# Transport Select Committee: The Roll-out and Safety of Smart Motorways

Response from the Institution of Engineering and Technology's Transport Policy Panel

## 1 About the IET

We are a charitable engineering institution with over 169,000 members in 150 countries – working to engineer a better world. Our mission is to inspire, inform and influence the global engineering community to advance technology and innovation for the benefit of society.

As a diverse home across engineering and technology, we share knowledge that helps make better sense of the world in order to solve the challenges that matter.

We bring together engineers, technicians and practitioners from industry and business, from academia and research, and from government and the third sector. We are member-led, independent and impartial.

## 2 About the IET Transport Policy Panel

The Policy Panel includes experts in all modes of transport who share thinking about the use of technology to improve transport. The panel includes road safety experts and traffic engineers and also significant expertise in aviation, automotive, maritime and rail, and also in human behaviour. Members contributing to this evidence have significant experience of the Highways England (HE) Smart Motorway programme, but the strength of the IET is bringing together the full cross modal view of learning about how experience from elsewhere can be brought to Smart Motorways.

In addition, we all use Smart Motorways as drivers. This means we can merge the user experience of Smart Motorways with our professional expertise.

## 3 Q1: The Benefits of Smart Motorways

Smart Motorways bring significant benefits, as they have been designed and implemented to address recurrent congestion on heavily used sections of motorway. They are an evolution of approaches successfully used over many years, with Controlled Motorways first introduced in 1995. The use of technology and conversion of the hard shoulder to a running lane, either permanently or dynamically, provides additional capacity to reduce congestion levels without the significant cost and disruption of building an extra lane. A Smart Motorway scheme can be implemented in 2 years, whereas a road widening scheme can typically take up to 10, so it is a cost effective and rapid method of providing much needed capacity.

Traffic flow becomes unstable as demand reaches capacity, so the ability to regulate speed according to traffic means flow can be smoothed, and there is less incentive to switch lanes. This effectively increases capacity. Smart Motorway schemes are individually calibrated so that the switching of speed signs is set locally to optimise operational benefits. Overall, this leads to improved journey reliability which users value, especially the freight industry. The reduction in start stop conditions also offers environmental benefits, reducing emissions associated with acceleration and idling.

Analysis of safety and performance data on implemented Smart Motorway schemes has shown overall improvements in safety. Safety benefits arise from better speed management and compliance, a reduction in lane changes and from the removal of the hard shoulder. The hard shoulder is a dangerous place with many fatal collisions historically occurring when drivers stop in a non-emergency situation, so removing the hard shoulder significantly reduces the occurrence of this hazard.

**Nevertheless, there is now a more frequent hazard of the stopped vehicle in a live lane, which has understandably attracted adverse publicity compared to the perceived "safety" of the hard shoulder.**

All motorways have the risk of a vehicle stopping in a live lane but in a conventional motorway, most reachthe hard shoulder. Hence in Smart Motorways it is the mitigation of risk that has changed. Therefore, alternative means are required to reduce the "time at risk" and bring the risk of that hazard becoming a collision down to (or better than) conventional motorway levels, where the hard shoulder is in itself a hazardous place.

**The IET's view is that firstly, safety for this use case can be improved by reducing the number of times vehicles stop on motorways, and then improving how they are detected and other drivers then warned and instructed.**

The following diagram explains this strategy, which we will now detail.

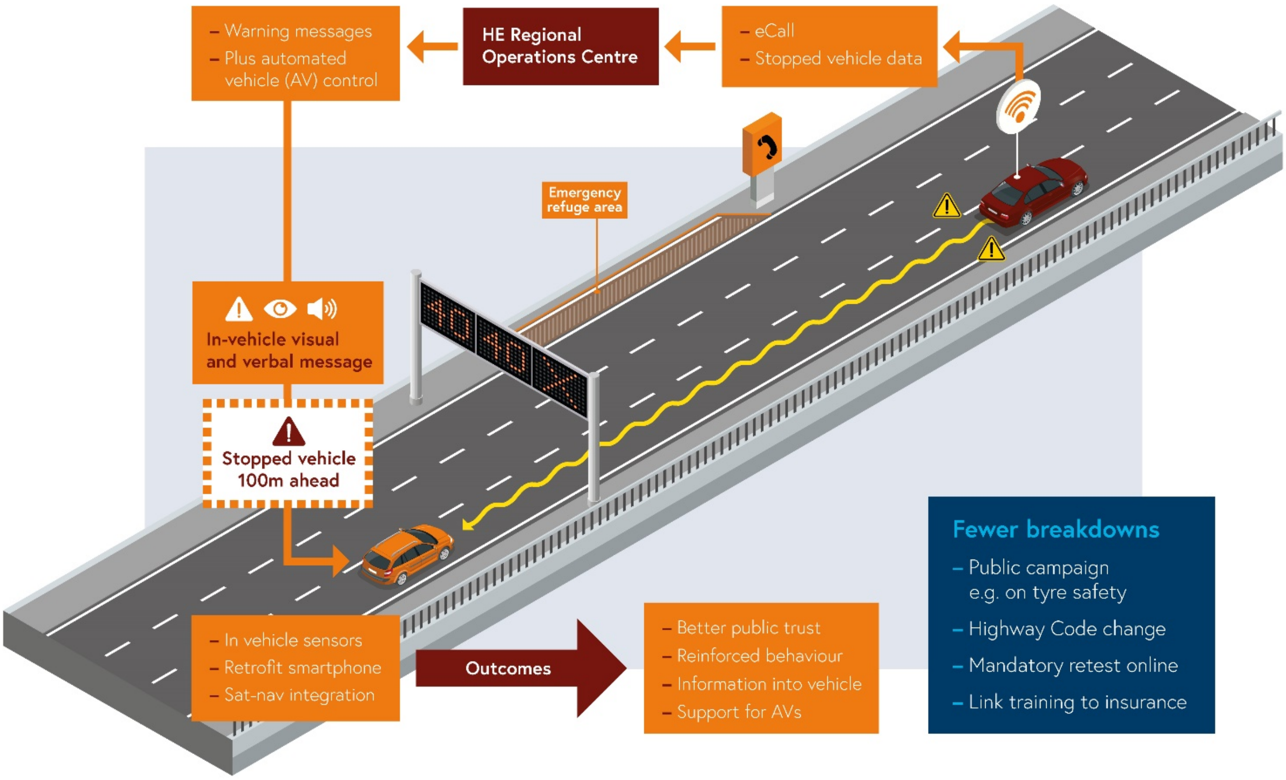


*Figure 1 - The IET's system of systems approach*

# 4 Q2: How Safety Should Be Improved

## 4.1 By reducing breakdowns

Vehicles themselves are now at a high state of reliability (hence the business case for removing the hard shoulder) but unless vehicles are maintained, this drops away. The causes of stopped vehicles on Smart Motorways are not as is often thought from collisions and vehicles running out of fuel, but in many cases, wheel and tyre failure as shown by Highway's England's own data[1]. Tyres are seen as a cost to the driver – not a fundamental safety item. We have heard that garages are being threatened with legal action if a vehicle fails its MOT test due to damaged tyres for example.

Other reasons for stopping include lack of fuel but there are also reports of vehicles stopping to swap drivers and exchange insurance details after a minor bump.

All the above need to be prevented through drivers being educated – and if required regulated – so that they take more responsibility for their vehicle BEFORE entering a Smart Motorway, or indeed any road. An emphasis on road pavement quality to reduce tyer damage would also help.

Electric vehicles are a forthcoming potential issue, as they do not coast once the battery is flat and cannot be towed off a live line. Hence, HE needs to think now about averting this problem.

Further ideas for reducing breakdown numbers, and hence exposure in live lanes, are:

- Providing fast automated tyre testing at every motorway service area;
- A hard-hitting education programme advising on checking your vehicle before you set out;
- Making it clear that vehicle safety has implications – it is not a cost but an obligation.

## 4.2 By use of technology to and from the vehicle

Most vehicles now have some form of connectivity – either fitted in the factory or through a smartphone used for satellite navigation.

Sat navs could receive information and warnings given similarly to directions – 'obstruction in left lane, move right'. Information from the Smart Motorway can also feed into the sat nav so alternative routes can be offered, and hazards can already be shown using systems such as google maps and Waze. Work is already underway on in vehicle messaging that can be added to existing sat nav apps.

[1] https://www.autoexpress.co.uk/car-news/103304/most-tyre-related-motorway-incidents-avoidable-says-study


*Figure 2: Repeating Smart Motorway warnings in sat nav (test message)*

HE already publishes their variable message signs in a way that can be shown in car but they should now introduce and openly publish “virtual” signs too – not just for motorways but for all their network to increase safety on roads such as all-purpose rural trunk sections that have real accident issues.

All the above use existing cellular communication but more could be offered in the future using emerging “V2V” communications that would enable messages from vehicle-to-vehicle.

One of the reasons for the exposure of a stranded vehicle is the time it takes for HE Operators to publicise verify and set full responses on signs, after sensors such as radar detect a stopped vehicle. But all newly launched cars and light vans have since 2018 been fitted with a system called eCall, a mandatory system that rapidly delivers data on vehicle collisions and has a manual button to contact the emergency services. A study in 2019 for HE[2] showed that this could be of increasing value in reducing the time taken to validate stopped vehicles by using this direct data feed, but this opportunity has yet to be taken up by HE even though this is fitted now to millions of vehicles.

Companies such as INRIX and TomTom also produce in real time data on unexpected queues and stopped vehicles taken direct from GPS devices and sat navs on-board vehicles. This could offer a further independent data source for HE to utilise.

HE has spent much time and focus on their own infrastructure and not looked more widely at services developed by others that could help them.

[2] https://gtr.ukri.org/projects?ref=971690

# 5 Q4: Improving Public Confidence via Trust and Education

## 5.1 Trust

At the moment the information provided by the Smart Motorway gantries is not updated quickly enough and is therefore not trusted by drivers. Information where there is an incident is shown promptly but it often is not removed promptly, so the user sees warnings but no hazard and loses faith in the information given and ignores it.

Equally, HE Operators need to be able to trust sensor technology more, to reduce the time to verify an alert (and have fewer false alarms). Using data from systems like eCall and Waze, for example, would help them trust their own systems more and reduce time to set warnings. Where data is received from the vehicle directly (e.g. an airbag activated message from a Smart Motorway area) sign setting should be automatically set due to the quality of data (airbag activations would mean a disabled vehicle) with no manual lag.

Better training of Smart Motorway operators, quality control audits of sign setting and better verification of emerging events would all improve the quality of signing.

As in vehicle systems also deliver the same information – and it ties up with what drivers actually see – consistency and “triangulation” of information will improve trust.

But this is not enough. The current messages used to warn and inform drivers are not impactive enough – their message has been lost over time. Initial messages such as “reports of” are hardly noticed by drivers. So work is needed to study, test and deploy more impactive signage and in vehicles messages, which would be trusted more by the addition of other information.

In addition, there is much confusion in the press and in road users’ minds about how safe Smart Motorways actually are, as there is up to now no independent review of the statistics. An independent road safety accident investigation body (as for aviation and rail) would help here.

## 5.2 Education

The users of the Smart Motorways need to be better educated in how to use them. This maybe via a refresher test (online or in test centres for those who are not able to access online) when licences are renewed or as part of a discount offered in vehicle insurance renewals. The requirements of signs such as red X could be ‘taught’ along with operation and procedures on Smart Motorways.

# 6 Learning Lessons from Other Modes of Transport

The IET Policy Panel sees value in learning lessons from other modes of transport where changes in operational practices have been deployed and actually increased safety.

## 6.1 Rail

UK railways are highly regulated and constraints (from the regulator as well as the infrastructure owner) means that no “vehicle” can move on them unless approved for use, and all risks have been managed to an “As Low As Reasonably Possible” standard. This includes using competent and tested staff. Similarly, changes to infrastructure undergo a comprehensive evaluation to ensure overall safety of the *system* is not affected detrimentally in either normal, degraded or emergency operation.

There is a safety culture that encourages recording of incidents (not just accidents but also near misses) so lessons can be learned without an accident happening. At the same time, all fatal accidents (and many less serious) are investigated by an independent body to identify the root cause (as opposed to allocating blame).

Railway safety is in a large part achieved by reliability of the *system*, competence of the users (in normal, degraded, and emergency modes) and the confidence they have in the system. If a driver is given a green signal, they are confident the track ahead is clear. If given a red signal, they know to stop.

## 6.2 Aviation

Since the beginning of transatlantic flight, continuous safe operation with increasing capacity has been achieved as technology advances to allow aircraft separations to reduce. Reliability of aircraft removed the need for four engines, and on-board avionics evolved too. Greater accuracy of measurement allowed reduced separation, and satellite communications and datalinks overtook radio for position reporting. Independent surveillance technology now provides full situational awareness to oceanic traffic controllers.

Coupled with pilot aids such as tactical collision avoidance and weather radars giving enhanced foresight means we are now beginning to see the constrained North Atlantic Track System evolve towards free-routing. This means an aircraft can plan the most optimal and fuel-efficient route without constraints imposed by keeping to a specific lane. By expanding the margins and choices available, the number of "lanes" increases, as do the possibilities for finding the most optimal route for duration, arrival time, or fuel-burn.

Freedoms through technologies help increase capacity, and in aviation, these are founded on sound systems-based approaches to challenge decades-old precedent. Another exemplar of this systems approaches to solving capacity challenges with strong headwinds at Heathrow, was to introduce Time-Based Separation. Traditionally, any aircraft arriving had to maintain a distance to the leading aircraft of at least three nautical miles or more, depending upon the relative sizes of aircraft. Evidence gathered from over million flights globally proved that the wake dissipates in strong headwinds and crosswinds quicker, and given the lower ground-speeds, closer separations can be achieved.

Of course, asking a pilot to fly much closer to the previous aircraft requires a vast education programme to reassure them that licences would not be lost and the concept of operation was indeed safe. New tools and data points were also added to air traffic control to ensure false alarms were not generated, and that complex mental arithmetic gave way to a simple visual indicator to ensure a safe gap is always maintained.

As with any system, like Smart Motorways, safer ways of increasing capacity can be found as long as an education programme and systemised behaviour is communicated to all stakeholders, and an appropriate level of equipment is available to the vast majority of users.

Taking analogies from aviation where all aircraft are being equipped with transponders, all vehicles (even old cars) can use in-built or smartphone traffic advisory services from Google and Waze that can alert in real time to stopped vehicles. A consistent approach to emergency broadcast to any distressed vehicle could alert surrounding vehicles.

Data on vehicles in distress is already becoming available via ecall, with global compatibility assured.

And as we move towards autonomy, “auto-piloted” vehicles of any type should programmatically "go-left" in limp-home mode or in the event of a catastrophic failure - as the rules in aviation for any emergency situation dictate - Aviate, Navigate, Communicate.

On the road it is no different – the message is to control the vehicle, find the safest place you can, then broadcast what the situation is. Common situational awareness, minimising false alerts, making technology blend with the human tasks to ensure as few difficult choices - all of these help keep us safe in the air and on the roads.

# 7 Conclusion – Our Ask of Government

The above shows there is no single “silver bullet” solution to improving the perceived and actual hazards on Smart Motorways. There is a need for a two threaded approach:

*People* – in terms of training and trust gained through consistent high quality signalling with impactive messaging, regulation and a focus on the core causes of breakdowns on motorways (e.g., tyre maintenance) and learning lessons from other transport modes.

*Technology* – both making the most of what we have already available and ensuring we are ready for future autonomy. This would result in:

- detecting and validating (automatically where possible) stopped vehicles faster and with more confidence than radar alone,
- warning drivers in vehicle and so improving trust in red X settings, and
- enabling future automated vehicle “control”.

## 7.1 To achieve this, we ask of Government:

***Think users!***
Increasing capacity by reducing separation between vehicles works well in other modes but this is because of a rigorous “system of systems” approach to safety in all modes, and because drivers and pilots (and all actors in the system) are trained and regulated.

- More mandatory training (e.g. an online refresher course) is needed for both the first driving test and subsequently specifically on Smart Motorways.
- Vehicle roadworthiness needs to be understood as a requirement for access to any road, not an additional cost to the driver.
- Far better and stronger education programmes are needed, and more impactive messaging.

***Make use of what is there already***
There are many quick win opportunities already in place – using sat nav for in vehicle messaging and services such as Waze, to alert drivers in any vehicle. The lack of use by HE of eCall to verify stopped vehicles is a serious omission. We suggest a need to use others’ innovations – the technology does not have to be owned or developed by HE.

***Safeguard the Future***

As well as making the most of currently connected vehicles in order to utilise what we have now, the onset of electric, more highly connected and then automated vehicles means we need to learn lessons from other transport modes. We need to think about preventing the need to recover more and more broken-down electric vehicles now. We also suggest:

- Government needs to safeguard such areas as frequencies allocated for vehicle-to-vehicle messaging;
- Government should set up an independent road safety investigation board as found in other transport modes to understand the reasons behind accidents and near misses and not apportion blame;
- Government needs to publicize more when problems occur the reality of the issue – that Smart Motorways are safer than hard shoulders overall.

## 7.2 Lessons for future

Introducing schemes like Smart Motorways in future transport should be mindful of the assumptions they make of driver understanding and ability, as technology on its own is not enough.

There is a need, as in many aspects of transport, to think in terms of **a system of systems**, not in the siloes we traditionally develop.

The IET is well placed and available to help foster this change in mindset.

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