

INTELLIGENT TRANSPORT INTELLIGENT SOCIETY.

Institution of
**MECHANICAL
ENGINEERS**

Improving the world through engineering

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**IF THE UK IS TO REMAIN
A COMPETITIVE
ECONOMY, IT IS CRITICAL
THAT MOBILITY OF
PEOPLE, THEIR GOODS
AND WHAT THEY
CONSUME IS EFFICIENT,
QUICK AND ECONOMICAL.**

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MECHANICAL ENGINEERS

This report examines different types of Intelligent Transport Systems and the potential economic, safety and environmental benefits from their development.

This report has been produced in the context of the Institution's strategic themes of Energy, Environment, Transport and Manufacturing and its vision of 'Improving the world through engineering'.

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**THE COST OF
CONGESTION ON OUR
ROADS IS ESTIMATED
TO BE OVER £8
BILLION A YEAR.**



EXECUTIVE SUMMARY

THE COST OF TRAVEL

Today, people travel more frequently and for greater distances than at any other time in our history. Whether by land, air or sea, they expect their journeys to be safe, reliable and quick.

With this increase in travel, transport related accidents are now one of the most common causes of death and injury in the UK. On average, over 200,000 traffic casualties are reported each year at an estimated cost of £19 billion to the economy.

On congestion, government statistics estimate road disruption to cost the economy over £8 billion a year. On our rail network, about 14 million minutes of delay are recorded each year, costing an estimated £1 billion to the economy.

In order for the UK to remain economically competitive, the country needs to develop and deploy technologies which can solve these issues.

This report outlines how Intelligent Transport Systems could help improve the safety of our transport networks, cut congestion, reduce the environmental impact of travelling, and present the UK with an attractive market opportunity.

By introducing intelligence into our transport network our mobility can become more efficient and economical.

WHAT ARE INTELLIGENT TRANSPORT SYSTEMS?

Intelligent Transport Systems (ITS) use information and communication technology to improve an individuals' travel experience. Some ITS technologies, such as satellite navigation in cars and traffic control systems on motorways and railways, are already widely deployed. In addition, there are new and emerging technologies which not only present clear benefits to society, but a new global market opportunity.

These Intelligent Transport Systems need to be introduced into our transport network now. These technologies and systems can help our transport networks become more integrated and enable a more efficient use of the transport industry's time, space and resources. For users of transport technologies, Intelligent Transport Systems can make travelling safer, quicker and more cost effective.

THE SAFETY CASE

Safety is the first priority for every commuter and transport provider. ITS has huge potential to improve safety in the UK's transport network and in particular our roads. For example, LATERAL SAFE which is an ITS tool that alerts drivers to obstacles and potential collisions at the side and rear of their vehicle.

ITS also has the potential to improve safety for cyclists. This issue has come to prominence, particularly in London, following the introduction of the city's popular cycle-hire scheme, the new cycle 'super highways' as well as a series of high-profile deaths and injuries – most notably a serious accident involving a cyclist who is also a journalist at *The Times* in late 2011.

In 2010, 111 cyclists were killed on Britain's roads – a 7% rise from levels the previous year. LATERAL SAFE could help cut the number of accidents caused by heavy goods vehicles' and lorries' 'blind-spots'. This is a particularly useful system as, although HGVs represent just 5% of UK traffic, they account for almost 20% of UK cyclist deaths.

ITS in the form of mandatory variable speed limits and average-speed cameras, which can track drivers' average speeds during an entire journey, have also been proven to reduce accidents, as well as having the additional benefits of reducing journey times and cutting emissions.

THE ECONOMIC AND ENVIRONMENTAL CASE

The economic case

The UK is the seventh wealthiest nation in the world, the eighth most densely populated and fifth most congested. If the UK is to remain a competitive economy, it is critical that mobility of people, their goods and what they consume is efficient, quick and economical.

ITS technology can help deliver Intelligent Mobility by helping people make informed and intelligent choices about the quickest, cheapest and most reliable type of transport to use for a journey, whether that be on road, rail, air or sea.

The economic opportunity for developers of ITS technologies is enormous. The UK has an established reputation for developing cutting-edge technology, from Formula One cars to world leading semiconductors. The global market for ITS technologies is estimated to grow to £40 billion by 2020, offering the UK a major new market, inward investment and employment potential.

The environmental case

The UK Climate Change Act introduced in 2008 sets a number of challenging and legally binding targets. These include a long-term target of reducing carbon dioxide (CO₂) emissions by 80% by 2050 compared to 1990 levels. ITS technologies have the ability to cut CO₂ emissions by reducing congestion through smarter traffic management tools.

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THE GLOBAL MARKET FOR ITS TECHNOLOGIES IS ESTIMATED TO GROW TO £40BN BY 2020.

THE NEED FOR AN INTEGRATED VISION

ITS can help make transport safer, more efficient and even cleaner by using systems that enable smarter traffic management tools that cut carbon dioxide emissions.

But a lack of cohesion, with many individual groups and companies trying to address these problems in isolation, is hampering progress. Government, industry and academia must work together to seize the opportunity presented by ITS and to help bring investment and jobs to the UK at a time when they are needed most.

RECOMMENDATIONS

A detailed vision for the ITS industry needs to be agreed. This should be led by government in close collaboration with industry. With an agreed vision, the Institution of Mechanical Engineers recommends that:

- 1. The newly formed Catapult for Transport Systems works with industry to develop an agreed unified vision for ITS across the UK's entire transport network within three years, focussing on increased capacity, congestion reduction, improved efficiency in movement, improved safety and reduction in environmental impact.**
- 2. Industry and government collaborate to make the installation of collision avoidance technologies, such as LATERAL SAFE, on buses, lorries, heavy goods vehicles (HGVs) and large goods vehicles (LGVs) mandatory by 2015, in order to improve UK road safety.**
- 3. Government introduces a nationwide co-ordinated charging and information system for all public transport within the next five years. This should be easy to use and provide cost benefits for individuals who use more efficient types of transport.**
- 4. Industry and government collaborate to enforce the installation of automated emergency response technologies like eCall in all new surface transport within the next two years.**



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**HEAVY GOODS
VEHICLES REPRESENT
JUST 5% OF UK TRAFFIC
BUT ACCOUNT FOR
ALMOST 20% OF UK
CYCLIST DEATHS.**

HOW CAN TRANSPORT BE INTELLIGENT?

Until the 19th century, it was rare for anyone to travel distances greater than 20 kilometers from where they were born. One of the first organisations to understand the importance of journey planning was the military which began to develop maps. Initially, mapping techniques were very basic but there has been a great deal of improvement in the last 20 years thanks to ITS technologies such as GPS systems, and journey planning tools that map routes.

An Intelligent Transport System (ITS) is one that has the ability to collect large amounts of data, process it and then modify actions in light of this real-time information. The aim is for this intelligence to be used within the transport system to influence the behaviour of the vehicle or the driver.^[1]

The adoption of these technologies could bring significant benefits to all aspects of the economy, for example, enabling businesses to become more competitive as transport and logistics costs are reduced; ensuring journey times are more predictable; and reducing the associated CO₂ emissions as less fuel is consumed.^[2]

ITS are often associated with autonomous transport, where the system itself, rather than a person controlling it, has the freedom and ability to make decisions to determine its actions. But intelligent systems and autonomous systems do not mean the same thing.

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**AUTOMATIC NUMBER
PLATE RECOGNITION
SYSTEMS ARE
INCREASINGLY
USED IN THE UK FOR
TRAFFIC MANAGEMENT.**



Intelligent Mobility and Intelligent Transport Systems offer a global market opportunity estimated to be worth £40 billion by 2020. If the UK could exploit this growing sector, it could generate billions of pounds of revenues, along with inward investment and the creation of jobs.

In 2009, the Department for Transport published a report, 'The Future of Urban Transport', which carried out an assessment of the impact of transport on the urban economy, health and environment. It is estimated that congestion delays were costing the UK economy £12 billion a year, while damage to health caused by poor air quality particulate pollution accounted for up to £10.6 billion. By comparison, physical inactivity and growing levels of obesity were costing the UK economy £10.8 billion per year, greenhouse gas (GHG) emissions £1.2–3.7 billion and noise from all sources £2.7 billion.^[3]

The report concluded that the public needs to be better informed about the economic, health and environmental impact of using different types of transport.

Intelligent Mobility will be accelerated through the introduction of ITS, as they will help people make better choices as to the type of transport they use. ITS allow people to make smarter transport choices such as using park and ride, real-time timetabling to choose between different types of transport, or car clubs and car sharing.^[4]

SAFETY

The EU, USA and Japan all currently have common targets to reduce road deaths by 50% over the next decade. ITS can help to prevent road accidents by developing safety margins that detect dangerous situations, extending driver awareness.

In 2009, the Cabinet Office estimated that the total annual cost of road accidents in the UK was £19 billion, with urban areas accounting for £9 billion of this total.^[3] It is well understood that by reducing speed in urban areas the number of casualties is reduced. One ITS tool that could help ensure that drivers reduce their speeds in areas, such as near schools, is the Automatic Number Plate Recognition System (see box).

Automatic Number Plate Recognition

Automatic Number Plate Recognition (ANPR) systems are increasingly used in the UK for parking enforcement, traffic management and congestion charging.

As a registration number is read, the date, time and location are recorded and the number is checked against a number of databases. As well as being used to alert police to vehicles that are stolen or involved in crime, in Melbourne, Australia these systems are also widely used to automatically record and issue fines to those individuals who have broken the speed limit. Fines collected through this ITS can then be re-invested into the transport network. Such tools could be used within UK cities to drive down the speed in areas where there are 30mph limits, such as near schools and playgrounds. A widespread roll-out of these systems would improve the safety of pedestrians, cyclists, drivers and passengers.

COST AND CONGESTION BENEFITS

Engineers continue to work on improving the fuel efficiency of vehicles in order to reduce fuel costs and carbon dioxide (CO₂) emissions. However, this can also be successfully achieved by using smarter traffic management tools. Reducing the number of starts and stops has a direct impact on the energy wasted by accelerating or decelerating, leading to a reduction in emissions. This approach, often referred to as eco-driving, also reduces overall journey times.

The Eddington Transport Study conducted in 2006 estimated that eliminating existing congestion on the UK road network would save £7–8 billion a year. However, if this problem was not tackled it would cost the UK an extra £22 billion by 2025.^[7]

The UK already uses cameras to measure the flow of traffic on motorways and highways for speed restriction and law enforcement purposes, or to identify vehicles for the collection of electronic tolls. These cameras could also be deployed to determine the condition of transport infrastructure and monitor the condition of pavements, roadways, and rail beds.^[8]

These systems help both the users of the transport systems and the infrastructure planners and maintenance providers. A promising project that uses cameras to promote better driving has already been launched by the Technology Strategy Board, Department for Transport and the Engineering and Physical Sciences Research Council called Foot-LITE (see box out).

ITS can help drivers become more energy efficient, reduce emissions from vehicles and cut congestion.

Foot-LITE

The Foot-LITE project was created to change driver information systems in order to educate and encourage safer and greener driving. By using existing technology such as sensors, navigation systems and smartphone applications, the vehicle is able to detect how well the driver is driving and give real-time feedback on how their driving matches the 'rules' described by the training and guidance provided by the Institute of Advanced Motorists (IAM).

The feedback to the driver includes aspects on levels of acceleration/deceleration, lane positioning and departure warning, headway and gear change advice.^[9]

ROAD CHARGING

Road charging is an ITS tool that has been used overseas for over a decade, and has been proven to influence individuals on the type of transport they use.

Since the introduction of the London Congestion Charge Scheme in 2003, there has been a 6% increase in bus passengers during the charging hours. It is worth noting that there is a bylaw that states that all net revenue raised by the Charge (£148 million in financial year 2009/10) has to be invested in improving transport infrastructure in London.^[10] This model could be adopted in other cities across the UK.

The implementation of the congestion charge shows how people can be encouraged to use different types of transport. But this shift will only occur if the commuter is informed, and if there are reliable and efficient alternatives. This is why real time intelligent timetabling and improvements to ticketing methods are so crucial.

HOW ITS CAN HELP PREVENT CLIMATE CHANGE

Today transport accounts for one quarter of EU carbon dioxide (CO₂) emissions and these emissions have continued to increase over the last 20 years.^[5] In the UK, road transport accounts for about 92% of domestic transport emissions and just over half of those emissions come from passenger cars.^[6] Traffic flow and driver behaviour is often overlooked by policymakers, but they have a significant impact on CO₂ abatement.

The UK has a target to reduce Greenhouse Gas Emissions (GHG) by 80% by 2050. Currently 21% of all domestic GHG emissions are caused by transport – which needs to be drastically reduced in order to meet this legally-binding target. The UK Committee for Climate Change (CCC) has said that it expects people making 'smarter' transport choices will have a big impact on reducing emissions.^[4] By introducing a cost-effective transport approach, we can ensure that we enhance our transport capability, capacity and efficiency and the ability to generate 'more for less' from our existing transport infrastructure.

The Institution believes that the Department of Energy and Climate Change needs to work with the Department for Transport to develop specific targets on the role ITS and Intelligent Mobility will play in helping to meet these carbon reduction targets.

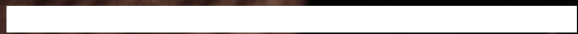
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**ROAD CONGESTION
COULD COST THE UK
ECONOMY £22 BILLION
EACH YEAR BY 2025.**



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**DELAYS COST AIRLINES
£1.1-£1.7 BILLION
EACH YEAR.**



ITS FOR NON-ROAD USERS

There is a common misconception that ITS benefit just road users. In fact all types of transport can benefit from ITS.

One ITS that is being developed as an important cost saving tool is the EU Single European Sky Programme. In the commercial aerospace sector, delays are estimated to cost airlines £1.1–1.7 billion a year. The Single European Sky Programme aims to improve air traffic management, aircraft positioning and communication technologies of air travel. This programme is developing interfaces and the communications systems using Global Navigation Satellite Systems (GNSS) such as Galileo.^[5] This allows flight control centres across Europe to monitor flights, their flight paths and help optimise journey routes and travel times.

Within the marine sector, the EU programme River Information Services (RIS) for inland waterway transport has been designed to optimise traffic and transport processes for inland navigation. This enhances a swift electronic data transfer between water and shore.^[11]

In 2011, the European Commission issued a white paper looking at Europe's different types of transport as an integrated network. Included in this paper is the ITS rail programme: the European Rail Traffic Management System (ERTMS).^[6] This system enhances cross-border interoperability and signalling procurement by creating a single European-wide standard for train control and command systems.

There is also an excellent example of computer usage in transportation in the USA. The Federal Aviation Authority (FAA) has initiated a concept of 'free flight' to enhance the safety and efficiency of the National Airspace System (NAS). This concept moves NAS from a centralised command and control system between pilots and air traffic controllers to a distributed system that allows pilots, whenever practical, to choose their own routes dynamically, for efficiency and economy.

ITS EXPERTISE IN THE UK

While many of the most impressive ITS schemes are located outside of the UK, the UK is home to the leading international centre for ITS development: MIRA's innovITS centre, located in the West Midlands (see box). By maximising the use of the InnovITS Centre, the UK could become a world leader in improving and developing ITS that enhances the safety of our transport.

innovITS Centre

innovITS Advance is a safe, controlled and private environment with all the road and telecoms infrastructure needed to develop and test applications that rely on communications between vehicles and highways or other vehicles. This is typically to improve safety, efficiency or to better manage traffic flows. The 4km road network is configurable to simulate an urban driving environment anywhere in the world, including a 2km outer circumference test track and a network of junctions and intersections, including a five lane section. There are urban road markings, traffic signals, steel gantries for installing equipment over the road, and CCTV monitoring, control and demonstration. There are also controllable private communications networks – 3G, GSM and wi-fi – allowing virtually any scenario of signal attenuation and denial to be created and replicated. Users are able to validate the performance of their systems with the help of high-resolution GNSS positioning to an accuracy of 20cm and a ground-truth video system. Other facilities include 3D visualisation to help customers prepare their test programmes before they arrive on site, a GNSS denial facility to replicate 'difficult' environments, and mobile dummies for testing pedestrian detection systems. These pedestrian detection systems are built on mechanised bases; they have visual, radar and thermal signatures that can accurately represent adult males, females or children.^[12]

With the emergence of technologies such as the internet and GPS, information and data can now travel much faster than people and goods. The ability to transfer data at such fast speeds allows for countless improvements to be made to our transport systems.

THE ITS SUPPLY CHAIN

ITS present huge opportunities for a variety of companies in the supply chain. From infrastructure companies like WS Atkins and Mott MacDonald; to digital suppliers like O2-Telephonica, BT and Virgin; and equipment suppliers IBM, Siemens, ARM, TomTom and Garmin. There are also opportunities for content suppliers such as the Highways Agency and Google; to vehicle manufacturers such as Ford, JLR, Nissan, Airbus Bombardier and Alstrom; and nascent technology providers including SMEs, universities and research and technology organisations.

DATA COLLECTION

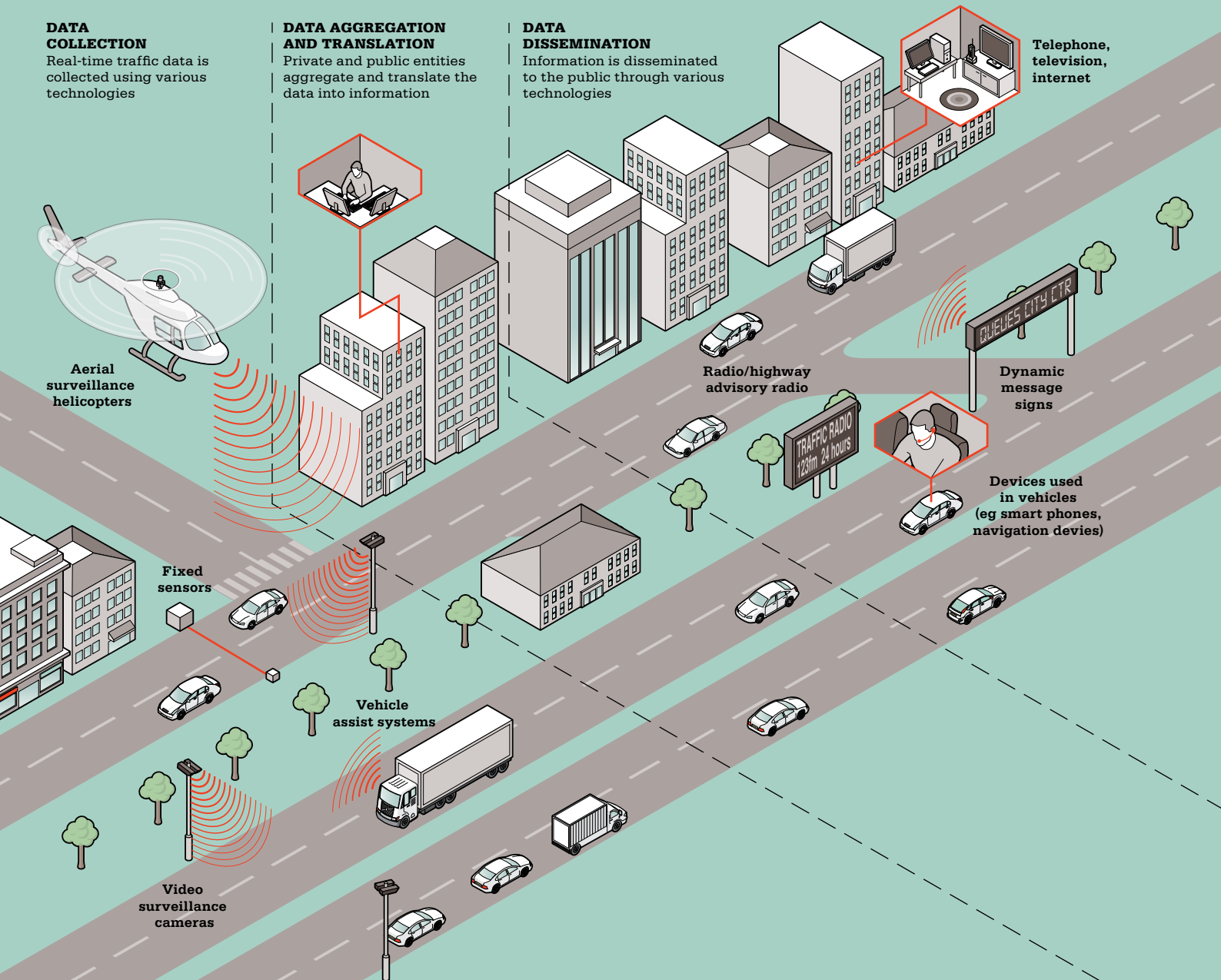
Real-time traffic data is collected using various technologies

DATA AGGREGATION AND TRANSLATION

Private and public entities aggregate and translate the data into information

DATA DISSEMINATION

Information is disseminated to the public through various technologies



INFRASTRUCTURE AND VEHICLE COMMUNICATION METHODS

ITS will form an integral part of future traffic management systems. It will enable traffic management systems to optimise network efficiency, as every vehicle's position and trajectory, as well as its desired destination could be mapped.

In the future there could be personalised routing that provides instantaneous traffic information with safety alerts to vehicles, depending on location and speed recommendations.

Personal routing information would be able to provide transport users with a choice of routes to reach their destination, and even suggest alternative transport methods they could use in order to avoid delays. One challenge that remains, however, is the need to filter this information to ensure that the driver of the vehicle is not overloaded with information.

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THE ABILITY TO TRANSFER DATA AT SUCH FAST SPEEDS ALLOWS FOR COUNTLESS IMPROVEMENTS TO BE MADE TO OUR TRANSPORT SYSTEMS.

TYPES OF ITS

ITS can be integrated into vehicles in a variety of ways. Systems can be categorised by their physical location, timing of the effects, safety measures, or the types of transport to which they apply. A common approach relates to the positioning of the system:

- 1. In-vehicle:** These are technologies within the vehicle such as sensors, information processors, on-board units or displays that can provide additional information to the user. They may also automate or intervene with some part of the driving task.^[13]
- 2. Infrastructure-based:** These offer two general functions. First, to provide drivers with additional information via roadside (trackside/control tower/port) messages, and second to better manage and control traffic flow. Sensors gather information from the environment, other vehicles, and infrastructure and then apply this information to influence driver behaviour.^[13] This may sometimes be referred to as infrastructure to infrastructure communication (I2I). Intelligent infrastructures swap data to provide a collaborative message that is sent to vehicles in the vicinity that may be affected.^[14]
- 3. Co-operative:** This involves communication between infrastructure and vehicles or between different types of transport which may either be one-way or two-way communication. These methods of communication are known as vehicle to infrastructure (V2I) or vehicle to vehicle (V2V).^[13]

V2V is the exchange of data through a wireless device that has a range that varies from a few metres to a few hundred metres.

V2I requires the vehicle to be able to transmit data to the traffic control centres, infrastructure operators or service providers. The data is then assessed and integrated with other information, and distributed to other vehicles in the vicinity.

Both technologies have the ability to improve safety, mobility, and efficiency.^[14]

ACTIVE AND PASSIVE SYSTEMS

Another popular means of differentiating between ITS technologies is by dividing them from the moment ITS takes effect – for the purpose of this section an automotive example is being used.

- 1. Active:** These are crash avoidance technologies that continuously monitor an aspect of the user, vehicle, environment or transport network and alert the user to potential danger, or intervene with the driving task to avoid danger.
- 2. Passive:** These are crash mitigation or minimisation technologies that act to enhance the safety of the driver or other road users by minimising the severity. The classic example of a passive system is an airbag.
- 3. Combined active and passive systems (CAPS):** These systems monitor the environment, vehicle or driver for potential danger and then apply passive safety measures if a crash is deemed unavoidable – currently these are only in-vehicle technologies.^[13] **Figure 1** shows potential CAPS locations on a typical road vehicle.

It is estimated that currently there are more than 138 different varieties of ITS systems that can be described as Active, Passive or CAPS.

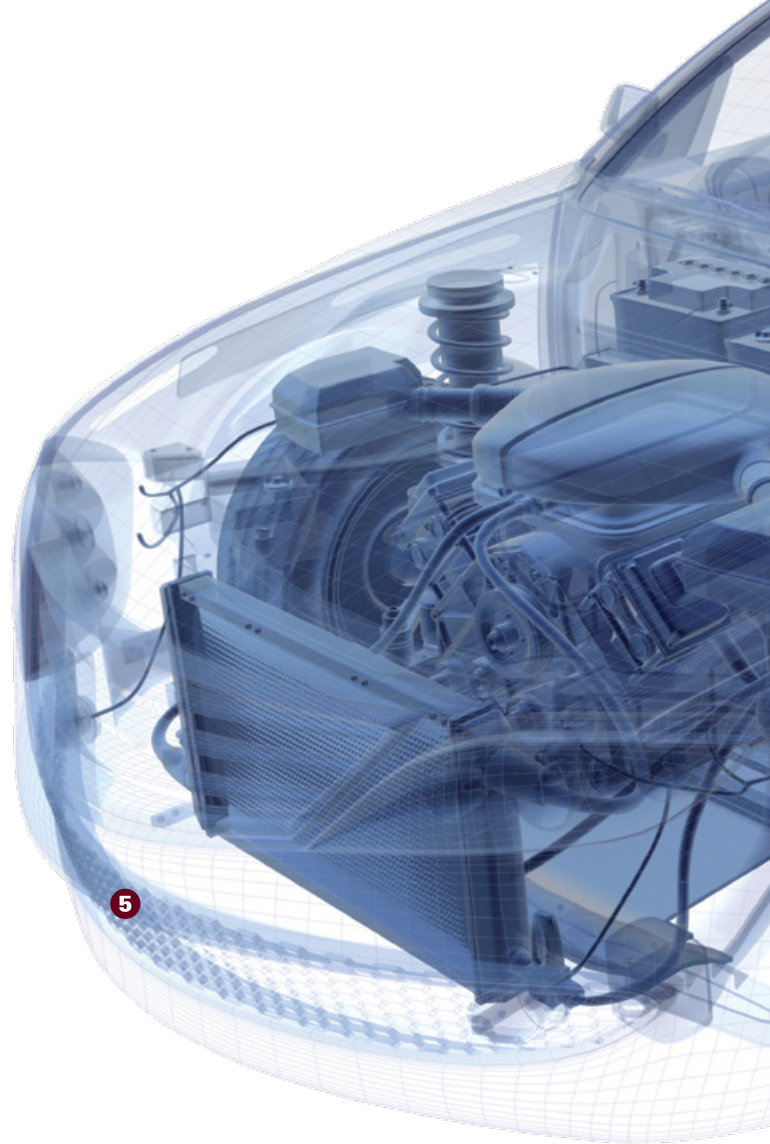


Fig 1: Active and passive safety technology

1. Airbags

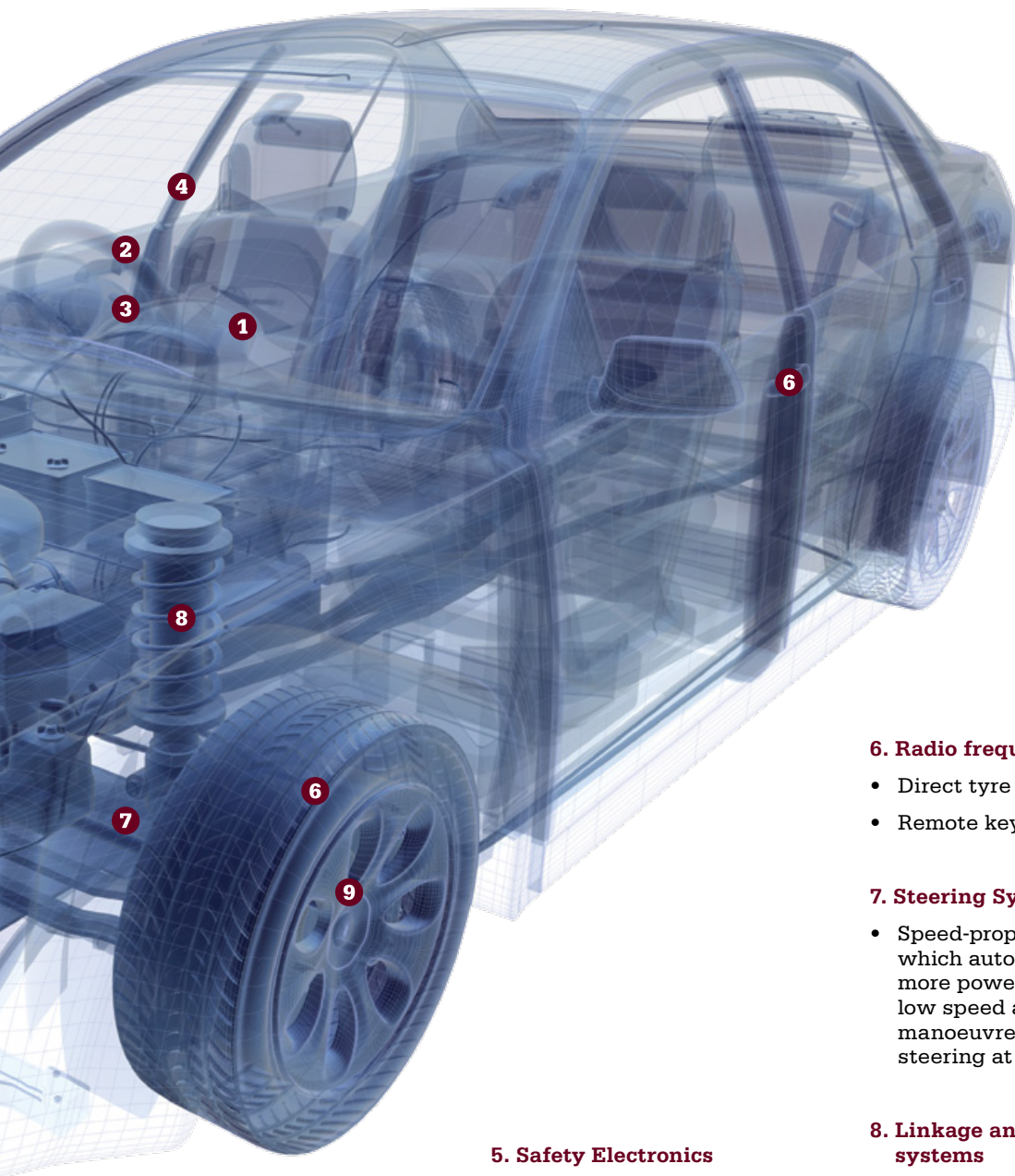
- Driver and passenger airbags.
- Self-adapting vent which releases air to reduce the airbag's pressure to fit around the occupant if he/she is in an unusual position.
- Active venting which enables the bag to inflate to accommodate different-sized occupants.
- Knee and side airbags.
- Curtain-rollover airbags which protect passengers in rollover accidents.

2. Steering wheel systems

- Touch sensors, much like the control surface of a laptop computer, integrated into the steering wheel. These can be used, instead of mechanical switches, to adjust heating and air conditioning.
- Vibrating steering wheel which notifies drivers of possible collisions, lane departures or drowsiness.
- Contactless horn system.
- Steering wheel with integrated microphone to allow for hand-free use of mobile phones.

3. Driver-assist systems

- Adaptive cruise control which maintains speed in accordance with stopping distances.
- Lane guide system whereby a laser or infrared sensor continuously monitors the vehicle's lane and alerts the driver if he/she unintentionally begins to wander out of lane.
- Collision warning system that will warn the driver if they are approaching an incident or if another vehicle is dangerously close. In the future this could lead to automatic braking by the vehicle.



4. Seatbelt systems

- Active control reactor, which allows the seatbelt to retract automatically in case of an accident.
- Buckle pre-tensioners which limit the amount a passenger moves during an accident.
- Active buckle lifters which improve accessibility.

5. Safety Electronics

- Engine Control Unit (ECU) and remote sensors.
- Vision systems have a number of applications including lane monitoring, night vision, occupant classification.
- Pedestrian protection through sensors in the front bumper area. These sensors send data to the ECU which analyses it and could enable the vehicle to stop in an emergency.
- Weight sensing system which determines whether airbag deployment needs to be tailored.

6. Radio frequency products

- Direct tyre pressure monitor.
- Remote keyless entry.

7. Steering Systems

- Speed-proportional steering which automatically provides more power-steering during low speed and parking manoeuvres and less power-steering at high speed.

8. Linkage and suspension systems

- Active dynamic control to stabilize vehicles.
- Control arms allowing the suspension of the vehicle to be changed according to passenger mass and desired ride style.

9. Braking systems

- Anti-lock braking which reduces wheels locking during emergency stops or on slippery surfaces.
- Traction control.
- Electronic lateral stability.
- Electric handbrake.

ITS IN EUROPE

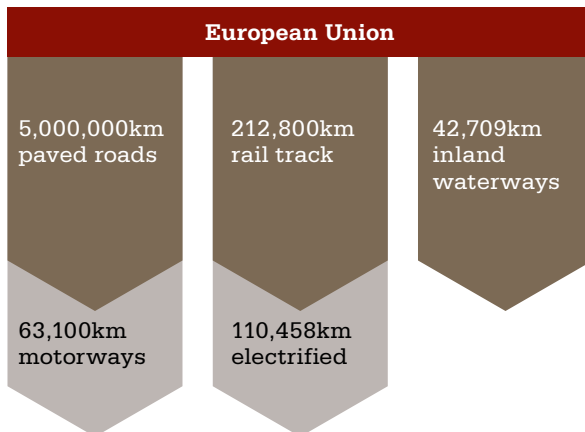
In its European Union Horizon 2020 Strategy, the European Commission (EC) said that in order to have smart, inclusive and resource-efficient growth in Europe, it was crucial to have a sustainable transport system.^[5] The EC has developed a vision that Intelligent Mobility will be part of its future and a tool that will ensure Europe can compete against continents like Asia and South America.

One area which is already seeing promising ITS development is Europe's public transport network. ITS is now an integral part of numerous European public transport systems, with on-board computers, GPS functionality and wireless communication already available on some buses, trains and trams. Penetration of this type of technology on public transport looks set to rise from 30% in 2010 to about 49% over the next five years.^[15]

Co-ordinating the development of an integrated transport system across the EU27 poses a huge challenge. To address this challenge the EC launched a programme known as the Trans-European Transport Network (TEN-T). This programme, which includes ITS development as one of its key projects, is designed to encourage member states to act together to provide key links for future cross-European transport infrastructure.^[11]

In addition, in 2009 the EC issued a Directive looking into the implementation of ITS into the road networks with the aim of finding Europe-wide solutions.^[16]

The Institution recognises that standardizing every part of the EU transport systems may not be appropriate, particularly with localised networks such as London Underground. But for transport systems with international links like aeroplanes or the Channel Tunnel a common approach would be beneficial.



SAFETY BENEFITS

Through the Transport Systems and Integration Catapult, industry, Government and academia will be able to share information more efficiently on safety systems, including ITS safety systems.

The technology used in aircraft collision avoidance systems – already deployed widely in commercial and military aircraft – is an ITS technology which could ultimately be transferred between different types of transport. These systems allow aircraft to communicate with each other using secondary radar techniques and transponders. The reliability of these systems allows operators to ensure that collisions are extremely rare in the industry.

A clear progression for this technology is to roll out collision avoidance systems into surface transport such as cars, HGVs and trains.

In Europe, 18% of all road fatalities involve motorcycle or mopeds. Compared to a car passenger, a motorcyclist is 26 more times likely to die in a crash based on miles travelled. In 2010, 111 cyclists were killed on Britain's roads – a 7% rise from the previous year. In addition, although HGVs account for just 5% of UK traffic, about 20% of UK cycle deaths involve HGVs – due in part to HGV 'blind spots' which could be avoided through collision avoidance systems such as LATERAL SAFE (see p20).

The EU, USA and Japan all have objectives to reduce road deaths by 50% over a decade, with many vehicle manufacturers seeking a 100% reduction.

ITS, with the implementation of systems such as Foot-LITE and LATERAL SAFE, can help reduce road fatalities.

The Institution of Mechanical Engineers recommends that industry and government collaborate to make the installation of collision avoidance technologies, such as LATERAL SAFE, on buses, lorries, heavy goods vehicles (HGVs) and large goods vehicles (LGVs) mandatory by 2015, in order to improve UK road safety.

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**ITS ON PUBLIC
TRANSPORT LOOKS SET
TO RISE FROM 30% IN
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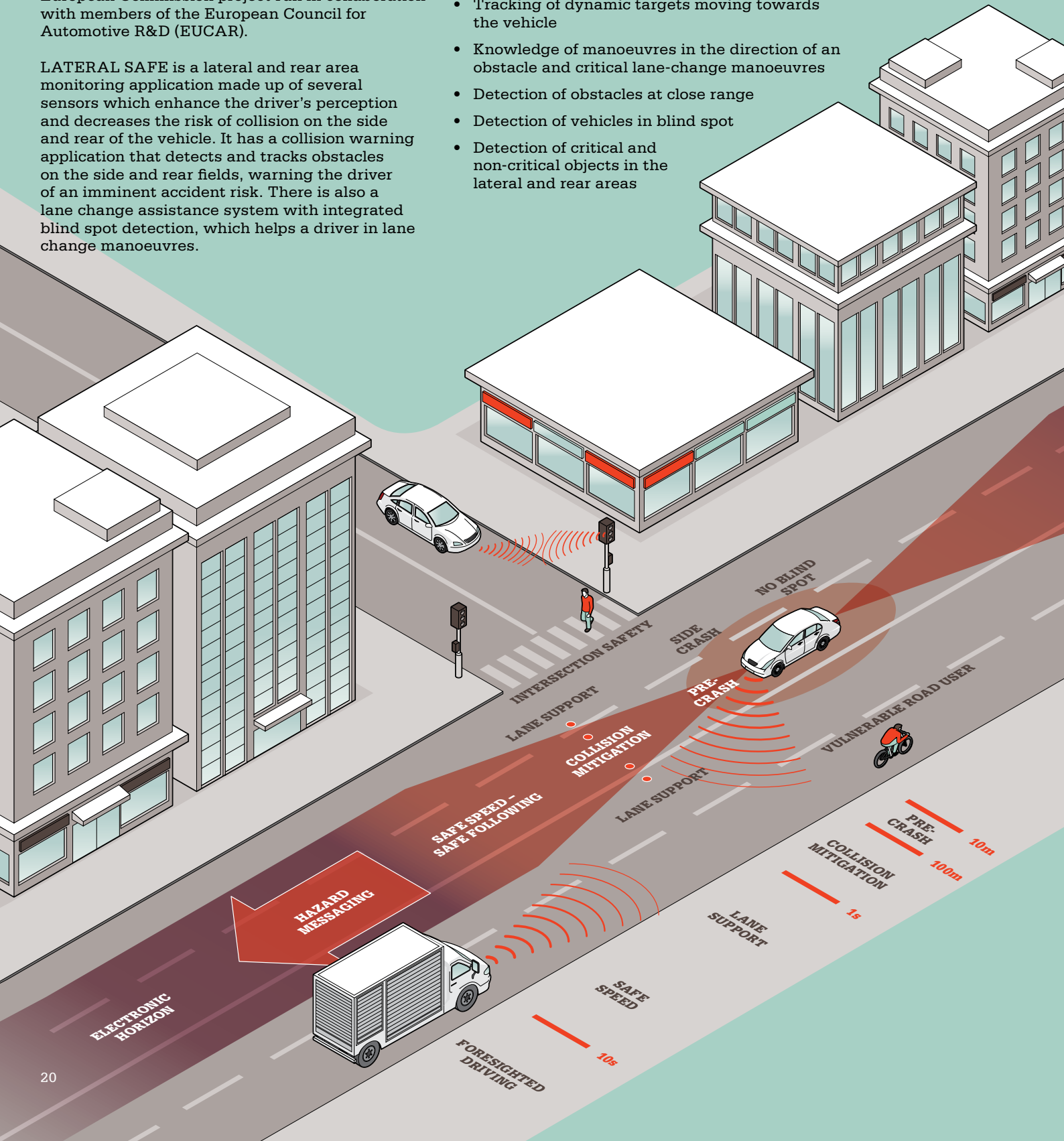
LATERAL SAFE

LATERAL SAFE is one of the sub-projects of a European Commission project run in collaboration with members of the European Council for Automotive R&D (EUCAR).

LATERAL SAFE is a lateral and rear area monitoring application made up of several sensors which enhance the driver's perception and decreases the risk of collision on the side and rear of the vehicle. It has a collision warning application that detects and tracks obstacles on the side and rear fields, warning the driver of an imminent accident risk. There is also a lane change assistance system with integrated blind spot detection, which helps a driver in lane change manoeuvres.

This multi-sensor system covers 270° of the vehicle's surroundings using the following functions:

- Tracking of dynamic targets moving towards the vehicle
- Knowledge of manoeuvres in the direction of an obstacle and critical lane-change manoeuvres
- Detection of obstacles at close range
- Detection of vehicles in blind spot
- Detection of critical and non-critical objects in the lateral and rear areas



COST AND CONGESTION BENEFITS

Currently, the pricing system of different types of transport, whether that be car, rail or aeroplane, rarely steers customers towards the most efficient and sustainable type of transport. The total costs to society of a particular type of transport, including the cost of infrastructure and maintenance, are rarely reflected in the costs paid by the user.^[5]

In order to deal with this issue, the Institution of Mechanical Engineers recommends that the Department for Transport develops a co-ordinated charging and information system that is easy to use and provides cost benefits to the public through their transport selection.

This would help support a shift towards lower carbon emitting forms of transport where appropriate and enable money generated through these charging structures to be put back into improving the infrastructure of the type of transport from which it was obtained.

The wide-scale roll-out of this type of ITS would enable passengers to be kept informed of any problems or delays as and when they happen and suggest alternative routes or alternative types of transport for reaching their destination. Apart from reducing traveller stress, this would also encourage people to use less environmentally damaging types of transport.

However, the development of this type of policy must take into account the 'rebound effect'.^[5] This effect is seen when technologies are introduced that lower the cost of, for example, driving a car, which often encourages more travel – thus cancelling any efficiency or cost savings of using the technology.

MANAGING DISRUPTIVE TRAVEL

In the future, ITS will be used to manage disruptive travel when required. For example, in bad weather conditions ITS will provide transport users with live updates of events, road closures, delays or notifications of accidents.

Rail has used ITS in the form of Active Traffic Management Schemes (ATMS) for many decades. Rail has much less flexibility to change routes compared to road and air transport but ITS can help the railway industry take advantage of the potential flexibility offered by the ability to increase passenger capacity on trains, and the frequency of trains on the track at peak times.^[17]

Aerospace can also benefit from the use of an ATMS during periods when there is travel disruption that it has no control over. In 2010, when the Eyjafjallajökull volcano erupted, the International Aviation Travel Association reported that the grounding of aeroplanes was costing the sector £164 million per day – a cost and disruption which could have been vastly reduced if more ITS technology had been put in place.

Active Traffic Management Schemes demonstrated on UK road networks

'Managed Motorways' Scheme on the M42

These mandatory variable speed limits have led to average journey times falling by a quarter on the northbound carriageway. Overall fuel consumption has decreased by 4% and vehicle emissions fell by up to 10%.^[18] It has been calculated that the ATMS on the M42 cost £6.2 billion less to build than widening the motorway and yet successfully met the original traffic objectives.^[19]

A14 Average-speed cameras Another example where the implementation of average-speed cameras led to a 21% reduction in the rate of collisions in the first year. The savings from the reduction in accidents are estimated at £9 million over the first five years at a cost to implement and operate of £4.6 million over the same period.^[19]

TRANSPORT COMMUNICATION METHODS

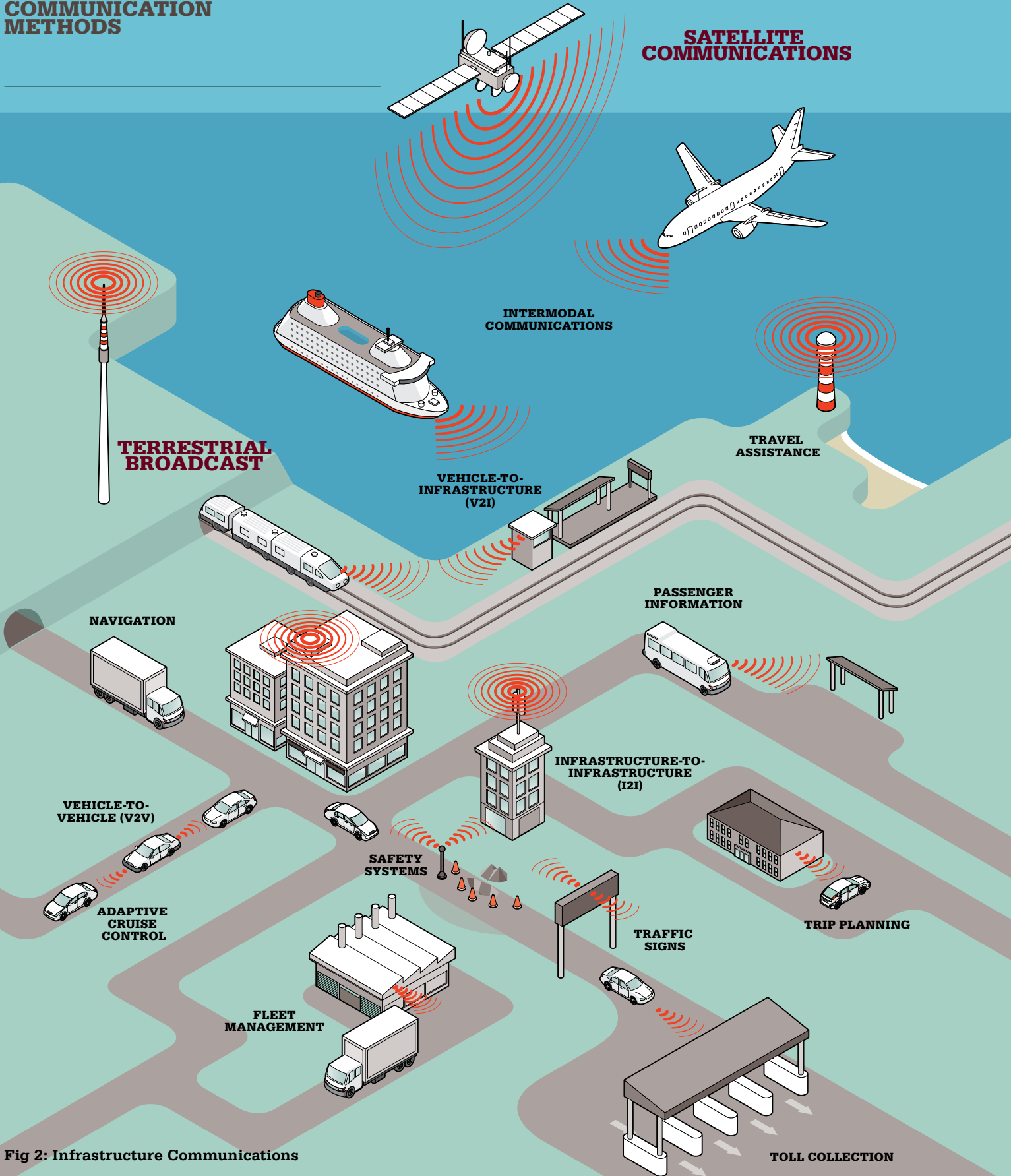


Fig 2: Infrastructure Communications

CHARACTERISTICS OF FUTURE TRANSPORTATION

As technology becomes more advanced and engineering problems are overcome the nature of our future transport system is likely to change. Key features involving ITS are expected to include:

- Driverless vehicles through automated computation. Future engineers and designers will develop automated decision-making vehicles, which will be able to achieve reliable, precise control and co-ordination.
- More types of transport providing a personalised service – for example taking you to your exact destination, rather than to a station or stop.
- A fundamental, common communication language of transportation networks – this may be demonstrated by V2V (Vehicle to Vehicle), V2I (vehicle to infrastructure) or I2I (infrastructure to infrastructure) communication methods.

It is already accepted by many that autonomous vehicle control will be our future. But there remain concerns regarding the eroding of driver skills and responsibility: if autonomy becomes the norm will drivers have the ability to respond in emergency situations if necessary? Who would be responsible for this risk, would it be the vehicle manufacturer or the driver?^[2]

It is clear that in some situations, autonomous vehicles already have the capability to fulfil human transportation needs – as seen in the Docklands Light Railway in London. An autonomous vehicle will have the capability of understanding and interpreting its environment by using sensors and will be able to navigate using intelligent navigation and GPS technology. Eventually there may be an input of end destination from a human, but then the vehicle will perform the mechanical operation of getting them to its destination. Through the technology described within this report, autonomous vehicles could provide a number of advantages in our future world. They could help minimise collisions and improve road capacity through the use of an intelligent infrastructure using traffic management.

Currently, autonomous vehicles are legal to operate on public roads in just one jurisdiction in the world: the US state of Nevada. The law to authorise the use of autonomous vehicles was passed in June 2011, with the support of Google. The Google driverless car is one of the leading projects in this field. The Google system combines information gathered from Google Street View, artificial intelligence software, with input from video cameras and sensors. There are also programmes such as the '2getthere' passenger vehicles from the Netherlands and the entrants of the DARPA Grand Challenge in the USA.

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**IN SOME SITUATIONS,
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With the current public spending constraints, transport investments need to deliver 'more for less' by moving people and goods more intelligently.^[20] The attraction of ITS is that we can use existing transport assets more efficiently by putting intelligence into what we already have. The realisation of Intelligent Mobility could have a significant market impact in the UK (and indeed the rest of the world) that would lead to wealth creation and a reduction in congestion which directly means a lowering in emissions as well as fewer accidents.

The Institution of Mechanical Engineers believes there need to be significant changes in urban mobility, which can be achieved by the Department for Transport developing intelligent infrastructure within the UK. Having such infrastructure in place will generate interchange between the different types of transport and yield significant benefits to the economy and wider society. The Department for Transport needs to provide comprehensive actions that bring together land-use planning, road use and parking, transport pricing, infrastructure development and public transport policy. Achieving an integrated and sustainable urban transport system has an impact on many stakeholders with a variety of interests.^[19] The Institution of Mechanical Engineers believes that the Department for Transport should work on developing intelligent transport infrastructure which will generate immediate interchange and information between types of transport and yield significant economic and societal benefits.

System integration will lead to enormous benefits across different organisations (eg Police, Councils, Highways Agency) as they exchange data more efficiently, enabling transport authorities to work together to improve traffic flow. This intelligent infrastructure would provide an accurate picture of network conditions, combining information from different sources to identify incidents, responses to be quick and effective. Transport strategies that are being developed to deal with bottleneck congestion would use this intelligent infrastructure to provide a feed of information to operators and the general public. This intelligent network would consist of nodes and links relying primarily on the efficient use of existing infrastructure via smart mobility solutions. These would be needed to bridge missing links, facilitate integrated transport and create links to neighbouring countries.^[5]

TRANSPORT SELECTION

Intelligent Mobility is about providing users with more accurate information to help them make the right choice on how they use transport and the type of transport they use. This information can be provided implicitly or explicitly by using systems such as social networks or instant messaging. Currently 82 million people in Europe use instant messaging, a 29% increase over the last four years. Social networking sites such as Facebook have over 800 million users.^[21]

Consumers need to begin to think about their mobility rather than thinking of choices between cars, buses and trains as competing systems. Public transport systems, private cars, freight vehicles, commercial fleet operators, infrastructure providers and government must all be involved in delivering the improved levels of mobility if we want to avoid congestion and the slow down of our economy.^[2]

Problems that are often displayed with adoption are the short-term user benefits (eg driver convenience) and are quite different from the long-term user benefits (eg congestion or pollution management at a national scale). Business drivers are also different for the vehicle Original Equipment Manufacturers (OEMs) and infrastructure providers and there is currently no authoritative forum in which these independent business interests are brought together. There is also a difference between the product developments and life cycles between the sectors (electronics/communications 6–12 months; automotive industry 3–5 years; infrastructure provision 5–30 years).^[2] Bringing together these opposing business interests could be a role that could be adopted by the Transport Systems and Integration Catapult.

ITS add value by improving safety, saving energy, improving reliability, as well as driving down the cost of travel. Introducing ITS to infrastructure and vehicles enables them to sense, analyse, anticipate, respond, communicate, co-operate, adapt and interface with their operator or user.

Mobility would be improved through the introduction of intelligent timetabling providing live departure and arrival times, routing tools to help with travel planning, and smart ticketing that could be used across all types of transport.

Smart ticketing

Smart ticketing is an approach that has been adopted across the world, including Korea where the smart card can be used on all types of transport (see box). London introduced the Oyster card system in July 2003 and by June 2010 over 34 million Oyster cards had been issued with seven million in regular use. Transport for London reports that 80% of all journeys, in all modes offered in their region, can be paid for using an Oyster card. More than 80% of all Tube journeys and 90% of all bus journeys in London are paid for through Oyster card. The card also offers the user the reassurance that they can travel around the city as and when they need to. In addition the fares are capped, which ensures that the users are getting value for money.

If the Department for Transport adopted an Oyster-style approach to the rest of the UK, it would create a single easy-to-use product that would make the public transport network more able to compete with the car.^[23]

The Institution of Mechanical Engineers recommends that government should introduce a nationwide co-ordinated charging and information system for all public transport within the next five years. This should be easy to use and provide cost benefits for individuals who use more efficient types of transport.

Korean Smart Card: T-money

This joint-venture was launched in 2004, by Seoul's Metropolitan Government, the LG Group (electronics), credit card companies and telecommunications companies.

T-money is accepted on all types of transport including bus, tram and taxis and can also be used for purchases at 21,000 vending machines and 8,300 convenience stores, fast food stores and car parks.

As of March 2009 there were 18 million T-money smart cards issued, with an average of 30 million T-money transactions a day. Seoul's subway is now paper free, producing savings of £18 million in 2009.^[24]

SECURITY

Intelligent Mobility and ITS can add value to society and businesses through a number of methods including: reliable tracking of vehicles (including stolen units); more secure transportation of dangerous goods; reduction of CO₂ emissions through better traffic management; reduction in congestion; accident avoidance and alerts; setting standards for compatible road charging systems.^[25] This is demonstrated with the security of freight which is known to be particularly at risk when changing between types of transport.

One such ITS which is currently in use is a Vessel Traffic Management and Information Service (VTMIS). VTMIS enables better dissemination of traffic information for operations management and provides access to vessel data and cargo data when required for safety reasons. This means that the owner can remain connected to the freight while it is on the transportation vehicles.

This system enables tracking and tracing across various modes, adding security to multi-modal transport networks and infrastructure, until it reaches its final destination. VTMIS also helps to improve contingency planning and access to marine pollution information.

Concerns have been raised when assessing the security of ITS. Questions such as, "How do we ensure that the management of personal data is handled safely?" or "What is the override capability in case a system goes wrong?" To address these concerns it needs to be recognised that there are a number of ICT tools in existence that have been developed that meet stringent security and safety standards within other sectors. With the introduction of ITS comes the need for new regulations. Part of these regulations would include the need to modify or adopt these standards when developing the ITS infrastructure. Defence and security companies, for example, have expertise that could be used in other markets to assist with this.

Vehicle Tracking

A truck driver travelling from Barcelona to Frankfurt currently needs to carry a GSM (global system for mobile communications) and a navigation system on board in addition to three different electronic devices for toll charges in the member states they cross. "It is important that these systems can talk to each other," says Anne Jensen MEP, the key sponsor who has been guiding the directive through the European Parliament's Transport Committee, adding that setting standards for road charging systems across Europe so that they are compatible with each other is a key objective. The European Parliament is critical of the increased use of sat-nav devices, which it feels sometimes cause more trouble than they're worth. It states: "Heavy trucks are often guided onto highly vulnerable and inappropriate roads."^[25] If the infrastructure were intelligent and could communicate with the vehicles through V2I communications then these issues would be eliminated. Within the freight industry it is deliveries over distances of less than five miles that would benefit from the introduction of ITS. Issues occur around out-of-town depots and where railways have been used for part of the journey for carrying goods and HGVs need to complete the last section of delivery. ITS can provide the technology to feed the information and statistics on the movement of goods as well as providing real time updates on the status of networks and deliveries of goods.^[4]

IMPACT ON USERS

With the introduction of ITS into vehicles, there will need to be careful assessment of the human-machine interfaces (HMI) between the vehicle and the user. The HMI between the in-built systems, providing the additional information in the form of communications and navigation, and the driver of the vehicle has a significant impact on the safety of the users and its surroundings.^[26]

One particular HMI scheme is eCall (see page opposite) which makes an automatic emergency call from a vehicle involved in an accident. This is clearly beneficial if the occupants are unconscious following the accident, but is also helpful for emergency services as it sends details of the vehicles involved and their exact location. This can ensure that emergency services arrive faster.

The Institution of Mechanical Engineers recommends that industry and government collaborate to enforce the installation of eCall in all new surface transport within the next two years.

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**MORE THAN 40,000
PEOPLE STILL DIE
ON EUROPE'S ROADS
EACH YEAR.**

eCall

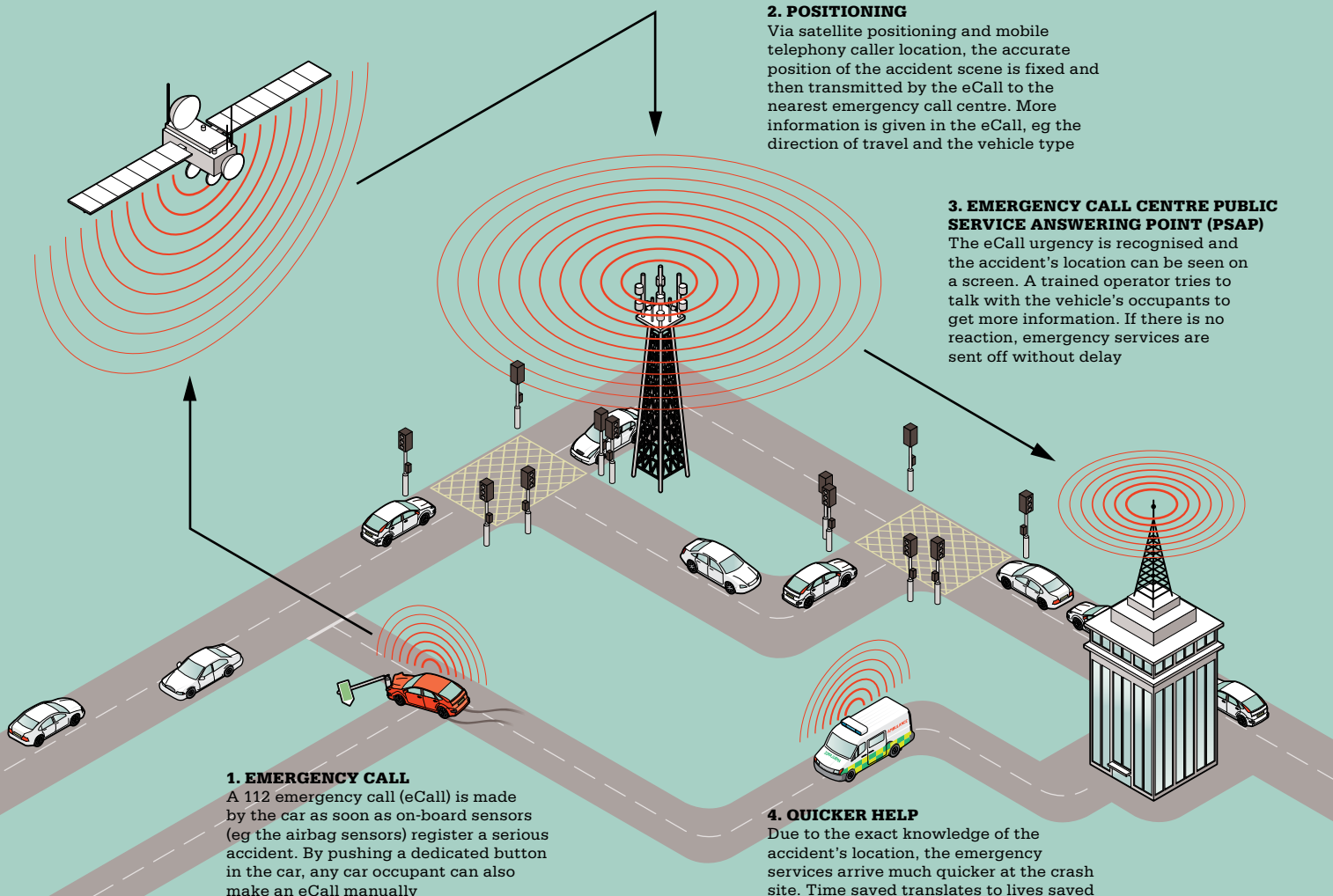
Both research and initial deployment have shown the great potential to improve road safety of advanced driver assistance systems (ADAS) such as electronic stability control, adaptive cruise control, lateral support (lane-departure warning and lane-change assistance), collision warning and emergency braking systems, as well as other applications such as eCall.^[26]

eCall is an electronic safety system that automatically alerts emergency services in the case of a serious car accident, and transmits location data from the accident scene. Even if the driver of the vehicle is unconscious the emergency services will be called, with the rescue team being made aware of the crash site's exact location.

Proponents of eCall say the response time of the emergency services is dramatically cut and fatalities could be reduced by 5% to 10%.^[25] More than 90% of accidents are caused by human error and more than 40,000 people still die on Europe's roads each year.

The eCall device works through the vehicle using its active and passive sensors to detect if there has been an impact – for example if an airbag has inflated, seat-belt control retractor has been engaged or if any of the driver-assist systems eg collision warning systems has been activated.

More than 70% of citizens responding to a Eurobarometer survey in Europe said they would like to have eCall installed in their next car.^[26]





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**WE NOW HAVE
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CONCLUSIONS AND RECOMMENDATIONS

In the UK there are already a number of ITS technologies in use: satellite navigation, adaptive cruise control, congestion charging and adaptive motorway management schemes, to name a few. We now have an opportunity to develop ITS technologies further to help ensure safer, more reliable and less environmentally damaging travel for all. The huge economic potential of developing ITS in the UK must be seized. The country could be missing out on billions of pounds of investment, as well as thousands of jobs, at a time when the country needs it most.

In order to fully benefit from the potential of ITS technologies to reduce road deaths, reduce congestion and improve efficiency, there needs to be close collaboration between the UK Government, the European Commission and other countries developing ITS. Government should also present a credible, detailed vision of ITS and how it fits in with government policy on transport, health and safety, the environment and business.

Barriers must also be broken down in industry with companies working in different sectors and producing different technologies sharing best practice and expertise.

In summary, the Institution of Mechanical Engineers recommends that:

- 1. The newly formed Catapult for Transport Systems works with industry to develop an agreed unified vision for ITS across the UK's entire transport network within three years, focussing on increased capacity, congestion reduction, improved efficiency in movement, improved safety and reduction in environmental impact.**
- 2. Industry and government collaborate to make the installation of collision avoidance technologies, such as LATERAL SAFE, on buses, lorries, heavy goods vehicles (HGVs) and large goods vehicles (LGVs) mandatory by 2015, in order to improve UK road safety.**
- 3. Government introduces a nationwide co-ordinated charging and information system for all public transport within the next five years. This should be easy to use and provide cost benefits for individuals who use more efficient types of transport.**
- 4. Industry and government collaborate to enforce the installation of automated emergency response technologies like eCall in all new surface transport within the next two years.**

CONTRIBUTORS

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