Introduction to ITS and C-ITS

Intelligent Transport Systems (ITS) is a generic term for the integrated application of communications, control and information processing technologies to the transport system. The resulting benefits save lives, time, money, energy and the environment and stimulate economic performance.

ITS covers all modes of transport and considers all elements – the vehicles, the infrastructure, the drivers and users – all interacting together dynamically.

The main function of ITS is to provide services and information for the full spectrum of users – in particular drivers, passengers, vehicle owners and operators, but also vulnerable road users like pedestrians and cyclists – and support safe and efficient traffic management by the transport network operators. The intention is to improve the operation of the entire transport system. With ITS, road users such as motorists, freight and commercial fleet operators and public transport customers can make better judgements on their travel decisions. Factors such as traffic conditions, road maintenance or construction work may potentially impact on travel times; weather conditions will affect the road network and safety.

ITS provides better quality and diversity of information on road and traffic conditions, often in real-time. The use of ITS in Road Network Operations also makes it possible to improve existing operating strategies and devise new ways of managing road traffic.

Function

ITS aims to serve the user of the transport system by providing– for the individual – more reliability and comfort for individual mobility and – for the operator of the transport system – more effective operations and decision making. The overall function of ITS is to improve the operation of the entire transport system (often in real-time) for transport network controllers, travellers, shippers and other users.

ITS deployment is influenced by commercial interests and policy initiatives at the international, national, regional and local level – which impact on the business practices of stakeholders in the public or private sector.

ITS provides a flexible approach to addressing common transport problems – one that emphasises the use of information, optimal decision-making and a high level of system adaptability. This compares with the more traditional approach of building additional road infrastructure and adding physical capacity. ITS offers alternatives to meeting future travel demand in situations where conventional approaches may not work – for example in heavily built-up locations or in areas subject to stringent environmental regulations.

More specifically, ITS includes a variety of tools, such as sensing, communications, and computing technologies – which can be applied in an integrated way to the transport system to improve its efficiency, safety, sustainability and the resilience of network operations in the events of serious disruption.

ITS applications

ITS has the potential to relive some of the most difficult problems that affect road transport today. In general ITS applications have the capability to:

- improve traffic flow by reducing congestion;
- quickly detect incidents and appropriately respond to them;
- improve air quality by reducing pollution levels locally and minimising travel delay;
- improve safety by providing advance warning before potential crash situations;
- minimise the impacts of environmental, highway and human factors that contribute to accidents.

ITS can also make travel more convenient by providing travellers with accurate and timely information about the traffic conditions on the network, and available transport options. It can also foster economic growth in a region, by improving mobility, enhancing travel time reliability and reducing energy consumption.

Road network operations

Many ITS applications have a role to play in effective road network operations – the aims of which include:

- making best use of the capacity available on the road network;
- ensuring that the road network operates in the most efficient, safe, and sustainable way possible.

In general, ITS applications that are designed to improve the efficiency, safety and/or sustainability of road networks are the applications most frequently adopted. Examples include:

- systems for managing traffic and travel demand – such as traffic control, incident management, electronic payment, travel demand management, parking management and control;
- traveller information systems applications that allow road users to make informed decisions on their travel choices – such as driver information and route guidance.

The concept of connected autonomous vehicles is becoming feasible and gaining support which will have major implications for road network operations – which will need full evaluation.

ITS benefits

All road users, including drivers and their passengers, pedestrians and cyclists – across all modes of road transport, including private cars, buses, coaches and commercial vehicles – can benefit from greater use of ITS. For example, ITS applications support:

- commercial vehicle operations of commercial operators, regulatory and tax agencies and road users – providing benefits such as electronic administrative processes and automated roadside safety inspections;
- public transport from the perspective of both operators and travellers – providing benefits such as improved observance of time-tables, optimised operations, improved security on-board vehicles and at terminals – and a higher standard of service by providing real-time schedule information to travellers.

Types of benefit

Improving the efficiency and sustainability of transport is a major goal of all ITS programmes around the world. ITS is commonly deployed to deliver improvements in network capacity, traveller mobility, economic productivity and policy-related goals.

Improving network

There are significant supply-side (network provider) benefits of using ITS for highways management to make best use of road capacity and increase throughput. For example, lane management have been one of the outstanding successes of ITS. This includes High Occupancy Vehicle (HOV) lanes, reversible flow lanes, variable speed limits and enforcement systems. These maximise the use of the infrastructure available, saving or postponing the very large costs of expanding road networks.

Improved vehicle control systems (crash avoidance systems) will increase throughput by reducing the headway required between vehicles. They can also help reduce the number of collisions, which means fewer traffic hold-ups. It has been estimated that a three-fold increase in throughput is possible with platooned vehicle operation. A less sophisticated automated highway system might increase throughput:

- by 30% (with rear-end collision warning in vehicles with similar performance characteristics)
- by 60% (with collision avoidance in vehicles differing in braking capacity)

Improving traveller mobility

Improving mobility by reducing delay, minimising congestion and improving travel reliability is a major goal of many ITS applications. The actual efficiency benefit to the traveller depends on the context. For example:

- until congestion significantly affects travel time, the advantage to drivers provided by in-vehicle or roadside traffic information is small – diversion information is not needed when the road ahead is clear;
- At the other extreme, in a completely congested network, the value of switching routes may be low.

Travel time savings will depend on levels of congestion and available opportunities for diversion. Among the most common measures is delay – which itself can be quantified in different ways – such as:

- average delay per vehicle;
- total delay in person hours;
- time variation from schedule for public transportation or freight delivery;
- a travel time index – such as the ratio behind the actual travel time and free flow travel time;
- travel time reliability to reflect the variability in travel time for a whole trip – related to the reliability of estimated arrival times.

Route finding and navigation

Direction and route finding information will generally have value regardless of congestion but there may be potential disbenefits from use of unsuitable roads, especially by heavy goods vehicles. Pedestrians can also benefit in terms of reduction in wasted time waiting to cross streets through smart signal controls.

Traveller information

Pre-trip traveller information has benefits for journey planning – in terms of better routeing, knowledge of interchange between modes, or overall journey times. Better informed travellers are able to choose alternative routes and modes, switch to public transport, and save time.

Productivity

While travel cost reduction is of interest to all road users, the benefits associated with ITS are most tangible to the operators of vehicle fleets. ITS productivity benefits have been assessed from the perspectives of fleet managers, transport authorities, and toll agencies. ITS options include automatic vehicle location (AVL) and computer aided dispatch (CAD) using sophisticated logistics software and close communications between the dispatcher and the driver. Each individual intervention appears marginal, but the overall effect in journey time reliability and time savings can make the difference between hitting a Just-in-Time delivery slot and missing it. In the USA, advanced routeing and decision-making software and organisation for the routeing of time-sensitive deliveries increased deliveries per driver hour by 24%.

In freight transport, there are two separate streams of benefits available from ITS:

- benefits to the supply chain as a whole;
- operating costs.

The first benefit stream concerns the operation of supply chains using data and information linked with communication technologies. Methods include control systems, vehicle tracking and load monitoring – to:

- facilitate back-loads, port and customs pre-clearance and communications with the customer about the progress of a shipment
- monitor drivers' hours, alertness and driving performance
- bring access cost reductions to hauliers through traffic management measures in urban areas – though some access policies that are enabled by ITS can impose constraints.

The second benefit stream concerns reducing the costs of transport operators by providing productivity improvements:

- many ITS applications are designed to mainstream business or regulatory processes (for example, some ITS applications related to Commercial Vehicles Operations);
- other ITS applications may help in the collection and analysis of data that can eventually result in cost saving to the agency.

The primary measure of productivity is typically cost savings as a result of an ITS implementation.

C-ITS: Cooperative Intelligent Transport Systems and Services

Cooperative Intelligent Transport Systems (C-ITS) refers to transport systems, where the cooperation between two or more ITS sub-systems (personal, vehicle, roadside and central) enables and provides an ITS service that offers better quality and an enhanced service level, compared to the same ITS service provided by only one of the ITS sub-systems.

According to the C-ITS Deployment Platform having been organised by the European Commission, cooperative Intelligent Transport Systems (C-ITS) shall use mature ad-hoc short-range (like ETSI ITS G5) and complementing wide-area communication technologies (like 3G, 4G, future 5G) that allow road vehicles to communicate with other vehicles, traffic signals, roadside infrastructure and other road users. The cooperative V2X systems are also known as vehicle-to-vehicle communications (V2V), vehicle-to-infrastructure communications (V2I) or vehicle-to-person (V2P) communications. In summary, the wireless data exchange between the different actors and ITS stations and related functions are named cooperative V2X communication. It supports a number of information, warning and assistance services which will be gradually deployed in coordinated innovation phases during the oncoming years.