INDIVIDUAL ASSIGNMENT
TNK052 - INTELLIGENT TRANSPORT SYSTEM

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Driver Assistance and Vehicle Control

1. What is the difference between active and passive safety systems?
   a. **Active Safety System**: Basically, active safety system is a safety system which actively help the driver to control the vehicle to avoid the accident. The main function of this safety system is *Collision avoidance by reducing the driver errors.*
   Application: Brake assist, Emergency braking, Collision Avoidance

   **Passive Safety Systems**: Basically, passive safety systems is a safety system which help the driver to protect the occupant (including him/herself) while the accident occur. The main function of this safety system is *Occupant Protection during and after the accident occur by reduce the consequences of errors.*
   Application: Pedestrian airbag, Crash severity sensing

b. Describe three ‘active safety’ and three ‘passive safety’ ITS applications that can be found in series produced cars.

   **Active safety ITS applications :**
   b.1) **ABS (Anti-lock Braking System)**
   ABS is a braking system which control the wheels when the driver suddenly push the brake at certain speed. This system recognizes the tendency of one or several wheels at an early stage and reduce the braking pressure on the wheel concerned. The expected results of this system are the driver can avoid obstacles and slow the vehicle down even after an emergency brake application

   b.2) **Night Vision System (NVS)**
   Night vision systems use different technologies to aid drivers in seeing the road during dark hour (Linder et al, 2007). Basically, this system bring through the driver can see the obstacle on the certain radius distance thus the driver can more ready for decision making while he/she drive. NVS using infrared camera to detect obstacle or pedestrian located at the distance which driver unable to see. There are two basic types of NVS developed in current produced-car, which are far-infrared sensor (FIR) and near-infrared system (NIR).
   FIR which used by the BMW is using a sensor to process the emitted-heat images of outside object. From that kind of process, warmer object will bring brighter resulted image. The weakness of this kind of NVS is when the object or obstacle have same temperature with its surrounding then FIR can not pick up the image.
   NIR which used by Mercedes beams an infrared light into the front area of vehicle. Honda use NIR with additional function which able to detect pedestrians and their movements by using two far-infrared cameras.
   Both types of NVS have similar purpose to improve road user safety while the activity were on less-light area.
   Reference:

   b.3) **Adaptive Headlight**
   Adaptive headlights follow the road curvature actively, illuminating not only in straight forward direction but turning the light beam in road direction when the car is in a curve (Linder et al, 2007). Adaptive headlight can provide better range of vision for the driver in order to keep driving safely. Basically, the headlight will move motorize depends on the speed, gyro and steering wheel angle. The driver can receive better information regarding the road that would be passed. Better information for the driver can provide better road safety levels. In addition to better information for the driver, adaptive headlight also can support better condition of driving to other driver in opposite direction.
In some system, Adaptive Headlight can give adjustment of the headlight up to 15 degrees as maximum angle and the other have the system which can turn on an additional headlight up to 90 degrees (Opel, Audi, Volkswagen and others model)
Reference :
Linder et al, *Intelligent Transport System (ITS) in passenger cars and methods for..., 2007*

**Passive safety ITS applications:**

*b.4) Head restraint*

Many car manufacturers put great efforts in minimizing the risk of whiplash injury by adapting head restraint and seat design (Linder et al, 2007). Human brain is a kind of "central processor" of human activity include driving, since all of the decision made by the driver is depend on information process in the brain and after all brain plays an important role on the possibility of human's life. Those are the reason why some car manufacture developed "whiplash injury risk reduction system". Lexus built the "rear pre-crash" (Toyota, 2007 as cited in (Linder et al., 2007)) which have the radar to monitor the rear part of the car. The head restraint will repositioned towards the head of the driver if the system detect an imminent rear-end crash. BMW has also an “active whiplash protection” . In this case the system is activated when a collision is registered, and moves the head restraint towards the driver’s head before the crash (Linder et al., 2007)

*b.5) Airbag*

Airbag being deployed in order to protect the occupant in high severity crash in a second. Advanced system of airbag are able to adapt severity of collision (some system adapt even to the driver mass) into its power deployment. (Linder et al., 2007). Nissan's Technical Centre Europe (NTCE) involved in the bone scanning project called Bone Scanning for Occupant Safety (BOSCOS) (Hardy et al., 2006 as cited in (Linder et al., 2007)) which able to adjust airbag power based on density of the occupant's bone structure. This kind of technology scan the bone using ultrasound technology to analyze the bone density of the occupant to adjust the power of airbag and seatbelt to maximize the offered protection. Airbags are, together with seat belts, the most common safety systems in cars, and the technical development presented above shows that there is still space to improve airbags (Linder et al., 2007).

*b.6) Pedestrian impact mitigating*

Main aim of this system is to minimize the pedestrian injury in the event of vehicle-pedestrian collision. (Linder et al., 2007). In the event of a pedestrian impact, the deployable bonnet lifts up a few inches, to create a cushioning effect between the engine and the bonnet. This system can avoid the pedestrian from hard point crash in the engine. Jaguar (XK model), Citroen (C6 model) and Honda (Legend model) already have this system in their manufactures. There are three sensors located inside the front bumper and a vehicle speed sensor on Honda Legend Model to determine if an pedestrian impact has occurred and signal an actuator to raise the rear portion of the engine bonnet (my 10 cm). (Linder et al., 2007). Other technology using Flexpoint Sensor Systems which able to determines the position of the object struck, intrusion speed and energy, and mass physical variables and use it on electronic process which can distinguish precisely the nature of the object struck (Hoffmann et al., 2002 as cited in (Linder et al., 2007))

2. **Which of the currently available in-vehicle ITS have been proven to reduce the number of traffic accidents? What do these systems have in common?**

Based on the given references, it has been proven that Anti-lock Braking system (ABS) along with Electronic Stability Control (ESC) became "most reduced the number of accident" in-vehicle ITS application. Both of ABS and ESC advantages is **used in Braking Assist Control (BAS)** in optimizing the vehicle retardation in emergency situations by maximizing the pressure in the braking circuits, aiding the possible too-weak brake pedal pressure of the driver and acting faster than the driver. (Linder et al., 2007: 50)
For some systems, especially ABS and ESC the penetration rate is large, and quite a number of evaluation studies have been performed, showing the impact on traffic safety. Behavior is by far the most common research area, and ABS and ESC are the systems evaluated most commonly (Linder et al., 2007). On American market, ABS and ESC are widely offered since 2004, even ESC will become standard in all cars from 2012 in the US by government regulation.

3. Discuss three types of sensors that are used in driver assistance systems to detect obstacles in the surrounding environment. What are the pros and cons of these alternative technologies?

Three types of sensors that used in driver assistance system are:

- **Radar-Sensor**
  Main advantage of radar sensor is that they perform equally well during day time and night time, and in most weather condition (Piao and McDonald, 2008). Creating a sufficiently large angular reach with correspondingly good angular resolution is one of the key issues with radar-based sensors (Agogino et al., 2000 as cited in (Piao and McDonald, 2008)).

- **Laser-Sensor**
  Laser sensors have the potential for a larger angular reach and a better angular resolution (especially with a scanning principle) than radar-based sensors (Piao and McDonald, 2008). The main disadvantage of laser sensors is that they are very sensitive to adverse weather conditions, for example rainy weather, which could result in reductions of detection range and create ‘ghost’ objects due to road spray (Piao and McDonald, 2008).

- **Infrared Sensor**
  Infrared sensor can be used effectively on night vision system. BMW built the night vision system that uses far-infrared sensor which images the heat emitted by object outside the car. Near-infrared sensor be used by Mercedes to develop night vision (Linder et al., 2007). The disadvantages of this sensor is about can not perform equally well during night time and day time (Piao and McDonald, 2008).

4. Can a system designed to control vehicle speeds be more effective in improving road safety than a collision avoidance system? Motivate your answer!

Yes, it can. Speed is the main factor which can affect into high-risk traffic accident. Inappropriate or excessive speed is a crucial risk factor in traffic accidents (Lu, Wevers and Der, 2005). Vehicle-speed control system such as ACC (Adaptive Cruise Control) can maintain the vehicles can keep vehicle stand in “normal driving” condition. In other word, this system can prevent road user from “crash probability” condition or even from the condition which need “passive safety” to be activated as explained in Holistic view on safety figure below (from ADASE Consortium (2004b) as cited in (Linder et al., 2007))
In the field of study, it is also found that as the driving speed of overall trips decreases and the distance to the forward vehicle before overtaking increases, indicating a positive effect on traffic safety (Sato et al., 2005). In other way, collision avoidance system still have tend to come to collision if there are system failure while operated.

5. Compare an autonomous adaptive cruise control and an adaptive cruise control based on inter-vehicle communication with respect to:

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Autonomous Adaptive Cruise Control</th>
<th>adaptive cruise control based on inter-vehicle communication</th>
<th>Reference</th>
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</thead>
</table>
| a) Potential safety issues | • Driver should take “manual” braking when sensor detect front obstacle.  
• Just need self-equipped vehicle instead equipped vehicles. | • Anticipate early braking manoeuvres when an ‘invisible’ vehicle in front is braking. This leads to a more natural following behaviour.  
• Both the proceeding and the following vehicles have to equipped. | (MacNeill and Miller, 2004)  
(Piao and McDonald, 2008) |
| b) Impact on overall traffic performance | • Have little impact since the system only regard threats within the immediate vicinity of the equipped vehicle. | • Have big impact since have ability to relay hazard information from a preceding vehicle to following vehicles, in an effort to prevent multi-vehicle accidents, particularly when in condition of poor visibility | Jin and Recker, 2006 as cited in (Piao and McDonald, 2008) |
| c) Technical requirement and feasibility | • Required Vehicle Positioning devices (radar, laser, fusion, DGPS*), friendly user interface.  
• Highly-feasible since not affected by another system | • Required inter-vehicle communication devices, transmitter, and infrastructure-vehicle communication devices  
• Low feasible since required high-cost of development and implementation of the system. | (Piao and McDonald, 2008) |
| d) User acceptance | • Most of vehicle manufactures developed this system into their car | • Although much research and development work has been carried out, there are no practical inter-vehicle communication systems in operation currently | (Piao and McDonald, 2008) |

* Differential Global Positioning System
1. Which are the components of the ITS information chain? Describe the function of each component and give an example of one system or application for each component.

- **Data Acquisition**: The main raw of information that informed to the ITS user is about data about real condition of current transportation. Data acquisition have function to collect the data needed for next process. Data which mentioned above is collected from the targeted-road include Travel times, Speed, flow, densities, degree of congestion, occupancy, queue-length, deviation from normal condition. Example: Stationary detector (mostly radar), ATIS.

- **Data Processing**: As further step, The data that has been collected from "Data Acquisition" process became an "Input" in "Data Processing" process. Data processing was included input, Network State Estimation, Prediction of future state, General and selection of action, action. Estimation and prediction is conducted by using theory which has been translated into system languages.

- **Information Distribution**: in this step, Processed-information distribute to the user by user-related media such as web-site, tv broadcast, Variable Message Signs (VMS), radio, portable communication and in-vehicle route guidance systems.

- **Information Utilization**: this step is very related to the interactive interaction between user and provider. When provider have real-time data about traffic condition, they sent it back to the user so that the user can make another decision based-on the information. The information not only provide about traffic control (such as adapted signal control, ramp metering, lane management, speed control) but also can provide the information about route guidance (VMS and In-vehicle systems).
2. a) Describe how different user groups can benefit from improved travel time information.

Generally there are four user groups which get benefit, which are:

1) **Individuals : commuters, business, non-working**
   - By travel time information, "individual" group can make better trip planning for their activity related to the shortest path or shortest time for their trips. They can decide about the transportation mode will be used in order to get the destination as well as planned-time) for businessman. Travel time information make the Pre-trip planning (activity, destination, departure time, mode and route) can be planned easily even during the trip.

2) **Public sector user**
   - Transportaion network operator can give accurate information about accident/road work/delayed to the user by using improved travel time information. By accurate information, public transport user can make better prediction and planning for their best public transportation mode will be used. Travel time information was also helped emergency service for the dispatching and evacuation activity by using network coordination and arranging.

3) **Freight movers and shippers**
   - Improved travel time information can help driver (or good company) to predict the best route for goods transportation to get to destination as well as planned (by considering the type of goods, fuel consumption, quality of goods). Better prediction leads to better satisfaction of customer which would increase the company profit.

4) **Private passenger fleet operator**
   - Operator can give higher quality of provided information to the customer by using improved travel time information which can make higher number of customer and also the profit.

b) Give examples of different ways or systems to obtain travel times. What are the advantages and drawbacks of each system?

1) Using In-vehicle mobile device which monitor their speed and location by GPS and use the locally stored Virtual Trip Lines (VTLs) to determine when a VTL crossing occurs (Herreraa et al., 2009)
   - **Advantages :**
     - By sending location and speed of vehicle data when VTL crossing occurs, provider can get real-time data of speed and location from in-vehicle mobile device.
     - This system can handle about privacy issues.
     - Through careful placement of trip lines, the system is better suited to manage data quality and privacy than through a uniform temporal sampling interval.
   - **Disadvantages:**
     - High cost of implementation since the system need lot of on-the-road device and in-vehicle devices for data collection
     - Vulnerable for low utility and highly sensitive data (Herreraa et al., 2009: 6)

2) Video cameras which using license plate reidentification
   - **advantages:**
     - Easily implemented since have high availability of device and it does not need in-vehicle devices.
     - Low cost of implementation
   - **disadvantages :**
     - Can not detect real route of driver and can not detect real-time speed of vehicle in out-reached area of camera.
c) What are the main obstacles for making a business success in providing travel times?

Obstacles in providing travel times:

1. Maximizing profit vs facility
   "In the private sector, the owner-operator must provide a facility where the revenues exceed the costs and provide a profit that meets or exceeds the expectations of the investors" (Florida’s Turnpike Enterprise, 2005).
   As well as explained in Evaluation of Traffic Data Obtained via GPS-enabled Mobile Phones: the Mobile Century field experiment (Herreraa et al., 2009) that both of GPS devices and VTL which lead to to the higher accuracy. Obviously, GPS devices and VTL detector will have high cost of implementation as the consequences.

2. Increasing revenue vs travel-time predictability
   "Users will make a trade-off between the cost of using a facility and the quality of the experience of using that facility. As stated previously, travel-time predictability will influence users’ willingness to pay" (Florida’s Turnpike Enterprise, 2005).
   In Evaluation of the Potential Benefits of Advanced Traveler Information Systems (Toledo and Beinhaker, 2006) explained that there are several levels of road guidance (i.e Static, historic, Instantaneous/Pre-trip, Instantaneous/En-Route, Predictive) but they all have fraction of travel time information which influence the data reliability by customer.

3. Decreasing Expenses vs resources
   "Inevitably these expenses will require human and physical resources and other support services. Raising the level and quality of customer service will inevitably increase expenses." (Florida’s Turnpike Enterprise, 2005).
   In the other side, further research is needed in order to test wether and how the robustness of the information could be improved if guidance was based on the various sources (Toledo and Beinhaker, 2006). More research would mean more resources (human and physical) needed for the business.

3. What are the main conclusions from the case studies evaluating the use of mobile phones for obtaining travel times?

Based on Evaluation of a cellular phone-based system for measurements of traffic speeds and travel times: A case study from Israel (Bar-Gera, 2007), the conclusion are:

a) Corresponden between travel time and speed system is good since floating car travel time measurement provided additional assurance for accurarcy of data.

b) Cellular phone data suitable fur usage in practical applications especially for ATIS (Advance Traveler Information Systems) included modelling, planning, and management of transportation infrastructure investments.

c) Potential limitation of this systems is in the "noise" that accompanies to the measurements.

d) another limitation is in the needs of additional studiesto quantify these effect more precisely and to evaluate their implications for different application.

e) It seems reasonable to anticipate the increasing of usage of this approach in coming future regarding the positive result of the cellular phone-based system.

Based on Evaluation of Traffic Data Obtained via GPS-enabled Mobile Phones: the Mobile Century field experiment (Herreraa et al., 2009), the conclusion are:

a) The comparrasion suggest the presence of some bias in the velocity estimation for some loop detectors, showing sometimes significant differences with the VTL measurements.

b) An average penetration rate between 2-3% was achived during the experiment, which is viewed as realistic in the near future, considering the increasing penetration of GPS-enabled celullar devices.

c) Traffic monitoring system based on GPS-enabled mobile phones is particularly appropriate for developing countries, where there is a lack of resources and monitoring infrastructure, and the penetration of mobile phones in the population is significant (and rapidly increasing).
d) a system that fuses both static (loop detector) and mobile sensors (GPS-enabled mobile phones) is expected to provide a more accurate estimation of traffic than each of them individually.

e) The potential errors, inaccuracies, and/or biases observed in the data will be addressed to compute travel time estimates or other features extracted from it as clearly as shown for the row data, with the proper flow models of highway traffic and corresponding inverse modeling techniques.

4. a) Give examples of different types of route guidance systems, both with respect to the technology used and the type of messages given.

Different types of route guidance systems:

a) Variable Message Sign (VMS) is guidance system which put along the roadside that provide advanced warning information about emergencies and incidents (which can lead to better safety) to the user by display sign and/or picture (Highway Agencies, 2011)

Type of message:
- Picture/sign i.e speed limit, under construction sign, emergencies, etc.

(b) In-Vehicle guidance system is personal guidance to the user/driver which provide information about traffic condition (speed limit, potential obstacle, travel time, alternative route, etc) along the desired route of user.

Type of message:
- text message
- route map guidance
Technology used:
- GPRS/GPS-enabled
- Radio Data System
- Interactive user-interface

**b) What are the driving forces for a more extensive use of dynamic in-vehicle route guidance systems? What are the problems that have to be solved?**

Based on *Evaluation of the Potential Benefits of Advanced Traveler Information Systems* (Toledo and Beinhaker, 2006) said that:

- Dynamic in-vehicle route guidance system may lead to travel times saving of up to 14%.
- Also reduced the travel time variability by up to 50%.
- Reduction in both travel times and travel time variability are higher for the more congested pm peak period compared to the am peak period.
- These result can lead to significant economic benefits to individuals, commercial fleet operations, and society as a whole.

Problems that have to be solved:
- Finding the best method to determine/estimate the travel time.
- Driver acceptance for the technology used in guidance system.(related to driver education)
- Additional studies or research for looking the most effective method for giving the information.

**Electronic Payment**

1. **Describe the benefits and the possibilities of a “smart parking” system based on electronic parking payments in the context of parking accessibility, parking utilization and parking as a management control measure.**

As explained in *Intelligent transportation systems and parking management* (Vianna, Portugal and Balassiano, 2004), benefit of “smart Parking” system are:

   a) For driver, this system helps them to locate and select the parking space suited to their requirement.
   b) Saving fuel and cutting operating cost as a addition to reducing the amount of time wasted during commutes.
   c) Reduce the delays for traffic flow which caused by the inefficient search for parking spaces.
   d) Keeping roads and crossing free from obstructions by reducing line-ups while someone wait for a parking place to become free.
   e) For transport authorities, this system offers better distribution of demand by making it easier to control these operation with better data monitoring.
   f) For transport operators, an increase in passengers carried is expected, due to either the expansion of park-and-ride trips, or through modal transfer encouraged through the implementation of more stringent parking control policies and the supply of related information.
   g) Guarantees the desired occupancy levels for parking managers.
   h) For users in general, integrated parking management means more stringent supervision, curtailing illegal parking and helping to reduce traffic accidents.

As explained in *Intelligent transportation systems and parking management* (Vianna, Portugal and Balassiano, 2004) The possibilities of a “smart parking” system are:

   a) Personalized vehicular guidance directed to a single user through display units fitted inside the vehicle.
   b) Prior planning for trips through the supply of relevant information on traffic and facilities (integration and parking status)
   c) The development of services booking or scheduling process, which may be ordered before or during the trip, through communication links with highways.
d) automatic payment and registration through development in the field of vehicle identification, also allowing access control.
e) Integration with other transportation systems through the development of Park & Ride facilities.

2. In the article by Turban and Brahms (2000) card payment technologies can be characterized into the categories contact systems, proximity (contactless) systems, and short range communications systems. Describe the similarities and differences of these different technologies. What are the pros and cons for each technology.

The similarities of those categories is that those categories need both of Identification (ID)-data and identifier devices to recognize which user has been able to receive the service. Those kinds of categories also need a main provider to maintain and monitor the data to keep it safe from tampering or duplication.

The differences of those categories can be seen in the table below:

<table>
<thead>
<tr>
<th>Functionality</th>
<th>Contact Cards</th>
<th>Proximity Cards</th>
<th>DSRC Tags</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Basic ID System (ROM)</td>
<td>Magnetic strip cards and IC EEPROM Card</td>
<td>IC EEPROM Card</td>
<td>ROM transponder systems</td>
</tr>
<tr>
<td>• Limited functionality read/write capability</td>
<td>IC EEPROM Card</td>
<td>IC EEPROM Card</td>
<td>Read/write transponder systems</td>
</tr>
<tr>
<td>• Multifunctional read/write capability</td>
<td>Contact smart cards</td>
<td>Proximity smart cards</td>
<td>Multifunctional read/write transponder systems or smart card inserted into RF transmitter</td>
</tr>
</tbody>
</table>

Note. DSRC = dedicated short range communication; ID = user identification; ROM = read only memory; IC = Integrated circuit; EEPROM = electronically erasable programmable memory

Pros and cons:

<table>
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</tr>
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<tbody>
<tr>
<td></td>
<td>Relatively inexpensive</td>
<td>Not requiring physical contact</td>
<td>Wider recognizing system (up to 200 ft)</td>
</tr>
<tr>
<td></td>
<td>Readily available from many vendors, and used in a wide range of applications</td>
<td>last longer and allow for significantly faster through.</td>
<td>thicker than credit card size magnetic strip cards or contact smart cards</td>
</tr>
<tr>
<td></td>
<td></td>
<td>limited range (between 1 in and 1 ft)</td>
<td>more expensive than proximity or contact card (between $700 and $4000 each reader, and between $25 and $45 for each tag)</td>
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<tr>
<td></td>
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<tr>
<td>Cons</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Have a small amount of data storage</td>
<td>The data usually &quot;read-only&quot;</td>
<td>Thicker than credit card size magnetic strip cards or contact smart cards</td>
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<tr>
<td></td>
<td>The data usually &quot;read-only&quot;</td>
<td>repeated and long-term use may cause the magnetic strips to lose their magnetism</td>
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</tr>
<tr>
<td></td>
<td>Criminals can change or duplicate magnetic strips fairly easily</td>
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</table>
3. a) Describe the general motivation for introducing congestion charging in an urban area. Which are the main problems to be solved, and why is electronic fee collection a part of the solution to those problems?

General motivation:

The consequences of rising car-ownership (demand) and use is the steady year-on-year decline in patronage for most forms of public transport. With the limited infrastructure, congestion charging is an option to manage the demand for car travel (Blythe, 2005).

The main problem of congestion charging is the additional infrastructure needed to charging system. Charging system should enable the collection of these charges at normal highway speeds and without the need for segregating vehicles into separate lanes, as with conventional toll-collection facilities (Blythe, 2005).

Electronic fee collection can be the solution since this type of collection system can act as an efficient charging mechanism that can levy road-use charges automatically from drivers without the need for them to stop and pay (Blythe, 2005).

b) Describe the technology of a future urban congestion charging scenario. Describe and explain which technologies you predict to be the most frequently used.

Future technology for urban congestion charging scenario:

- Microwave-based dedicated short-range communication (DSRC) systems
  
  These systems need road-side equipment, typically mounted on a gantry, with electronic tag in the vehicles which may be read-only, re-write or smartcard-based. Read-only tags operate reliably only if used for single-lane operation at low speed and over a short range. The code relates to the identity of the vehicle or the identity of the user's account. More advanced tag is the "read-write" tags which are a logical development of the read-only tags. The most flexible in-vehicle units (IVUs) are transponder (smart tags) that often support smartcard interfaced to them.

- Wide-area communications-based systems

  As a more recent innovation in charging and tolling technology, wide-area system also widely known by the term MPS (Mobile positioning systems). This system use two technologies which are GPS (Global Positioning System) whose satellites enable suitably equipped vehicles to calculate their location accurately and a two-way communications link based upon either GSM or DSRC. The in-vehicle unit (IVU) contains a GPS receiver and some computing and memory, which must contain a record of the location of all charging points either pre-stored or downloaded directly via the units communication link.
An MPS (Mobile Positioning System) lends itself to distance-based and zone-based charging as well. Such a system was planned to go live on the German autobahn network in 2002.

- **Video-based license-plate recognition**
  
  In Video-based system, the system rely on the accurate "reading" of vehicles' license plates as the primary means of identifying, charging and enforcing vehicles in a congestion charging scheme. Automatic number plate recognition (ANPR) systems process the video images taken by a camera at the roadside or on a gantry, locate the plate in the image and convert this into the appropriate alphabetic/numeric characters, without any human intervention. By these scheme, it can remove the need for any in-vehicle equipment to be installed. Unresolved problems with ANPR are:
  - Number plates of many and different shapes and size
  - Number plates which are not retro-reflective
  - Difficulties for accurate reading in poor weather, due to dirt/rain/snow
  - Non-standardised fonts
  - Similarities between some letter/numbers.

Because of the simplicity of operation, potential for supporting additional services for vehicle users and easy for users to understand (just pass a point and pay), **DSRC-based system** will be most frequently used in the future time.
4. Describe the concept of marginal cost pricing for tolling of heavy goods vehicles. Give examples of parameters which can be part of the marginal cost. Give an example of a price list for the per kilometre charge if these parameters are used. Focus on the parameters (factors) that are included, and spend less time thinking about the actual per kilometre price for each of the parameters. Why is marginal cost pricing believed to be a fair way of paying for the use of infrastructure?

The concept is about calculating the maximum allowed gross laden weight, number of axles and the type of suspension which give additional cost to the society. The difficulties of heavy good vehicle to have a manoeuvre on the road (because of its dimension and space needed) can lead to the congestion, noise and high level of pollution. Those effects give cost impacts to the other road user and environment as well infrastructure. As the result, heavy goods vehicle should be charges which is called marginal cost. This marginal cost was included the cost of:

- Road maintenance
- Environmental effect/impacts
- Congestion and accident
- Fuel consumption

The example of marginal cost calculation is about congestion cost which caused by longer travel time of vehicle than usual. At the current traffic condition, the number of vehicle is 2,000 cars/hour and one additional car can cause the delay time 0.1 second larger, so as the results in social marginal cost is about 2000*0.1 = 200 in larger total time.

Marginal cost pricing has been believed to be a fair way of paying for the use of infrastructure because it was directly related to the extra-costs for the negative impacts which caused by heavy goods vehicles. By his pricing method, operator can safely covered the maintenance of infrastructure.
Freight Transport Management

1. Consider the three main objectives of ITS; (1) increased safety, (2) reduced environmental impact and (3) enhanced profitability. With respect to these objectives briefly present five ITS-applications of relevance for the freight domain that focus on (some of) these objectives and discuss to what extent you think these applications are able to achieve their objectives.

- **Food processing**

  People are becoming more concerned about what they eat everyday. There is an increasing desire to know both what it is that is being eaten as well as where it has come from. This in turn is leading to a strong requirement to move towards full traceability solutions. Initiatives for item level tracking are well advanced in some areas such as tracking of beef products and requirements are getting stronger in many others. The organisations that can show full traceability are the ones that can make gains in customer satisfaction and market share as well as demonstrating the inherent safety of their products, the quality of their processes and the strength of their corporate governance. Small and cost effective RFID tags in the MHz and GHz frequency bands will be key in a range of food products to increase safety and maintain consumer confidence.

- **Farm Management**

  Radio-frequency identification (RFID) is currently being deployed in government mandated livestock identification schemes across the world. RFID in its basic function can help authorities identify animals, especially when traceability becomes paramount during disease outbreaks across regions. (Trevarthen and Michael, 2008)

  The use of RFID will assist farmers to maximize their productivity – an important aim in the modern competitive dairy industry. It is expected that the new farm management practices enabled by RFID will allow farmers to increase the volume and possibly the quality of milk output from their herd. This may be achieved through improved practices to monitor the health of their herd – thus minimizing illness and subsequent low production of cows, speeding up the milking process – thus enabling the cows to return to the paddocks quicker, optimizing feed to suit each cow production and stage of lactation cycle etc. The use of RFID for automation will also aid to minimize labor inputs, thus allowing each farmer to cater for
more cows, or enabling farmers to have more time to spend on other activities – either way, maximizing results from their input. (Trevarthen and Michael, 2008)

- Flight Industry

In flight industry, RFID is very useful for baggage tracing for the customer. By tracing the baggage, both of customer and airport operator can easily find the baggage with time and energy saving as a result.

For example, Delta’s RFID-enabled baggage system will give the company the ability to track a bag from the time a passenger checks it in at the departure airport till the time the bag is claimed at the baggage carousel at the arrival airport. At check-in, the RFID tag’s serial number will be associated with the passenger’s itinerary. Delta will position fixed readers at check-in counters and on conveyor belts where the bags are sorted. The airline will also equip baggage handlers with portable readers and outfit aircraft cargo holds with built-in readers. These can also be positioned to scan bags as they are loaded and unloaded from the unit ULD containers that are loaded into the hold. Through this surveillance system, Delta should be able to all but eliminate the problem of misloaded and misdirected checked luggage, and the attendant costs of reuniting the lost bag with the passenger.

- Forest industry

Automatic identification system (in this case is RFID) can be used in the context of Supply chain management to clearly identify the product in the supply chain and make an essential contribution to the supervision and even control of the product flows. This produces a clear picture as to which products are at a specific place at specific time. By this system, rotation cycles in the timber supply chain can be shortened and quality losses can be reduced.

- Distribution

The difficulty in preserving the nutritional characteristics of fresh food-stuffs during transportation presents a direct problem to food distributors where the perishability of the produce requires it to be handled in ways not necessarily conducive to the traditional view of cost effective distribution activities. Fresh vegetables provide a representative example of perishable goods; the nutrition value and taste are at their best directly after harvesting, decreasing as time elapses until the food is spoilt (Osvald and Stirn, 2008).

2. a) In (Shladover, 2005) several projects that focus on automated road transportation are mentioned. What are the driving forces behind these projects and which are the main technical challenges?

Driving forces behind the project:

- Freight movement is vital function for all human activities, especially critical to the viability of modern industrialized society.
- The cost of moving the goods is an unavoidable part of the cost of production, but it can be reduced by use of the most efficient goods movement technologies.
- The cost of unskilled manual labour is high in all modern industrialized countries. This produces strong economic incentives to replace that labour with automation technologies wherever it is feasible.
- The process within factories typically operate at very low speed within a carefully structured environment. These kind of restriction make it feasible for first-generation automation technologies to operate safely and effectively.
• Although use of the automated movement increased the capital cost of the terminal, it produced savings in maintenance and operating cost.

Main technical challenge:
Main technical challenges is about dedicated lanes for the automated trucks. There are several technologies needed in all cases, which are:
• Electronic control of steering
• Electronic control of engine
• Electronic control of braking
• wireless data communications among the vehicles
• Measuring vehicle longitudinal position on roadway and relative to forward vehicles (GPS, radar and lidar system becoming available, but with somewhat limited capabilities)
• Measuring vehicle lateral position on roadway and relative to roadway and side and rear approaching vehicles.
• Human -machine interfaces to enable drivers to move between manual and automated driving
• fault-tolerant control software and computer(s) to maintain safety even when failures occur

b) These kinds of projects exist both in Europe and North America, but do you think the objectives and contexts are the same or they differ to some extent (discuss and elaborate on potential differences the regions in between)?
Although the transportation system needs and institutional environment are somewhat different on each continent, there are still significant similarities in the approaches that have been adopted. Some of these projects are focused on development of generally applicable technological capabilities for freight transport automation, and the other are focused on addressing location-specific needs. Although purely technological issues tend to be universal, the trade-offs that must be considered in selecting the most appropriate technologies are heavily dependent on local consideration such as the cost of alternatives, the institutional structure of the freight industry and its customer and transportation system condition.

3. a) Benchmark the use of three technologies satellite positioning, RFID and bar coding as means of both tracking and tracing freight. In addition elaborate on the strengths and weakness of each type of technology and exemplify how each of them are (alt. could be) used in practice by establishing three scenarios.
The table will describe about the strengthness and weakness of each type of technologies

<table>
<thead>
<tr>
<th>Type</th>
<th>Strengthness</th>
<th>Weakness</th>
</tr>
</thead>
</table>
| Satellite positioning | ✓ Detecting current location of movement (goods)  
✓ Provide reliable location and real-time information  
✓ Have high range of coverage area | × depend on weather  
× needs high energy consumption |
| Barcode             | ✓ Has been a popular method for identification of product  
✓ Can be used in database identification  
✓ Have low cost since cuncume low energy | × operated manually  
× highly influenced by the dirty condition  
× Limited identification of item (just the type) |
<table>
<thead>
<tr>
<th>RFID</th>
<th>✓ Specifically identify the item</th>
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<tbody>
<tr>
<td></td>
<td>✓ clearly independent from dirty</td>
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<tr>
<td></td>
<td>condition</td>
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<tr>
<td></td>
<td>✓ capable to traced, tracked and</td>
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<td></td>
<td>sensed</td>
</tr>
<tr>
<td></td>
<td>✓ capable to be updated without</td>
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<td></td>
<td>line-of-sight</td>
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<tr>
<td></td>
<td>✗ limited coverage area</td>
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<td></td>
<td>✗ high cost of investment</td>
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</table>

The implementation scenario between satellite positioning, RFID and barcode on the timber supply chain management:

The workers of wood company using **satellite positioning (GPS)** where the right of cutting location for wood and GPS is also used for identifying truck location and distribution control. Before the material transported to the distribution centers, **RFID can be tagged on the containers in the production unit**. It is use to identify and track the material condition i.e. the position, the quality of material in good condition, etc. Finally, **the Barcode can be tagged in the product itself** because barcode system is cheaper than RFID.

**b) For which purposes do you think an international railway freight operator would benefit from using a tracking device on its railcars? What technology/-ies would you recommend the company to use, in which context and why?**

Benefit from using tracking device on the railcars are:

- More efficient train dispatching
- Better utilization of line capacity
- Reduced energy consumption
- Reduced power consumption on electrified lines
- Reduced wear on vehicles (and track)
- Improved working environment for dispatchers and drivers

Technologies recommended for the company are:

- RFID can be used to monitor the trains included the containers within the commodity still in good conditions i.e. the temperature, the packaging, etc.
- GPS can be used to detect the position of goods during the distribution process
- GSM can be used to send information to train control center or either operator and the customers about the condition their packages.

**4. What current or future technologies/concepts do you think will be revolutionary for ITS applications within freight management and logistics (motivate your answer)?**

The combination of RFID, GPS, GSM and even barcode technologies can be revolutionary for ITS applications within freight management and logistic.

By this combination, the company can reduce the unexpected cost during the movement of the goods such as the road congestion. It will be addressed by using GPS to monitor the road condition. Company also can control the process of movement based on the type of good which contained by RFID tags system. Again, company can help the customer to trace the goods by using both of RFID and GPS. Company can control the amount of in-and-out goods by checking the barcode of each goods. Government also can get benefit by the ease of goods controlling by RFID system (in the case of on-the road goods regulation)

All of these system work can maximize the productivity of goods company and in the end also can maximize the benefit to the entire society.
References


