

Motoring is a huge activity in the UK as it is in the rest of the world. In Britain last year we travelled 675 billion kilometres by road: that is more than 8,500 kilometres each for every man, woman and child; and we shifted more than 155 billion tonne-kilometres of road freight. The revenues in play are huge: around £26 billion pounds a year comes into the Treasury from fuel and road taxation. This taxation process has two main objectives: first, to raise revenue, and second, to provide a means of moderating the negative impacts of traffic growth.

However, it is a very blunt control instrument: a sledgehammer, rather than a scalpel. The evidence of its effectiveness in restraining growth is, self-evidently, limited; and as recent events have shown the political kick-back can be formidable! To add to that, it is both socially and geographically divisive. Indeed the whole subject of transport is, as we all know, very political.

I should like to offer a new approach for charging for, funding and managing road travel in the UK—as a preliminary to an open discussion. I should like to present you with an alternative system: a radical shift away from our current, tax-based system for funding publicly-owned roads. What I am going to suggest is not a fine-tuning of our existing system, or the introduction of limited tolls on some roads, such as the motorways or bits of some city centres. What I am going to propose tonight is a radically new way to organise the funding, management and charging for the use of our national highway network—both trunk and local.

## The current scene

Let me start by looking at how the network is currently

funded. Road users pay for their travel through two main mechanisms. First, vehicle owners pay a tax on their vehicles—the ‘Vehicle Excise Duty’ (currently £155 per annum for a private car and up to £5750 for a heavy goods vehicle—though the Chancellor has said this will now come down to just under £4000 on Budget day). It is interesting to recall that when it was brought in before the War, it was called the ‘Road Fund Licence’. In the budget speech introducing it, the Chancellor of the day stated that the fund would be ‘used for road improvements, and will not become an instrument for raising general revenue’. How times have changed!

Secondly, and who could fail to be aware of it after recent news, road-users also pay for their travel through fuel duty. A litre of unleaded petrol currently costs around 85p in the UK: and somewhat more than 60p of this goes to the Treasury, in the form of fuel tax and VAT. The Treasury then allocates a comparatively small part of this tax to the provision and upkeep of the network. As a result, the link between service provision and use is very remote and essentially through the ballot box.

These funding/taxation mechanisms are relatively crude, and affect some sections of society disproportionately. For example, those who live in rural areas, and who often have little discretionary income, usually rely heavily on private cars, since there is no viable public transport available. And VAT aside, business users, whether in cars or heavy goods vehicles bear the same level of costs as the social user. Those who use our main roads at peak times are charged the same as those who use country roads in off peak periods. There is therefore little incentive for anyone to consider alternative times or routes that would benefit our economy, our society or our environment.

Nor is there anything in the system designed to make our society more inclusive. Rural communities are excluded by poor public transport, the disabled have little more than preferential parking and the poorest amongst us, prevented from car use by the high cost, see this as reinforcing the privilege gap.

Our current system of charging for road use lacks focus therefore, and is widely perceived as unfair in its operation and effects. A more flexible charging approach is clearly needed.

## Signs of change

Many countries use tolling to raise, or contribute to, tax revenues. In much of Europe, tolls are charged for motorway use. Charging for road use in this way—through traditional 1950s style ‘stop & pay’ toll plazas (Figure 1)—does have some advantages. It does, albeit

crudely, align the payment made with the amount of highway usage. The modern equivalent is the electronic tollbooth (Figure 2), which allows uninterrupted movement but otherwise performs the same function and has a similar effect. But in either case it is ‘leaky’: it often has the effect of an uncontrolled increase in traffic on adjacent non-tolled, highways.



Figure 1



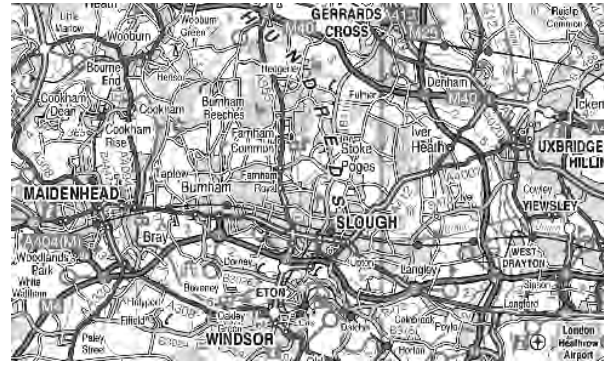
Figure 2

None the less the concept of charging for road use—and for the precise amount of road use—does offer much greater transparency. If tolling could be comprehensive and ‘sealed’ it would have the clear potential to offer large improvements in traffic control and management. By tolling I mean any road-specific charge for movement, and I include cordon charging and similar devices.

One major problem in the past has been that only on the most densely trafficked routes was tolling a commercially attractive option. There is the physical infrastructure to construct and maintain, and, in traditional systems at least, a substantial work-force to pay. It is clearly not possible to put a tollgate on every road, so there is always the likelihood that local toll-avoidance routes will develop. That is where the ‘leakiness’ arises.

These ‘rat-runs’ usually have undesirable consequences for both congestion and the local residents.

It is clearly never going to be feasible to build payment points, no matter how sophisticated, on every link in the network, ranging from a motorway to a country track. Just look, in Figure 3, at the complexity of this tiny bit of the network close to where we are here in Crowthorne.



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Figure 3

On the national motorway network there are 800 links, for other trunk roads there are a further 13,000 links. If we include all other roads, the number jumps by a factor of ten or so. This is a very big number. But perhaps this misses the point.

### Thinking laterally

In all of the discussion so far, road charging has been treated as a ‘point’ activity. By this, I mean charging is normally seen as an event which takes place at a discrete *physical* point in space and time. In effect, that makes it a type of sampling process! Either we cover the country in gantries or we allow big gaps to persist, and distort traffic movement artificially.

If, however, we could have an infinite number of tollgates distributed across the whole road network, tolling would no longer be a ‘point’ activity. Every movement of every vehicle, from driveway to motorway, could be captured. There would be no possibility of ‘rat-runs’ developing as part of a toll-avoidance strategy by the better-informed driver, since there could be no un-tolled—or perhaps I should say un-charged—rat-runs. There might, and I would say would, be lower cost alternative routes which were managed by the network operator to provide choice to the traveller and to create a better traffic balance across the total network.

Until recently however, there has been no alternative to charging for use by tolling at physical points as I have described. The only real choice was to toll or not

to toll: a choice between the UK approach, based on fuel tax and VED, and the continental system based on lower fuel taxes and selective tolling, mostly applied to the motorways, in conjunction with a different tax structure.

To recap, the main problem with existing forms of tolling is that it is essentially a sampling process. But tolling in this way creates a local distortion of the traffic pattern around a payment point. Incidentally, any physicists in the audience this evening will recognise this situation. A measurement exercise that distorts the phenomenon being measured is a classic example of Heisenberg's Uncertainty Principle in action! But perhaps this is a little too far-fetched: I am not sure that the conclusions of quantum mechanics really apply to traffic.

Although, now I come to think of it, there are some interesting wave-like phenomena in a traffic stream, and if we could only come up with a viable quantum tunnelling mechanism (Figure 4) we really would be on the way to solving congestion! But I digress. Technology has now made it possible to create an infinite number of tollgates around the network—virtual tollgates! Let me outline how the technology and the concept might work.



Figure 4

### 'Virtual' tolling

The key technical elements of a comprehensive system are as follows. First, it would use the Global Positioning Satellite system, or GPS, Figure 5.

It is only quite recently that the performance of GPS has improved to the point where it is now a serious contender for use in connection with road charging. As many of you will know, last May the accuracy available from GPS systems improved dramatically.

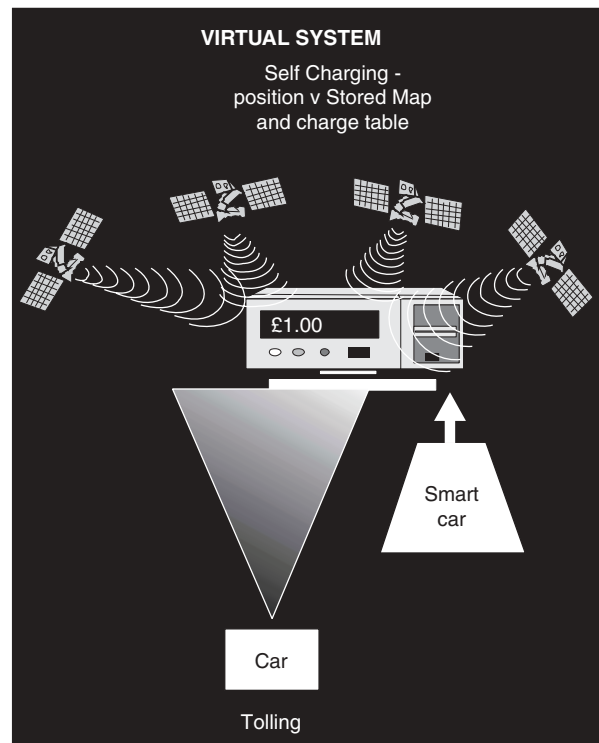


Figure 5

There is a little history behind this. Last May, the United States government turned off 'selective availability'—more commonly known as 'the dither'. Selected Availability had been originally introduced to degrade the accuracy of GPS, so that it could not be used to assist non-US armed forces.

Prior to May 2000, US forces—who had the technology to undo SA—were given the full, ±10m, high-resolution location system. The rest of the world had to make do with 'dithered' GPS, which gave a resolution of around ±100m. Dithered GPS was fine for sailing, aviation or hiking, but the 100m resolution meant that it couldn't tell if you were driving along a motorway, or on the adjacent farm track. Look at TRL in plan (Figure 6), and you can see that our observation tower spends most of its time on the lawn according to dithered GPS.

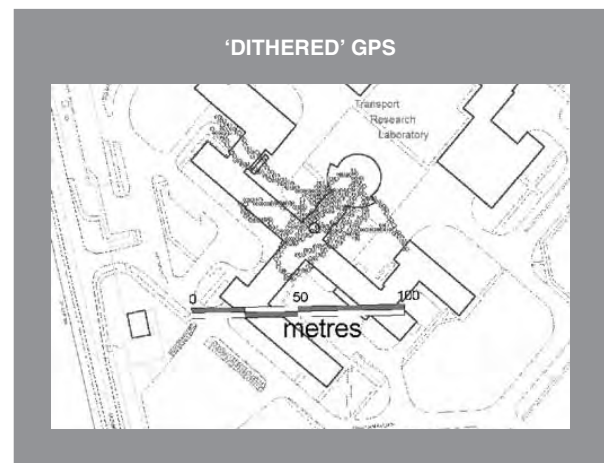


Figure 6

For the past decade or so the US, & the US electronics manufacturers, have had a virtual monopoly on GPS technology. This was because the US government had launched, and owned, the only functioning GPS satellite constellation. This situation has now changed. There are European and Russian satellite networks under construction (known as GLONASS & EGNOS), and many manufacturers worldwide are about to market GPS receivers for these new satellite systems. The price of GPS equipment—which to an extent has been kept artificially high by the US monopoly—is, therefore, likely to fall very rapidly in the next few years.

Since the European and Russian systems are not going to be degraded through ‘dithering’, the US manufacturers would have lost a substantial market had *Selected Availability* not been turned off. And so, unsurprisingly last May, it was.

The new, more accurate GPS forms the first piece of our jigsaw. It gives us the means by which vehicles can be tracked, to better than  $\pm 10\text{m}$ , anywhere on the network: from farm track to motorway (Figure 7)! It gives us the means by which in-vehicle devices can track and record location, and convert location change (movement) into charges, by reference to an electronic map within the vehicle, without any other reference to the outside world, and—this is important—with an in-vehicle record only.

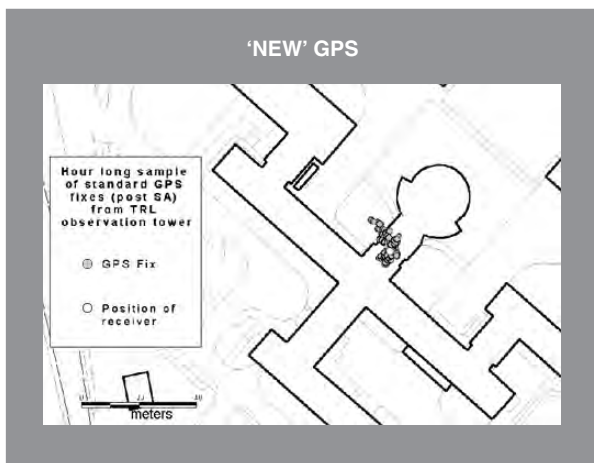


Figure 7

The charging system could use a pre-pay smart card which is decremented, thus guaranteeing the user anonymity. However, the vehicle’s record of its own movement could also be used by the driver in any challenge or appeal, but would not otherwise give any central authority knowledge of where he or she had been.

But tolling on its own is not enough. To get real advantage we need to include a second, additional system—a communication device. This second step—I should emphasise would be partly a matter of user

choice. Once a GPS kit has to be installed, it would be a minor, low-cost addition to include a mobile phone chip-set, Figure 8. This would allow the vehicle’s location to be identified at central recording points. It would also allow value-added services to be ‘piped in’ to the motorist. These would provide separate and additional revenues: although I will discuss the revenue arguments a bit later on.

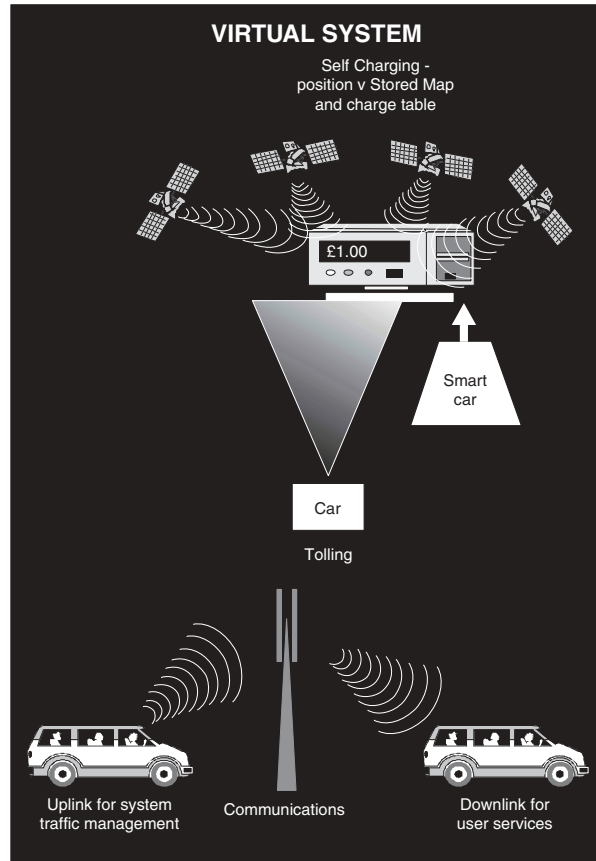


Figure 8

The function of the mobile phone link is thus two-fold. First, it gives the system operator knowledge of the movement of vehicles and traffic, and therefore the ability to manage the network better. Secondly if the user chooses to give the system knowledge of his or her identity, it enables service providers to supply added-value services like route guidance. The two functions are closely related: the sort of analysis that would be needed by the highway manager for traffic control would also provide the basis of a route guidance and information system for drivers.

The final component is the financial system by which the tolling transactions can take place. Electronic banking and payment systems are now common place and it would therefore be comparatively straightforward to link in tolling charges through prepaid smart cards, direct debit or credit cards. Charging could be focused on the garage forecourt and linked to eligibility for duty free fuel. I suggest that the financial systems needed are already available and that this part of the system would not delay the introduction of virtual tolling.

Let us look at how a system along the lines I've proposed might work. First, notice that it is very flexible. Charge zones, rates, and times could all be varied. Premium rates could be charged for travel at peak times, on popular routes, or when the air quality is poor. Users of 'green' vehicles could be rewarded or encouraged through a reduction in fees. It would even be possible to apply discounts to create a truly inclusive society.

If we look a little further ahead, it is even possible to imagine a second generation system that could be adjusted in response to real-time events such as local congestion, accidents or topically floods!!

Let me come on to who would control all of this in a minute. But I am not going to map out detail—the options are in principle wide. The key point I am making is that this degree of control becomes possible, and that its effects should be liberating not repressive: it would enable greater efficiency whilst offering all of the instruments of an inclusive and environmentally better supply of transport.

User choice is fundamental to such a system. Communications links between a vehicle and the highway operator can be used to update the electronic map, change charging rates, and notify the driver of those currently in force. It could provide choice between journey time and cost and a comparison between road and other modes. The driver may then decide to postpone travel until a cheaper time, or continue by another mode, such as rail.

The essential difference between a comprehensive virtual charging system, in effect represented by this first road map; and an old-fashioned 'pay at a point' tolling system, illustrated by the charge points on the second map is this. A charging system based on GPS—a virtual infrastructure, in other words—has no leaks in it. All vehicle movements are captured. A 'stop & pay' system on the other hand will always leak—and in so doing, will generate uncontrolled local distortions in the traffic flow. The communication link provides real-time data to network operators to enable them to provide an improved service. It also provides the traveller with an opportunity to access a range of real-time value added services, many of which would be derived from the system data.

### A potential technical way forward

Now, let us consider for a moment what the likely technical issues with this concept might be.

First, let us look at GPS location. This is something we have studied in some depth at TRL, as part of our self-funded research programme. We have shown that it is possible to model the visibility of the GPS satellites in any urban or rural location, using digital map data to create a virtual 'skyline': (Figure 9). These

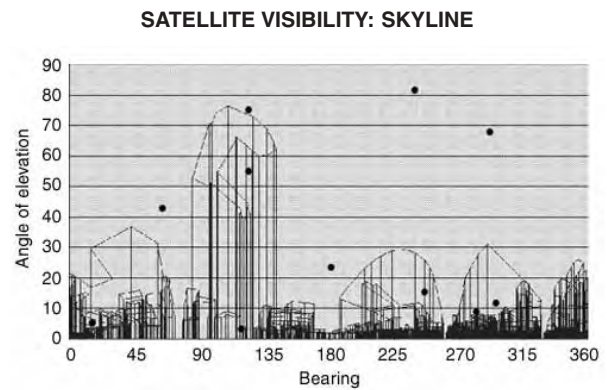


Figure 9

simulations show that it is normally quite feasible to 'see' at least five satellites (enough for a good position fix!), even in central London, where the view of the horizon can be quite restricted.

There are a few situations where fewer than five satellites are visible. For example, this can occur when the road runs through a deep cutting, in a tunnel, or traverses a particularly narrow urban canyon. Our studies suggest that these (quite rare!) situations can be retrieved in a number of ways. Probably the simplest solution is to use digital map data, and to calculate which link the vehicle must have followed from the entry and exit 'fixes' at the borders of the 'invisible zone'.

Alternatively, for a small expenditure, 'pseudolites' can be provided: Figure 10. These are low-cost GPS transmitters fixed to gantries, or adjacent tall buildings, which the vehicle receiver perceives in exactly the same way as a satellite. Incidentally, the use of pseudolites in tunnels is nothing new: they were originally developed as an aid to surveying in mines and quarries!

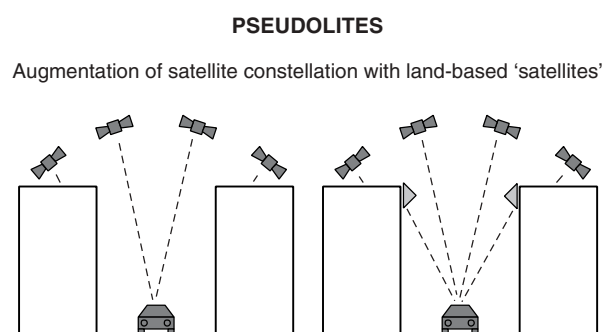


Figure 10

Now, let us look at communications. I think you will all agree that the current mobile phone networks are very reliable—and they are getting better all the time, as new base-stations are added. Even if there are occasional 'drop outs' these do not present a problem because regular communications are not part of the tolling system. In fact, for prepaid smart cards no communication system is required at all.

As long as the driver can see how his charge is accumulating—to reinforce the point of use charging concept—I doubt if, even in direct debit systems there is any need to poll the device more than once a day for charging purposes. And this could be done overnight.

Communications from the vehicle are important, however, because knowledge of traffic flows and densities are essential to the provision of quality network management and real-time driver advice and information. How often information needs to be captured for this purpose remains to be seen. I suspect statistical sampling techniques could mean that individual vehicles would only have to be polled every half-hour on trunk roads and every ten minutes in urban areas. This is of course based on a belief that journey time and rate of flow is important rather than accurate traffic densities. The rate of polling would therefore be set by the need to balance bandwidth use and service provision.

Our studies at TRL have led us to the conclusion that there is nothing in the technology which stands in the way of a comprehensive tolling system along the lines proposed. I am not presenting a technological argument in this lecture: the necessary equipment and systems already exist. The problem is defining the political path and the transitional arrangements. There is also the issue of the timetable by which we get from here (i.e. the current arrangements) to there (a completely tolled, road system).

### Some analogies

There are some interesting analogies here. Some aspects of comprehensive tolling bear striking similarities with the way in which telephone networks operate. For example, in both cases the users control the time at which they use the network: and hence their costs. Both systems can have congestion charging: in the case of telephones it is normally known as a peak rate charge band. There is even an element of modal choice, in that phone users can choose which network or services they use. It is also interesting to note that the value of the additional services provided using the fixed network has grown exponentially and now totally dominates the value of the basic service—fixed point to point voice calls. Just look at the value of the mobile phone licences where the vast majority of calls spend most of their time on the fixed line network.

The revenue flows in a virtual road charging system are also very similar to those that would take place in a telephone system.

Quite apart from the core travel charges, the value-added services would function in a very similar way to that in which the existing utility networks allow a variety of operators to sell to the consumer through a common infrastructure.

Looking at these analogies between a virtually-tolled road network, and the operation of telecoms and utility networks, has led me to the belief that it is entirely feasible to operate the UK road system in a way that mirrors closely the operation of a telephone network.

### Institutional issues

The system I am proposing would change the whole way the national road network is operated. It is only now, at this stage, that we can see the full scale of the change. Such a system would be immensely more powerful than any transport policy instrument available at present. It could be used to bring about major changes in the economics and societal impact of transport—and also its effect on the environment.

How to use it would be a political choice, and I do want to emphasise that threshold. There is nothing within the system I am describing that points to one political position or another. It would be for governments to decide on the balance to be achieved in operation by the instrument of virtual tolling. The difference when compared with present systems would be that virtual tolling would allow close alignment between charges and high level objectives.

Thus charges for road use could be set in pursuit of a range of possible political objectives such as social inclusion, support for disabled people and rural communities, or even the haulage and farming industries! Moreover the case for using the system in pursuit of environmental objectives, both those limited geographically or locally, and global concerns, is very strong. Premium rates could be charged for travel at peak times, or on popular routes, or when the air quality is poor in the locality. Users of ‘green’ vehicles could be rewarded or encouraged through lower fees.

The overall scope of such changes is extensive. This would not be a marginal adjustment—it would be radical in its capability. But it also provides a potential separation between the setting of policy objectives and the operation of the road system. The government clearly is responsible for the first—it sets the political objectives—but the operator would run the system, and this might or might not be the government or one of its agencies. In principle the system could operate in three broad ways:

It could be:

- an entirely public system;
- a public tolling system, with licensed value added services; or
- a fully privatised network service.

The choice between these options is a political one.

The fundamental principles of the system should not depend on which option were to be followed. And one could envisage transitional stages on route to a final model.

For me, full privatisation would be the most challenging but it could provide a key political benefit, Figure 11. It would offer a strong measure of separation between the political requirements of transport provision and revenue raising on the one hand, and the operation of the system on the other—so distancing government from the day-to-day aspects of transport that it finds most difficult to respond to.

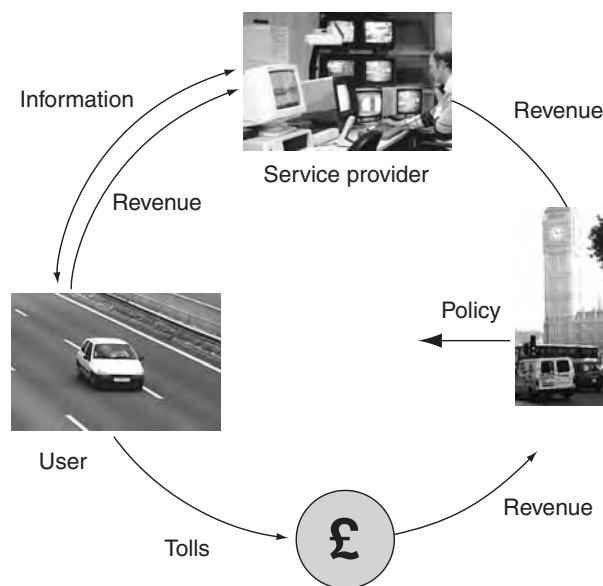


Figure 11

The obvious first reaction to the idea of fully private operation within parameters set by government, is the tension between ‘increasing trade’—ie the private sector’s motivation to increase traffic—and government objectives to limit traffic growth. This would be for the parameters set by government to control. The need for government to do this would encourage more stable forward-strategies to be set down and would in turn exploit the degree of economic control made possible by virtual tolling. Thus government in setting its forward plans would determine the functional dependence of private revenues on traffic volumes, on different parts of the network.

This would apply to both individual and shared transport use—ie so-called public transport. The interaction with other modes—rail, air, sea—would be set by interface requirements.

Let us assume that the decision to create a virtual tolling system (on whichever of the three models) has been made: how are we going to implement the new system? I suggest that the objective would be to ‘sell’ the system to the electorate as a replacement for VED and fuel taxes, using the arguments I developed earlier of greater

transparency and fairness. I come back to this in a moment. I would suggest that it will be important to make the tolling scheme cost-neutral when compared to the total revenue raised by our current arrangements (remember the ‘OR’ in my title?). The challenge will be to make it perceived to be cost neutral to each individual at the key point of transition.

The technology requirements are that every vehicle should be fitted with a GPS location system. Some new vehicles already have these, and in due course most of the existing, non-equipped fleet could be phased out. In the interim, a number of measures could be taken. The GPS charge card system could provide access to duty free fuel with a premium rate of VED being applied to non-equipped vehicles.

If we do include a mobile phone as part of the system, so that the vehicle’s location and possibly identity are known, a whole range of services could be made available. Firstly improved network management and secondly value added services for the user. These services would form the basis for many new businesses. The inclusion of a highway-vehicle communications link clearly makes the system a much more attractive proposition in a business sense, and this is likely to attract private capital.

It would probably even be cost effective for after-market systems to be subsidised by the network operator and/or the service providers.

The perception of the issue of privacy could prove to be a major difficulty during the transition to the new system. The electorate, and hence politicians, are likely to object to any system that they perceive as ‘big brother’, monitoring their movements. This is a real argument, which must be faced: but it should be recalled that the movements of those of us who use mobile phones (getting on for 50% of the population) are already tracked, and nobody seems to mind. Moreover, the intrinsic tolling part—the GPS-based system—would be completely anonymous, since the journey data would be stored within the vehicle, with charging being done daily, weekly or even monthly. There is no requirement for vehicles to be in constant communication with ‘the network’. Thus, even the most ardent privacy-seeker should feel that they have adequate protection!

If two-way communications are used, then (just as is now the case with mobile phones) the position of the vehicle will be known. But remember, it does not necessarily have to be an identified vehicle! No identity is needed to provide the system with the knowledge it needs; only for providing services to the customer.

There is one element of ‘big brother’ that will be said to exist, even if the privacy issues are dealt with along

the lines I have described earlier. This is the fact that some central authority (be it government, or a private company) will ultimately be in control of the cost of your journey. But, in reality, this is no different from any other form of transport service. Provided the user has choice and can affect cost by behaviour and provided cost is directly related to service, it should be possible to sell the concept to a user. Rail and air travellers are already used to choosing between first and second class accommodation or peak and off peak pricing. I therefore feel that, provided the interests of the users are safeguarded, this element should gain broad acceptance. Presumably some form of consumer watchdog would be required—OFFROAD, perhaps?

Now, I am sure that the question of ‘enforcement’ is strong in your minds. How could we stop an unscrupulous road-user taking a pair of pliers to his road-charging unit, and disabling it, before making off to enjoy un-metered use of the network?

Well, if vehicles that do not have an active unit are required to pay an inflated price for fuel, it seems likely to me that there would be little incentive to disable the system in the first place. Theft and reuse of smart cards can be prevented in much the same way as programmed hotel door keys in that they can only be used in the vehicle they were intended for. The longer-term solution is of course to ensure that the traveller perceives real value from the additional services provided by the system because after all as long as the benefits of having the system exceed those of not having the system there will be little need for enforcement.

Now, let us assume that the government decides to run with the idea. What would the likely timetable be?

As I have said several times, all the engineering and financial elements of a virtual tolling system already exist. Public acceptance and therefore the political will is I suspect some way off. However, traffic is growing inexorably, congestion is getting worse and selective tolling is becoming a reality. Over the next few years we will have a number of largely uncoordinated tolling systems introduced around the country that offer little or no inter-operability.

Unless we have the courage to take a look into the future our children will inherit chaos. I am not suggesting that we stop what we are doing. The trials and experiments that are being proposed are essential if we are to build our understanding of how aggregate behaviour is likely to be affected by tolling.

I am suggesting that, in the mean time, creative and innovative people in government, the transport industry and the IT and communications industries need to get together to explore this option

But what we are talking about is a massive change and we need to look at time-scales. The important point here is that in political terms this is not a ‘here and now’ issue—we have so-called ‘soakage time’.

However, if this is to be a real option in the foreseeable future—the thinking process involving all parts of what would be an extremely large public private partnership would have to start soon.

A radical change of this scale would require a very broad-ranging discussion, and the consultation process—green papers, white papers and so on—would take several years to complete, Figure 12. I suspect that even if we started very soon it would take some years before the completion of the consultation process. If enabling legislation were required—it could take up to ten years. And remember during that time we are likely to have at least two elections—and we all know what that does to the political process.

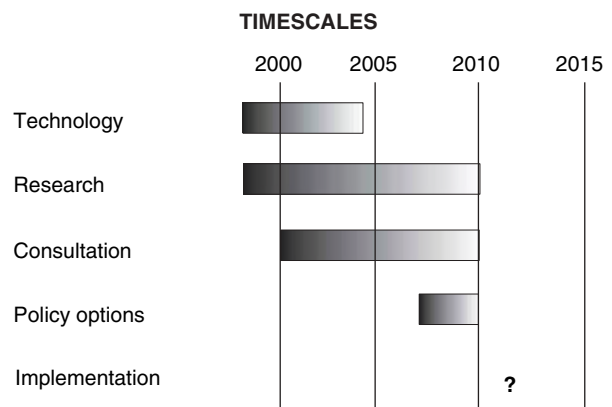


Figure 12

So I see this as a ten-year programme, learning along the way: but I am convinced that we could be viewing virtual tolling as a real possibility by, perhaps, 2010 – 2015.

## Conclusion

Let me draw this together. There is of course a raft of issues to be resolved: the perceptions in relation to privacy, the environment and the impact on other modes are all technical and political issues that will need to be addressed. The impact on network efficiency, traveller behaviour and the role of the value added services are all critical. All of these have been discussed in the light of our present systems but this proposal changes the very fundamentals on which much of our current understanding is based.

The issues are complex and wide-ranging. New knowledge will be needed in particular about the behavioural reactions about which we know little, and consultation will be needed with all stakeholders including the potential users. The process of transition will need to be carefully thought through.

But, if we could find a solution to the political and institutional issues, technology could enable us to transform our national road transport system for the benefit of our economic and environmental well-being, and, give us a platform on which to build a truly inclusive transport system, Figure 13.



*Figure 13*

I hope I have said enough to stimulate some discussion and debate. My objective is to create an opportunity for us all to challenge current thinking and use the opportunity that technology has given us to take an ambitious, if controversial, step forward.

# DISCUSSION

## Rod Kimber

Thank you for a splendid overview and a very challenging proposition. There is much for us to discuss and debate and there are many issues. These involve an interaction between the technological, operational, policy, and financial arguments.

For the discussion, I am going to ask two of TRL's experts to join us on the platform to form a small panel—they are Neil Paulley, Senior Research Fellow at TRL who brings wide experience of transport planning and transport economics, and Ken Perrett who has been much engaged with the development of telematics and intelligent transport systems. They will join Garth and me in responding to questions and comments from the audience.

## Question/Comment

The key thing about the central proposition for all-inclusive charging is how to get there. The ten year timescale is a good objective. It can be argued that a sudden revolution, with a distinct switchover point, is not necessary since much can be done in the meantime; and there are initiatives in progress that are leading in the right direction.

Two countries at least are introducing systems for heavy goods vehicles which are close to what is being proposed here. Switzerland will be turning on their system shortly, and every Swiss goods vehicle will pay according to the distance they travel on the Swiss roads. Whilst not quite as sophisticated as the system envisaged in the lecture, it does use GPS as a backup for measuring distance. Germany is committed to introducing a similar but more sophisticated system for goods vehicles in 2003, and a lot of the technological development needed for this system will lead us in the right direction. The Hong Kong positioning system is also relevant.

The potential value of value added services is also becoming more widely recognised. At the same time, there is recognition of the potential for vehicle based charging systems by several city authorities: that you could introduce a VPS (Vehicle Positioning System) in parallel with a cordon system—for example a registration number based system with camera enforcement. Such a VPS system could then be used for value added services as well, and the charges taken through the same medium. These things can all help to seed the transition to the system being proposed, and to build up to it progressively over a 10 – 15 year period.

## Rod Kimber

Current developments in a number of places certainly bear on parts of the proposition that is being argued, and that brings one to think immediately of transitional processes. That is the argument for integration and progression. The fundamental question is whether such development would be sufficient to take us there.

## Garth Clarke

Experience with large scale projects in the private sector leads me to take a more heretical point of view. What goes against the progressive, incremental, argument is the opposition of scale: the collection of £30 billion worth of revenue does not easily transfer organically. Experience in the communications industry is that value added services could possibly add twice the base revenue sum. This is why the big bang argument is attractive. It brings in the advantage of scale at the outset; it would seriously involve private capital; and it would be a real driver to get things moving. That is why I am nervous about the prospect of trying to creep across a chasm in small steps. The opportunity that is open to us is to be able, now, to plan ten years ahead, and so enable serious and specific thinking to be developed with the potential key players, including particularly the financial institutions and the communications industry.

### **Ken Perrett**

The key to the whole thing will be user acceptance. The Swiss and German systems will tax lorries, and they are not popular with the truck operators. In contrast, the system proposed in the lecture *should* by its nature be popular, because it would be equitable and would lead to a much more efficient and targeted way to levy tax. But if equitability is not demonstrable, then enforcement will become very difficult. That is why managing acceptability amongst users is the key to the whole thing. Moreover, in Europe there is a history of introducing systems piecemeal and then going through a long and involved process of co-ordination and harmonisation. It would be far better to develop a coherent plan.

### **Question/Comment**

Technologically the system proposed seems perfectly possible, although it will need to be subtle in order to avoid rat running through the cheaper areas—cheaper in terms of the road user charges that is. Those living in such areas might need to be defined differently from those constituting ‘through traffic’. But given that it seems reasonable.

The main question, however, is that if all of this money is collected, how will we persuade the government to part with it? Getting them to part with fuel tax at the moment is pretty difficult.

### **Garth Clarke**

The key is the value added services, without which the proposition would collapse. The value to the service providers of getting access to some 30 million ‘15 foot mobile phones’—ie the user in his car—is what would drive the whole thing.

### **Question/Comment**

Yes, accepted. But how then would roads be built and maintained, and how would safety be ensured? How do we ensure that the funds collected go to those things in the right way? Moreover, the answer must depend on what assumption is made about whether the ownership of the road network remains public or not.

### **Rod Kimber**

This leads to a central issue. The parameters for answering that question would determine the whole function of the system. It seems to me that ultimately the credibility of the system proposed in the eyes of the public will depend on governments being prepared to set long-term strategies; these strategies would define, amongst other things, how maintenance, safety, and signs and other driver information could be provided. Such strategies would have to be pretty open and clear. They would of course, as a first principle, address the ownership of the road system. But the system proposed here does not in fact *depend* on decisions of that type: it would enable alternative models of ownership to be implemented.

### **Neil Paulley**

The question is ultimately one of public acceptance. The public will expect the government to set clear objectives and requirements and they will only be reassured if these guarantee the maintenance, availability and safety of routes in the network. Given that, I see no reason why such a system could not work. It is the setting of these objectives, and the credibility of their delivery, that would determine public acceptability.

## Garth Clarke

Consider what BT did to the telephone network. It illustrates just how committed one becomes to maintaining the network and ensuring its efficient operation when one depends on it to provide services involving very big revenue flows. This focuses the mind wonderfully.

## Question/Comment

Isn't there a question mark over the virtuous circle shown in one of the slides (Figure 11). Whilst there was money flowing *from* the vehicle, the only thing flowing *back to the user* was information. While the demand for travel is high—as witness the 675 billion kilometres driven in 1999—the flow of information will do little if anything to increase capacity. Research generally shows that information is of most use when incidents happen; but the effect for a congested network is small. So although we can see revenue generated, it isn't clear that motorists would feel it was coming back to them in value. Therefore isn't there insufficient benefit to make it politically acceptable?

## Garth Clarke

I think you have to look at other things than that particular revenue growth line. The important thing is that if you look at the road network in the country something like a third of the total mileage driven goes on the trunk network which is 4% of the physical road mileage and the rest goes somewhere else. If you were the network manager of electricity movement on integrated circuits (at one end of the scale) or of the national grid (at the other) you would ask why we are not doing something with the other 96%. So what I think would happen in a system with differential tolling, is that there would be an alternative routes between (say) London and Birmingham: there would be a lower-cost, lower-quality route that takes longer but still uses part of the central network, and a high-speed, high-quality, high-cost route. This would be like you have in France. If you were going from the north of France to the south on holiday you might wander your way down, staying in hotels and so on; but if you were on business and you had to get down in a hurry you would probably pay the fee and go down the autoroute.

Moreover, congestion is growing, and in fact you don't have to change traffic levels on the trunk road network by much—and the same applies to capacity—to affect congestion a lot. Differential tolling could be used to spread the load much better than the current system.

## Rod Kimber

The other side of the question is implicitly to do with hypothecation in relation to the collection of revenues. What, in short, do you do with them? And what benefits will people see?

The parameters within which a government might want to operate a system would, of course, be open to be adjusted so as to determine how the revenues were used. That really goes to the fact that the proposition argued is apolitical: it does not actually presume political policies in itself. So government could set up a hypothecation channel if it wanted, provided it could manage it clearly, transparently, and with credibility—although the tension between Treasury decisions about public spending across the board, and the financing of the particular roads requirements and user benefits will be ever-present.

## Neil Paulley

The user will benefit in several ways. I agree that information on its own will not be perceived as a significant benefit by the motorist except at times of very big travel delay or difficulty. However, the charging principle itself will be to attempt to make more efficient use of the network, and this should result in decreased journey times for travellers. In this respect information is a bonus, rather than a main benefit, as is the provision of other services to cars. Moreover, as at the present time with congestion charging, much can be made of the hypothecation of revenues to public transport and, of course, to improvements in the road network itself.

### Question/Comment

Following from that is the basic question: ‘What would the user actually be being charged for?’ The debate on road user charging over recent years has mainly been over how to create in people’s minds the connection between the (potential) charges they would pay and the social cost they impose on others by their own use of the roads. The problem is that if you say ‘We are going to charge you for your use of the roads’, people will immediately respond that they already pay for them, via petrol and VED taxes. So when do you ‘cut in’ charging? Tolls on the Severn Bridge, for example, are self-evidently clear enough; but on ordinary roads, would you set a threshold below which charges would not apply—for example on uncongested rural roads? Such thresholds would be highly political of course.

### Garth Clarke

To start with, the charges would have to be perceived by the user as neutral. They would have clearly to be an *alternative* to fuel and VED taxes. The first step would be to achieve that transfer. Subsequently, the charges would become progressively more sophisticated—charging the ‘fast’ groups of travellers, discounting the slower groups, and allowing discounts for groups which would otherwise be seen as being at risk of social exclusion: some rural communities, disabled people, and so on. But the essence is cost neutrality in aggregate, and initially—as far as possible—for individuals as well.

### Question/Comment

As a brief supplementary, people’s perceptions of cost are strongly driven by what has happened in the recent past. An example is the fuel protest we have just witnessed. People seem to be sensitive to recent marginal price shifts, rather than to the true economic costs. They judge by price movements over, for example, the past year, rather than over a decade, and rather than looking at full economic costs compared to other modes of transport or alternative activities.

### Rod Kimber

This is a real issue. The argument in favour of the proposed system of charging is that because the Government would be put in rather a strong position with regard to economic control over transport—the actual movement of people and goods—it would *have* to state clearly, in advance, its forward road transport policies and control parameters. That should lead to a stable investment and operations framework. But in doing that it would be faced with the kind of perception alluded to—that is, to a greater public sensitivity to short-term marginal price shifts than to the full underlying economics. Managing those perceptions would be fundamental.

### Question/Comment

Returning to user acceptance, even with a relatively neutral system there are going to be winners and losers—at the ends of the distribution, so to speak—and one only needs the losers to make up a few percent and they would be quite powerful. Is there a way of setting the charges on roads such that minorities cannot seize the system up?

### Neil Paulley

I suspect there will always be a minority who feel aggrieved because there always is. But the point is that if the system is fair and people generally see that it is, then it’s a question of how to deal with the particular extreme areas of difficulty. Whilst they, inevitably, cannot all be found a completely neutral position they can usually be accommodated, once identified.

### Question/Comment

Regarding user acceptance, it is a fact that the current system is difficult. People have been concerned about several issues, particularly the tax escalator, and the environment. There is a good deal of cynicism about these things. This situation may provide the opportunity to push strongly for change now. But while there is an argument that we should be reviewing our road user taxation, the Treasury may see it all as a trap. The argument runs that what is needed is to separate the charge for roads from the tax for general expenditure, so that people could see what is being taken for schools, hospitals, and so on. In that way they would see a charge to use roads which they could understand. They could see what they paid and what they got. But to move forward on this would require a fundamental change in Treasury thinking. The point is that any system that challenged the current tax structure would meet resistance, for understandable reasons. The system argued in the lecture would face exactly this difficulty, wouldn't it?

### Garth Clarke

I totally understand, but the crux it seems to me is to have a strategy. While people may discuss this or that potential tolling system, they are still in fact shackled to current thinking. We could so easily drift along this path and finish up in 10, 15 or 20 year's time without really having re-examined the framework at all. But if, instead, we could form a 10 or 15 year plan, now, to investigate seriously the propositions I have argued, we should be thinking ahead, and we should be learning about the possibilities in terms of public acceptability—at the same time as the technology is advancing so rapidly. We would learn a great deal. Without that learning, and without exploring this more radical path, we might well finish up in 15 years time without very much fundamental change, and with traffic and transport issues by then an overwhelming priority.

### Question/Comment

Agreed. But whilst we can push with technology and pull with policy arguments, we shall still face the institutional barrier of the Treasury's position. The challenge is to find how we can make it a win-win situation for motorists and a win-win situation for Treasury, isn't it?

### Rod Kimber

That would be a unique achievement! But we do have to find a way. A key advantage to the Treasury would be the increased flexibility and focus that the proposed system offers. It would provide a much more politically sensitive tool: for example it would enable Governments to tackle the complicated problems of social and economic exclusion. Compared with the existing arrangement which is in effect a very crude compromise, this would provide the Treasury with the very instruments it needs. And no doubt there would be many ways of delivering it. For example, one could still retain a fuel specific element of taxation if needed.

### Question/Comment

A basic question: 'Why should road user charging be introduced?' What is the true objective? Is it to control traffic demand or to manage it? Or is it to provide various alternative levels of service to the motorist? Or is it to force people to use other modes of transport? And in the latter case, do you think the time scales are sufficient to allow for the other modes of transport catch up?

### Ken Perrett

Some of the work that has been done in Europe has been in trying to *discern the objective* of various European charging systems, and in trying to explain what systems were actually installed according to the objectives. And the key question is indeed about objectives: that is what drives the debate. But political thinking tends rather to be in terms of the technology; and so long as we think in that way, so we shall always end up asking: 'What can ITS do?' In contrast, the *real* question should be 'What *benefits* should we be seeking?'

What benefit is the spade in your garden? The answer is none at all, if you don't do any gardening. That is the problem. A tool to implement policy will only work if the policy itself is clear and accepted. The difficulty is that policy always gets diverted into asking 'How are you going to do this or how are you going to do that? What technology will you use? What communications will you use?' It is important therefore not to be side-tracked by confusions between the means and the objectives.

### **Question/Comment**

Two points. The first is on making the charges neutral. One way is not to levy any charges in year one, but to increase them progressively in subsequent years. That means that the infrastructure would have to be introduced on the basis of the value-added elements argued in the lecture and the promise of future revenues.

The second point is that one of the problems with the systems developed in France to levy tolls was how to decide what level of charge is needed to be sufficient to generate a given change in behaviour. We need to know the relationship between the two. Once some knowledge had been established of that, then a system could operate in which people bought, or were allocated, rights to movement. This is a bit like the idea of *permits to pollute*. Once the economics had been set in relation to behaviour, one could even envisage a trade developing in these rights of movement, just as it could develop in permits to pollute.

### **Rod Kimber**

The second argument illustrates, in principle, the potential power of the whole system. But as for the first, I feel wary of the sort of gradual introduction envisaged, since all of our experience indicates that the marginal value of value-added services introduced progressively in this way is insufficient for them to pay their way. If their full value is to be realised, the whole process needs to be kick-started, and I don't think this can happen in a gradualist way: unless we kick-start the process it probably will not happen. But at the introduction, the revenue flows need to be neutral: both in aggregate, and for individual users. The whole process would need to be seamless. In fact it would work better if there were a marginal *advantage* to individuals at the time of transition.

### **Question/Comment**

The argument that the value added service part will be attractive to people does not seem particularly convincing. What they will mainly be confronted with is an instrument which would enable the government to take considerable revenues. This is what they would mainly see.

### **Rod Kimber**

But this is—genuinely—a matter of presentation, and choosing the most effective means for introduction. The fact is that the benefits to the user would be substantial. The network would operate in a smoother and more effective way, congestion would be reduced, and choice introduced. This choice would be based on a clearer differentiation between the higher cost, higher level of service routes and the lower cost routes. As a result the constraints on both business and private use would become much less arbitrary and efficiency should therefore increase, generating wealth. So this really is a key question: how these things would be best articulated, because the political barriers to entry will depend strongly on that.

I need to draw the discussion to a close at this stage. Thank you all for your contributions. Throughout, the discussion has brought out issues that cannot be addressed by the current system, but which could be dealt with by the proposed system. We deliberately chose this topic for the first of this series of lectures so as to stimulate just this sort of radical discussion. So I think we succeeded in that.

One dimension that does need to be emphasised is that what we know already about behavioural reactions is confined almost entirely to marginal changes. That means that we have little on which to go in predicting how behaviour would respond to the more fundamental issues and propositions raised here.

But there is a great deal that is happening now, and there are some massive opportunities in front of us. If we are to make progress, what does emerge clearly is that we have got to be thinking very seriously about these issues *now*, and we do need to get plans in place for examining them as options and developing fully what would be involved. If the outcomes are in the event not what we planned, we shall still have learned a great deal and we shall know far more about the choices ahead of us. This kind of thinking informs policies; and it can only do that effectively if it seriously opens up all of the options.

Let me close by thanking Garth again for his splendid lecture and for stirring up such a wide range of interest. Thank you all very much for coming. I hope this is the beginning of the debate and that we shall hear much more of these ideas in the future.