

# A CRITICAL OVERVIEW OF DRIVER INFORMATION SYSTEMS; THE NEED IN LARGE CITIES

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## ABSTRACT

The growth of traffic has exacerbated a number of problems like congestion and delay. In the field of dynamic traffic management, providing systems that disseminate necessary information to drivers and guide traffic according to the most efficient paths considering the current traffic conditions has been a central idea. Information technology gained predominance as the limitations of traditional traffic engineering became apparent. This paper elaborates on Driver Information and reviews critically current technologies available. Need for the applications of such systems is also addressed.

**Key Words :** Information technology, Driver information, Route guidance

## SÜRÜCÜ ENFORMASYONU SİSTEMLERİNİN BİR KRİTİĞİ; BÜYÜK KENTLERDEKİ GEREKSİNİM

### ÖZET

Araç trafiğindeki artış, tıkanıklık ve gecikme gibi problemlerin de büyümesine neden olmuştur. Dinamik trafik yönetimi çerçevesindeki ana fikir, sürücülere gerekli bilgileri veren ve anlık trafik koşullarını gözönüne alarak en uygun güzergah üzerinden araçları yönlendirebilecek sistemlerin uygulanmasıdır. Klasik trafik mühendisliğindeki sınırlar nedeniyle Enformasyon Teknolojisi önem kazanmıştır. Bu makalede Sürücü Enformasyonu sistemleri tanıtılıp, uygulamada olan tekniklerin kritik bir incelemesi yapılmıştır. Bu tür sistemlere olan gereksinim de ele alınmıştır.

**Anahtar Kelimeler :** Enformasyon teknolojisi, Sürücü enformasyonu, Araç rotalama

### 1. INTRODUCTION

Transport enables socio-economic relationships to be developed and sustained. This is manifest in the continuous dependence on transport of various kinds to move goods and passengers. To neglect transport would be to bring society to standstill, literally and metaphorically. The introduction of the automobile put personal transport on the top and increased the need for more road infrastructure. Furthermore, as populations and economies grew, demand for road transport increased. The more the demand for individual mobility, and hence roads, the more the complexity of the road transport problems. The number of cars per kilometre of road is growing each day. At the same time, lack of space, budgetary

priorities and environmentally considerations have restricted the extent to which new construction and increases to road capacity can be carried out. In addition, the growth in city sizes and road networks have aggravated the overall transport problems and experts are continually seeking alternative solutions to these problems. Mobility has always taken an important part in people's lives. Distances travelled by both people and goods increased as the century wore on, through the development of both the transport sector and the corresponding infrastructure. Accordingly, it can be said that people tomorrow will be more mobile than ever before. Although the growth of traffic builds up considerable problems, people still desire to travel as smoothly as possible. To provide better

transportation systems for the 21st century, it is necessary to integrate man, vehicles and network as well as to improve the safety and efficiency of transport systems. However, several unfortunate consequences caused by transportation, such as increasing energy consumption, pollution, road accidents and traffic congestion, can be mentioned.

At the beginning of the 1980s' the coupling of computers and telecommunications resulted in the introduction of Driver Information (DI) systems to ameliorate the day to day traffic problems faced by drivers who seek information on traffic situations, road and weather conditions and other traffic related information through different media. As the 21st century is approached, technology is developing more rapidly than ever before. Therefore, there is need for traffic information and communication systems offering effective solutions especially where physical changes to the existing infrastructure, such as constructing new links or widening roads and so on, are almost impossible.

## 2. CONCEPT OF ROUTE GUIDANCE

### 2.1. Introduction

As a general concept Information Technology in transport, that came into the limelight in the 80's in order to be able to cope with transport problems and introduce necessary solutions as economically and environment-friendly as possible, can be classified as follows:

- a) Traffic Management and Control (i.e. Urban Traffic Control, congestion monitoring, incident detection, ramp metering, speed control, lane use control, access control),
- b) Public Transport and Fleet Management,
- c) DI and Route Guidance,
- d) Automatic Debiting, and
- e) Communication Links and Intelligent Systems.

From the above classification, Route Guidance (RG), which is meant to route vehicles on to minimum cost paths, is one of the technologies applied in the road transport sector to ameliorate traffic problems.

Information for RG is available in such places as traffic control centres, local authorities, police, motoring organisations and meteorology centres. The question is how to collect, collate and disseminate it. To do this successfully, following objectives for determining an optimum route are identified by Catling (1994-a).

- Guide to major roads and keep vehicles staying on the same road as long as possible,
- Guide to the route that has stable, small variance in travel time,
- Guide to the route where there is no congestion,
- Guide to the route that passes through as few intersections as possible,
- Guide to the route with the shortest travel time,
- Guide to the route with the shortest distance,
- Guide to the cheapest route,
- Guide to the route where number of turns is minimum, and
- Guide to the route that avoids going through a certain area of town.

Therefore the expectations from dynamic RG can basically be listed as follows:

- Improve mobility for travellers in the region,
- Reduce travel times and operation costs,
- Reduce transportation infrastructure costs,
- Improve highway safety,
- Reduce transportation energy consumption, and
- Reduce transport-generated pollution and noise.

### 2.2. What Will Drivers Need ?

Drivers needs for information will change with circumstances and with degree of familiarity with the network. The most likely information they wish to be given is:

- a) Shortest recommended path,
- b) State of the road and weather conditions,
- c) The general traffic situation (in order, basically, to estimate the travel times), and
- d) Any unexpected incident ahead.

Some factors are relatively important, such as travel times, length and ease of the route and road surface conditions, from drivers point of view at the pre-trip stage. Furthermore, accidents, road and weather conditions are also needed by drivers. To meet drivers' needs two types of data must be available:

- a) The distance between junctions and the type of road (for providing an indication of the capacity and average travel speed) and
- b) The actual operation conditions (describing transient variations in the network caused by, for example, unexpected traffic flows, bad weather, roadworks and accidents).

In order to collect these two basic types of data, there are a number of methods: The network data can be obtained from some places, like local traffic control centres, police, and motoring organisations. However, for up-to-date traffic data closed-circuit television systems, automatic vehicle detectors (inductive loops, ultrasonic, infrared sensors

and etc.) and image processing techniques are necessary.

### **2. 3. Need For Route Guidance**

Drivers normally reach their destination by following a route through the road network with the help of their previous experiences, maps, street signs, radio traffic bulletins and etc. However, many studies have shown that drivers are unable to select the shortest route leading to some 6-8 % errors. Preventing this by even static RG could save up to 400 billion vehicle-km per year (Anon., 1993).

Furthermore, the function of RG is not only to guide vehicles through unfamiliar areas, but also, with denser traffic and much more population expected, to provide solutions for crowded cities in terms of reduced travel times and fuel consumption. For example in Europe in the year 2000, a reduction in accidents by 2.5 % to 6 %, a reduction in travel times by 3.5 % to 9 %, and a reduction in fuel consumption by 4 % to 10% are the values estimated to be achievable as a result of RG applications (Jeffery, 1986). Some research is being performed on valuing the wastage caused by lack of knowledge about the most convenient route, for both private cars and commercial vehicles. Similar studies are trying to determine the benefits from establishing DI systems on networks.

For example, Günay (1996) assessed the technical benefits of collective RG, considering a System Optimising approach, in order to be able to propose a better traffic management system for İstanbul. His study revealed considerable differences between guided and unguided traffic.

Incidents causing major congestion are likely to occur on motorways and main links of large towns. The delays caused, therefore, have priority to be examined. For instance, in Great Britain, delays due to major incidents were estimated to cost about \$ 150 million per annum (Russam and Jeffery, 1986). This figure will have increased with car ownership and traffic levels. Another aspect to the time-loss on highways is poor routeing. It was claimed (Russam, *ibid.*) that the average inefficiency incurred by the drivers' choice of route is about 6 % when compared with the minimum cost routes which could have been used; however, about one third of this waste is incurred on journeys for scenic or other reasons and would be unlikely to benefit from improved guidance. It is significant that this average inefficiency was made up by most drivers making a few relatively large errors

## **3. RG TECHNOLOGIES**

### **3. 1. Introduction**

Categorisation of RG technologies can be in different forms. Some researchers prefer to classify them according to the location of basic routeing process as vehicle based and infrastructure based. Another approach is on the basis of information communication types described in Section 4. In addition to these classifications, Figure 1 outlines a more systematic structure in accordance with the methods of disseminating information to drivers.

### **3. 2. Pre-trip Information Services**

Before journeys, drivers can get some supplementary information, which is not covered by previously printed maps. This information usually gives road and traffic conditions and shows which route is best at a particular time. These services are the media (i.e. newspapers, pamphlets and TV) and the telephone. Personally tailored maps and itineraries obtained from interactive video text systems of the motoring organisations or proprietary packages can also be mentioned in this category (Bonsall and May, 1989).

### **3. 3. Roadside Displays**

Information can be given via roadside displays, in two different ways as fixed road signs and Variable Message Signs (VMS). VMS can be used for collective dynamic RG purposes. The advantage of VMS is that the information is seen by all road users. Nevertheless, there is a problem of compliance. Giving explanatory messages is likely to increase system credibility. However, Bell (1994) argued that advice rather than explanation may reduce the variation of driver response. He also stated that variation in speed among vehicles is an important risk factor.

The provision of collective dynamic RG involves the following steps:

- (a) Data collection,
- (b) Processing of traffic data,
- (c) Classification of traffic information and
- (d) Dissemination of messages.

Motorways are the main areas of their use to disseminate information about reduced speed limits, the number of lanes which are closed to traffic, ramp metering, road surface, weather conditions and traffic situations ahead. VMS are used to show lane availability in "tidal flow" traffic schemes as well; matrix signs, mounted on gantries to provide one

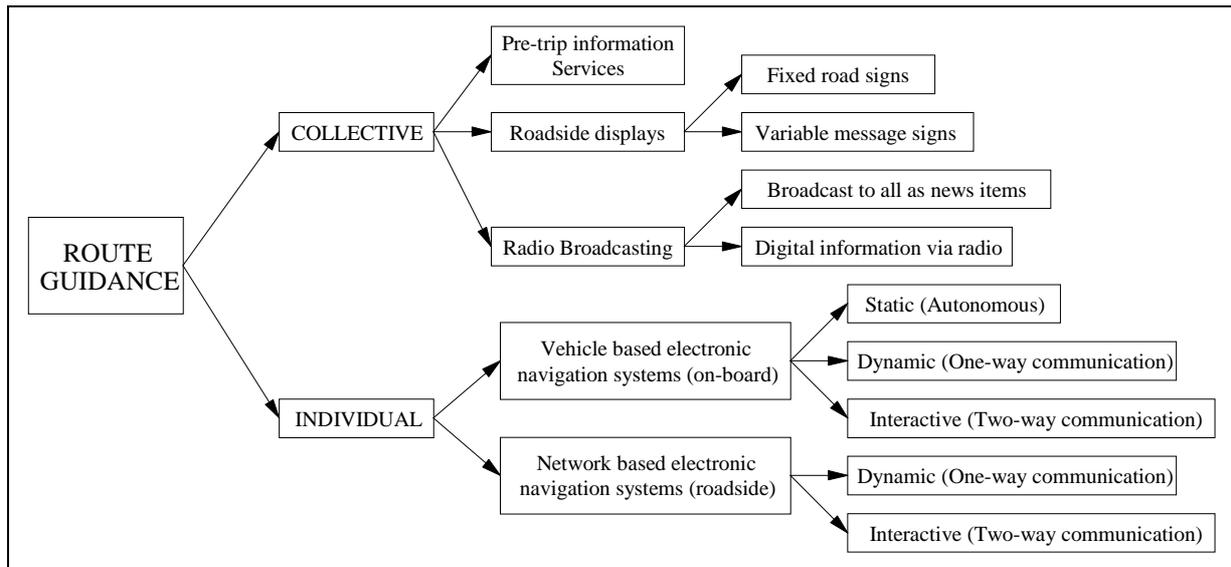


Figure 1. Outline of basic route guidance methods

sign over each lane, can show lane availability, by either a white downward arrow or a red cross. An example of such a scheme is on London's Albert Bridge. Günay (1997) introduced another employment of Keep in Lane variable messages to improve the quality of traffic flow in untidy flow situations which is mainly observed in developing countries. In order to show whether there is space in a car park or not, VMS can also be used. Fibre optics, technically, are based on the ability of smooth strands of transparent materials, commonly glass, to conduct light with little transmission loss (Wyman, 1995). As an example, Glasgow's CITRAC is a traffic control scheme which uses fibre optic technology together with secret signs to show speed limits. Another common way of giving information through VMS is LED technology which is considerably cheaper than conventional traffic signals (Mayer, 1997).

Studies on VMS showed considerable accident reductions. Even in the early years of their applications, a reduction of 29 % in Germany and of 20 % in the Netherlands have been observed (Bolle, 1985; Beukers, 1984).

The cost of a VMS installation can be expected to vary widely, depending on the number and type of signs used, and the communication infrastructure required for controlling them remotely.

### 3. 4. Traffic Information Broadcast Systems

Although there are some radio broadcasts disseminating road and traffic news by either local or national channels, because many drivers do not hear the broadcast or the information is not relevant

to some road users, this general service is relatively inefficient. According to Russam and Jeffery (1986) the efficiency is raised by traffic broadcasts having electronic labels which enable frequency scanning radios to switch the set to receive the message, as in the German Autofahrer Rundfunk Information (ARI) system. Traffic information broadcasting systems are used basically to advise drivers of traffic incidents and hazards, and to encourage them to divert or postpone their trips according to the network situations. The ARI system, whose main function is to assist in tuning to the broadcasting stations which provide traffic information and to alert the driver when a traffic broadcast is imminent, can be given as an example.

Cellular-radio networks or low-power transmitters can be used to target the information better. In order to meet drivers' particular needs, digital transmission techniques, enabling the information to be selected, are also used. In addition to this, the Radio Data System (RDS), proposed by the European Broadcasting Union, enables digital information to be superimposed on the normal VHF/FM broadcasts. SOCRATES (System Of Cellular Radio for Traffic Efficiency and Safety) is based on the Global System for Mobile Communications (GSM) cellular radio network (Catling, 1994-b). The downlink from the base station to the vehicle is operated in a broadcast mode for disseminating traffic information. The uplink to the base station allows multiple access by floating cars in order to collect travel time patterns. A special vehicle unit would be required to decode the traffic information which could then be displayed either as internationally recognisable symbols, or as synthetic speech (Jeffery, 1986).

The Radio Data System-Traffic Message Channel (RDS-TMC) is able to transmit 50 to 100 bps (i.e., about 50 messages per minute) of digitally coded traffic information as an inaudible signal via the ordinary FM radio channel. Digital radio transmission is used so as to update databases containing road network information as well. It can be used to inform either roadside or in-vehicle equipment as a part of the automatic guidance system. The advantages of RDS-TMC systems can be summarised as follows:

- a) Information can be filtered (drivers receive only what they need),
- b) Information can be called up whenever needed,
- c) Information can be up-to-date any time,
- d) Information can be broadcast in different languages and
- e) There is no need to lay cables, compared to beacon based RG techniques.

The disadvantages of the system, however, are:

- a) A high repetition rate of broadcasting information is needed (traffic situations change rapidly and drivers need information at a specific time); and sometimes,
- b) Too many incidents occur in one area.

The American Highway Advisory Radio (HAR) system is now widely used in America and two different radio frequencies are allocated for this purpose. A subsequent development of an Advanced HAR (AHAR) system attempts to avoid the need for manual tuning of the car radio by using a subsidiary FM receiver which automatically mutes the car radio to its initial state after the roadside message has been repeated twice.

The BBC CARFAX system was also proposed for transmitting traffic information. Jeffery (1986) states that the system consists of a network of low power medium frequency transmitting stations all operating on a single channel and sited about 40 to 70 km. apart to cover all or selected parts of the country. Another example is The Rhine Corridor, described by Bouver (1994), in the Netherlands which basically has the following components:

- a) A traffic information collection system at the traffic information centre,
- b) A message generation system, that automatically converts the traffic messages from the traffic information system to TMC messages,
- c) A message data-communication system and

- d) A TMC broadcasting system for the integration of the TMC messages and the distribution to and transmission on all transmitters/ frequencies.

The bi-directional communication could briefly be summarised as follows.

Metropolitan Transportation Centre to Roadside:

- a) Spread Spectrum Radio Systems and
- b) Digital trunking radio.

Roadside to Motorists:

- a) Low-power HAR with flashing signs,
- b) AHAR,
- c) Radio Data Systems and
- d) Cellular call-in.

### 3. 5. Electronic Navigation Systems

Electronic RG and systems basically consist of in-vehicle units, roadside equipment and control centres. It is difficult to start the installation of the ground infrastructure before the wide use of onboard systems is ensured. Onboard equipment for dynamic navigation comprises a transceiver, a router with a display, a locator with sensors, dead reckoning devices and a map memory. The necessary elements to implement the dynamic navigation system are:

- a) A traffic information source,
- b) A ground-vehicle communication media,
- c) Vehicles equipped with navigation systems and
- d) A digital map database.

The result of route optimisation is the recommendation of how to reach a destination from a given starting point. RG can be carried out by the following procedures:

- a) The optimum route for an Origin-Destination, which is based on the map and the travel time of each link, is calculated and
- b) The turning direction is determined from the route and the position of the vehicle.

Traffic Master, as an example, is one of the first in-vehicle information systems introduced. First, the M25 London orbital motorway, and then the whole UK motorway network are the typical application areas of the system. The data is obtained through the sensors installed on highway bridges. In the case of congestion, messages are generated by the control centre and transmitted to the equipped vehicles. The in-vehicle unit visually displays the current status of the motorway network covered by the sensors. The driver, then, receives the information, such as locations and types of the congestion, and the average speed of the traffic. This dissemination is

performed minute-by-minute enabling the driver to make decisions on the convenient route choices.

#### **4. MOBILE COMMUNICATION TYPES**

Four levels of communication are defined in DI applications as briefly discussed in the following:

Type I one-to-many mobile communication provides traffic and parking information to drivers and assists them in making their decision. For instance, AMTICS (Advanced Mobile Traffic Information and Communication System) and practical version of RACS (Road-Automobile Communication System) of Japan belong to this group. Moreover various systems using RDS-TMC are also in this section, like CARMINAT which is based on some other tested systems: CARin, MINevre and ATlas.

Type II mobile communication is a two-way communication system which has some functions like RG, parking management, traffic control and emergency calls. ALI-SCOUT, which uses an infrared communication system, and SOCRATES, which uses next-generation cellular radio system, both belong to this category.

Type III mobile communication is designed to exchange identification codes by two way transmissions and realises individual one-to-one communication such as message and/or data transmission in a dialogue fashion. Automatic Vehicle Identification, Automatic Vehicle Management, fleet management, CACS (Comprehensive Automobile Traffic Control System) and RACS (Road/Automobile Communication System) can be given as examples.

Type IV mobile communication is defined as vehicle-to-vehicle communication, vehicle-to-ground communication and combinations of these two. This type is still in the research phase. It will be used for the purposes of controlling vehicles in non-autonomous automated systems designed to realise functions such as autocruise, collision avoidance, and convoy/platoon. PROMETHEUS (Program for European Traffic with Highest Efficiency and Unprecedented Safety), organised in 1986 and costed about \$800 million, can be considered in this category (Benz, 1994; Whelan, 1995).

#### **5. RG SYSTEMS BEING TESTED**

SOCRATES, a two way communication system, measures travel times of all guided vehicles from point to point, and uses these data as the basis of

determination of the best routes. Expected benefits from this system are travel time and distance savings and reductions in accident, pollution and wear-and-tear on vehicles, roads and people. The system consists of in-vehicle units, roadside units and a central computer. In-vehicle units, an odometer, a compass for dead reckoning and a map pass information to and from roadside units which are connected to the central computer over telephone lines that allows medium range communication. SOCRATES is based on the GSM cellular radio network in each direction. The downlink from the base station to the vehicle is operated in a broadcast mode for disseminating traffic information. The uplink to the base station allows multiple access by floating cars in order to collect travel time patterns. The main disadvantage of the system is the cost of using the mobile phone network. However, a significant benefit of the system is that the use of cellular radio requires no additional infrastructure investment because of the introduction of GSM. Main applications of SOCRATES are:

- DI, RG and trip planning,
- Public transport management,
- Parking information,
- Fleet management,
- Advanced traffic control (controlling traffic flows in order to optimise the efficiency of operation of road networks),
- Data for traffic management and transport planning,
- Instant messages to emergency services and motoring organisations, and
- Tourist information,

The LISB (Guidance and Information System, Berlin) field trial of Ali-Scout (now referred to as Euro-Scout) began in Germany in 1989 (Siemens, 1994). It contained 700 equipped vehicles and 230 infra-red beacons associated with signalised intersections on an 800 km-network. Equipped vehicles transmit the information of their travel time and route between beacons, hence providing real time information on traffic conditions. The central computer uses this information to determine the best routes and sends this back to drivers via the beacons.

In Euro-Scout (Sodeikat, 1993), at the start of users' journey, destination is entered into a small computer in the vehicle. When the vehicle moves, the in-vehicle navigation equipment determines the position of the vehicle. Whenever it passes a beacon, the user receives the best route which has been generated by central computer, for all destinations. Communication is performed through a two-way infrared link. Beacons, which are located next to the

signal heads, can use existing cables when they are mounted with traffic lights. Guided vehicles are able to measure link travel times which are returned to the central computer via the beacons in a so-called vehicle telegram. This information is continually updated at different times of the day in the centre. The system, therefore, is characterised by its centralised feature requiring main information process carried out in the control office rather than in-vehicle units. The system has been introduced in Stuttgart by installing a total of 130 beacon heads on traffic lights. A second example is Berlin with 340 beacons. A third one is in Oakland county, Michigan, with 100 beacons and 1000 equipped vehicles. The basic components of the system are:

- a) The navigation computer (a magnetic field sensor and a display control unit) and
- b) The transceiver.

The start up costs are high with this technique, but in-vehicle equipment costs and the cost of increasing the number of users are low. For comparison, in SOCRATES, start-up costs are much lower while the cost of equipping each vehicle and adding additional users is high. There are also some weak points of the system:

- a) The routing algorithm does not take account of multi-destination users and
- b) The system is heavily dependent of roadside infrastructure and a break down in the centre may cause the failure of the system as a whole.

CARMINAT (Bruneau, 1994) stores the information of traffic conditions collected off vehicle on central computer as database. The system is a one-way communication of traffic information on the down-link by using RDS. The road user receives the information as radio broadcast from his/her car radio. The in-vehicle equipment also contains a map, odometer and compass. The system was developed and used in Paris by Renault and Philips and also introduced in the Netherlands. The objective of CARMINAT is to study and develop a range of systems for the acquisition, transfer, processing and presentation of information necessary and/or useful to the driver (Olberding et al, 1990). The classification of real time data collection can be as follows:

- a) External information-regarding the road and traffic conditions, etc.,
- b) Vehicle diagnostics- regarding the state of the vehicle via sensors located in key points of the vehicle and
- c) Navigation information from wheel sensors.

The system works by implementing the following procedures:

- a) Transmission,
- b) Processing of information,
- c) Dissemination, and
- d) Reception.

CARIN (CAR Information and Navigation System) is an autonomous (static) navigation system used in route planning and guidance. The digital map, stored on CD, shows the best route to a chosen destination by a simplified map and voice guidance by a speech synthesiser. The map display is also capable of giving some general tourist information. Other in-vehicle equipment is a sensor (magnetic compass) and a navigation computer which carries out the main task. The data collection, in terms of positioning and directing, is implemented by the sensors of the vehicle as it moves. This information, updated every three seconds, is used for map-matching. The basic advantage of the system is that it does not rely on any external sources, like expensive beacon infrastructures. The route planner algorithm determines the best route minimising the travel time and/or distance. Because the main disadvantage of the system is being unable to receive the current network and traffic situations, CARIN is being modernised to be able to receive the external information via the car radio with the introduction of RDS-TMC. Moreover, in future CARIN will offer a fully interactive traffic management opportunity using the European D-net telephone system. AMTICS (Advanced Mobile Traffic Information and Communication System), is aimed generally at commercial transport, such as taxis and delivery vehicles, and so provides schedules of air planes and trains, etc. via a general purpose in-vehicle terminal. The system was established in Tokyo in 1988 and in Osaka in 1990 (Kawashiwa, 1993).

## **6. CRITIQUE OF RG SYSTEMS**

In vehicle based systems, such as CARIN (static RG), CARMINAT, AMTICS (dynamic RG), and SOCRATES (interactive RG), the main route optimisation task is implemented by the on board computer. However, infrastructure (network) based RG systems carry out the guidance mainly by the equipment which is outside the vehicle, like Euro-Scout. The algorithm is defined by the traffic management to meet their needs. Therefore drivers may fear that the information received is against their individual benefits. Their hesitation may reduce the acceptance of the system and therefore the desired influence on traffic efficiency. Vehicle-based systems have average equipment costs which can be met by the users. Therefore they can be

introduced to the market without facing serious problems. Nevertheless, infrastructure-based systems, on one hand, offer low cost equipment in vehicle (a simple dead-reckoning navigation device and a transmitter-receiver unit as vehicular components) and fully dynamic guidance but, on the other hand, need rather expensive road side equipment, such as beacons connected to a central computer. The installation of infrastructure devices for acquisition, processing and distribution of traffic data may be complicated and time consuming. Vehicle-based systems have only a limited capability to react to actual traffic situations. Furthermore, the planning process performed by the on-board computer can take into account special wishes of drivers which are appropriate for them, but cannot be influenced by the traffic management authorities. However, in network-based RG systems, with precise knowledge of the road network and the actual traffic situation, the central computer system carries out the route optimisation process. The traffic situation is described by the travel times needed to drive from one beacon to another within the network equipped with a number of beacons. The result of the optimisation is a recommendation of how to reach a destination from the respective beacons.

Such systems discussed above (both vehicle or network based) can only be introduced gradually, especially in developing countries. This is due to the fact that people are unskilled and stranger to these new systems, and may result in inefficient and improper applications. Their applications, also, of course, heavily depend on the life standards of the societies and the economic levels of countries. VMS and TMC are the most convenient systems to be applied particularly in developing countries due to their simplicity and cheapness. A typical VMS only costs about \$225,000 (Miles and Perrett, 1997). More sophisticated systems requiring computer centres, roadside equipment like beacons and in-vehicle units are more likely to be expensive. However, in cities with high traffic levels, the authorities may consider in the near future to establish electronic navigation and information systems with the co-operation of private investors and vehicle manufacturers. In addition to the Western or Far Eastern electronics and car company branches in Turkey, as an example, Aselsan Co., which is quite a successful home-based researcher and producer in electronics field, have already made some attempts regarding Information Technology schemes (Oranç, 1997). Table 1 is the summary of this section outlining most of the currently used IT and RG technologies.

Table 1. Some Examples of The Most Common Driver Information Technologies

NAME	Main Process	Link Type	TYPICAL FEATURES
AHAR (USA)	Central	Type I	In-vehicle radio receives within 3 miles zone. Formerly known as HAR.
ALI (Germany)	Central	Type II	Information exchange between road & vehicle is through the inductive loops. Information display optically is in-vehicle unit.
AMTICS (Japan)	Central	Type I	Information broadcast to drivers (collective) Main functions: Navigation, Supply of traffic information (static or dynamic).
ARI (Germany)	Central	Type I	Information broadcast to drivers (collective). Traffic Information is collected by police and broadcast dynamically.
CACS (Japan)	Central	Type III	Destination can be given to the in-vehicle unit digitally. Central computer determines the quickest route together with VMS.
CARIN (Netherlands)	On-board	Type I	In-vehicle unit is capable of dead reckoning, map-matching, storing and displaying the information. On-board.
CARMINAT (France)	On-board	Type I	Uses RDS-TMC. Computer aided navigation and CD-ROM in the vehicle.
EURO-SCOUT (Germany)	Central	Type II	Beacon based communication between vehicle and ground. Formerly Ali-Scout
PROMETHEUS (Europe)	On-board	Type IV	Vehicle to vehicle, centre to vehicle and vehicle to centre communication. Toward smart cars and highways.
RACS (Japan)	On-board	Type I, II	In-vehicle unit: CD-ROM, odometer & compass. One or two way (via beacons) communications are possible.
RDS-TMC (Europe)	Central	Type I	Digital data inaudibly & in parallel with a normal VHF/FM stereo radio program. Receiving is any time & language desired.
SOCRATES (Europe)	Central	Type II	Cellular radio communication digitally between on-board computer & information centre. Same message for each cell.
Traffic Master (UK)	Central	Type I	Probably the most advanced system of this type.

## 7. CONCLUDING REMARKS

DI systems offer different means which give necessary information to drivers. These information could be about road, weather or traffic conditions. Even if drivers have good knowledge of the road network, there is usually a lack of information about traffic conditions. Thus, significant congestion problems and environmental effects are resulted.

Individual or collective route guidances are the parts of DI task. Collective RG systems such as VMS or Radio Message Channel inform drivers who may be able to divert around an incident or any kind of traffic jam to avoid unnecessary congestion and time delays. Dynamic RG provide real-time guidance based on information on current traffic conditions obtained from vehicles being guided. While DI applications basically offer User Optimum equilibrium conditions in networks, System Optimum strategies can be achieved by RG systems, because DI systems especially with high-cost in-vehicle equipments are purchased by individuals and are expected to satisfy drivers' needs. In the absence of route control, each driver will generally try to minimise his/her own route travel time. This, therefore, will result in user optimum traffic pattern. In most cases, this pattern is considerably different from the system optimum traffic patterns. This is because of some individual drivers who cause larger travel times to the overall system, although their selfish decisions give quicker routes for their journeys. Shorter distance, minimum cost, less traffic, fewer stops and greater safety could also be the indicators of route selection criterion. Traffic and network investment authorities should make their decisions, before spending large amount of money, toward the two-way communication type applications, because in the near future most systems are likely involve this type information systems (Mc Donald, 1996).

This overview has given quite wide ranging information about RG systems and available technologies. Need for such systems in large cities were discussed. Furthermore, it is expected that these systems could only be applied gradually in developing countries in the near future. The degree of acceptance of route control is quite important. In order to be able to predict the likely success of any RG application, some knowledge of driver response to advisory messages is also necessary.

A questionnaire survey is usually carried out for this purpose. Much more research is needed regarding the system operation, while theoretical models are able to give ideas about the systems itself.

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