Written evidence submitted by CGI IT UK Ltd (EVP0123)

This document contains CGI's response to the Transport Select Committees Call for Evidence on Zero Emission vehicles and road pricing. CGI has chosen to provide evidence for two of the Transport Select Committee's bullet points on road pricing:

- Which particular road pricing or pay-as-you-drive schemes would be most appropriate for the UK context and the practicalities of implementing such schemes;
- The lessons to be learned from other countries who are seeking to decarbonise road transport and/or utilise forms of road pricing.

About CGI

CGI IT UK Ltd has been delivering secure, mission-critical technology solutions for clients working in Space, Maritime, Defence and Intelligence for over 40 years. With around 6,000 experts globally and over 1,400 in the UK we work in partnership with our clients to enable digitally-driven business transformation.

The boundaries between Space, Maritime, Defence and Intelligence continue to blur and CGI is uniquely placed to help clients to securely join the dots. CGI delivers secure, mission-critical space systems including data processing and exploitation, satellite communications, robotics, command and control, on-board software, modelling and simulations, ground segment engineering, navigation and situational awareness. Our unrivalled experience enables us to deliver new approaches to enhance the protection of UK National Security and critical infrastructure.

Which particular road pricing or pay-as-you-drive schemes would be most appropriate for the UK context and the practicalities of implementing such schemes;

It is clear that any future Road User Charging (RUC) scheme must be equitable in order to gain the public's support. A "pay as you use" model is therefore highly likely. This would mirror the existing national taxation approach where fuel consumption (as an indicator of usage) is the primary means used to levy tax.

However, any scheme proposed will need to provide transparency and accountability to ensure buy-in. The current Fuel Duty and Vehicle Excise Duty based concept is simple for people to understand, and is transparent. It is not a given that replacement schemes will offer the same level of transparency and this will need careful consideration when forming the system's requirements and design.

A further challenge for any replacement system is enforcement. With the exception of Vehicle Excise Duty, the current scheme is largely self-governing, or rather governed by petrol forecourts who collect tax revenue on behalf of the government. Motorists have little/no latitude for avoiding Fuel Duty with the current scheme.

Any replacement scheme that seeks to link actual miles travelled against tax charged will also need to consider the provenance of the underlying data used. This in turn leads to the

following key considerations for any system that underpins a national Road User Charging scheme:

- **Assurance** – the system needs to be built to a standard and using a supply chain that establishes trust in the operation of the system, both for taxpayers and for the UK Government. An important element of this is sovereignty – ideally any future UK RUC system (or systems on which it depends) will be a UK one in terms of its supply and operation, especially as the system will likely be regarded as Critical National Infrastructure (CNI) when in operation;
- **Authenticity** – the data collected by the system, especially that underpinning the tax revenue collected, needs to be demonstrably authentic. If this data needs to be used for enforcement, then it must have a level of authenticity sufficient to meet the standards required by any laws that may be applied;
- **Resilience** – the system needs to be resilient to failures and interference, both accidental and nefarious, in order to deliver the availability needed. On the assumption that a future RUC system will at least account for what is currently collected through Fuel Duty [1], then an unmitigated single day outage would result in a loss of tens of millions in tax revenue. This also highlights a key difference compared with the current Fuel Duty based scheme – when motorists fill up with fuel today they are pre-paying tax for mileage not yet travelled. Any future RUC system that seeks to record in real time (or near real time) mileage travelled will likely have a much higher availability (and therefore resilience) requirement than systems that collect tax through retail outlets;
- **Integrity** – the outputs of the system need to be demonstrably correct, especially those that establish the tax payable or those used as the basis for enforcement action. This relates not to whether the data is genuine and authentic (as described above), but to the correctness of the data. For example, a hypothetical charging scheme that levies higher rates of tax for motorway use than for rural road use would need to ensure that roads of different classes that run close to one another could not be confused when usage data is collected.

Before a Road User Charging concept can be considered, it is instructive to identify the usage scenarios that any RUC system would likely have to support. An example set is given below as a means to guide the concepts evaluated:

Table: Potential RUC Usage Scenarios

Scenario	Description
Private Vehicles	Taxation for any UK Registered motor vehicle that is used for private purposes, including mopeds, motorcycles, cars, vans and above (if privately owned/used).
Commercial Vehicles	Taxation for any UK Registered motor vehicle that is used for commercial purposes, including mopeds, motorcycles, cars, vans, busses and lorries.

Scenario	Description
Private Hire Vehicles	Taxation for any UK Registered motor vehicle that is used for individual private hire purposes, such as taxis, limousines and rental.
Newly Sold Vehicles	This is effectively a sub-class of the use cases above, but the system may need to distinguish between newly sold and existing vehicles as the means to monitor usage for each may differ (for example, accounting for smart technologies that will increasingly be built into Electric Vehicles (EVs) and autonomous vehicles (AVs) in the future).
Existing Vehicles	As above.
Foreign Vehicles	Foreign Vehicles entering the UK road network may be subject to a different taxation scheme and different means to levy and collect the taxation (if indeed taxation is levied).
Inner City Travel	The amount of tax levied per mile for travel in inner cities may differ compared with urban and rural travel. In addition, the mechanics of monitoring road usage in inner cities could differ, necessitating different solutions. For example, a newly introduced national RUC scheme could choose to integrate with existing regional congestion charging schemes (such as the London Congestion Zone) rather than replace them.
Urban Travel	As above, the tax levied and method of monitoring usage could differ in Urban contexts compared with Rural and Inner City use cases.
Rural Travel	As above.

In Vehicle Tracking (IVT)

It is likely that a national scheme, especially one for which rural and urban road pricing is required, will require some form of IVT capability. Existing regional schemes, such as the London Congestion Charge, rely on roadside infrastructure solutions such as ANPR.

Whilst use of roadside technologies could be expanded to cover wider areas, achieving coverage of the entire UK Road Network in this way would be prohibitively expensive and could meet public resistance as well.

A more autonomous solution is therefore likely, one which would be centred on technologies built into the vehicle itself. This would likely be a combination of:

- Vehicle telematics, used to digitally record speed / distance travelled;
- Positioning technology, used to determine the location of the vehicle and therefore the types of roads that have been used;

- Time transfer technology, providing an authenticated means to timestamp the usage data collected by the vehicle;
- Secure communications technology, allowing the road usage data to be securely transmitted to the RUC systems used to determine the tax payable.

Such in-vehicle technology, often referred to as an On-Board Unit (OBU), is increasingly being placed into new and existing vehicles to support applications such as insurance "black box" schemes (wherein driving habits are monitored and can be used to lower premiums) through to digital tachographs used to monitor commercial vehicle driving profiles.

Vehicle telematics technology is already mature, and therefore unlikely to need significant evolution for a future RUC solution. In respect of positioning and time-transfer technology, use of a Satellite Navigation System is an obvious choice given that it requires very little in-car infrastructure and serves remote areas well, even those with no terrestrial infrastructure. However, Satellite Navigation does have some vulnerabilities and limitations – these are highlighted later in this document.

Secure communication of the usage data could be achieved in a number of ways. If the RUC technology is deployed into an EV then the usage data could potentially be delivered when the vehicle is plugged in to charge. However, this would require changes to existing EV charging designs and standards, so could prove expensive. A simpler alternative would be to use existing mobile communications technologies such as 5G.

Road-Side Tracking Infrastructure (RTI)

RTI may be used where a future RUC scheme chooses to subsume existing regional charging schemes (such as the London Congestion Charge) which already make use of RTI, or as a means to provide additional usage data for enforcement action.

Financial Management

The heart of any RUC system will be the financial management systems used to calculate the tax to be levied and to collect the revenue. Anonymised road usage data will be a key input.

Interoperability between the Financial Management systems and other UK Government systems is also likely to be needed, as detailed below.

Data Collection & Analytics

Data Collection and Analytics will be needed to process tracking data received from IVT and RTI, both as a means to generate anonymous usage metrics per vehicle and to detect anomalies and outliers, for example where RTI has observed road usage for a vehicle with no corresponding IVT data, potentially as evidence for enforcement action. There may also be further applications for the data collected, such as analysis of road usage patterns for road maintenance planning, congestion analysis and carbon footprint reporting purposes, or even for law enforcement.

Enforcement

The current Fuel Duty based system of revenue collection is difficult for motorists to avoid and simple in its operation. However, any future RUC system, especially one that uses IVT, will be at risk of being subverted by users to some degree to avoid paying tax.

An enforcement function may therefore be needed, and a particular challenge that the system will face will be distinguishing between accidental and deliberate cases of tax avoidance.

This goes to the heart of the IVT and RTI technologies used to collect evidence of road usage, their limitations and vulnerabilities. Current Satellite Navigation systems for example are vulnerable to both accidental and deliberate manipulation, as detailed later.

Integration and Interoperability

It is highly likely that a future RUC system will need to be interoperable with other systems, including those operated by UK Central Government functions, Regional Government and commercial.

A national RUC scheme may well also subsume or interoperate with existing regional and toll based schemes, in which case some level of interoperability may be required. Interoperability with international schemes is also a possibility, especially for commercial goods traffic flowing between the UK and Europe.

Furthermore, there will likely be a need for the system to align with existing and emerging standards for in-vehicle technology, such as those being developed for OBUs. This will be particularly important if there is a need to interoperate with other systems – new or existing regional congestion charging schemes within the UK, and any European schemes used to track commercial vehicles for example.

Security, Privacy, Availability, Integrity

Any future RUC system will have specific security and data privacy requirements. The system will need to be compliant with GDPR (and/or any future UK legislation addressing data privacy). The system will also likely be considered CNI.

These individually and in combination will place onerous security requirements on the system.

Research and Development (R&D)

Many of the technologies needed to build such a system exist today, but some do not or do not offer the performance, resilience or integrity needed. A national RUC programme is likely to trigger or contribute to one or more incubator R&D projects, or the requirements for such projects. Examples could include:

- Data Fusion and Machine Learning technologies to build an accurate picture of road usage that is able to identify bone-fide usage from outliers, whether they be due to system failures, accidental interference or deliberate avoidance;
- New positioning technologies used as the basis of collecting road usage data, through either IVT or RTI.

Satellite Navigation Systems as an RUC Enabler

Current Satellite Navigation Systems, otherwise known as GNSS (Global Navigation Satellite System) are an obvious enabler for any future Road User Charging scheme because they can form the basis of IVT technology that is:

- Relatively cheap (at user level);
- Widely available;
- Operable in all of the usage scenarios identified for RUC – in particular inner city, urban and rural contexts;
- Readily accepted by the public, who make substantial use of GNSS technology already;
- Increasingly being built into motor vehicles as standard.

However, GNSS technology, whilst increasingly relied upon in the UK, is subject to limitations and vulnerabilities of which many users are unaware [2]. In the main, these are due to the very low power signals that are used by current GNSS systems, making it relatively easy to either overpower them (therefore denying access to the GNSS service) or replace them with a different signal in order to spoof or fool the user receiver.

These vulnerabilities make existing GNSS systems relatively easy to inhibit or subvert, both accidentally and deliberately. Incidents have been reported worldwide [3], with the cause of accidental interference often due to faulty equipment, with users of that equipment oblivious to the problems caused.

Nefarious suppression or manipulation of GNSS signals is also increasingly common. GNSS jammers are cheap to buy and can be very effective because GNSS signals have such low power. **Often jammers are bought to mask illegal activities that GNSS trackers are designed to mitigate – for example, GPS enabled ankle tags or trackers embedded into stolen vehicles, with individuals unaware of the much greater knock-on effects that the jammer may have – such as interference with emergency service or aviation use of GNSS systems**.

Aside from the vulnerabilities identified above, a further issue arises because currently available GNSS systems are without exception operated by foreign governments/entities. It remains the case that the UK has no ultimate control over these systems, or the level of assurance that they can provide to the UK.

These issues raise the question of whether a future UK Road User Charging scheme should be critically dependent on GNSS technology that is not designed or operated by the UK. A loss of GNSS services would of course not just affect capabilities such as Road User Charging – it would have wider consequent impact on the UK economy, CNI services and military capabilities. The economic impact alone is estimated to be substantial [4].

The UK Government has already recognised the need to address this through programmes such as UK GNSS and the Space Based PNT (Position, Navigation, Timing) Programme [5], with the aim of:

- Providing independence from foreign systems;
- Delivering a secure, resilient and robust GNSS system for the UK and our allies.

Road User Charging represents a perfect example of why a UK controlled, assured and resilient Space Based PNT capability is needed.

This would form one part of a systems of systems based approach to assured PNT within the UK, and CGI believes that the very best way to address this is through an incremental delivery approach that allows these capabilities to be designed and developed at the very earliest opportunity.

The lessons to be learned from other countries who are seeking to decarbonise road transport and/or utilise forms of road pricing.

Countries all around the world are looking at solutions to provide road user charging. The majority of these, if not all, are proposing an assured GNSS solution. Although there are a number of schemes proposed, none are currently in operation.

VIAPASS in Belgium is a mileage-based road tax for Heavy goods vehicles. Each vehicle over 3.5 tonnes driving on Belgian roads has to have an OBU (On Board Unit). The OBU uses GNSS technology to record what distance the vehicle has travelled on which roads, and calculates the appropriate charge. There are 6 accredited service providers for the OBUs. The VIAPASS scheme has ensured that different manufacturers have conformed to the same standard and provide the same service. VIAPASS has been operational since April 2016 and is the supervising and coordinating public organisation for the system of systems that they have built for road charging. It has overcome the logistical challenges of running the scheme including but not limited to, infrastructure, multiple OBU manufacturers, and financial/charging aspects. They have also included environmental aspects into their billing profile.

The Netherlands government were proposing a national pay-to-drive project but it was declared controversial and stopped in 2010. This is now being revived as there has been a shift in public opinion and public transport organisations now agree that introducing a national pay-per-kilometre scheme is the only policy option for the government.

The EU GSA (European GNSS Agency) have been analysing the use of EGNOS for road user charging in Europe. EGNOS (European Geostationary Navigation Overlay Service) makes existing satellite navigation signals suitable for safety-critical applications. Several R&D projects funded by the EC (European Commission), using trials with real users driving in real life situations have demonstrated the added value of using EGNOS when paired with GNSS, as an efficient tolling technology. The GSA have introduced a set of directives to ensure that there is compatibility across systems, making for smooth operation across EU members states. The directives name two technological solutions for the on board units: Direct Short Range Communications (DSRC) and Satellite positioning paired with mobile communications.

Reference Documents

The following documents are referenced by this document:

ID	Title	Reference
[1]	A road map for motoring taxation, Stuart Adam and Rebekah Stroud, Institute for Fiscal Studies, October 2019	https://www.ifs.org.uk/publications/14407
[2]	Satellite-derived time and position: Blackett review, UK Government, 30-Jan-2018	https://assets.publishing.service.gov.uk/government/uploads/system
[3]	Thousands of GNSS jamming and spoofing incidents reported in 2020 – Guy Buesnel, Resilient Navigation and Timing Foundation, December 2020	https://rntfnd.org/2020/12/24/thousands-of-gnss-jamming-and-spoofing-incidents-reported-in-2020-guy-buesnel/
[4]	The economic impact on the UK of a disruption to GNSS, London Economics, June 2017	https://londoneconomics.co.uk/blog/publication/economic-impact-uk-disruption-gnss
[5]	Government to explore new ways of delivering 'sat nav' for the UK, UK Govt Press Release, September 2020	https://www.gov.uk/government/news/government-to-explore-new-ways-of-delivering-sat-nav-for-the-uk

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