European Cooperation in
Legal Metrology (WELMEC) e. V.
Bundesallee 100
38116 Braunschweig
Germany

WELMEC

Informative Document

Taxi meters versus taxi services in MID MI-007

**Prepared by
WELMEC Executive Board**

May 2022

1. Purpose of the document

The purpose of this informative document is to provide information on the use of GPS/GNSS systems (e.g. Galileo, being a European project) in transportation of persons from the view point of legal metrology experts of legal metrology authorities. In evaluation of the fitness for purpose of the EU directive MID such information is also sought by the European Commission, seeking advice whether the use of GPS system can be a part of legislation for measuring the distance of the taxi trips, the velocity etc.

2. Description of the situation

Currently, basically 2 systems are used in the field for transportation of persons as a paid service to charge the fee for a ride: classical taxis equipped with taximeters as regulated by the EU MID, MI-007 or so called ride-hailing services (Uber, Lyft, Bolt etc.) when the fee is determined using receivers of a GPS signal in the car. The distance travelled is then defined as a cumulative effect of individual positions of the car taken with certain frequency. The precision of the distance determined in a such a way depends on the ability to compensate for pieces of trajectory where the GPS signal is not available out of various reasons (obscured by obstacles - tunnels, underpasses, high buildings in municipality areas, alleys of trees or is jammed near high security areas). The experience indicates that frequencies higher than 1 position per second should be used, especially in municipality areas.

As concerns GPS measurements, it is clear that all measurements in not clear sky conditions become difficult and problematic. In the case of GPS distance measurements, one needs to go on road sections which are free from obstacles such as bridges, buildings, tunnels, or trees. Long distance measurements are therefore made using optical correlators, wheal impulse and sometime also supported by video cameras and digital mapping.

Therefore, the basic question is:

Can the GPS-based system be used for measuring such distances etc. in legal metrology applications (and what the requirements on the equipment used might be) ?

- An experiment in obstructed areas was once made by our Dutch colleagues on a motorway lined up by an alley of high trees – the GPS signal was simply not available as the signal path between the satellite and the receiver in the car has to be free (unobstructed). Yes, in fact, all those obstacles would cause a shorter distance of the taxi trip so that consumers are not negatively influenced, however it is simply not legally tight-proof.
- It could be considered somehow technically possible on limited sections, i.e. some hundred meters, based on the considerations mentioned above (free from obstacles). For longer sections, new and intelligent GPS systems, also supported by vectorial based maps (VMAPs – see below), could work in future. However, the most challenging part is the regulation itself since there is no clear solution to this for the moment. A real metrology approach should obviously also cover the traceability aspect which with GPS systems is a difficult task since the satellites are not really under our control. One solution would be to have a parallel measurement ongoing on a reference section. But even there, one could argue, that the two measurements do not correspond since it could be possible that different satellites have been used.
- The VMAPs public availability is still a debated discussion according to the Wikipedia description (Link). The basic level (Level 0) is free but at certain point there are fees to be considered, especially on 3D vector maps that can guarantee a reasonable accuracy (the accuracy of e.g. Google Maps is unknown – in the ideal case 1 – 2 m as

to location which can impair up to 40 m in urban areas – urban canyons - due to false reflections from buildings). On the internet a number of providers can be found:

Download for free Switzerland vector map SVG

Raster vs Vector Maps: What's the Difference & Which are Best? | CARTO Blog

Free Vector Maps | Royalty-Free Vector Maps

Natural Earth - Free vector and raster map data at 1:10m, 1:50m, and 1:110m scales (naturalearthdata.com)

- The latest twist in technological developments is the use of so called pseudolites. Pseudolite is a contraction of the term "pseudo-satellite," used to refer to something that is not a satellite which performs a function commonly in the domain of satellites. Pseudolites are most often small transceivers that are used to create a local, ground-based Global Positioning System (GPS) alternative. The range of each transceiver's signal is dependent on the power available to the unit.

  Being able to deploy one's own positioning system, independent of the GPS, can be useful in situations where the normal GPS signals are either blocked/jammed (military conflicts), or simply not available (exploration of other planets). Pseudolites are normally used to augment the GPS by improving dilution of precision (DOP). Or pseudolites are also used to implement GPS-like indoor location systems, where pseudolites are acting as GPS satellites. Pseudolites use cheap voltage-controlled oscillator so pseudolite-based location system shall provide a methodology to compensate clock differences among pseudolites.

- Availability of the signal – the signal is sometimes jammed around some Embassies, satellites of some countries purposefully would give false information in times of international crisis and wars (e.g. during the Iraq war, the GPS receiver has to have an ability to filter them out). To overcome such problems is not an easy task and it is quite costly.

On the other hand, GPS/GNSS system in open space can well be used to measure speed (and acceleration) and other parameters (pitch, roll, heave) of moving objects (e.g. drones). Current inertial system can operate at frequencies up to 200 Hz, e.g. miniature inertial system ELLIPSE2-D with 2 GNSS receivers can be integrated in a “standard” car to be used for testing speedometers (the cost is high: ca 20 000 EUR). To apply such technology to measure the speed of cars for legal enforcement would require a mandatory installation of such inertial systems in commercially available cars – it might be a far cry today but it cannot be excluded in future, similar to mandatory installation of tyre pressure gauges in cars under European legislation. As to the speed of moving objects, accuracies far exceeding those required for testing speedometers can easily be achieved (maximum permissible errors being ± 3 km/h up to 100 km/h).

3. Conclusions

The situation can be improved in future by those 3D vectorial based digital maps but those maps might be accessible only for a fee – not the ideal situation for legal metrology when certain maximum permissible errors have to be guaranteed so that it could hardly be tolerated that the accuracy depends under what conditions the ride is being made (even if the effect is in favour to the consumer). Whether any regulation can arrange for GPS systems in a high accuracy mode based on VMAPs is also a question.

Instead using maps it looks like that using pseudolites is a more promising technology, now being implemented e.g. in Japan, however not in Europe at the moment. This technology would overcome the above-mentioned difficulties in areas where “normal” GPS/GNSS signal is not available. To achieve a comparable accuracy compared with current MID taximeters (2 % of the distance travelled for taximeters installed in a car – OIML R21) would not be a problem with frequencies to take the position higher than 1 position/s. Such GPS systems can easily measure the speed of the car so that any tariff system (single or double application of tariff according to MID, MI-007) can be implemented.

Only lawyers can decide whether those arrangements are suitable for any legislation even if the resulting fees in ride-hailing systems are currently lower than those charged by taxis (even if in the course of time the gap is getting closer). It has to be pointed out here as well that the simplicity and robustness of distance measurements derived from the axle rotations of the car can hardly be overcome.

There might be some other applications of GNSS system in legal metrology, often in association with Internet of Things (IoT) gadgets. In Europe the GNSS system Galileo is near completion, therefore it offers itself to use it for such applications, especially taking into account the fact that there is a special EU institute to develop such applications: European Global Navigation Satellites Systems Agency (access through its User Consultation Platform). E.g. the Galileo High Accuracy Service (HAS) with a horizonal accuracy of up to 20 cm might be usable in traffic applications.