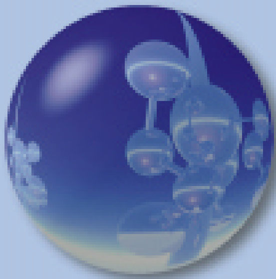
ITS developed by Japanese Police



ITS

Intelligent Transport System

Japan Traffic Management Technology Association

Institute of Urban Traffic Research

ITS developed by Japanese Police

ITS

Intelligent Transport System

Japan Traffic Management Technology Association
Institute of Urban Traffic Research

INDEX

Policy section

INDEX

Universal Traffic Management Systems

Policy section

- Current Road Traffic Conditions And Systems
- Traffic Management and Control by Police
- Traffic administration by the police
- Transport systems and Society
- Theory of traffic management

Current Road Traffic Conditions

The modern society is often called as "the car society." It is true that motor vehicles have been widely used as a transportation medium for people and commodities, and that they have played a very important role in socio-economic development in Japan. Motor vehicles possessed by Japanese people tend to increase year by year, and they have reached in number about 73,220 thousand at the end of 1997. Right above figure shows the numbers of motor vehicles by vehicle type.

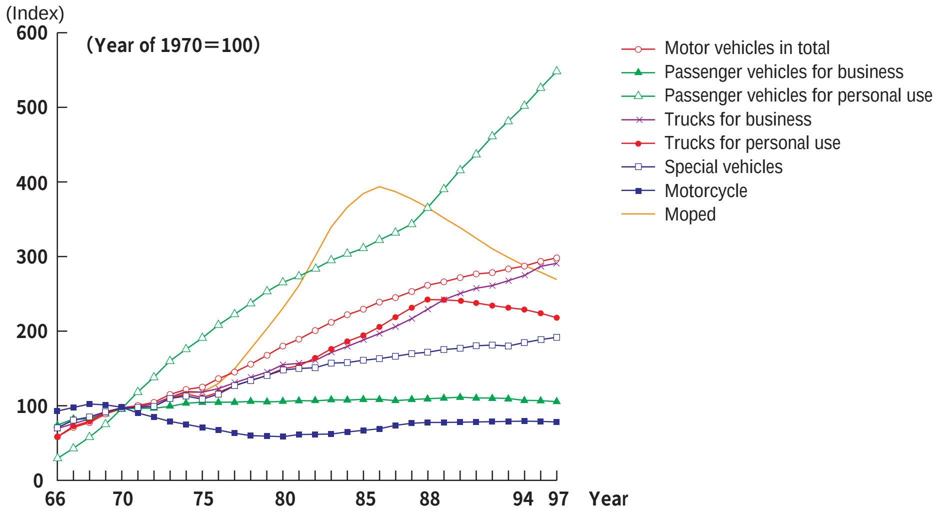
On the other hand, the number of driver's license holders exceeded 50 million in 1984, while it was approximately 26 million in 1970, when the fatalities of traffic accidents recorded the highest in the past. The license holders reached 71,271,222 at the end of 1997. It means that among those who are 16 years old or older and qualified for driver's license test, one in every 1.19 men and one in every 1.88 women, i.e., one in every 1.47 people in total, hold the driver's license. The numbers of driver's license holders are found in right bottom figure.

In this way, motor vehicles have already become essential for our daily lives.

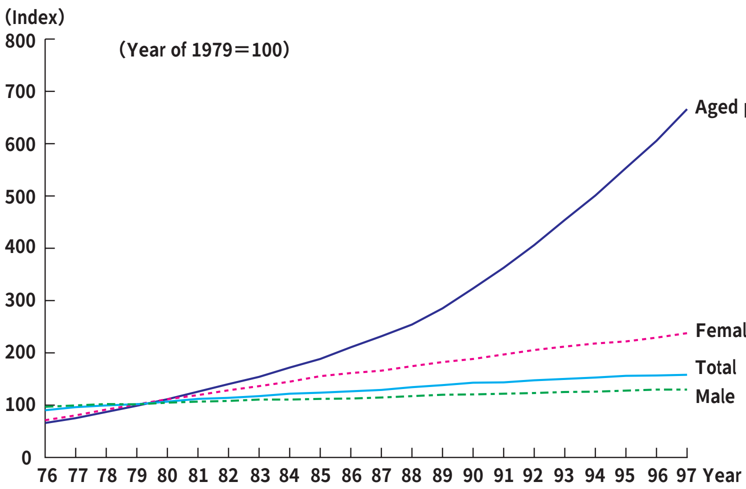
However, some negative aspects of 'the car society' should not be forgotten. For example, the fatalities of traffic accidents run up to 9,640 in 1997. The figure tells us that still now nearly 10 thousand precious lives are lost due to traffic accidents. In other words, about one person is killed in every 55 minutes. As for the number of traffic accident case, the figure of the last year, 779,590, recorded the highest of the past again. This record has been renewed every year in the last 5 years.

In order to deal with the above situations and for the realization of a matured "car society," the Japanese police is performing various kinds of activities including the creation of a safe traffic environment with education for traffic safety, traffic guidance and enforcement, and traffic regulations and safety facilities.

No. of registered motor vehicles by vehicle type (1966 - 1997)



No. of driver's license holders (1976 - 1997)



Conditions of Traffic Accidents

The number of traffic accidents reached 779,950 in 1997 (increased by 8,506 (1.1%) from the previous year), including 9,640 fatalities (decreased by 302 (3.0%)) and 957,481 injured (increased by 15,278 (1.6%)). Although the annual fatalities were less than 10 thousands for 2 years from 1996, the number of accidents broke the worst record for 5 years running. The injured have also kept the 900-thousand level for the last 3 years.

The fatalities of the 1997 are shown in above left figure by situation. The fatalities on motor vehicles come to 4,251, which is the largest figure and equal to 44.1% of the total deaths. Figures of each situation have decreased from those of 1996, except for fatalities on bicycles. The most conspicuous figure is that of deceased pedestrians, which has decreased by 151 (5.4%).

The fatalities in 1997 by age are shown in the bottom figure. For the last 5 years, the aged people have ranked first and the youth (from 16 to 24 years old) have kept second. The shares of the aged people and the youth in the fatalities come up to respectively 2.2 times and 1.6 times as large as their shares in population. Looking into the trends of recent years, the deceased youth have diminished for the 7 years running, while the aged fatalities increased in 1997, though they once fell off in 1996.

Above right figure shows the data of fatalities in 1997 by situation combined with their age, which represents the following distinctions:

- Among fatalities on cars, the youth form the largest proportion (27.5%);
- As for fatalities on motorcycles, the youth make up an overwhelmingly large proportion (55.5%);
- As for fatalities on bicycles, the aged make up an overwhelmingly large proportion (54.8%);
- The overwhelmingly large number of deceased pedestrians are the aged people (59.3%).

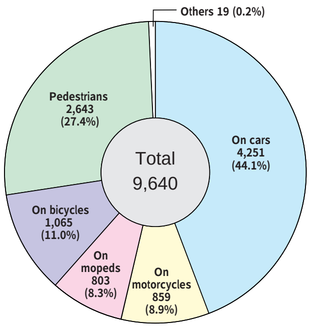
When looking into the fatalities on cars with or without wearing seatbelts, it is conspicuous that fatalities without seatbelts, which amount to 2,696 (decreased by 303 (10.1%) from the previous year), are by far more than the fatalities with seatbelts, that is, 1,338 (increased by 199 (17.5%)). The number of fatalities without seatbelts had been increased for 6 years running from 1988, but it started decreasing in 1994.

Comparing the fatality rates (see note) of deceased on cars with and without wearing seatbelts, the rate of deceased without seatbelts (2.12%) is about 7 times as high as that with seatbelts (0.30%).

Moreover, comparing the fatality rates of deceased on cars with air bags, the rate of deceased without seatbelts (0.33%) is about 10 times as high as that with seatbelts (3.40%).

(Note) No. of deceased/(No. of deceased + No. of injured) x 100

Fatalities of traffic accidents by situation (1997)



Fatalities by situation and age (1997)

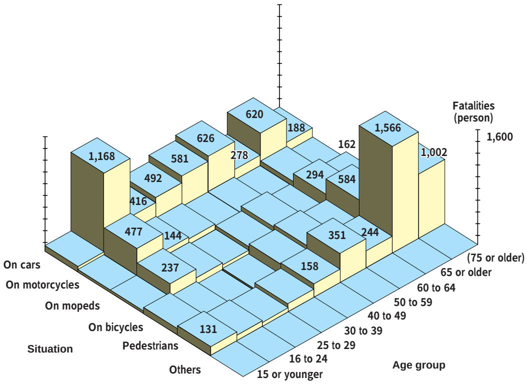
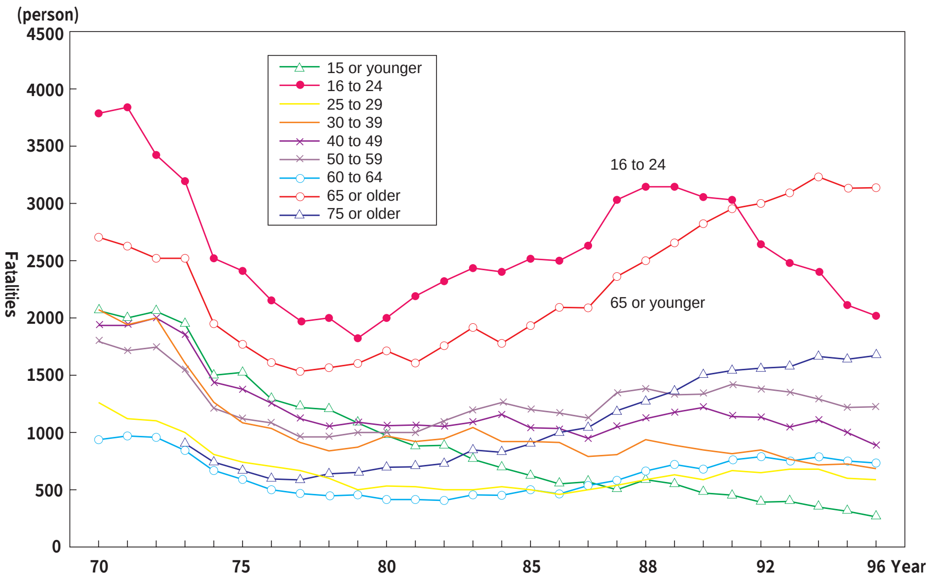


Figure 1-10 Fatalities by age group



Traffic Administration System

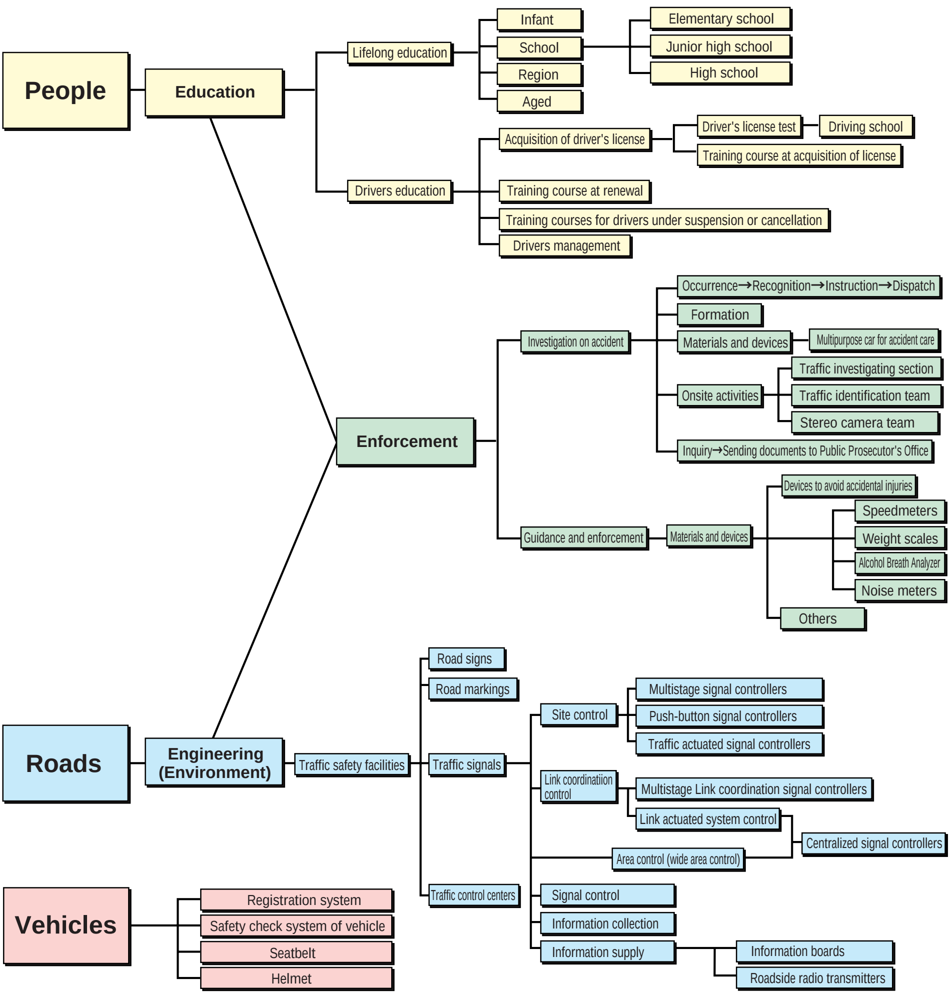
Traffic administration in a broad sense in this country is under the charge of several administrative agencies. Road traffic consists of three elements, "people," "roads," and "vehicles." The road administrators such as the Ministry of Construction take charge of building a part of hardware, the road, and the Ministry of Transport takes the responsibility of controlling another part of hardware, the vehicles, while, the police manages software, that is, the road traffic including 'people,' 'vehicles,' and 'roads.'

As for building roads that is under the charge of road administrators, the Ministry of Construction and local governments, the Ministry of Construction takes responsibility for it under the Road Law and determines the criteria of road structures and fixes the standard on permissible size and weight of vehicles to go through the road. Meanwhile, each road administrator constructs, maintains and manages roads.

Management of the vehicles themselves, which is under the charge of the Ministry of Transport, includes administration concerning the body of vehicles, such as technical standards for safety of vehicles, vehicle registration and insurance. In addition to that, the Ministry of Transport is in charge of authorization to give approvals and permissions of road transportation business like passenger transportation by buses or taxis and cargo transportation by trucks.

The management of road traffic taken charge of by the police consists of 3 'E's as in the right figure: education, engineering(environment) and enforcement.
The general traffic problems concerning economy are under the responsibility of the Economic Planning Agency and the general arrangements of traffic safety measures are of the Management and Coordination Agency.

Main Traffic Measures



Traffic Police Organization

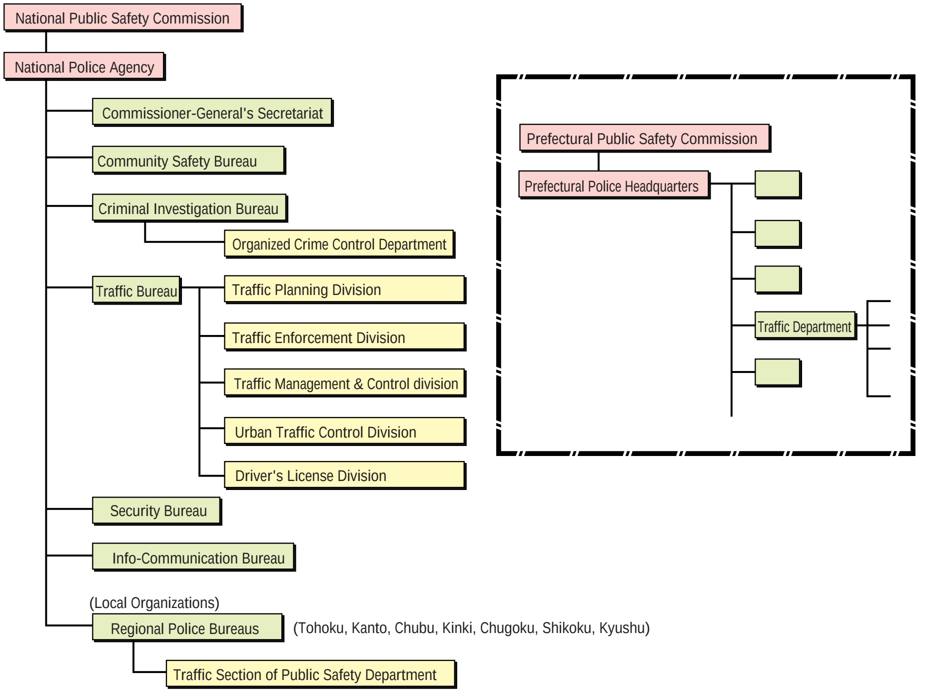
The Japanese police organization is formed by local police organizations and the National Police Agency. Local police organizations are organized in each prefecture for pursuing the duties of police, that is, to protect personal life, body and property and to maintain public safety and order. Under the administration of the Public Safety Commission, which is under the control of the Prime Minister, the National Police Agency was established as the national agency to direct and supervise the local police headquarters within the scope of its official capacity. Furthermore, 7 Regional Police Bureaus operate as its local branch offices.

In the National Police Agency serves Commissioner General of the agency as chief administrator of the traffic police, as well as Deputy Commissioner General as his assistant, and the Traffic Bureau is placed as the internal office in charge of office works of the traffic police. The Traffic Bureau supervises the Traffic Planning Division, Traffic Enforcement Division, Traffic Management and Control Division, Urban Traffic Control Division and the Driver's License Division.

Moreover, each Regional Police Bureau has a traffic department to play a leading role in the traffic police services requiring wide-area arrangements.

Each prefecture has its own police organization, named the Prefectural Police Headquarters under the administration of the Prefectural Public Safety Commission, which is supervised by the prefectural governor. The Metropolitan Police Department operates as the headquarters of the prefectural police organization in Tokyo Prefecture, and as for other prefectures, a Prefectural Police Headquarters has been established in each prefecture. The Superintendent-General of the Metropolitan Police Department and the Chiefs of Prefectural Police Headquarters bear the responsibility of the traffic police administration as chief administrator of each prefecture. Besides, a traffic department is placed in each local police headquarters to deal with desk jobs regarding the traffic police. Each traffic department consists of the section for planning and execution of the traffic police administration services, together with the Traffic Police Squad and the Expressway Traffic Patrol Squad which are taking charge of traffic guidance and enforcement. As for Hokkaido Prefecture, however, the whole prefecture is divided into 5 areas which respectively have the public safety commission and the area police headquarters except for Sapporo area, where the prefectural police headquarters is located.

Furthermore, the Metropolitan Police Department and the Prefectural Police Headquarters divide their territory into districts, each under the jurisdiction of a police station headed by a station chief. As front-line operational units, police station perform their duties in close contact with the local community. Police box (koban) and residential police boxes (chuuzaisho) are subordinate units of police stations, i.e. police stations and the subordinate units perform respective services concerning the traffic police.



National Public Safety Commission
National Police Agency
Commissioner-General's Secretariat
Community Safety Bureau
Criminal Investigation Bureau
Organized Crime Control Department
Traffic Bureau
Traffic Planning Division
Traffic Enforcement Division
Traffic Management & Control division
Urban Traffic Control Division
Driver's License Division
Security Bureau
Info-Communication Bureau
(Local Organizations)
Regional Police Bureaus
(Tohoku, Kanto, Chubu, Kinki, Chugoku, Shikoku, Kyushu)
Traffic Section of Public Safety Department
Prefectural Public Safety Commission
Prefectural Police Headquarters
Traffic Department

Budget for Traffic Police

The budget for the traffic police is composed of the police budget included in the national budget and the local police budget included in the prefectural budget. Expenses for local police organizations are imposed in principle on prefectural governments, but a certain kind of expenses are paid from the national budget.

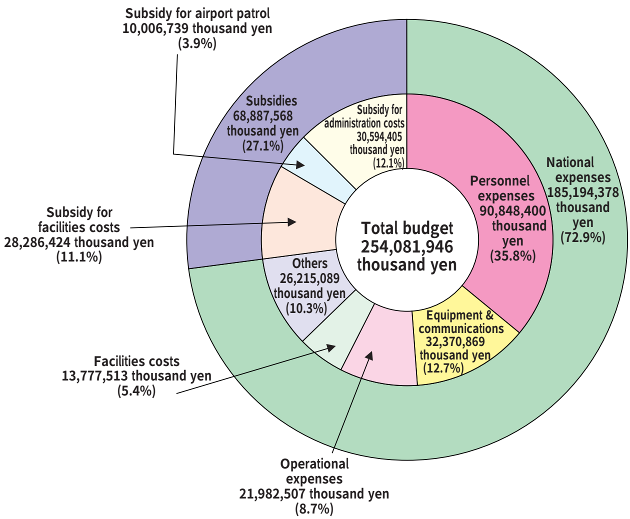
The national budget allotted to the traffic police is used for the police vehicles purchased by local police organizations to utilize for the traffic police, expenses for the police school to foster traffic police officers, special expenses for local police organizations like some investigations of serious traffic crimes, and subsidies to local police organizations to execute programs in accordance with to the Emergency Measure Law Relating to the Improvement of Traffic Safety Facilities.

With regard to the establishment of traffic safety facilities, the Emergency Measure Law Relating to the Improvement of Traffic Safety Facilities has clarified the national government's duty on development of countermeasures against traffic accidents. The national government has made up a plan of installing the facilities together with local governments so that they may positively join the program. Also a subsidy system has been developed under which the national government offers subsidies for a part of expenses for such facilities. In cooperation with the road administrators the Seven-Year Plan for Traffic Safety Facilities Improvement is being earnestly promoted since 1996.

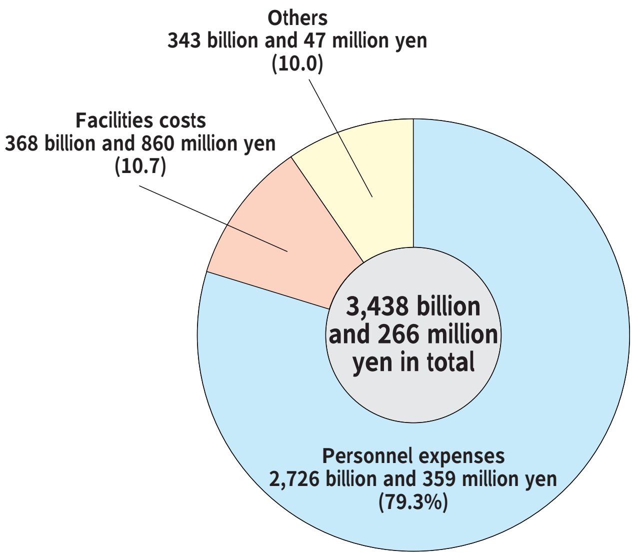
The Seven-Year Plan for Traffic Safety Facilities Improvement consists of the Earmarked Traffic Safety Facility Improvement Programs whose costs are partly or wholly borne by the national government, and the local government's self-programs for Traffic Safety Facilities. The traffic police carries out the said Seven-Year Plan with 840 billion yen for seven years, of which 210 billion yen is covered by the Earmarked Traffic Safety Facility Improvement Program and the remaining 630 billion yen by the local governments' self-programs. As for the Earmarked Traffic Safety Facility Improvement Program, a half of the expenses are granted to the local police headquarters as subsidies, which amounts to 18.413 billion yen in the budget of 1997.

The Universal Traffic Management Systems (UTMS) being an important part of the Intelligent Transport System (ITS) are deployed under the budget for the Earmarked Traffic Safety Facility Improvement Programs, since the systems need to be deployed under uniformed functions covering wide-area throughout Japan and with supply of real time information. In 1997, approximately 75% of the whole expenses of the Earmarked Traffic Safety Facility Improvement Programs are appropriated for deployment of the UTMS.

National Police Agency Budget (at the beginning of 1997)



Local Police Headquarters Budget (at the beginning of 1997)



Traffic Management and Control by Police

The traffic management and control means to manage and control the traffic generally with traffic regulation using signs, markings and signals, supply of traffic information utilizing the traffic control system, and permits of use of roads. It is the duty totally entrusted to the police according to the Road Traffic Law.

The object of the traffic management and control is, as stated in the provisions of the Road Traffic Law, "to avoid dangers on roads, to ensure safe and smooth traffic flow and to support preventing obstacles caused by road traffic." It is not only aiming to prevent traffic accidents but also to create smooth traffic flow. The prevention of the so-called traffic pollution is one of the object as well.

The Road Traffic Law prescribes the authorities of the police to realize these objectives concerning the traffic management and control.

First of all, the Prefectural Public Safety Commissions and the chiefs of the police station have an authority to carry out traffic regulation, which is to be executed with traffic signals, road signs, road markings and onsite instructions by police officers. Traffic regulation shall be executed against a specified object and within a limited area, a certain section of a road or a specified place, and it can be carried out at limited dates or hours.

The traffic information is supplied by the Prefectural Public Safety Commissions to drivers, and it includes essential information for vehicles to go through a road. While the traffic regulation ensures safe and smooth traffic flow by a forcible power called traffic enforcement against offenders, the traffic information supply system aims to ensure the same by stimulating drivers to select the route voluntarily.

The right to grant permits for using roads for constructions, street stall and so on rests with the chief of the police station.

The traffic management and control on national trunk roads is left within the authority of the National Public Safety Commission.

As for the traffic regulations at disasters, which constitutes the exception of the traffic regulations in normal times, the authority at such times also rests with the police.

(1) Traffic regulations by prefectural public safety commissions

By signals

By road signs and road markings

Onsite instructions by police officers

By chief of the police station or chief of the Expressway Traffic Patrol Squad

By police officers or traffic wardens

(2) Traffic information supply

(3) Permit for using roads

Permit for using a road

Permit for entering into the closed road

Permit for parking at no-parking zone

Permit for parking at time-limited parking zone

Permission for releasing restrictions (Permission for carrying load other than fixed equipment, permission for carrying people on deck, and permission for loading beyond limits)

Permit for towing beyond limits

Parking Space Certificate

Traffic Flow Management

Among many duties of traffic management and control, the most important and difficult task is to manage and control traffic flow, that is, to manage and control traffic volume, speed and direction of traffic flow.

Traffic flow is greatly affected by social demands for traffic and geographic conditions of roads. Since motor vehicles continue to increase these days, the volume of traffic flow has a tendency to grow still the more, which causes serious social problems such as traffic jam, noise and car exhaust fumes.

Under these difficult traffic situations, the police manages and controls traffic flow by applying traffic regulations with signs, markings and signals as the base, and by utilizing intelligent systems, especially in urban areas, such as the general traffic control system with link coordination signal functions together with traffic control system to supply traffic information. The adoption of the Universal Traffic Management Systems (UTMS) to be stated later is a new challenge focusing on the Advanced Traffic Control Systems with the key technology of infrared beacon that enables two-way communications between motor vehicles and the traffic control system. With the success at Nagano Olympic as a turning point, the UTMS have started operations one after another.

The police also grapples with many other measures in cooperation with governmental agencies concerned, in order to ensure smooth traffic flow. The main measures include the creation of community zones and the transportation demand management.

The community zone is created to secure traffic safety in the living area of the residents by the cooperation between the police and the road administrator, applying some traffic regulations such as maximum speed restrictions and prohibition of heavy vehicles, and simultaneously adopting physical measures like creation of humps and narrows.

Transportation demand management includes recommendation of staggered office hours to the society through governmental agencies concerned in order to realize time shifting of traffic demands, and it also includes the support to public mass transportation for reducing traffic volume of vehicles through establishing the PTPS (Public Transportation Priority Systems), or by creating exclusive or priority bus lanes.

Community Zone

1 What is community zone

A residential or similar kind of area where pedestrians should be given priority, and which has a certain uniformity and develops aspectual and general traffic measures in order to advance safety, comforts and conveniences within the area.

In the community zone, the safety of pedestrians is ensured by reducing vehicular traffic volume, lowering vehicles' speed, and excluding illegal parking. For that purpose, it is planned and managed with an appropriate combination of software, that is, speed restrictions of 30 km/h within the zone, no-parking regulation, one-way street regulation, etc., and hardware, such as road composed with devices like humps, narrows and so on.

2 Methods of community zone

(1)Software

●Zone 30 (Speed restrictions of 30 km/h within the zone), and no-parking regulation (within the zone)

To designate the community zone and execute speed restrictions of 30 km/h and no-parking regulation in the area. By regulating the whole zone, it aims to prevent vehicles effectively from entering into the zone.

●One-way regulation, directional designation, and stop regulation

To prevent vehicles effectively from passing through the zone area by combining the above regulations. Residents' agreements are required.

●Heavy vehicle prohibition

To ensure the safety by prohibiting heavy vehicles which scarcely have necessity of entering into residential area.

(2)Hardware

●Coexisting road for people and vehicles

To reduce vehicles and their speed and to secure safe space for pedestrians by combining humps and cranks at narrow roads which do not have enough space for sidewalks.

●Humps

To create convex pavement on the surface of a roadway to give uncomfortableness to those who are driving at exceeding speed. Its purpose is to make drivers lower speed at humps by showing in advance that humps are situated on the road.

● Narrows

To reduce the speed of vehicles by narrowing the width of roads physically or visually.

● Chicanes (slaloms and cranks)

To arrange pavement in zigzags (cranks) or winding (cranks) so that drivers may be forced to reduce speed for steering.

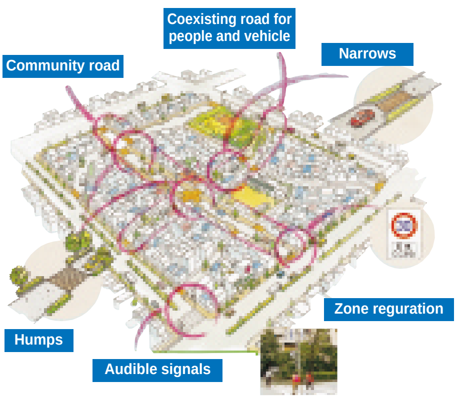
● Uneven surface of pavement

To warn vehicles of high speed by producing small shocks and resonant noises from comparatively small bumps and dips placed at certain intervals in the shape of a belt or from specially processed surface of pavement.

● Audible signals

To tell the visually handicapped people with special sounds that the green light is on at the pedestrians' signal.

Community zone



Transportation Demand Management

1 Meaning of transportation demand management

Traffic congestion is a phenomenon generated from the transportation demand that exceeds the traffic throughput (capacity) of a road during a certain period of time. Accordingly, dissolution of a traffic congestion can be achieved by (1) expanding traffic throughput of the road or (2) adjusting transportation demand to the road capacity. The past efforts to dissolve traffic congestion focused on the method (1). In other words, they mainly took countermeasures against bottlenecks by constructing road networks such as bypasses and ring roads, constructing multileveled intersections and railroad crossing, and improving the intersection configuration, as well as they sought fulfillment and advancement of the traffic control system.

However, the above method has some problems. Sometimes it is necessary to acquire a new site, and in other cases it is not economical to provide a new facility on roads merely due to a limited hours of traffic congestion.

Transportation Demand Management (TDM) is a system to moderate traffic congestion within a city or a region by stimulating drivers to change their traffic actions.

2 Main Measures of Transportation Demand Management

● Bus lanes and Public Transportation Priority Systems (PTPS)

● A scheme to reduce the transportation demand by giving priority to bus, one of the public mass transportation media, in order to expand its convenience and then advance its usage rate.

● Promotion of flextime and staggered office or school hours

A scheme to shift the time period of commuters' transportation in the whole area so that the peak of the morning rush-hour traffic congestion caused by the concentrated transportation demand may be moderated.

● Park and ride

A scheme to lessen the total number of motor vehicles by creating parking lots near railroad stations and bus stops to urge passengers on private cars or other transport of inefficient carrying capacity to change to efficient ones, that is, public mass transportation media such as the bus and the railway.

● Joint collection and delivery

In accordance with the changing social situations, attentive services to offer "whatever required at whenever required" have won popularity, and, as a result, cargo trucks for collection and delivery have decreased their carrying efficiency. It has produced a situation that a considerable number of trucks are currently running on the road. This scheme aims to diminish the number of trucks on the road by advancing joint collection and delivery to increase the carrying efficiency of trucks.

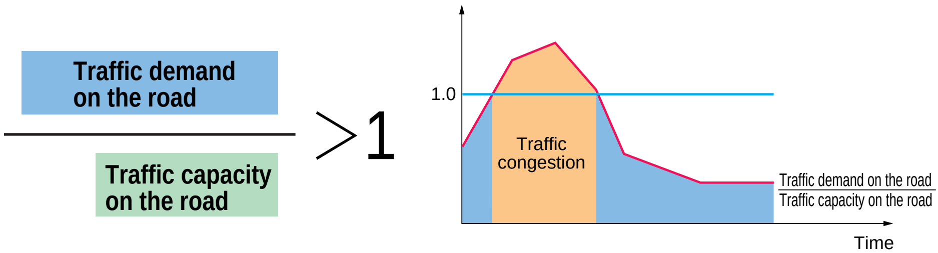
● Road pricing

A scheme to charge a toll concerning congested areas or time periods for promoting utilization of public mass transportation media and for moderating the peak of congestion in rush-hours.

● Driving regulations

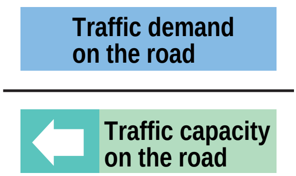
A scheme to restrict motor vehicles on roads within the congested area and time period for the purpose of advancing utilization of public mass transportation media and moderating the peak of rush-hours congestion. License plate numbers are sometimes used for such restrictions.

Mechanism of traffic congestion

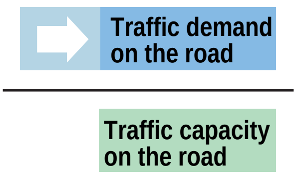


Dissolution of traffic congestion

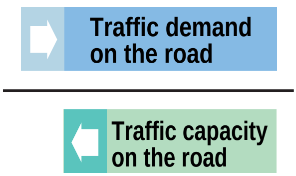
①Expanding the capacity



②Adjusting the demand

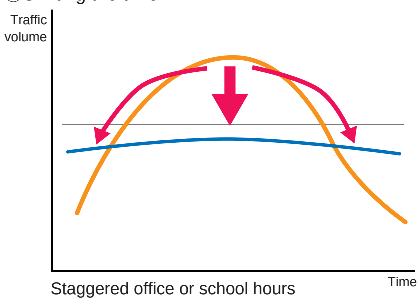


③Combination



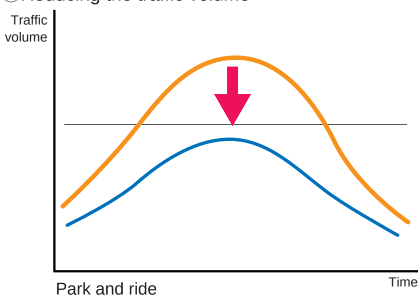
Traffic Demand Management

①Shifting the time



Staggered office or school hours
Road pricing

②Reducing the traffic volume



Park and ride
Joint collection and delivery

Road Pricing

1 Meaning of road pricing

This is one of the methods of TDM, charging tolls on vehicles on roads within congested areas or time periods, in order to increase usage of public transportation media or to moderate the peak of rush-hours congestion. This measure aims to dissolve traffic congestion by levying tolls to vehicles entering into a certain area or going along a specified route, and by pressing those who have little necessity of using cars in the congested area to use public mass transportation media like bus or railroad instead. It also aims at dissolution of traffic congestion by charging higher tolls during a specified time period of rush-hours and diversifying the timing of transit.

2 Road pricing system

●Entrance charge system

A system to charge a toll on vehicles entering into a specified area in order to prevent vehicles from entering into certain areas such as centers of cities and tourist towns. (Kamakura City has started a social experiment of adopting the road pricing system combined with other methods like the park and ride system.)

●Passerby charge system

A system to charge a toll on vehicles going through a specified area for reducing the number of vehicles running within a certain area like centers of cities, etc.

3 Problems in road pricing

Generally speaking, roads are applied with "the principle of opening roads free of charge (by the understanding that it is prescribed that roads are to be constructed by a public entity and opened to citizens free of charge)." Therefore the road pricing system which discriminates road users by collecting tolls is against the major premise of the above principle. Besides, there is no consensus existing on fairness, privacy, or the use of collected money.

TOPICS Examples overseas

●Norway (Oslo City) "Tolling"

All vehicles driving toward the city center except for public transportation media are charged of tolls. Several gates are established on the way to the city center, and drivers shall pay the toll every time they pass by a gate. They have choices among from paying money to a tollkeeper at the gate, using a coin machine or driving along an automatic toll-collection lane. (Entrance charge system)

●Singapore "Area license"

A method to give entrance permission only to vehicles attached with the 'area license' on the windshield. This license can be purchased before entering into the specified area. Watch boxes are placed near the entrance to stop offenders. People can choose a day ticket or a monthly ticket. (Passerby charge system)

Day ticket

Monthly ticket

Traffic Information and Traffic Management & Control

When the police is going to accomplish its duties on traffic management and control, it is important to carry out traffic guidance and enforcement on the base of each traffic regulation, as well as to urge drivers to disperse the traffic flow voluntarily with their own judgment by supplying drivers with appropriate and real-time traffic information at appropriate timing including traffic jam information. That is why the traffic information supply to drivers constitutes the essential method of traffic control, according to the Road Traffic Law, and it is included in the duties of the Prefectural Public Safety Commission (hereinafter stated as the Public Safety Commission). Therefore, the Public Safety Commission is positively advancing installation of traffic information collecting equipment including vehicle detectors, traffic information supply units including information boards and roadside radio transmitters in order to do its duty of traffic information supply. Furthermore, it is simultaneously promoting infrared beacons (infrared vehicle detector) that have both functions of collecting and supplying traffic information.

As stated above, the Road Traffic Law prescribes that traffic information shall be supplied by the Public Safety Commission. If there were plural suppliers of traffic information, the investment might be made for twice, which would be a substantial waste of money. Moreover, inconsistent informations might generate drivers' confusion. Consequently even on expressways, where facilities should be installed with collected tolls from the viewpoint that beneficiaries should bear the cost, and in case that it is the road administrator who installs a facility to collect and supply traffic information, the Public Safety Commission must be ensured to collect and supply traffic information practically by itself in a unified system, by reflecting its opinions to policies to establish and operate such facilities, and by receiving traffic information from the road administrator.

For the purpose of realizing the complete supply of traffic information and assisting its supply in a unified system, Juridical Person Japan Road Traffic Information Center was established in 1970, and since then it has played an important role for over a quarter of a century.

In recent years, private companies are actively supplying traffic information on the background of increasing and diversified demands for such information together with development of integrated communication technologies. However, if the supplied information or the way of it is inappropriate, its effects on the traffic flow would be enormous. Besides that, it may be against the intention of the Public Safety Commission to supply traffic information in a unified system. Accordingly, in the amendment of the Road Traffic Law in 1997 a provision was added concerning the duties of traffic information suppliers. It prescribes that traffic information suppliers must be careful to support safe and smooth traffic flow by supplying correct and appropriate traffic information.

Traffic guidance and law enforcement

Guidance and Law Enforcement are essential part of traffic police activities to establish the order of traffic and realize a safe and smooth traffic environment. Without the understanding and endorsement of the people, they could not be conducted effectively.
Therefore, the police devote more efforts to traffic monitoring activity and traffic patrols to prevent violations of traffic rules. At the same time, the police promote effective guidance and crackdown by focusing on malicious, dangerous and troublesome cases of violations and taking into account local traffic conditions, the types and incidence of traffic accidents, and people's demand for crackdown.

1 Tightening of crackdown on violations that are malicious, dangerous and troublesome to others.

(1) Crackdown is focused on malicious and dangerous violations of traffic rules, such as driving without a license, driving while intoxicated, driving at speeds remarkably exceeding the speed limits, ignoring traffic signal, overloading, passing other vehicles recklessly, etc. Another priority of crackdown is given to vicious cases of violations, such as obstruction to the operation of buses in bus lanes.

(2) Guidance and crackdown activities are conducted in tandem with advertising activities for enlightenment of drivers and passengers, to increase the use of seat belts. On roads, policemen aggressively direct drivers and passengers to use seat belts.

(3)Guidance and crackdown are promoted at weekends and at nights, when serious accidents, such as fatal accidents, are increasing, and at intersections.

2 Effective promotion of crackdown on illegal parking

The police have tightened crackdown on illegal parking at intersections of trunk roads, pedestrian crossings, bus stops, etc. In addition, the police make efforts to promote effective crackdown by increasing the use of instruments to stop wheels of illegally parked vehicles and more strictly applying a rule to remove forcibly such vehicles and store them at the certain place. Efforts are made to clarify the background responsibility of the drivers of illegally parked vehicles, and to establish various systems, such as a system to guide drivers to parking lots to prevent illegal parking, and to warn drivers of illegally parked vehicles to abandon.

3 Promote measures against motorcycle gangs and hot rodders

The police promote stricter crackdowns on motorcycle gangs and hot rodders cruising by giving them individual guidance and taking into protective custody. To do so, the police gather information through activities of all departments of the police and analyze the current situation of motorcycle gangs and hot rodders based on the obtained information. In addition, to make such gang groups disband and make their members leave such groups, stricter crackdown is pursued on violations of rules prohibiting dangerous massive behaviors, lack of silencers of vehicles, etc. Moreover, to take up vehicles from motorcycle gangs and hot rodders, illegally remodeled vehicles are confiscated more strictly, and efforts are made to clarify the background responsibility of remodeling workshops that were involved in illegal remodeling.

No. of cases of major types of violations of the Road Traffic Law (1993-1997)

(1) No. of crackdown cases by type of violation

Type of violation \ Year		1993	1994	1995	1996	1997
Driving without a license or qualification (no. of cases)		113,670	107,463	101,466	102,378	102,861
	Index	100	95	89	90	90
Drunken driving, Driving under influence of intoxicating liquor		333,429	342,034	329,611	337,179	343,593
	Index	100	103	99	101	103
Exceeding speed limit (exceeding by more than 30 km/h)		483,527	489,751	498,425	549,065	587,318
	Index	100	101	103	114	121
Disregarding traffic signal		473,465	508,475	539,568	606,267	660,218
	Index	100	107	114	128	139
Failure to stop		482,666	547,346	616,155	685,763	779,445
	Index	100	113	128	142	161
Failure to protect pedestrians		29,153	30,021	35,760	41,626	49,252
	Index	100	103	123	143	169
Illegal parking and stopping		2,887,611	2,805,539	2,538,829	2,447,841	2,412,846
	Index	100	97	88	85	84

(2) Number of notifications of basic points of administrative measures

Not using seat belts		3,201,611	4,121,493	4,195,524	3,963,937	3,722,020
	Index	100	129	131	124	116

Trends of motorcycle gangs and hot rodders (1993-1997)

Type of violation \ Year			1993	1994	1995	1996	1997
Conventional types of group	No. of groups		850	840	834	939	1,013
	Total no. of members		32,257	27,736	26,731	26,720	25,796
		Non-members of groups(%)	18,179 (56.4)	14,734 (53.1)	14,406 (53.9)	13,863 (51.9)	12,471 (48.3)
	No. of cruising incidents		5,203	5,599	5,825	6,674	6,357
	No. of participants		105,527	106,738	107,486	115,205	112,056
Unconventional types of group	Total no. of members			7,743	9,624	8,558	8,255
	No. of cruising incidents			1,116	1,310	2,279	2,531
	No. of participated vehicles			53,634	49,852	55,688	54,623

Notes:1. ( ): ratio of non-members to the total number of members

2. The collecting of statistics on non-conventional types of motorcycle gangs and hot rodders was started in 1994.

Analysis of traffic accidents

1 Advanced analysis of traffic accidents

To plan really effective measures for traffic safety under the current severe traffic conditions, it is very important to establish a comprehensive investigation and analysis system for traffic accidents and to make an accurate analysis of causes of traffic accidents by sophisticating statistics for traffic accidents.

The police has been working at investigating traffic accidents from scientific viewpoints and with actual evidences to identify the facts and causes of accidents. A traffic accident statistic report is prepared for each case of traffic accidents to collect data which are utilized to implement effective preventive measures against traffic accidents. Based on the collected data, statistic and case analyses are performed in the daily work.

Moreover, the police started a three-year plan in 1997 to make a database of images such as sketches of traffic accident scenes in addition to the traditional integrated database of traffic accidents, for labor-saving in the documenting of traffic accident statistic reports and for sophistication of traffic accident analysis.

2 Traffic Accident Research and Analysis Center

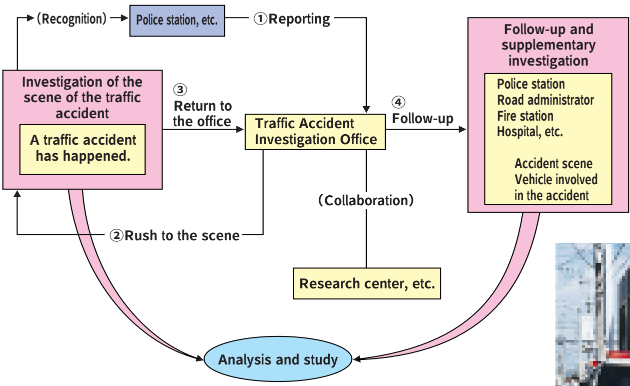
The Traffic Accident Research and Analysis Center was established on March 5, 1992 under the joint control of National Police Agency, Ministry of Transport and Ministry of Construction. Its objectives are to contribute to traffic safety measures taken by both the public and private sectors, by establishing a comprehensive traffic accident analysis system which can make both the macro- and micro-analysis, concentrating traffic-related data possessed by relevant ministries and agencies, and making detail analysis of each case of traffic accidents.

On July 11, 1992 under the Road Traffic Law, the Center was designated by the National Public Safety Commission as an analysis center for traffic accident investigation which conducts researches and studies for preventing traffic accidents and for minimizing damages caused by traffic accidents.

Personnel of the Center go to the scenes of actual traffic accidents to make comprehensive and scientific investigation (micro-investigation) from the viewpoints of persons, vehicles, roads and paramedics. During 1997, data for 319 cases of traffic accidents were collected, totaling to about 1,200 cases since its establishment.

Results of the analysis are provided to the Traffic Police in developing traffic safety programs and measures, and are also provided to other traffic-related agencies and organizations, while paying attention to the protection of privacy, to promote the implementation of effective traffic safety measures.

Investigation of a traffic accident



Micro-investigation

Fatalities of persons on board by position and wearing seatbelt.

Seat position \ Year			'88	'89	'90	'91	'92	'93	'94	'95	'96	'97	Increase/ decrease
On steering		Seat belting	852	934	869	761	807	789	839	935	926	1,056	+ 130
		Non-belting	1,672	1,980	2,183	2,476	2,570	2,687	2,371	2,356	2,145	1,946	- 199
		Unknown	78	92	104	91	76	73	64	120	122	171	+ 49
		Subtotal	2,602	3,006	3,156	3,328	3,453	3,549	3,274	3,411	3,193	3,173	- 20
On passenger's seat	Front seat	Seat belting	218	237	202	193	184	184	210	194	204	266	+ 62
		Non-belting	485	559	616	688	660	639	578	521	488	416	- 72
		Unknown	14	23	29	22	15	18	16	19	20	28	+ 8
		Subtotal	717	819	847	903	859	841	804	734	712	710	- 2
	Rear seat	Seat belting	14	9	6	19	11	9	12	7	8	14	+ 6
		Non-belting	362	396	461	382	430	417	375	363	353	326	- 27
		Unknown	9	8	14	9	11	5	5	9	9	18	+ 9
		Subtotal	385	413	481	410	452	431	392	379	370	358	- 12
	Other positions	Seat belting	0	1	0	0	0	0	0	0	1	2	+ 1
		Non-belting	15	13	16	31	18	14	12	26	13	8	- 5
		Unknown	0	0	1	3	1		0	0	0	0	- 0
		Subtotal	15	14	17	34	19	14	12	26	14	10	- 4
Subtotal of riders		Seat belting	232	247	208	212	195	193	222	201	213	282	+ 69
		Non-belting	862	968	1,093	1,101	1,108	1,070	965	910	854	750	- 104
		Unknown	23	31	44	34	27	23	21	28	29	46	+ 17
		Subtotal	1,117	1,246	1,345	1,347	1,330	1,286	1,208	1,139	1,096	1,078	- 18
Total		Seat belting	1,084	1,181	1,077	973	1,002	982	1,061	1,136	1,139	1,338	+ 199
		Non-belting	2,534	2,948	3,276	3,577	3,678	3,757	3,336	3,266	2,999	2,696	- 303
		Subtotal	101	123	148	125	103	96	85	148	151	217	+ 66
		total	3,719	4,252	4.501	4,675	4,783	4,835	4,482	4,550	4,289	4,251	- 38

Note: The figures in the increase/decrease box are compared with the figures of the prior year.

(Unit: persons)

Judicial Investigation of Traffic Accidents

1 Simplification of judicial investigation of traffic accidents

When a traffic accident happens, persons involved in the accident are required to "rescue the injured, take necessary measures to prevent secondary accidents and other dangers, and report the accident to the police" under the Road Traffic Law. The victimizer of a traffic accident may be accused of civil liability (liability for compensation), criminal liability (criminal liability for the death or bodily injury through negligence in the conduct of occupation and the offence of the Road Traffic Law) and administrative liability (suspension of the driver's license, etc.).

Because a traffic accident causes trouble not only to the persons involved but also other people such as passers-by and traffic of other vehicles, to reduce people's burden of the trouble and to restore the traffic flow to the normal condition as soon as possible, the police rushes to the scene of the traffic accident as soon as it receives a report of the accident to rescue injured persons and make necessary investigation speedily and accurately to identify the cause of the accident.

The police has also adopted other arrangements for minimizing the burden of people and for prompt restoration of the traffic flow. For example, the Omission of Inspection of the Accident Scene System" has been adopted. If the traffic accident is minor (evidenced by the fact that vehicle involved can move by itself, etc.), and the persons involved do not want inspection of the accident scene by policemen or other certain requirements are satisfied, inspection of the accident scene by the police may be omitted, and the persons involved in the traffic accident may go to a police station or police box to report the accident. Another examples are the use of the "Summary Report Form for Special Case" which is a more simplified report form than the former form, for a traffic accident resulting in a minor bodily injury (generally requiring three-week or less medical treatment for recovery) and satisfying certain requirements, and development and operation of scientific equipment called "Computer Aided Drafter of Accident Scene". Moreover, if it is very difficult for the victim or witness of a traffic accident resulting in bodily injury to report personally to a police station upon the summon because he/she lives in a distance place or he/she is very busy, it is allowed for the police to interview such person by telephone and submit a report of investigation by interview instead of the usual statement given before an investigator.

2 Investigation of hit-and-run cases

As the number of vehicles increases, vehicles become faster, and the traveling area of an vehicle becomes wider, investigation of hit-and-run cases is getting more difficult every year. However, by focusing on making a prompt and proper initial investigation and by developing identification equipment for traffic accident and other scientific investigation technology such as the image search system for traces left in traffic accident scenes, most of the criminals of hit-and-run cases resulting in the death of the victims have been arrested.

3 Investigation of special traffic cases

Special traffic cases such as insurance frauds tends to involve organized crimes and extend to wider areas. To respond to such circumstances, the police has been actively promoting joint or united investigation by two or more police departments of relevant prefectures.

Occurrence and arrest of hit-and-run cases resulting in the death of the victims (1993 to 1997)

Classification / Year	1993	1994	1995	1996	1997
Occurrence	398	415	387	320	292
Arrest case	356	408	363	309	287
Arresting rate	89.4	98.3	93.8	96.6	98.3

Arrests of criminals in special traffic cases (1996-1997)

By crime type	Classification / Year	1996	1997
Total numbers	Case	3,037	1,518
	Arrested criminals	1,372	1,184
	Damage (million yen)	68,297	60,581
Murder or injury cases camouflaged as or by means of traffic accidents	Case	4	15
	Arrested criminals	5	30
Traffic accident cases regarded as intentional	Case	62	59
	Arrested criminals	66	57
Cases where an intentional crime was committed after the traffic accident	Case	188	93
	Arrested criminals	245	148
Automobile accident faker cases	Case	92	354
	Arrested criminals	20	18
	Damage (million yen)	1,956	1,489
Insurance fraud cases	Case	330	236
	Arrested criminals	327	251
	Damage (million yen)	66,219	58,979
Document forgery cases	Case	2,358	757
	Arrested criminals	704	674
Other crimes	Case	3	4
	Arrested criminals	5	6
	Damage (million yen)	122	113

Note: The number of cases, persons, and the amount include attempted cases.

Traffic Safety Education

Because everybody is involved in the traffic as a driver, pedestrian, biker, etc., and many traffic accidents are caused by personal factors, traffic safety education has great importance as a traffic safety measure.

1 Guide on traffic safety education

Under the Road Traffic Law revised in 1997, the National Public Safety Commission published a Guide on Traffic Safety Education in August 1998, a guide for traffic safety educators to provide traffic safety education effectively and properly. The police, safe driving supervisors, traffic safety campaign promoters in the community, and traffic safety educators in private organizations and local governments will use this Guide on Traffic Safety Education to implement traffic safety education in Japan systematically and step by step.

2 National Traffic Safety Campaign and Traffic Safety Education

National Traffic Safety Campaign is implemented in spring and autumn every year to spread knowledge on traffic safety and to raise people's awareness toward traffic safety as well as to promote observance of traffic rules and practice of good traffic manner. During the campaign, national and local public organizations and private organizations such as the Traffic Safety Association cooperate each other in a wide variety of national campaigns to raise people's awareness toward traffic safety by conducting various activities fit to individual communities encouraging voluntary participation of people in the communities.

In addition, in cooperation with related organizations and groups, the police has been providing practical traffic safety education programs focusing on participation and experiencing, fit for various age groups from little children to the aged, depending on their involvement to road traffic and the emotional and physical development and conditions. Based on the Guide on Traffic Safety Education, such education programs will be further promoted.

3 Traffic safety education for the so-called "traffic vulnerable group"

To prevent traffic accidents involving children, the aged and the physically or mentally impaired while they are walking or riding bicycles, the police has been, in cooperation with educational institutes, welfare organizations and other various groups, providing traffic safety education and instructions, and promoting the use of reflecting materials to prevent traffic accidents at night. Especially, voluntary activities by traffic safety aged-instructors for the aged are encouraged.

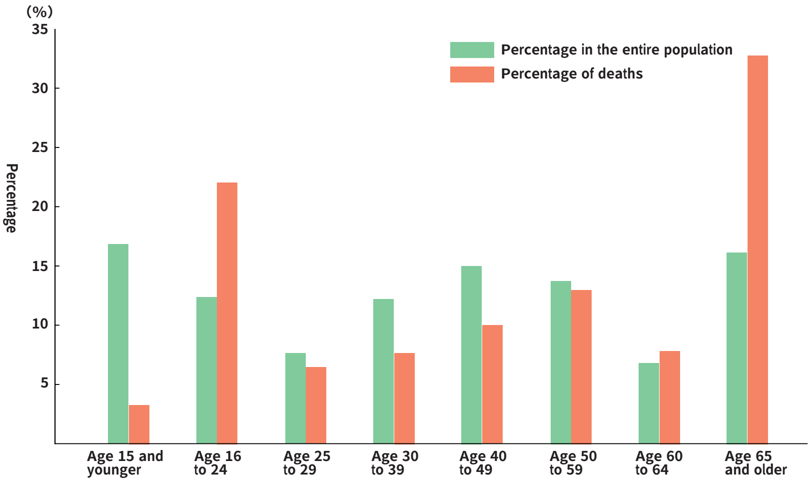
4 Driver education

The Training Academy of Japan Safe Driving Center provides drivers with opportunities to learn practical and technical knowledge and skills on driving. It also provide periodic education programs and on-site seminars for safe driving supervisors in companies.

Traffic safety lecture for children

Bicycle safety lecture for the aged

Percentage of deaths by traffic accidents by age group and comparison with the percentage of each age group in the entire population (1997)



Drivers Management

(1) Driver's license examination

Generally, aptitude test, skill test and academic test must be taken to acquire a driver's license. The National Police Agency is reviewing the driver's license examination to modify the current academic test, which examines on the knowledge necessary for driving vehicles, into a more practical examination by using illustrations to evaluate the ability of the examinee to recognize and discern dangers and to judge his/her operation in actual traffic situations.

(2) Renewal of a driver's license

When a driver renews his/her driver's license, whether the driver maintains the aptitude required for safe driving is checked, and education programs on laws, regulations and information related to road traffic are provided at the same time to enhance drivers' awareness toward safe driving. This system plays a very important role to secure the traffic safety and maintain the effectiveness of the driver's license system by ① removing or correcting drivers having any problem in their aptitude as drivers, ② communicating to all drivers revised provisions of the Road Traffic Law and the current road traffic conditions in the education program provided at the time of the renewal of the license, and ③ removing wicked drivers such as those ignoring the repeated order to report to the police station for a traffic offence, etc., or escaping from an administrative disposition.

(3) Administrative disposition on driver's license

An administrative disposition on the driver's license will be executed against a licensed driver whose driving is deemed to be a highly potential risk for safe road traffic. To quickly remove repeated offenders of traffic regulations and drivers often causes traffic accidents, the Public Safety Commission in each prefecture works for prompt and accurate execution of administrative dispositions against problematic drivers depending on their level of danger.

(4) Drivers management system

The drivers management system, comprised of a host computer installed at the National Public Safety Commission and data transmitting terminals installed at each prefectural Public Safety Commission, keeps centralized control of a mass of data on drivers throughout Japan, to execute efficient control of driver's licenses for a vast number of driver's license holders.

(5) Driver education

Driver education is provided in license courses of driving schools for acquiring a driver's license and in various re-education programs for licensed drivers provided by the prefectural Public Safety Commissions and other related organizations and groups. These license courses and programs will be improved further.

(6) Measures against wrongful foreign drivers in Japan

As the internalization expands, forging and wrongful acquisition of driver's licenses by foreigners are increasing. The police endeavors to find and arrest such wrongdoers.

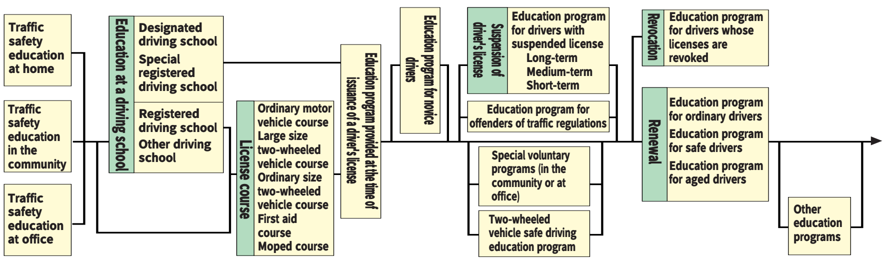
Occurrence and arrest of hit-and-run cases resulting in the death of the victims (1993 to 1997)

Percentage of driver's license holders in the eligible population (105,330,000 persons): 67.7%

Men: Population by age group (in thousand persons)	Men: Percentage of driver's license holders	The number of driver's license holders (men)	Age group / Population (total of men and women) / The number of driver's license holder (percentage)	The number of driver's license holders (women)	Women: Percentage of driver's license holders	Women: Population by age group (in thousand persons)
2,750	34.4	945,464	Age 75 and older 7,840,000 998,423 (12.7%)	52,959	1.0	5,090
2,320	66.0	1,531,328	Age 70 to 74 5,310,000 1,765,468 (33.2%)	234,140	7.8	2,990
3,190	75.5	2,407,457	Age 65 to 69 6,760,000 3,017,128 (44.6%)	609,671	17.0	3,580
3,730	82.2	3,064,221	Age 60 to 64 7,720,000 4,217,706 (54.6%)	1,153,485	28.9	3,990
4,090	87.4	3,573,274	Age 55 to 59 8,320,000 5,448,697 (65.5%)	1,875,423	44.3	4,230
4,440	91.5	4,064,207	Age 50 to 54 8,940,000 6,741,694 (75.4%)	2,677,487	59.5	4,500
5,350	93.1	4,980,028	Age 45 to 49 10,680,000 8,696,254 (81.4%)	3,716,226	69.7	5,330
4,100	94.9	3,892,342	Age 40 to 44 8,160,000 7,060,248 (86.5%)	3,167,906	78.0	4,060
3,950	96.8	3,823,008	Age 35 to 39 7,830,000 7,101,822 (90.7%)	3,278,814	84.5	3,880
4,200	97.4	4,092,399	Age 30 to 34 8,310,000 7,687,686 (92.5%)	3,595,287	87.7	4,100
4,840	96.8	4,684,688	Age 25 to 29 9,550,000 8,786,794 (92.0%)	4,102,106	87.3	4,700
4,880	88.2	4,302,506	Age 20 to 24 9,550,000 7,884,767 (82.6%)	3,582,261	76.7	4,670
3,270	37.2	1,217,419	Age 16 to 19 6,380,000 1,864,535 (29.2%)	647,116	20.9	3,100
51,110	83.3	42,578,341	Total of men and women 105,330,000 71,271,222 (67.7%)	28,692,881	52.9	54,220

Note: The population figures are estimates shown in the Monthly Population Estimates as of December 1, 1997 published by the Statistics Bureau of the Management and Coordination Agency. Because a figure smaller than a thousand is cut off, the figure shown in the total line may not agree with the aggregation of individual items.

Flow of Driver Education



Administrative disposition on driver's license by year (1993 to 1997)

Classification \ Year	1993	1994	1995	1996	1997
Total numbers	1,696,759	1,548,439	1,402,677	1,441,478	1,475,625
Revocation	45,199	39,231	36,304	35,655	36,779
Suspension	1,651,560	1,509,208	1,366,373	1,405,823	1,438,846

Environmental problems and Traffic police

Global warming caused by greenhouse gases including carbon dioxide, CO_2,is a worldwide problem to cope with. Japan accounts for 4.8% of all the CO_2 emissions in the world, being placed fourth. About 20% of the CO_2 emissions in Japan is produced by the transportation sector and approx. 88% of it is emitted by automobiles. Therefore, reduction of CO_2 is one of the urgent problems for us to solve.

In the Kyoto protocol adopted in the Third Conference of the Parties to the United Nations Framework Convention on Climate Change, UNFCCC-COP3, in September 1997, Japan accepted the emission targets to cut by 6% from 1990 level in the period from 2008 to 2012. The police is expected to take measures to control global warming, cutting CO_2 emissions from automobiles by optimized traffic management system. The "Guidelines on promotional measures against global warming," which was compiled following the COP3 (passed the Cabinet in June 1998) includes traffic management policies which the police should promote. The following are four major systems shown in the guideline.

・ITS (Intelligent Transport System)
VICS (Vehicle Information Communication System)
UTMS (Universal Traffic Management Systems)
・TDM (Transportation Demand Management)

Among them, the EPMS (Environment Protection Management Systems), one of the sub-systems of the UTMS, draws particular attention. Aiming to alleviate traffic pollution, the EPMS controls traffic signals to minimize the number of times vehicles have to stop, while collecting necessary information on air pollution and traffic volume by utilizing infrared beacon and environmental sensors. The EPMS also provides information on detours and warning in a heavily polluted areas. An experimental operation of this system conducted in Shizuoka in the period from 1996 to 1997 showed that there is a certain correlation between vehicle's speed and CO_2 concentration and that the introduction of the traffic control system reduced the amount of CO_2 emissions. The system will soon be put into practice along the Route 43 in Hyogo Prefecture.

Conformity to environmental standard for nitrogen dioxide and suspended particulate matter (fiscal 1991-1996)

Nitrogen dioxide

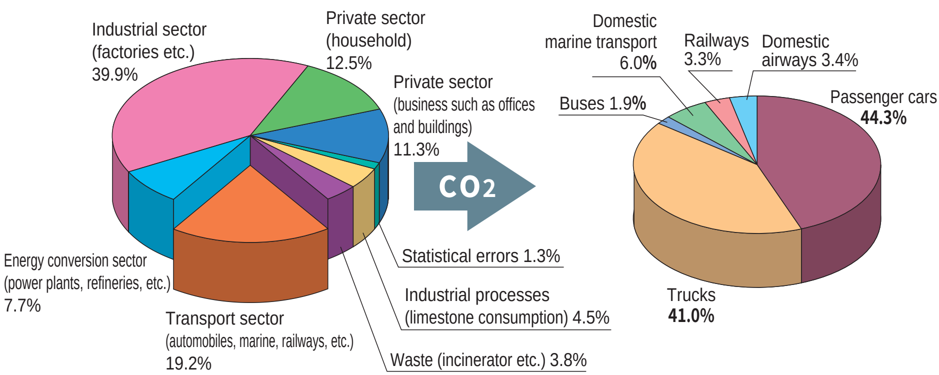
Area	Fiscal year	1991	1992	1993	1994	1995	1993
Entire area of designated places	Number of measured places	150	152	155	162	165	168
	Number of achieved places	42	70	55	63	68	56
	Achievement rate	28.0	46.1	35.5	38.9	41.2	33.3
Designated places in Tokyo areas	Number of measured places	94	95	98	104	108	110
	Number of achieved places	24	43	30	36	42	40
	Achievement rate	25.5	45.3	30.6	34.6	38.9	36.4
Designated places in Osaka and Hyogo	Number of measured places	56	57	57	58	57	58
	Number of achieved places	18	27	25	27	26	16
	Achievement rate	32.1	47.4	43.9	46.6	45.6	27.6

Suspended particulate matter

Area / Fiscal year	1991	1992	1993	1994	1995	1996
Number of measured places	166	182	190	210	216	229
Number of achieved places	50	61	77	69	76	97
Achievement rate	30.1	33.5	40.5	32.9	35.2	42.4

Source: Air Pollution in Fiscal 1996 by the Environment Agency

Estimated CO_2 Emissions in Japan by Sectors (1994) <White Paper on the Environment>



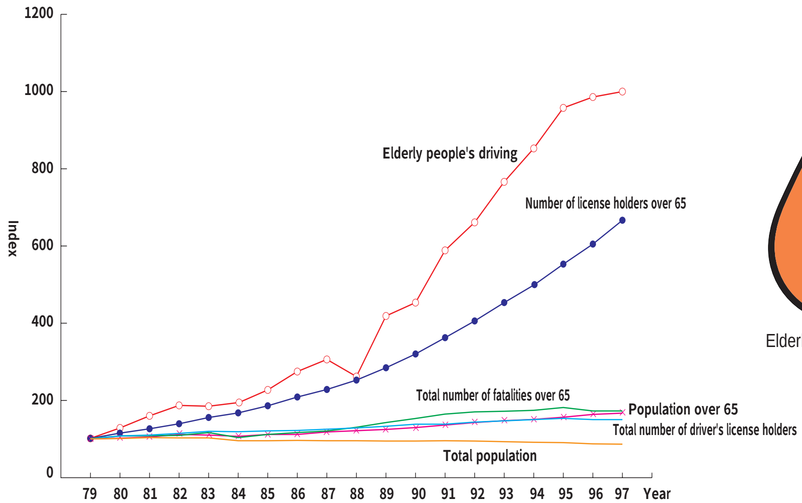
Aging Society and Japan Traffic Police

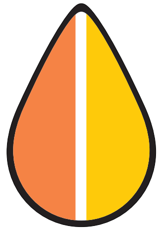
In Japan, the numbers of traffic accidents caused by elderly drivers due to deterioration of their physical function and those involving elderly pedestrians have sharply increased in recent years, while our society has been aging in a way no other advanced countries have. Therefore, in order to reduce such accidents, it is extremely important to take measures targeting the elderly. In this context, the police has provided and will provide various programs to assure safety driving by the elderly as well as to protect elderly pedestrians.

Programs to assure safety driving by the elderly include counseling and medical check-ups to help elderly people to recognize their own physical function and driving technique. Educational programs for elderly drivers are also offered, one of which is a lecture using a driving simulation system. Furthermore, the police has conducted R&D aiming to make the DSSS (Driving Safety Support Systems), one of the sub-systems of the UTMS (Universal Traffic Management Systems), fit for practical use. The DSSS makes use of the infrastructure of the Traffic Management and Control System and IC cards. Two-way communication between an infrared vehicle detector installed close by traffic signals and a vehicle with UTMS in-vehicle-unit enables to detect a pedestrian with an IC card coming toward the intersection. Since such warning device will help reduce traffic accidents involving elderly drivers, earliest possible realization is anticipated.

In order to protect elderly pedestrians, the police encourage private organizations to voluntarily provide traffic safety educational programs. It has also promoted to install pedestrian signals specially designed for the elderly and the disabled. Such signals will lengthen the time the green light is on when it detects a person holding a portable transmitter crossing the road. Furthermore, the police emphasizes the construction of the Community Zones where elderly people can walk around in peace. In order to support these safety programs for elderly pedestrians, the DSSS is also expected to play an important role.

(1) Population over 65, Driver's license holders, Fatalities





Elderly driver's symbol

Number of driver's license holders over 65

Item / Year	Total	Number of driver's license holders over 65	Component ratio	Index	Male	Component ratio	Female	Component ratio
1969	24,782,107	178,993	0.7	100	178,321	99.6	672	0.4
1970	26,449,229	214,072	0.8	120	213,246	99.6	826	0.4
1971	28,000,367	251,684	0.9	141	250,623	99.6	1,061	0.4
1972	29,474,643	292,938	1.0	164	291,556	99.5	1,382	0.5
1973	30,778,778	351,998	1.1	197	350,154	99.5	1,844	0.5
1974	32,143,688	410,395	1.3	229	407,960	99.4	2,435	0.6
1975	33,482,514	468,757	1.4	262	465,600	99.3	3,157	0.7
1976	35,148,742	563,156	1.6	315	558,760	99.2	4,396	0.8
1977	37,022,922	647,699	1.7	362	641,844	99.1	5,855	0.9
1978	39,174,099	738,043	1.9	412	730,136	98.9	7,907	1.1
1979	41,042,876	833,868	2.0	466	823,312	98.7	10,556	1.3
1980	43,000,383	949,248	2.2	530	935,094	98.5	14,154	1.5
1981	44,973,064	1,067,955	2.4	597	1,049,239	98.2	18,716	1.8
1982	46,978,577	1,190,607	2.5	665	1,165,976	97.9	24,631	2.1
1983	48,814,356	1,325,827	2.7	741	1,293,640	97.6	32,187	2.4
1984	50,606,685	1,469,286	2.9	821	1,427,106	97.1	42,180	2.9
1985	52,347,735	1,634,937	3.1	913	1,577,555	96.5	57,382	3.5
1986	54,079,827	1,814,902	3.4	1,014	1,738,227	95.8	76,675	4.2
1987	55,724,173	2,007,320	3.6	1,121	1,906,506	95.0	100,814	5.0
1988	57,423,924	2,222,375	3.9	1,242	2,090,011	94.0	132,364	6.0
1989	59,159,342	2,493,275	4.2	1,393	2,322,217	93.1	171,058	6.9
1990	60,908,993	2,812,121	4.6	1,571	2,590,534	92.1	221,587	7.9
1991	62,553,596	3,155,742	5.0	1,763	2,874,120	91.1	281,622	8.9
1992	64,172,276	3,526,939	5.5	1,970	3,174,400	90.0	352,539	10.0
1993	65,695,677	3,937,736	6.0	2,200	3,500,204	88.9	437,532	11.1
1994	67,205,667	4,344,463	6.5	2,427	3,813,017	87.8	531,446	12.2
1995	68,563,830	4,792,613	7.0	2,678	4,154,365	86.7	638,248	13.3
1996	69,874,878	5,250,024	7.5	2,933	4,496,499	85.6	753,525	14.4
1997	71,271,222	5,781,019	8.1	2,701	4,884,249	84.5	896,770	15.5

Economic activities and Traffic police

Rapid movement toward deregulation in recent years has made business owners' demands for physical distribution extremely diversified and sophisticated. Responding to such demands, the government has been implementing various policies to reduce distribution cost and grade up distribution systems and the traffic police is required to cooperate for the efficient distribution through the optimum traffic control.

The traffic police has conducted R&D aiming at the earliest nationwide adoption of the MOCS (Mobil Operation Control Systems), one of the sub-systems of the UTMS. Through the two-way communication between an infrared vehicle detector and a vehicle with UTMS in-vehicle unit, a business office can trace its trucks and give them operating information, which enables the office to conduct an efficient operating management. After an experimental operation of the system which started in April 1996 in Sapporo proved the system's effectiveness, the system was put into practical use there. The system also played a major role in the Nagano Winter Olympic Games held in February 1998, supporting the efficient operation of Games-related vehicles.

In order to control traffic congestion caused by activated economic activities and to minimize its adverse influence on economic activities, traffic volume should be reduced as much as possible. Since promotion of the usage of mass transportation systems as well as the appropriate traffic control are considered to help reduce traffic, the police has introduced the PTPS (Public Transportation Priority Systems), one of the sub-systems of the UTMS in order to encourage people to use buses. Under the systems, lanes exclusively for buses and the priority signal control will help them run on time. The system has been introduced in Tokyo and Sapporo and will be introduced in Hamamatsu city.

Traffic congestion's influence on your daily life is enormous. The following are how much you lose due to traffic congestion.

●Time and money

approx. 5.6 billion hours per year

approx. 50 hours per capita per year

When converted into money;

approx. 12 trillion yen per year

approx. 100 thousand yen per capita per year

After compared cruising time per year in a congested road with that in a non-congested road, converted the times into wages

source: Ministry of Construction

●Energy

twice as much fuel as is expected with no traffic congestion

gasoline-run car

Cruising speed: 40km/h Fuel consumption: 69cc/km

Cruising speed: 10km/h Fuel consumption: 170cc/km

Source: Ministry of Construction

●Emission

load factor to environment twofold to fourfold

Compared emissions by each cruising speed of heavy-weight diesels.

When compared emissions with a cruising speed of 40km/h to ones with a cruising speed of 5km/h, amount of NOx increases about three times, CO_2 two times, and CO four times.

Source: "Automobile Industry," the June 1993 issue

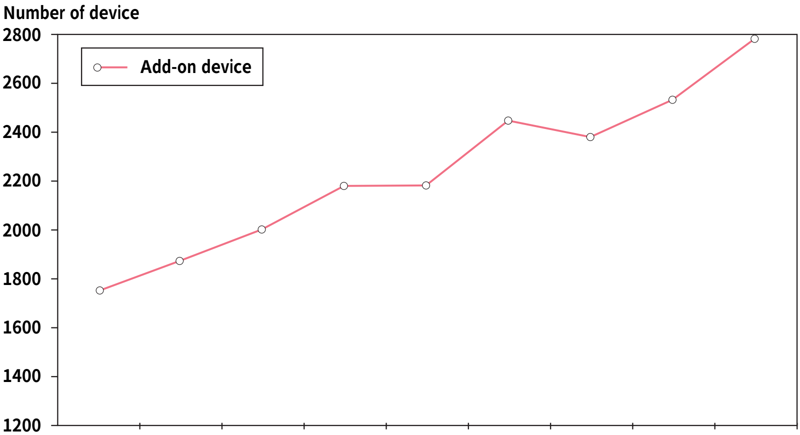
Traffic management in disasters

It is presumed that, in the events of natural disasters such as earthquakes, storms, and floods, traffic will be greatly damaged due to the limited number of roads available because many roads would be cut off or blocked by collapsed buildings. Once the power is cut, traffic signals will stop functioning, which will lead a chaotic situation in the city and main road networks connecting cities. Secondary disaster is another anxiety and rescue vehicles would also be prevented from reaching the devastated areas. It is, therefore, inevitable for the police to direct appropriate traffic management so that routes for rescue vehicles are secured and smooth evacuation instructions can be given, while collecting information on damaged roads and traffic conditions.

In order to make such traffic management possible in disasters, the police takes preventive measures including disaster drills, a planning of a detailed traffic control procedures in disasters, and educational programs to confirm drivers what they should do when a devastating earthquake hit the region. Rescue vehicles which are to be sent to the devastated areas will be selected and, step by step, traffic information boards will be setting up at places where people can easily obtain information on detours and damages to the roads.

The police also promotes to install disaster-resistant traffic safety facilities. For example, various vehicle detectors, CCTV cameras, and information boards will be installed in major roads which will be used in an emergency to support the central traffic control system; the traffic control center, a nucleus of the traffic management and control system, will be reinforced to be earthquake-resistant so that the center may continue to direct the appropriate traffic control according to the situation even in a disaster; traffic signals at major intersections are being equipped with a self-starting power generator, which will prevent them from stop working when the electric power fails.

installation of Add-on device of power generator for traffic signal (nationwide)



	1987	1988	1989	1990	1991	1992	1993	1994	1995
Add-on device	1,758	1,879	2,004	2,182	2,187	2,446	2,384	2,530	2,789

Mechanism of traffic congestion

When traffic demand exceeds traffic capacity, roads become congested. The traffic capacity is determined by various factors such as width, configuration, and incline of a road. When many vehicles pass at a certain section of road and its volume exceeds the inherent road capacity, some vehicles will not pass through there and the traffic congestion is getting appeared.

The section of a road where vehicles gather more than the road's capacity is called a "bottleneck." Intersections on roads and merging places, sags*1), and tunnels on expressways can be bottlenecks. In the section called sags, where a downward incline changes into an upward one, speed gradually slows down. When drivers are unaware of the change, they keep the same distance between themselves and the cars they are following. Slowing down with little change in a distance between noses of the two cars*2) will lengthen a time between noses of the two cars*3). Eventually, the number of cars which can pass through the section per hour will decrease. Capacity at a sag section depends on whether a driver is aware of the change or not. A survey shows that the traffic capacity at a sag where the change is hardly noticed is 20-30% less than that at other sags where a change is distinct.

Even though there is only a little amount of excess in traffic demand at first, if such situation goes on for a long time of period, traffic will be congested and cause a great problem. For example, in November 1990, congestion caused by 10% excess of the demand for 2 hours, beginning at the Kasai junction of the Metropolitan Expressway, eventually extended to seven-km-long and lasted approx. 4 hours.

There are two possible ways to mitigate and eventually dissolve traffic congestion; one is to increase the capacity of a road and the other is to adjust traffic demands. In order to increase the capacity, constructing new lines and widening roads may be helpful. Such projects, however, require to obtain proper amount of land, which is quite difficult in Japan. Therefore, the TDM measure which aims to adjust traffic demands, broadly transportation demands, has drawn peoples' attention. The method is to give some incentives to drivers so that they are encouraged to change their departure time or to take trains or other public transportation system instead. The said congestion on the Metropolitan Expressway could be dissolved if 20% of drivers change their departure time by averaging 15 minutes up to 30 minutes.

*1) a section where a downward incline changes into an upward incline

*2) a distance from the nose of a car to the nose of the following car

*3) a time period which two cars with no other cars in between pass through a point

Traffic flow simulation

Simulation means to reproduce actual conditions through various means. While conventional methods use models for a simulation, computerized numerical simulation has recently been adopted in many cases. Traffic flow simulation is one of those which adopt the computerized numerical simulation method and is divided into two major groups according to what is to be modeled; micro-simulation and macro-simulation. The former aims to model movements of a car, such as how to follow a car and how to change lanes. The latter aims to describe traffic phenomena by approximating a traffic flow as a fluid or considering several cars as one group.

The traffic flow simulation method is used for various purposes including assessment of effect of improved or newly constructed roads, traffic operation plans, and dissemination of traffic information. Although a simulation is modeled according to each case, all the simulations take the following procedures:

1)Specification:
Input and output of simulation shall be decided upon taking the simulation purposes into consideration.

2)Modeling:
Modeling of traffic phenomena shall be made to meet the above specification.

3)Implementation:
Programming shall be progressed according to the model.

4) Verification of a simulation:
Verification shall be conducted whether the program correctly reproduces a traffic phenomenon according to the model under a virtual traffic condition.

5) Validation of reproductivity:
Validation shall be confirmed how well the simulation reproduces the actual situation.

With the progress of the ITS technologies, the police is expected to manage and control traffic much more dynamically and effectively than ever. It is also expected to put a traffic flow simulation model into practical use since it helps reproduce or predict traffic situations which vary from moment to moment.

Technology section

- Traffic Management and Control System
- Universal Traffic Management Systems

1 Traffic Management and Control System

The traffic management and control system is designed to distribute and guide fitly the volume and the flow of the traffic in the overcrowded cities based on the existing road network. This system works to support urban mechanism through making the most of facilities of motor vehicle.
The traffic management and control system has been established in every prefecture in Japan and is being operated through the traffic control center of the Police Headquarters as the nucleus.
The traffic control center located in each prefecture manages traffic covering the entire area of its region by integrating the information transmitted from the city centers in the main cities and the sub-centers in medium-sized and small cities of the prefectures in which they are located.
Incidentally, there were 170 control centers in total in Japan at the end of 1997, including 47 headquarter centers, 28 city centers, and 95 sub-centers.

(1) System structure

The traffic control system is structured hierarchically to allow for future expansion and ensure safety.The lower layer of the system directly controls the traffic signals, the vehicle detectors, the roadside transmitters, and the message sign terminals; its structure is designed for extra equipment be added easily in the future.The upper layer of the system integrates the lower layer and consists of the signal control subsystem, the information collection and supply sub-systems, as well as the operation management sub-system which interfaces with the supervisors, and the traffic information data base. These systems are connected by a local area network (LAN), which permits large volumes of data to be sent at high speeds.

(2)Information collecting sub-system

The traffic control system collects information transmitted from roadside vehicle detectors (ultrasonic, infrared, etc.), such as traffic volume and speed, and vehicle types. Collected data are sent to the traffic control center. Congestion length, saturated traffic volume, and division rate are calculated from this information. Also, based on data sent from the travel time measuring terminals, the traffic control center calculates travel times and estimates travel times for those roads not fitted with such terminals.

(3) Signal control sub-system

Based on the traffic data gathered by the information collecting sub-system, the signal control sub-system determines the cycle lengths, split control, and offset values which control the signal devices; this is carried out in the upper layer of the system. Having processed the data, the signal control sub-system then directly operates the signal controllers via the lower layer of the system.

(4) Information supply sub-system

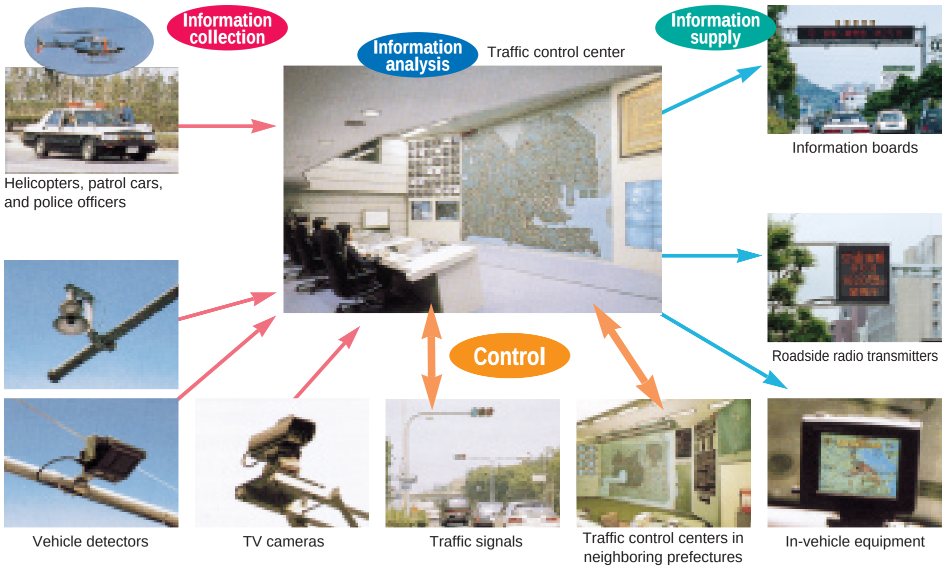
This system provides drivers automatically with information about congestion, travel times, traffic regulations, and parking space availability through roadside transmitters, variable information boards, information terminals, and in-vehicle navigation units. Information is also provided automatically in response to telephone or fax inquiries.

(5) Operation management sub-system

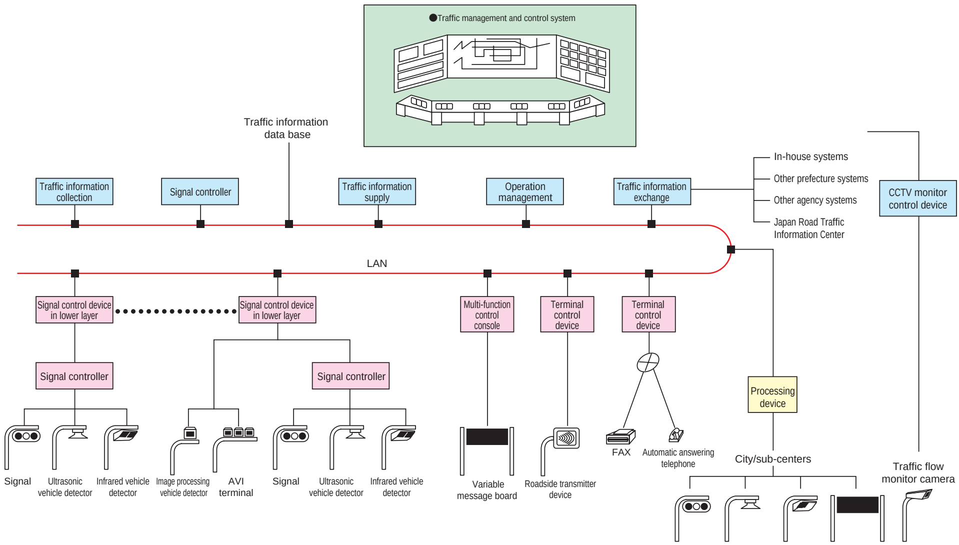
This system manages and operates prefecture-wide traffic control systems. It provides traffic supervisors with information on traffic and on how the systems are functioning through man-machine interfaces such as the traffic wall map and CRT displays. The traffic supervisors are the ones who take charge of the operation of the traffic control center. Based on the provided information, they change control parameter settings. This system also exchanges traffic and road information with systems operated by other prefectures and road administrators.

Traffic Control Center

Traffic control system structure



System structure diagram



Information Collection Equipment

The traffic control system collects information via different types of vehicle detectors, TV cameras, and the like information collection equipment and sends it to the traffic control center. Various vehicle detectors are in use, including ultrasonic, infrared (optical beacons), radar, and loop vehicle detectors. The most in number is the ultrasonic vehicle detector. This type of vehicle detector is essential for sensor actuated control, link actuated system control, and area control. These various vehicle detectors installed in Japan numbered more than 110,000 at the end of 1997.

(1)Ultrasonic vehicle detectors

An ultrasonic vehicle detector consists of an ultrasonic sensor head and the main unit. The head emits an ultrasonic wave down to the ground. The main unit measures the passage of time between the emission of a wave and the reception of its reflection, thereby detecting vehicles. In general, the head is mounted approximately 5 m high right above the road. Its position is perpendicular to the road surface. There were approximately 88,000 ultrasonic vehicle detectors installed in Japan at the end of 1997.

(2) Infrared vehicle detectors (optical beacons)

Also known as an "optical beacon," an infrared vehicle detector consists of a head and the main unit. Functions of the infrared vehicle detector are to detect vehicles passing on the road using near-infrared-light and to perform two-way optical communications with vehicles. The number of optical beacons installed in Japan was approximately 18,000 at the end of 1997.

(3) Radar vehicle detectors

A radar vehicle detector, also named "R-type vehicle detector," in Japan is constituted of a transceiver and the main unit. The transceiver projects a microwave and receives its reflection. According to the intensity of the reflected microwave, the radar vehicle detector detects moving vehicles. Moreover, it also measures vehicle speeds taking advantage of the Doppler effect and discriminates vehicle types judging from duration in which vehicles are present. There were approximately 4,500 radar vehicle detectors in Japan at the end of 1997.

(4) Image processing vehicle detectors

An image processing vehicle detector consists of a TV camera and the main unit. The TV camera films vehicles. By processing images, this device detects vehicles, counts them, and measures their speeds. The image processing vehicle detector, installed right above a lane or roadside, is capable of measuring vehicles in multiple lanes with a TV camera.
Image processing vehicle detectors installed in Japan numbered approximately 1,200 at the end of 1997.

(5) Bus detectors

Buses are detected by an application of the various vehicle detectors. There were approximately 1,100 bus detectors installed in Japan at the end of 1997.

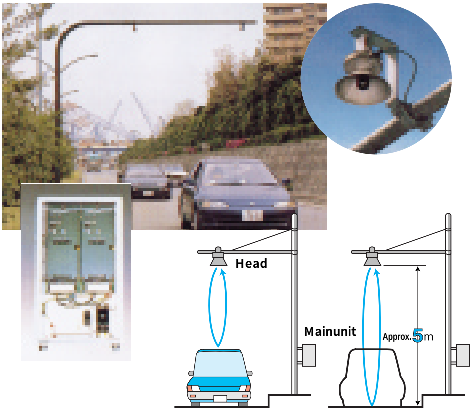
(6) Travel time measuring (AVI) terminals

These terminals take pictures of moving vehicles using CCD cameras installed over roads. They read license numbers on vehicles by real-time image processing. Other terminals located far from the former terminals take pictures in the same way to match the processed images, leading to calculation of the travel time between them. AVI terminals installed in Japan numbered approximately 800 at the end of 1997. These covered approximately 570 sections, or approximately 4,100 km.

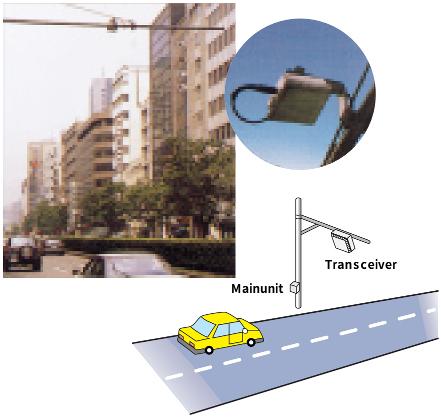
(7) CCTV cameras

These cameras are installed at intersections and the like. Traffic control centers can control camera direction, zoom function, and wiper operation. The images captured by the cameras are sent to the traffic control centers through image transmission lines. Traffic control center operators can select required images and display them on monitor screens where camera numbers permit. The number of CCTV cameras installed in Japan was approximately 2,100 at the end of 1997.

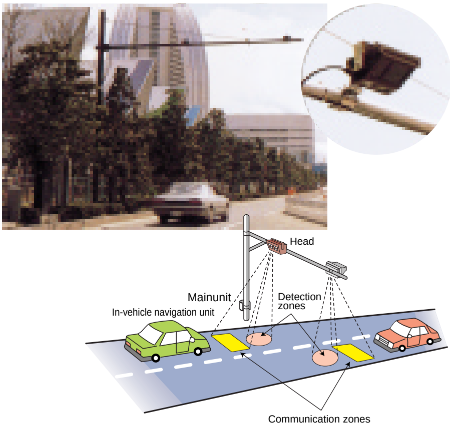
(1) Ultrasonic vehicle detector



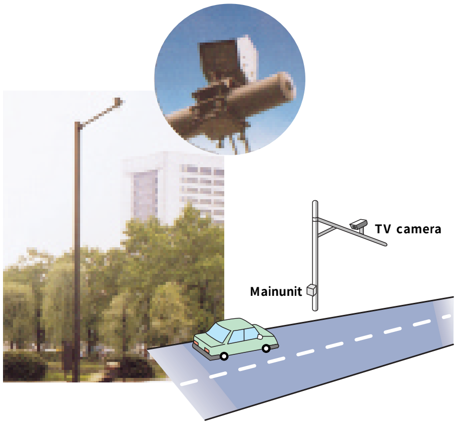
(2) Radar vehicle detector



(3) Infrared vehicle detector



(4) Image processing vehicle detector



(5) Bus detector

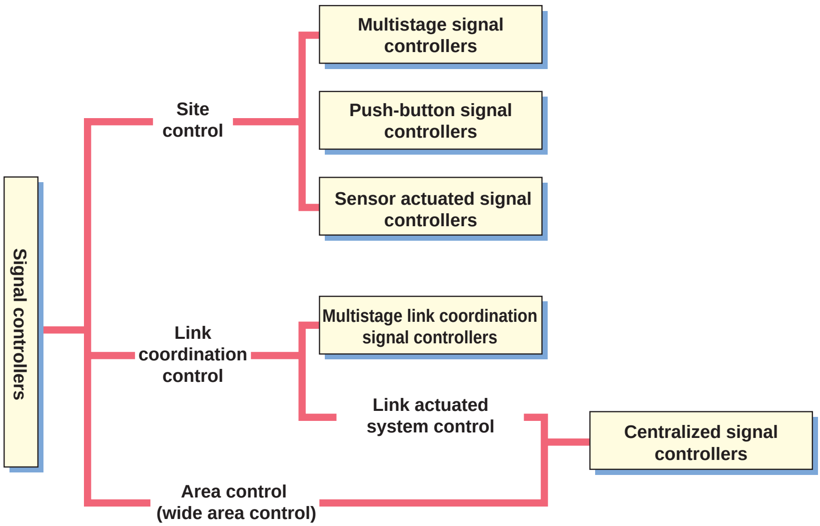
(6) AVI terminal

(7) CCTV camera

Signal Control Equipment

Signal controllers are installed at intersections where a good view of roads is obtained in four directions. Different kinds of signal controllers are installed for operation of site control, link coordination control and area control of signals.

There were approximately 170,000 signal controllers installed in Japan at the end of 1997.



1 Site control

(1)Multistage signal controllers

For multistage control, traffic volumes are surveyed and a green signal length best suited to each hour and the day of the week is selected.

An electronic time switch is provided in the signal controller, which keeps the time and the day of the week. According to the time and day it keeps, the time switch automatically selects a suitable control pattern among those that were stored in advance.

This type of multistage control is suitable for intersections whose hourly and day-to-day traffic patterns are almost constant.

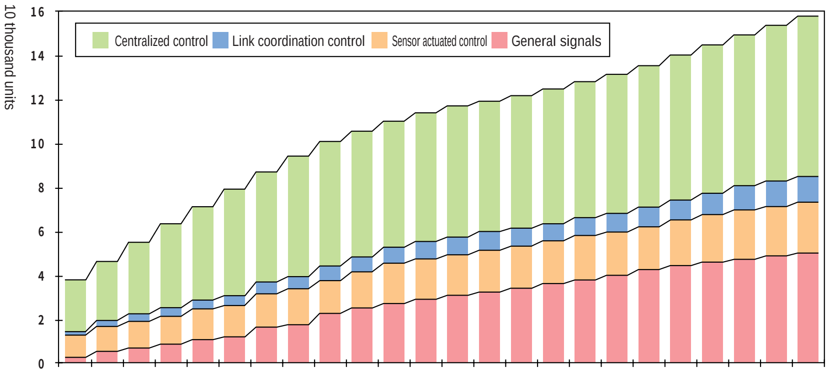
There were approximately 47,000 multistage signal controllers installed in Japan at the end of 1997.

(2) Push-button signal controllers

With this controller, a pedestrian signal turns to green only when a pedestrian wishing to cross a road presses the push-button attached on a signal post. The traffic signal for vehicles remains green unless the push-button is pressed.

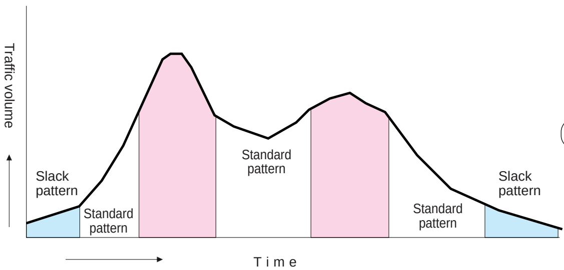
There were approximately 24,000 push-button signal controllers installed in Japan at the end of 1997.

Number of traffic signal controller



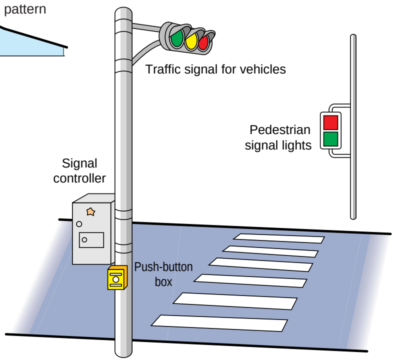
	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
Area control	0.26	0.52	0.71	0.88	1.09	1.23	1.7	1.81	2.28	2.53	2.74	2.93	3.11	3.26	3.45	3.64	3.83	4.05	4.3	4.44	4.61	4.79	4.92	5.06
Link coordination control	1.02	1.16	1.32	1.41	1.43	1.5	1.62	1.62	1.52	1.71	1.86	1.87	1.91	1.96	1.95	1.96	2.04	1.96	1.98	2.09	2.15	2.23	2.27	2.31
Sensor actuated control	0.23	0.28	0.32	0.35	0.42	0.47	0.54	0.57	0.65	0.68	0.72	0.76	0.78	0.82	0.79	0.79	0.81	0.87	0.9	0.95	1	1.08	1.12	1.14
General signals	2.31	2.72	3.29	3.83	4.25	4.81	4.97	5.41	5.66	5.69	5.68	5.81	5.86	5.91	5.99	6.05	6.12	6.28	6.37	6.55	6.73	6.85	7.06	7.27

(1) Multistage signal controller



Concept of multistage control

(2) Push-button signal controller



State 1: push-button not pressed

- Traffic signal for vehicles: green
- Pedestrian signal light: red

State 2: push-button pressed

- Traffic signal for vehicles: green → amber → red
- Pedestrian signal light: red → green

Signal Control Equipment

(3) Traffic Actuated Control

Although the multistage control works satisfactorily if traffic flow profiles are constant, it cannot deal with traffic volumes that vary in an unpredictable manner. To overcome this difficulty, the traffic actuated control uses vehicle detectors for determining green signal length according to the measured traffic volume.

(a) Semi-actuated signal controllers

This controller keeps the green signal for the main road. It turns the signal for the subordinate road green only when it detects a vehicle or pedestrian on that road. The semi-actuated control is suitable for such intersections that the subordinate roads have relatively low traffic volumes. There were 10,471 semi-actuated signal controllers in Japan at the end of 1996.

(b) Full-actuated signal controllers

While the semi-actuated control uses vehicle detectors only on subordinate roads, this control method provides vehicle detectors on all directions including the main road so as to control green signal lengths in each direction according to their traffic volumes. The full-actuated control is suitable for such intersections that traffic volumes substantially change in each direction or traffic conditions vary in an unpredictable manner. The number of full-actuated signal controllers installed in Japan was 970 at the end of 1996.

(c) Traffic actuated signal controllers for right-hand turns

Where right-turn vehicles are many and have substantial hourly changes, fixed time control of them would result in congestion due to jamming right-turns or in wasted right-turn signal lengths. Therefore by installing the vehicle detectors for right-turn lane, the traffic actuated signal control for right-hand turns performs the signal control so that right-turn arrow signal lengths may change according to the volumes of right-turns. This control improves processing capacity of intersections as well as increases the safety of right-turns. Traffic actuated signal controllers for right-hand turns installed in Japan numbered 1,792 at the end of 1996.

(d) Signal controllers for semi-actuated control during slack hours

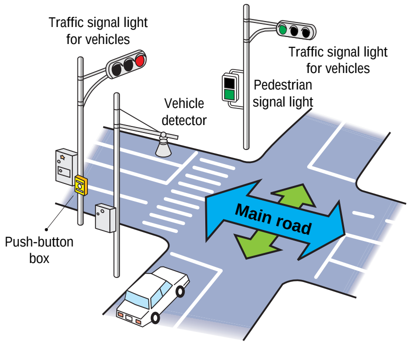
These controllers carry out a kind of semi-actuated signal control. They perform standard signal control during daytime hours when traffic volumes are high, while during slack hours as in the nighttime they conduct semi-actuated control with the traffic on main roads given a priority.

This kind of control is fit for such intersections that the traffic that crosses the main roads substantially decreases during slack hours from that in the daytime. There were 11,626 signal controllers for semi-actuated control during slack hours installed in Japan at the end of 1996.

(e) Speed sensor actuated signal controllers

R-type vehicle detectors capable of measuring vehicle speeds are located near intersections. When they detect vehicles running at unusually high speeds, these controllers shorten green signal displays at downstream intersections if those signals are green, or lengthen red signal displays if those signals are red, to stop such vehicles without any problems. This kind of signal control uses speed information sent by detectors. The number of speed sensor actuated signal controllers installed in Japan was 1,094 at the end of 1996.

(3)Traffic Actuated Control



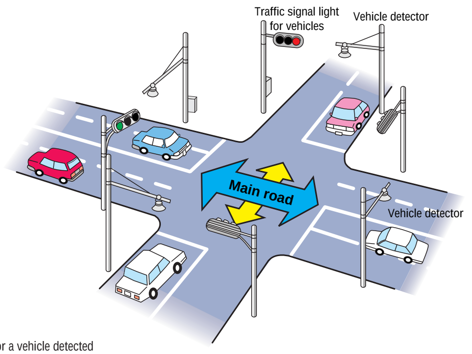
State 1: push-button not pressed or no vehicle detected

- Traffic signal for vehicles: green (for the main road)
- Traffic signal for vehicles: red (for the subordinate road)
- Pedestrian signal light: red (for the subordinate road)

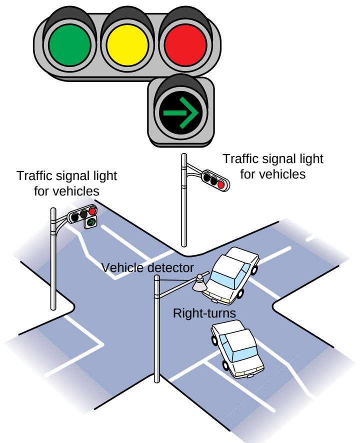
State 2: push-button pressed or a vehicle detected

- Traffic signal for vehicles: green → amber → red (for the main road)
- Traffic signal for vehicles: red → green (for the subordinate road)
- Pedestrian signal light: red → green (for the subordinate road)

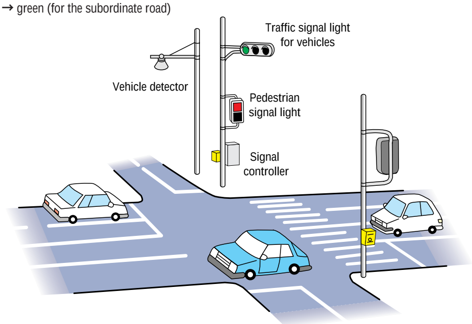
(a) Semi-actuated signal controller



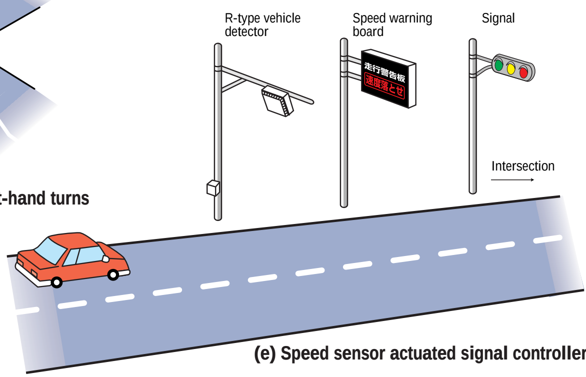
(b) Full-actuated signal controller



(c) Traffic actuated signal controller for right-hand turns



(d) Signal controller for semi-actuated control during slack hours



(e) Speed sensor actuated signal controllers

History of traffic signals

1 Development of traffic signals

(1) Traffic control was first introduced in Japan in 1919. At that time, the police gave signs by waving their hands. Various types of traffic signals have since been used, beginning from information-board type signals which were manually operated, and then to portable-lamp type signals with electric bulbs, and, at present, automatically operated signals.

A prototype of the present traffic signals is the automatic signal which was imported from Reynolds Co., U.S. in March 1930. The signal with three lights in green, amber, and red was installed at the top of a pole which was placed at the center of the Hibiya intersection in Tokyo. The signal was designed in two phases way that the amber light was on after the red one as well as between the green and the red. This historic first traffic signal and the information-board type signal are now displayed in the Traffic Museum in Kanda, Tokyo.

(2) Although instructions and notice by the Metropolitan Police regarding traffic signal's function were established in April 1930, trams' conductors were the only people who understood the meaning of signals and followed the instructions. Therefore, "Go," "Caution," and "Stop" in black letters were added on the surface of each signal light so that ordinary people were able to understand what they meant.

(3) With the advance of motor transportation, the number of traffic signals in major cities in Japan gradually increased. Although 370 sets of signals were installed in the district of the Tokyo Metropolitan Police Department in 1941, most of them were destroyed during World War II. After the war, the police started traffic control again with hand-waving signals, which became so popular that a hand-waving signals competition was held in December 1948.

Meanwhile, the restoration of traffic signals made very slow progress in spite of the urgent request by the U.S. Occupation Army.

(4) Remarkable growth in Japanese economy in around 1955 was accompanied by a rapid increase in motor transportation volume. In 1960, the Road Traffic Law was enacted which established the base of the present concept concerning traffic management. The law also clearly stated that the Public Safety Commission is responsible for installation of traffic signals. Concurrently, the number of traffic accidents has increased. "The Emergency Measure Law Relating to the Improvement of Traffic Safety Facilities" was issued and enacted in April 1966 in response to a public earnest demand for appropriate road traffic environment in the road traffic era. In compliance with this law, traffic signals facilities have been greatly improved and the number of signals also increased. (See Table 1)

(5) Each municipal government adopted its own type of traffic signals for the visually impaired (Audible signals) until July 1975, when two of them were officially designated to be installed nationwide; one with two kinds of bird's chirping sounds and the other with two Japanese folk songs. Under the 2nd Five-year Plan for Traffic Safety Facility Improvement starting in fiscal 1976, a subsidy was allocated to the installation of these two types of signals for the visually impaired.

2 Number of traffic signals (See Table 2)

Table 1: Chronological table of traffic signals in Japan

Year/Month	Item	Remarks
1919.9	Hand-waving signals introduced	Traffic control by hand-waving was started at the Ueno-hirokouji intersection at Ginza 4-chome, Tokyo.
1930.3	Automatic traffic signals imported	The first traffic signal imported from U.S. was set at Hibiya intersection in Tokyo.
1930.4	Standard of signaling announced by the police	The Metropolitan Police Dept. decided to insert "Caution" between "Go" and "Stop."
1930.12	Domestic automatic traffic signals installed	Domestic signals were installed at three junctions in Kyoto by Electricity Dept. of Kyoto Prefecture.
1933.4	Synchronized-type signals in use	Synchronized-type signals were installed along Showa Blvd. and Ginza Blvd. which enabled the link coordination control.
1933.4	Budget allocation for traffic signals	The Metropolitan Police Dept. appropriated an installation budget for 11 sets of automatic signals.
1934.6	Push-button signal for schoolchildren in use	Push-button signals for schoolchildren were installed at two intersections on Dai-ichi Keihin.
1934.10	Additional signals clarified by the police	Meanings of arrow signals in amber and green and flashing amber were clarified by the Metropolitan Police Dept. (Meanings of green, amber, and red signal displays were already clarified in 1930.)
1947.11	Road Traffic Enforcement Law enacted	The Road Traffic Enforcement Law stipulated that pedestrians must follow traffic signals. Enforcement regulations indicated what each signal means, how to give a sign, and how to install and maintain traffic signals.(Green light was named as blue in Japanese)
1953.2	Semi-actuated signal control in use	Semi-actuated type signal with foot board sensor was installed in front of Keio University, Tokyo.
1955.9	Signals for the visually impaired in use	A signal which let the visually impaired know the change of signaling with a bell sound was installed at Higashida-cho, Suginami-ku, Tokyo. After various types of signals for the visually impaired were introduced, two types of such signals,one with a bird's chirping and the other with Japanese melodies were designated to be installed in 1975.
1961.6	Link actuated signal system imported	U.S. made signals controlled automatically on traffic volume were installed on Dai-ichi Keihin, Tokyo. (Domestic signals in such kind were invented in the following year.)
1965.9	Man-shaped signals for pedestrians installed	Man-shaped signals for pedestrians were installed in addition to signals for vehicles at Oiwake intersection in Shinjuku, Tokyo. The green lights of such signals were designed to flash before the red light was turned on.
1966.1	Wide-area signal control started	Wide-area signal control with computers was applied to 35 intersections in Ginza, Tokyo.
1966.2	Specifications were issued by the National Police Agency	Specifications for the standard traffic signals were first issued. (Comprehensively revised in Sep. 1972)
1966.4	The Emergency Measure Law Relating to the Improvement of Traffic Safety Facilities	It was approved at the 51st Diet Session that the government would bear or subsidize installation expense of traffic signals.
1968.12	Scrambled crossing method implemented	The method which allowed pedestrians cross an intersection diagonally was first introduced at Kogai-bashi intersection, Kumamoto City.
1970.7	Road Traffic Law's executive regulation was revised.	The revised version allow vehicles nearing an intersection continue to go at the amber signal display. It was also decided to set a period of time when red signals on both sides of an intersection are on after the amber signal display.
1973.6	Bus priority signal control implemented	The priority signal control for buses was started at Minami intersection at Kami-iida-shako, Nagoya City.
1978.6	Pedestrian signal with display of waiting time in use	Pedestrian signal lights with display of waiting time were installed at Kita-zume intersection at Ebisu-bashi, Osaka.
1993.10	LED type signals in use	A traffic signal with LED was installed at Higashi intersection at Shiro-koji-hisaya, Nagoya City.

Source: "Fifty-Year History of Traffic Signals in Japan" by the Association of Traffic Control Facilities

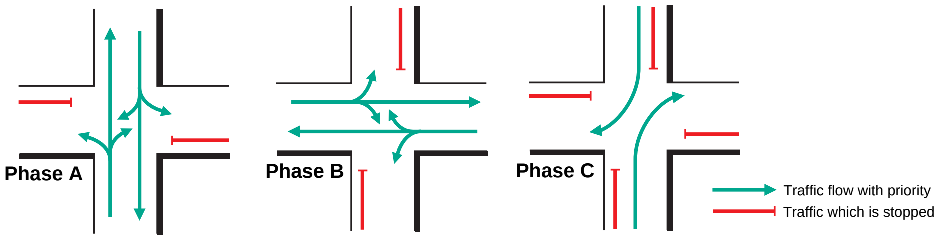
Table 2:Number of traffic signals installed [unit]

1960	1965	1970	1975	1980	1985	1990	1994	1996
2,536	8,285	23,290	63,846	101,100	119,520	135,634	157,792	161,891

Signal Control Method

1 Phase

Traffic flows in different directions are in turn given priority to go by traffic signals. The period of time when a group of vehicles and pedestrians on the side of a green light is allowed to go is called "phase." At a normal intersection, as shown in the following figures, phase A and B are usually seen by turns, which is called 2 phases. At an intersection where many vehicles take right-turns, phase C is inserted between A and B, where it is called 3 phases.



2 Clearance period

The following is the way how to avoid a car crash at an intersection when a traffic signal changes.

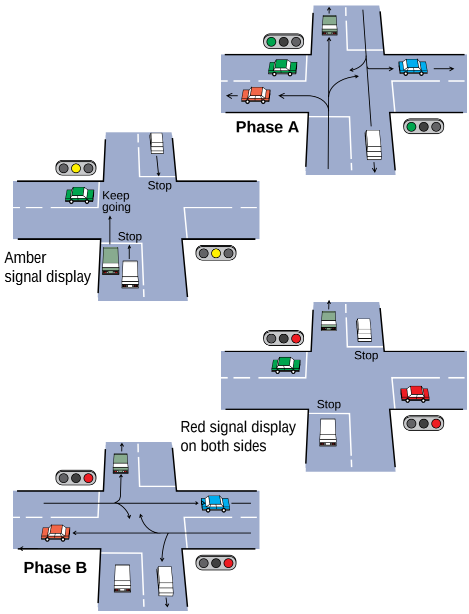
When phase-A changes into B, it is necessary for vehicles on the flow to stop at the stop line or pass through the intersection before the phase A changes into B. Therefore, in transition from A to B, a certain period of time is set to clear vehicles in the intersection, which is called "clearance period." The clearance period is shown by totaling periods when an amber signal display is on and when all the red signal displays in the intersection are on. The length of the period is determined by the shape and space of an intersection.

(1) Amber signal display

Since some vehicles are not ready to stop at the time a green signal display turns into an amber signal display, the amber signal period allows such vehicles to pass through the intersection.

(2) Red signal display at both sides

A period when red signal displays on both sides are on is set long enough for vehicles in an intersection to get away from the intersection. When the period is too long, some impatient drivers do not stop at an amber signal display or start their cars before the green light is on. On the other hand, when the period is too short, some vehicles may be left in the middle of an intersection even after the color changes. Therefore, an appropriate display period should be carefully set up.



3 Three factors in signal controlling

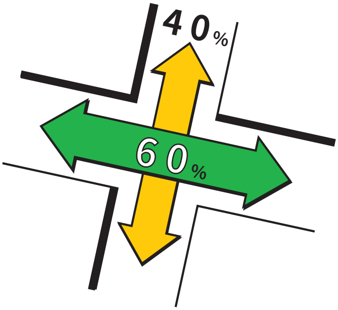
Appropriate setting of timing or signal controlling is important for traffic signals operation. There are three types of timing, "cycle," "offset," and "split."

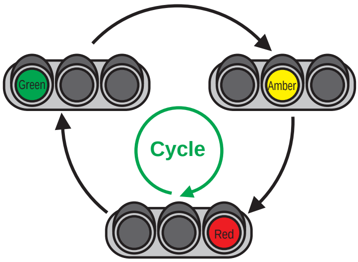
(1) Cycle

A period when signal display turns from green to amber, and then to red is called a "cycle," which is shown by the second. When the cycle is too short, traffic may be congested because only a small amount of traffic is allowed to go. On the other hand, the cycle which is set too long will be inefficient. Various factors including traffic volume, space of an intersection, and crossing time of pedestrians should be taken into consideration when a cycle is determined. A longer cycle is usually adopted at an intersection with a large traffic volume.

(2) Split

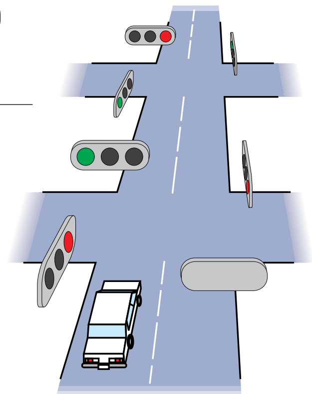
A period of time allocated to each phase in a cycle is called a "split," which is shown by the percentage. Major roads with larger traffic volume require longer period of time compared to secondary roads with smaller traffic volume. An appropriate split should be determined according to traffic volume of a road as follows:when a cycle is 100-second cycle, 60 percent (60 seconds) will be allocated to a major road while 40 percent (40 seconds) to a secondary road.

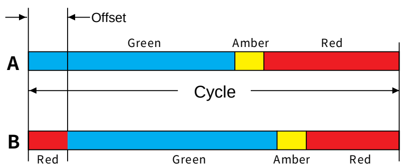




(3) Offset

A time lag is set between two traffic signals next to each other in order to allow vehicles on a major road to keep driving without being stopped by each traffic signal. The time lag between times when the green lights of signals next to each other are on is called an "offset." This is shown by the second or percent per duration of a cycle. When there is a 10-second time lag between signals A and B, each of which has a 100-second cycle, you can say that there is a 10 per cent or a 10 second offset.





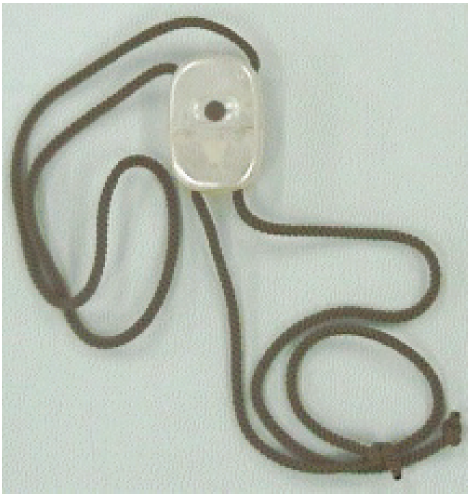
Since "cycle," "split," and "offset" are inevitable to help traffic flow smoothly, they are regarded as three major factors in signal controlling.

TOPICS Pedestrian-friendly Control

1 Sensor actuated control for the elderly and the disabled

This signal control system allows the elderly and pedestrians disabled in the foot to go pedestrian crossings safely, walking more slowly than other pedestrians do. The time the pedestrian green light is displayed is extended by pressing the button on a special white box or the button on the small pendant transmitter carried by the user.

1) Special push-button box



Small pendant transmitter

2 Sensor actuated control for pedestrians

The volumes of pedestrians on pedestrian crossings are measured by pedestrian detectors. The pedestrian green light length is extended or shortened if the volume is higher or lower, respectively, than a preset value. Signal lengths in seconds are selected efficiently according to the volume of crossing pedestrians.

3) Pedestrian detector

3 Display of pedestrians' waiting time

This device shows how long the pedestrians at pedestrian crossings have to wait for turning green in figures or by indicators.

4) Display Device of pedestrians' waiting time

4 Audible signals

This type of signals lets sight-impaired pedestrians crossing roads know that the signals are green, and guides them by either melodies (“ Toryanse ” (a Japanese children's song) or “ Kokyo-no Sora ”) or bird chirping sounds (“ tweet, tweet ” or “ cuckoo ”).

5 Audible accessories for pedestrian signals

This device lets pedestrians know turning green by means of a chime ring followed by human voice (“ Bing-bong ”“ The signal is green now ”).

Link Coordination Control

1 Traffic control method for road line

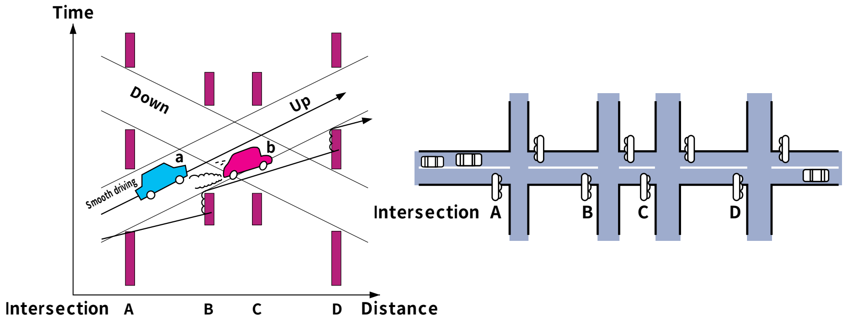
Link coordination control is a method to link adjacent signals by offset patterns to let vehicles pass smoothly with a minimum number of times they have to stop.

If vehicle **a** that has passed intersection A runs at a certain constant speed, it can then pass intersections B, C, and D without having to stop at each intersection as the signals turn to green in sequence. In contrast, vehicle **b** that increases its speed must stop at intersections B and D. As a result, there is no difference between times that vehicles **a** and **b** pass intersection D, which left intersection A at the same time. Consequently, vehicles that increase speeds take almost the same time to reach their destinations as those that run at a certain constant speed.

Offset patterns are intended to allow vehicles to run safely and smoothly without encountering red signals and having to stop if they go at a certain constant speed. Another effect of offset patterns is to deter overspeeding vehicles.

However, offset patterns do not mean that, if optimal adjustment of offset patterns is performed, vehicles can pass all intersections without stopping. For example, while traffic volumes on a road may be about the same in both directions during off-peak hours, that in the up lanes may become higher than the down lanes during the morning rush hours. The offset control then gives priority to the up lanes to increase traffic flow, thereby permitting no chances for the vehicles in the down lanes of going without a stop. Offset patterns are adjusted according to current traffic conditions, as explained above.

An example of offset pattern



2 Multistage link coordination control

The multistage link coordination control is a type of multistage control provided with a link coordination control function. Three control patterns are provided, which are suitable, for example, for congested, standard, and slack traffic flows. These patterns are selected depending on the time of day.

This type of control is effective on such roads that traffic flow is relatively constant and flow patterns are distinct.

3 Link actuated system control

If traffic flow on some roads changes constantly, it is necessary to control traffic in accordance with changes. The link actuated system control is suitable for such roads. This type of control comprises a central unit that determines cycle lengths, split values, and offset patterns, vehicle detectors that collect information such as traffic volumes, and signal controllers. The central unit, signal controllers, and vehicle detectors are connected via telephone lines to exchange information one another.

The central unit collects information such as traffic volumes via vehicle detectors installed at representative locations on routes. It automatically selects a control pattern fit for the traffic conditions from several control patterns stored in advance, to control each signal controller.

Area (Wide-area) Control

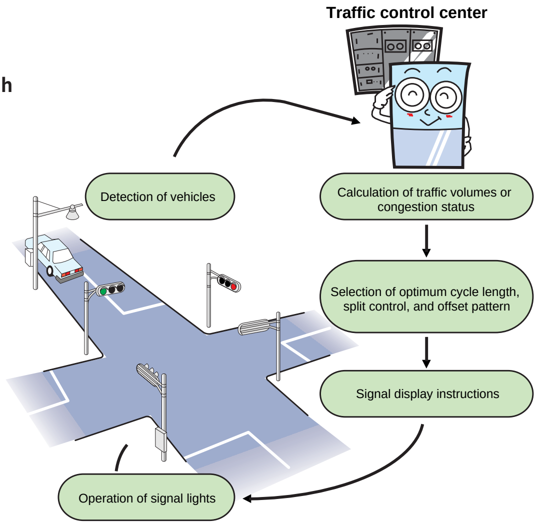
Let us consider efficient traffic control in an area provided with many signals. In major cities, trunk roads of high traffic volumes intersect with medium-sized and narrow roads in a complicated manner, on which numerous vehicles and people come and go. A great number of signals are installed in such an area to prevent accidents and create a smooth flow of traffic.

If each signal operates independently from others, the traffic in a city will become chaotic. In addition, link coordination control does not improve traffic flow on subordinate roads that intersect with trunk roads.

Area traffic control is in need to improve control efficiency for urban road traffic that forms a very complex structure. In general, area traffic control is known as “area control” or “wide-area control,” each signal being controlled by the computer in the traffic control center.

1 Area traffic control sequence

Below is a control sequence for each signal under area traffic control.

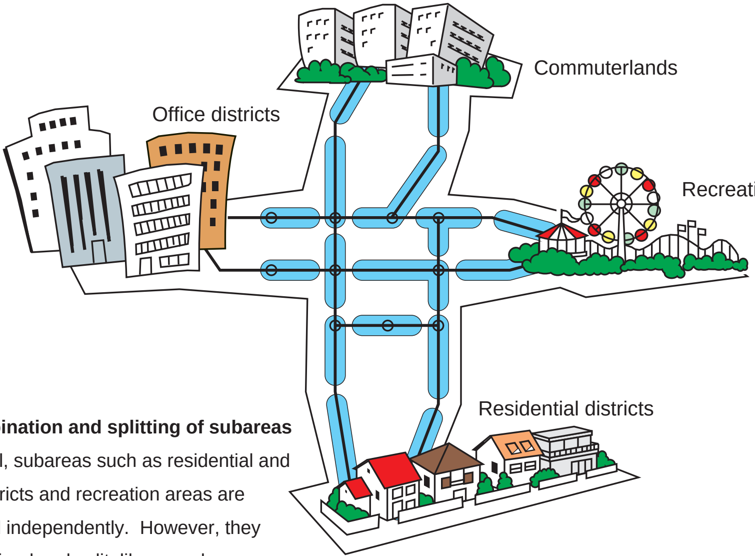


2 Area traffic control method

In cities, congestion of commuter traffic is seen in mornings and evenings in some districts, pedestrians are many in shopping districts, and tourist traffic floods on non-working days and holidays in some other districts. There are various flow profiles depending on the characters of districts. If such differences are disregarded and the same control pattern (cycle length, split value, and offset pattern) is used, congestion may occur in some districts due to short green signal lengths. In other districts, conversely, waste green signal lengths may be produced, resulting in extended stop time or an increased number of stops.

To eliminate such wastefulness, intersections in an area are classified into groups of similar flow profiles (these are named “subareas”). In each subarea its optimal control pattern is used. Moreover, each subarea is linked with other subareas to control the whole area.

By setting up subareas this way, it becomes possible to carry out careful control of complicated flows of a vast number of vehicles in the whole area.

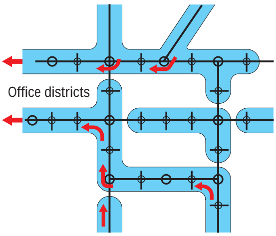


(a) Combination and splitting of subareas

In general, subareas such as residential and office districts and recreation areas are controlled independently. However, they are combined and split, like amoebas, according to current traffic conditions so as to set up optimal subareas for traffic control.

For example, subareas are set up to connect residential and office districts during the morning and evening rush hours to make smooth flow of commuters. On holidays, other subareas may be created to connect residential districts with recreational areas. Thus subareas are reconstructed hourly and on specific days of the week for traffic control.

It is possible to carry out sophisticated control by setting up subareas suitable under various conditions.



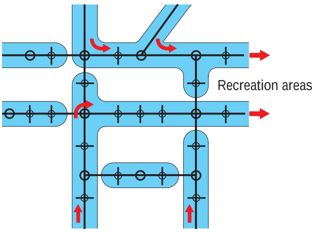
An example of combined areas during morning and evening rush hours

(b) Subarea control suitable for traffic conditions

Control patterns for each subarea and linkage between subareas are calculated with a computer using data such as traffic volumes collected by vehicle detectors. Best control schemes are used for current traffic conditions.

Recently, a method has been developed to minimize congestion. In this method, accumulated data are used to predict congestion, and the result is incorporated into traffic control.

Area traffic control is applied to urban and suburb areas, in which many signals are installed, and is very effective.



An example of combined areas on non-working days

Information Supply Unit Information Boards and Other Devices

1 Information Supply Unit

The information supply unit is a general term for equipment intended for real-time supply of information to drivers, such as congestion, accidents, roadworks, traffic regulations, and travel times.

2 Types

(1) Information boards

Information boards are installed on the roadside to supply traffic information. Boards in this category are as follows: character information, variable message, preset message, formulated information, small (character) information, and small (travel time) information boards.

(2) Roadside radio transmitters

These devices supply traffic information in voice edited by voice synthesizers at the traffic control centers. Radio transmitters and antennas installed on roadside emit radio waves. Drivers can access this information on their car radios at 1620 kHz.

(3) Traffic information service via telephone and fax

Users can access traffic information edited by traffic control computers by calling specific numbers. This information is available in voice for telephones or in maps and charts for fax machines.

(4) Information terminals

These terminals are mainly installed at public facilities for user convenience. Traffic information is supplied in maps and characters on monitor screens.

(5) Vehicle Information and Communication System (VICS)

VICS is an ITS project promoted jointly by the National Police Agency, the Ministry of Posts and Telecommunications, and the Ministry of Construction. Traffic information collected by local police headquarters and road administrators is transmitted to the VICS center through Japan Road Traffic Information Center.

The VICS center edits and processes the traffic information and distribute it via the following three media. (See also descriptions of VICS on page 90.)

- Infrared beacons (infrared ray) intended for surface roads
- Radio beacons (quasi-microwaves) intended for expressways
- FM multiplex broadcasts intended for wide areas

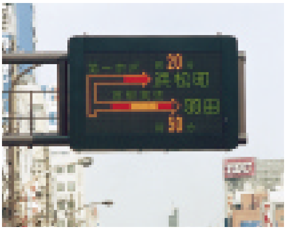
3 Information to be supplied

The traffic control center (See also description of the traffic control centers on page 42) receives various information about traffic conditions such as traffic volumes, congestion lengths, travel times which are collected automatically by vehicle detectors including infrared beacons, traffic accident information reported by police men at the site, and other related information such as roadworks and traffic regulations, edits and processes them , thereafter supply the following contents, although they slightly differ depending on the supply media.

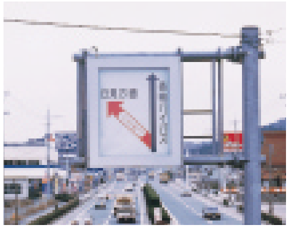
- Congestion status: road names, congestion lengths, and degree of congestion
- Travel times: road names and travel times
- Incident information: road names, location names, incident information (accidents, traffic regulations, etc.)
- Parking information: location and space availability
- Wide-area information: messages, cautions, etc.

Traffic information boards

Character information



Variable message



Preset message

Formulated information

Small (character) information board

Small (travel time) information board

Roadside radio transmitters (1620 kHz)

Traffic information service via telephone and fax

VICS

Traffic information terminal

Effects of the Traffic Control System

1 The Traffic Control System

Managed and operated by the police, the traffic control system is a unified system for ensuring safe and smooth traffic flow. It is designed to distribute and guide fitly the volume and the flow of the traffic in the overcrowded cities based on the road network. This system works to support urban mechanism through making the most of facilities of motor vehicle.

2 Traffic Control System Equipment

Traffic safety facilities that constitute the traffic control system include those listed below. These facilities are developed and maintained under the Emergency Measures Law Relating to the Improvement of Traffic Safety Facilities established in 1966.

(1) Traffic control centers (They are established at the Police Headquarters. In some main cities, city centers are also established.)

(2) Information collection equipment such as CCTV cameras and vehicle detectors

(3) Information supply unit including information boards and roadside radio transmitters

(4) Traffic signals

(5) Equipment for information exchanges with neighboring prefectures and other agencies

3 How the Traffic Control System Works

(1) Collects traffic information from policemen at site, CCTV cameras, vehicle detectors, and other devices.

(2) Analyzes, processes, and records collected traffic information.

(3) Controls traffic signals fitly based on the results of analyses and processing of traffic information.

(4) Provides drivers with traffic information via information supply unit and other devices (see also page 60).

The traffic control system has functions shown above. These functions are supervised by the traffic control center established at the Police Headquarters in every prefecture. The center works as the core of the traffic management and control system.

4 Effects in Detail

Economic benefits were calculated on each category to evaluate the effects of the system. Results are shown in the table.

Benefits were evaluated in terms both of smooth traffic flow and reduced accidents.

5 Aims

The traffic management and control system is constantly improved for advancement along with technological progress. Universal Traffic Management Systems (UTMS: see also page 74) were developed as an innovative concept to implement ITS. Based on UTMS, the traffic management and control system is constructed so as to realize a traffic society that is safe, comfortable, and environmentally friendly.

Calculation of annual benefits (per signal or device)			
Categorical name	Smooth flow benefits	Reduced accident benefits	Remarks
Traffic control center	35,406	651	The value in the reduced accident benefits column is shown for reference.
Development of area control	55,312	1,481	The value in the reduced accident benefits column is shown for reference.
Development of link actuated system control	48,788	1,234	The value in the reduced accident benefits column is shown for reference.
Development of programmable multistage system control	―――	1,704	The value in the reduced accident benefits column is shown for reference.
Development of semi-actuated control	4,684	5,508	The value in the smooth flow benefits column is shown for reference.
Development of push-button control during slack hours	―――	4,108	
Development of semi-actuated control during slack hours	―――	4,155	
Development of speed actuated control (high speeds)	―――	6,108	
Development of speed actuated control (driver dilemma)	―――	7,386	
Development of traffic actuated control for right-hand turns	13,738	7,280	The value in the smooth flow benefits column is shown for reference.
Development of multiple signal indications	―――	7,706	
High-speed driving deterrence device	―――	7,102	The value in the reduced accident benefits column is shown for reference.
Development of sensor actuated control for the elderly and the disabled	―――	6,427	

Remarks:① Unit: \1000/year

② Smooth flow benefits were calculated as that in the directions of the main roads except for the development of traffic actuated control for right-hand turns. Values per direction of individual signals were doubled.

③ Concerning benefit calculation of traffic control center, development of area control, development of link actuated system control, and development of programmable multistage system control, interlocking remote equipment is taken into consideration when obtaining the results.

④ "—" denotes that no survey was conducted.

Parking Guidance Systems

1 Parking Guidance Systems

Parking guidance systems provided in urban areas are connected with the traffic control centers to carry out unified control of parking information at the traffic control centers.

The traffic control centers combine parking information and other traffic information to supply information such as parking locations, availability, congestion near parking areas, using parking guidance signs and other devices.

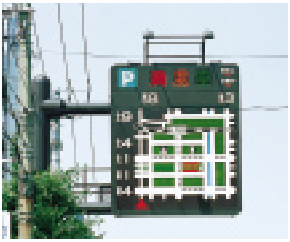
2 Parking Guidance System Equipment

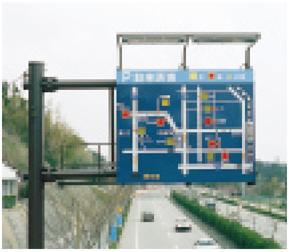
Parking guidance systems use entrance signs, parking guidance signs, and other devices.

3 Effects

Drivers can learn parking space availability information in advance, so they can go to nearby parking areas with available space immediately. Drivers can also learn congestion status near parking areas, so they can avoid congestion.

The numbers of vehicles dawdling on the road searching and waiting for parking space are expected to decrease.





Parking area management system

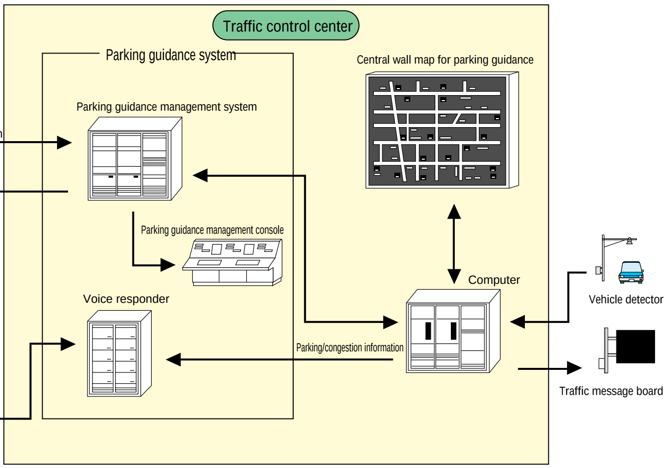
Communication controller (subscriber lines supported)

Parking guidance information processing unit

Central parking guidance unit

Man-machine interface system

●System structure



Illegal Parking Deterrence System

1 Illegal Parking Deterrence System

The traffic control centers watch major intersections and routes and the vicinity of stations where vehicles are likely to park, using CCTV cameras installed at such locations. Illegal parking is monitored. For drivers who are seen to be parking, the loudspeakers broadcast warning messages to eliminate their illegal parking.

In concrete, major intersections on trunk roads are provided with CCTV cameras and loudspeakers, which are operated from the traffic control centers via central units, consoles, monitor screens, and microphones.

2 Effects

Illegal parking is one of causes of traffic congestion and accidents.

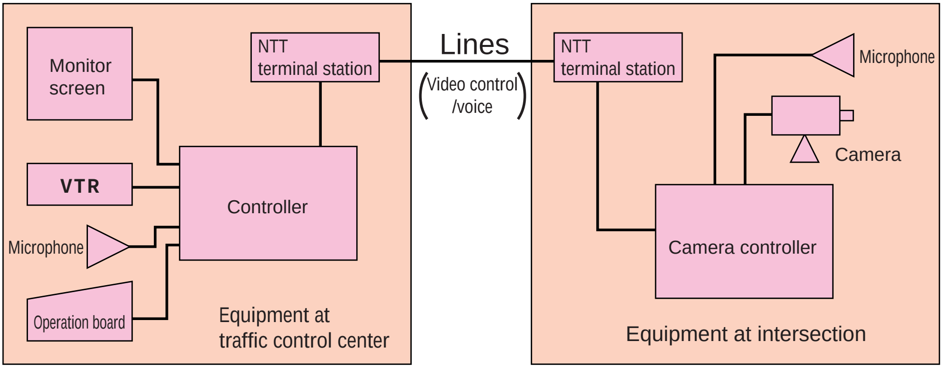
The illegal parking deterrence system, if effectively operated, will eliminate illegal parking and maintain disciplined traffic in areas close to city centers. As a result, traffic congestion and accidents on trunk roads are deterred.

3 Expected Developments

Recent technologies, such as image processing and various sensors, make it possible to detect illegal parking automatically.

Regarding the use of CCTV cameras incorporated in the illegal parking deterrence system, practical applications of various functions and new studies are underway. Examples include automatic video recording immediately before and after accidents, which utilizes the impulsive sounds produced at the time of accidents, and more advanced function of automatic accident notification, as well as monitoring traffic flow.

Video capturing accidents is highly useful for the analysis of accident occurrence mechanisms. Such video is expected to become valuable data for formulating traffic safety measures.


Monitor screen
NTT terminal station
Lines
(Video control /voice)
NTT terminal station
Microphone
VTR
Controller
Camera
Microphone
Camera controller
Operation board
Equipment at traffic control center
Equipment at intersection

High-speed Driving Deterrence System

1 High-speed Driving Deterrence System

The high-speed driving deterrence system is provided for road sections in which traffic accidents frequently occur due to overspeeding and reckless driving is seen constantly. It is one of safety facilities intended for deterrence of traffic accidents and noise.

In concrete, the system measures speeds of moving vehicles. For overspeeding ones, warning boards display messages such as "Slow Down." Cautions or warnings are issued directly to drivers to let them to reduce speed. It is also possible to control signals ahead of moving vehicles to turn red forcibly, so that they stop at signals and drive safely.

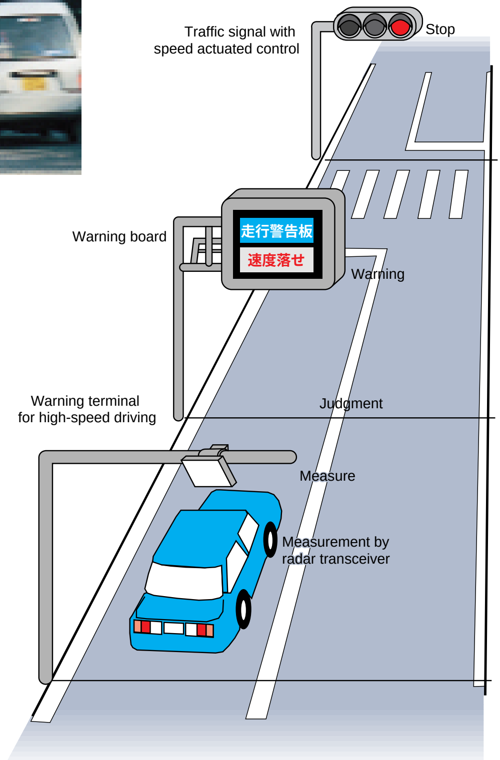
2 Effects

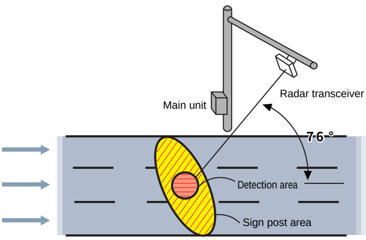
Overspeeding vehicles and careless driving decrease in numbers. The system is also useful for prevention of accidents caused by overspeeding.

3 Expected Developments

The system is capable of real-time recognition of vehicles that persist in overspeeding as violations. Their license numbers and features may be sent to nearby patrol cars, thereby catching violations immediately. This has become possible by the progress of science and technologies, especially, the digital technology. Some prefectures have already introduced and put into operation.


その車！
速度違反
速度落せ


Traffic signal with
speed actuated control
Stop
Warning board
走行警告板
速度落せ
Warning
Warning terminal
for high-speed driving
Judgment
Measure
Measurement by
radar transceiver


Main unit
Radar transceiver
7.6 °
Detection area
Sign post area

Oncoming Traffic Indication System

1 Oncoming Traffic Indication System

The oncoming traffic indication system lets drivers learn the approach of oncoming traffic on roads where drivers cannot see ahead as they curve. The aim of this system is to prevent accidents caused by protruding from the centerline to the opposite lane.

In concrete, vehicle detectors are installed on the opposite lanes. When the approach of oncoming traffic is detected, the system displays a warning such as "Oncoming Traffic Ahead" or "Go with Care" to ensure driving safety.

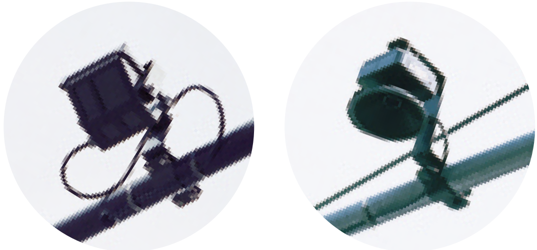
2 Effects

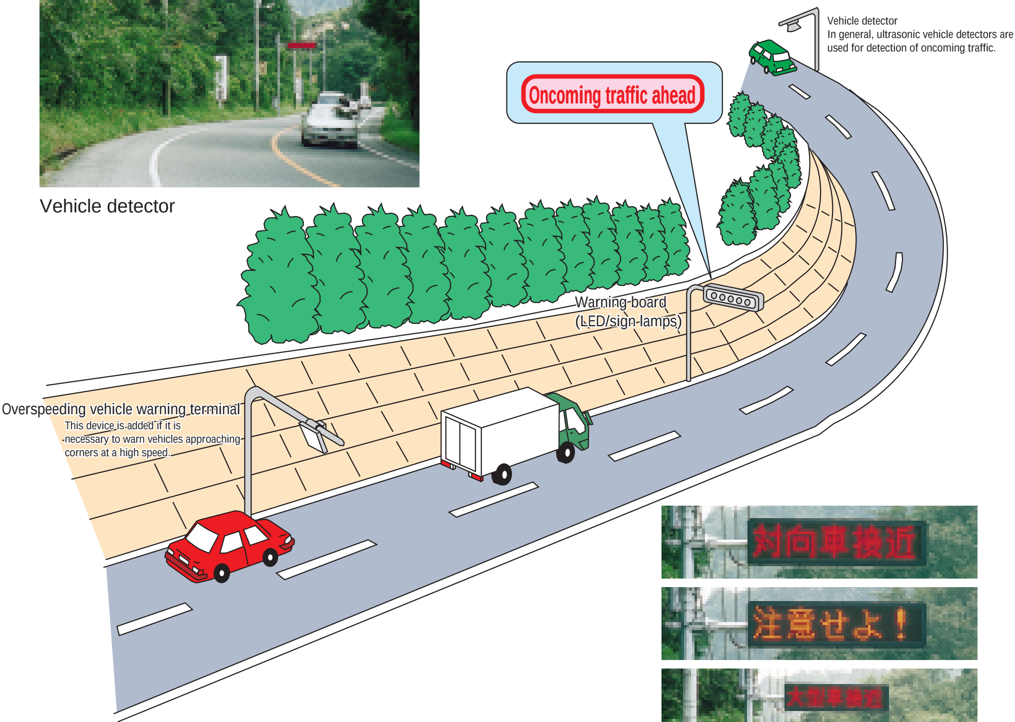
Calling drivers' attention is effective for accident prevention. By adding a vehicle detector capable of speed measurement, the system can also issue a warning for overspeeding vehicles.

3 Number of Units Installed

There were 130 units installed in Japan at the end of 1997.

Vehicle detector





Warning board (Kui Town)

Centerline Shifting System

1 Centerline Shifting System

The centerline shifting system uses centerline signs, variable signs, special lights, and other devices to set up centerline shifting sections. In these sections, more lanes are allotted in the direction of higher traffic volumes.

This system deals with predictable variations in traffic demands. During morning and evening rush hours, it, for example, increases up lanes in the morning and down lanes in the evening.

2 Effects

Traffic flow increases by allotting more lanes in the directions of high traffic volumes, thereby deterring or alleviating congestion.

The centerline shifting system improves the efficiency of limited roads. It is an effective means for promoting the smooth traffic flow program.

3 Changes in Lane Usage

Sufficient publicity periods are provided before introducing the centerline shifting system so that every driver may know the implementation of the system. Police officers attend at the early stage of introduction to control and guide vehicles.

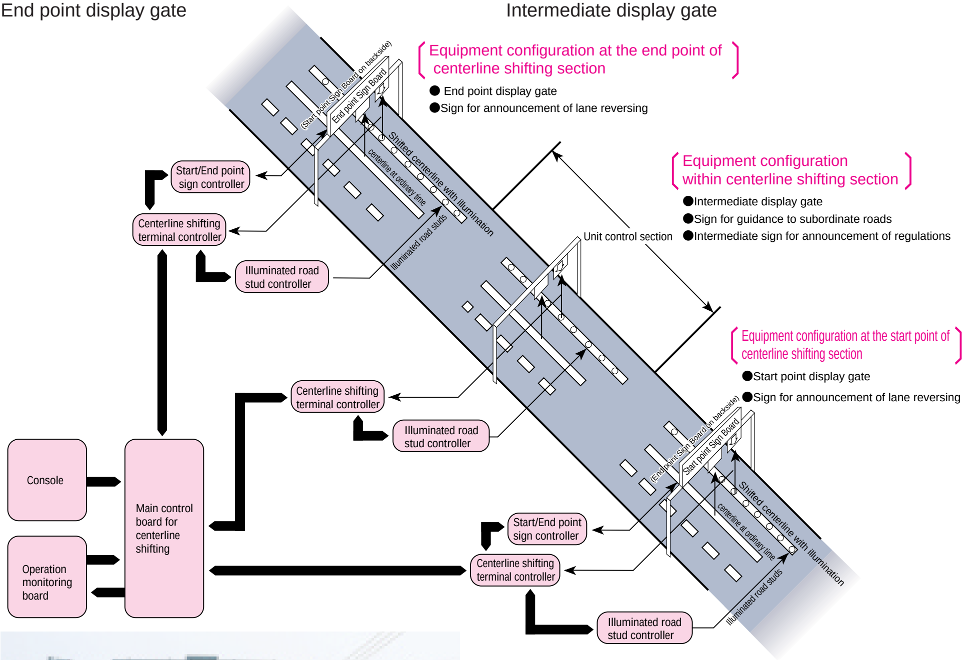
4 Reversing Lane Directions

In order to reverse lane directions in the morning and evening, vehicles are prohibited to enter the section for some minutes to clear the vehicles therein.

The time taken for clearing vehicles depends on the length of the centerline shifting section.

End point display gate

Intermediate display gate



Start point display gate

UTMS21

The annual fatalities by traffic accidents in Japan has decreased to below 10,000 but still remains high (9,000 range), with the number of traffic accidents themselves increasing annually.

Meanwhile, the percentage of the aged in Japan's total population is also increasing sharply. In view of these, we have been engaged in R&D of practical Intelligent Transport Systems (ITS), which combines information communication, electronics and various other high technologies, taking persons, roads, vehicles and all other traffic-related factors integrally.

For practical ITS, the National Police Agency has been promoting the Universal Traffic Management Systems 21 (UTMS21) concept. The aim is to create a "safe, comfortable and environment-friendly automobile society", providing vehicle drivers with real-time traffic information through two-way communication with each vehicle, via infrared veacons -- the key infrastructure of the their sub-systems.

As shown in right-above figure, the UTMS21 involves nine systems: Integrated Traffic Control Systems (ITCS) as a core, Advanced Mobile Information Systems (AMIS), Public Transportation Priority Systems (PTPS), Mobile Operation Control Systems (MOCS), Dynamic Route Guidance Systems (DRGS), Help System for Emergency Life Saving and Public Safety (HELP), Environmental Protection Management Systems (EPMS), Driving Safety Support Systems (DSSS), and Intelligent Integrated ITV Systems (IIIS). Some of these systems have already been realized, some being in R&D process. AMIS, PTPS and MOCS are already put to practical service.

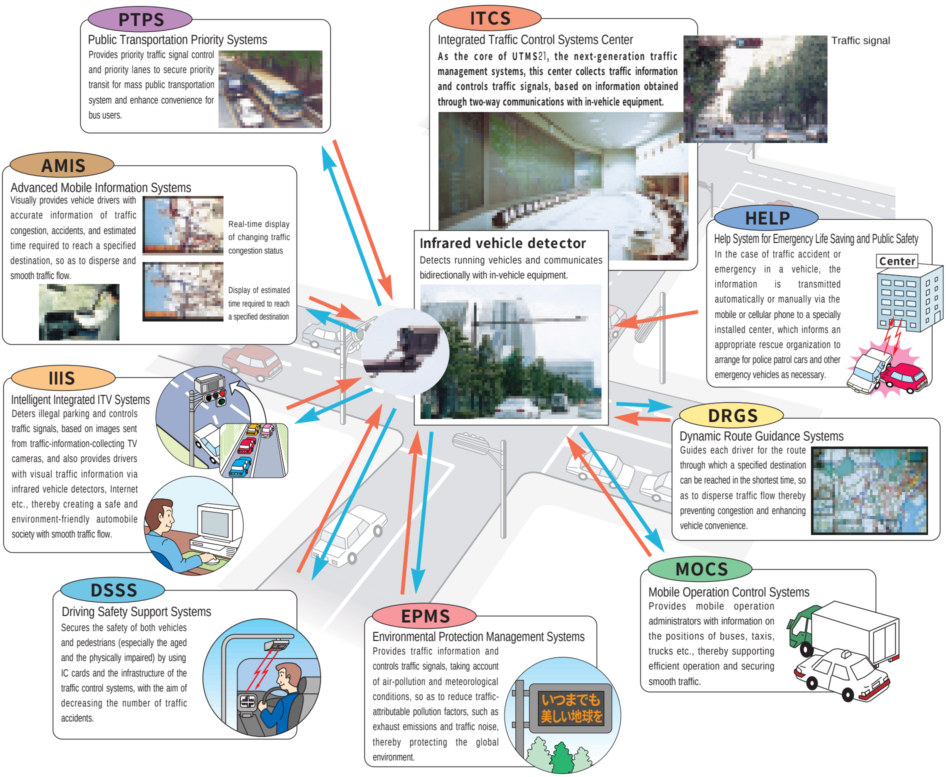
With AMIS, traffic information collected by the traffic control center at each prefectural police headquarters is supplied to the Vehicle Information and Communication Systems (VICS) center. At present the traffic information is being provided for drivers via FM multiplex broadcasting, infrared beacons and radio beacons in the Tokyo Metropolitan area, the Chubu area and the Kinki area.

PTPS/MOCS have been introduced in Sapporo city, Hokkaido since April 1996. These systems, using traffic safety facilities (infrared beacons, traffic signals, traffic control centers etc.) installed by the police in Sapporo, have successfully improved bus service punctuality and increased the number of people using buses in consequence.

To create an environment friendly to physically impaired persons as well as to the aged persons who are increasing in number at a rapid pace, the National Police Agency has been making efforts for early introduction of DSSS. The Agency has also been dedicated in R&D of EPMS, to give solutions to the pollution issues caused by CO_2 and NOx emissions, which are the subject of global concern.

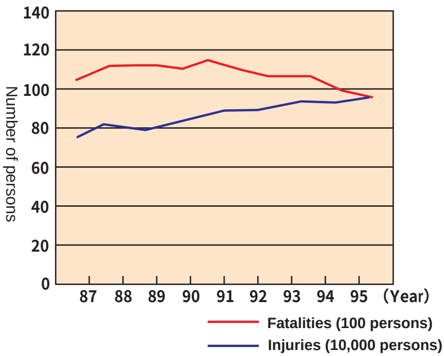
For future tasks, the National Police Agency also considers development of new sub-systems using infrared beacons, in the fields of efficient physical distribution support system, traffic demand management system, pedestrian support system etc.

Concept of UTMS21 Services



Trend of Traffic Accident Casualties

Year	Fatalities in traffic accident	Injuries in traffic accident (Unit: 100 persons)
1988	10,344	7,528
1989	11,086	8,148
1990	11,227	7,903
1991	11,105	8,102
1992	11,451	8,440
1993	10,942	8,786
1994	10,649	8,817
1995	10,679	9,227
1996	9,942	9,422
1997	9,640	9,589



ITS (Intelligent Transport System)

Today, the term "ITS" is often used in various government guidelines and newspapers. This "ITS" is an abbreviation for Intelligent Transport System. In Japan, this term is translated as "advanced road traffic system."

ITS was introduced as a "trump" in an effort to create a safe, comfortable, and environment friendly traffic society. Information communication technology, electronics technology, other science and technology are utilized to tackle problems including traffic accidents and traffic congestion in recent years.

Research and development on ITS have been under way actively in advanced countries, including Japan, European countries, and the United States. Research and development on ITS in Japan have been led by five relevant ministries and agencies including the National Police Agency, industries and academia.

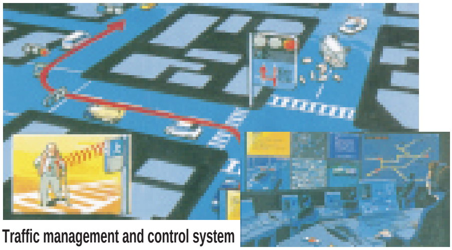
Regarding the specific commitments into ITS in Japan, the Japanese Government established "The Advanced Information and Telecommunications Society Promotion Headquarters" (The Promotion Headquarters), in which the Prime Minister is the chairman and concerned ministers are members, who issued the governmental basic policy, titled as "Basic Guidelines on the Promotion of an Advanced Information and Telecommunications Society" in February 1995. Based on this basic policy, the five relevant Agency and Ministries jointly prepared a guideline, named as "Guidelines on the Increasing Use of Information and Communications in the Fields of Roads, Traffic, and Vehicles" in August 1995.

This guideline becomes the fundamentals of the "Comprehensive Plan for ITS in Japan" issued in July, 1996, which was also jointly prepared by the said five relevant Agency and Ministries. Following are the area for ITS development raised by the said Comprehensive Plan;

① Advances in navigation system
② Electronic toll collection system
③ Assistance for safe driving
④ Optimization of traffic management
⑤ Increasing efficiency in road management
⑥ Support for public transport
⑦ Increasing efficiency in commercial vehicles operation
⑧ Support for pedestrian
⑨ Support for emergency vehicle operation

The National Police Agency advocates UTMS21, which is the ITS we promote based on the said Comprehensive Plan for ITS. At present, some of the subsystems in UTMS21 are in use, some are under implementation and some are in research and development stage. Especially, the National Police Agency is working at present on research and development of DSSS to support the elderly and handicapped, and also is giving priority to traffic pollution matter such as CO_2, NOx, and noise. The research and development has made progress to the point where implementation of the Environment Protection Management Systems is close at hand. The details are in the chapter of UTMS21(page 74).

System's image realized by ITS

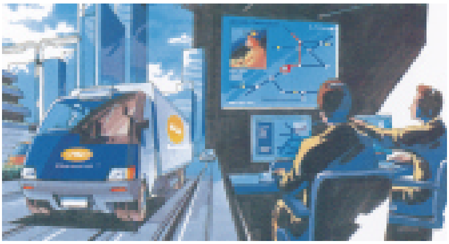


Traffic management and control system

The travelling time is measured more accurately, monitoring of the traffic situation is advanced, and control of traffic signal can be made more precisely as the results the smoothness of traffic flow will be facilitated. In addition, it becomes possible to adopt route guidance through variable message signs on the road and navigation systems so that the traffic flow on the road has less uneven in the whole traffic network.

Travel/road traffic/driving information supply system

It becomes possible to receive guidance on the route to get to the destination faster by receiving road traffic information on less traffic volume. Operational information on land, sea and air public transportation also becomes available. This allows each person to select and combine transportation suitable for his/her needs and desire.



Transportation efficiency improvement system

By getting hold of present locations of vehicles for business use and implementing appropriate operation management, vehicles driving without freight or with small freight can be eliminated. As a result, the load on the road is reduced, facilitating the traffic flow smoothly. Similar operation management is implemented on emergency vehicles and vehicles for road management. In this way, efficient road/traffic management can be achieved.

Electronic toll collection system

Payment at a toll gate of the toll road and an exit of the parking lot can be made automatically without stopping by utilizing the wireless card system. Because it is not necessary to stop at the toll gate, traffic congestion and accidents attributed to toll gates can be eliminated or reduced, thus facilitating the traffic flow smoothly. It is contemplated that the toll payment is made by prepaid cards or deduction from the bank accounts.

Disaster crisis management system

When large scale disasters such as earthquakes/floods occur, information can be collected promptly on the disaster status. It also becomes possible to carry out traffic regulations of general vehicles, guidance of rescue vehicles, and priority passage control. When information communication facilities are damaged in the disaster area, their backup system will be substituted.

Vehicle driving warning/control/collision prevention system

Distance between a preceding vehicle and the own vehicle and maintenance of the driving lane are monitored by utilizing small powered radar, which achieves safer driving. For example, if the distance between cars falls below the safe distance, automatic control is carried out, and the safe distance between cars is maintained. Alarms go off against hazards attributed to deviation from the driving lane, approach speed and excessive turning of the steering wheel at a curve and intersection. The goal in the future is to achieve automatic driving of vehicles on guideways used exclusively for physical distribution and roads exclusively used for automatic driving.

System architecture

ITS (Intelligent Transport Systems) will realize a safe, smooth and environment friendly traffic society with people, roads and vehicles integrated closely by utilizing information communication technology and electronics technology.

In the backdrop lie increasingly grave difficulty in building new roads for surge of traffic demand in terms of land utilization, financially, and environmentally.

In such a situation, the government presented "Basic Guideline on the Promotion of Advanced Information and Telecommunication Society." This policy was followed by preparation of "Guidelines on the Increasing Use of Information and Communications in the Fields of Roads, Traffic and Vehicles" by five relevant Agency and Ministries (the National Police Agency, the Ministry of International Trade and Industry, the Ministry of Transport, the Ministry of Posts and Telecommunications, the Ministry of Construction). Further, "Comprehensive Plan for ITS in Japan" was made out.

ITS is a system where system components are intertwined complicatedly. System architecture clarifies how each component of the system affects each other and works as one and stipulates functions of the entire system and each subsystem.
In this system architecture, each subsystem does not assume specific technology. Instead, it allows a system developer to design freely. It is also prepared so that there is no overlapping and lack of subsystems and components, which achieves efficient planning and operation. In addition, because information exchanges are clearly specified among subsystems, establishment of ITS system architecture and standardization for information exchanges are indivisible.

At present, the five Agency and Ministries are working on system architecture in cooperation with relevant fields (refer to page 83). Configuration of the system architecture in Japan is as follows:
① User service: specific services supplied by ITS
② Theoretical architecture: functions which the system should be furnished with, information to be dealt with, and their mutual relationship
③ Physical architecture: optimal configuration of the system to cover function and information
④ Possible sphere of standardization: sphere subject to standardization of interface among ITS components

At present, ① user service is prepared, and completed up to the right bottom table. (as of end of August, 1998) In the future, it is scheduled to proceed with the work in order of theoretical architecture, physical architecture, and possible sphere of standardization.

System architecture is also prepared overseas. One representative example is by ITS National Architecture by ITS America completed in 1996. There is also System Architecture in Europe, namely in England and Holland.

Framework for mapping out system architecture

- 5 ministries and agencies liaison meeting — VERTIS
  - Private enterprises
  - Relevant institutions
  - Universities

Initial Proposal

Development area	User Service
1 Advncement of navigation system	1.Supply of traffic related information; 2.Supply of destination information
2 Electronic toll collection system	3.Electronic toll collection
3 Assistance for safe driving	4.Supply of driving environment information; 5.Hazard warning; 6.Driving assistance; 7.Automatic driving
4 Optimization of traffic management	8.Advancement of traffic management; 9.Optimization of traffic flow
5 Efficiency improvement of road management	10.Efficiency improvement of maintenance management service; 11.Management of special vehicles; 12.Supply of traffic regulation information
6 Support of public transportation	13.Supply of public transportation utilization information; 14.Operation/operation management support of public transportation
7 Efficiency improvement of commercial vehicles	15.Operation management support of commercial vehicles; 16.Continuous automatic driving of commercial vehicles
8 Support of pedestrians	17.Route guidance; 18.Hazard prevention
9 Operation support of emergency vehicle	19.Automatic report in case of emergency; 20.Emergency vehicle route guidance/rescue operation support
Original plan for individual user service: 46.Supply of advanced information communication society related information	21. Supply of advanced information communication society related information

individual user service

1 Supply of route information to drivers
2 Supply of information from other agencies to drivers
3 Preliminary supply of route information
4 Preliminary supply of information from other agencies
5 Preliminary supply of destination information
6 Supply of destination information to drivers
7 Supply of destination information at service areas and parking areas
8 Electronic toll collection on toll roads
9 Electronic toll collection at parking lots, ferryboats, etc.
10 Supply of road environment information
11 Supply of surrounding vehicle information
12 Hazard warning of preceding vehicles
13 Hazard warning of side vehicles
14 Hazard warning of front crossing vehicles
15 Hazard warning of driver/vehicle conditions
16 Driving assistance for preceding vehicles
17 Driving assistance for side vehicles
18 Driving assistance for front crossing vehicles
19 Driving assistance for driver abnormality
20 Automatic driving of general vehicles
21 Automatic driving of management vehicles
22 Planning support of traffic management
23 Support of traffic management/facility service
24 Support of parking measures
25 Support of drivers
26 Support of police activities
27 Maintenance of traffic order
28 Support of traffic management responding to incidents
29 Optimization of traffic signal control
30 Route guidance
31 Dynamic lane control
32 Support of road management service
33 Efficiency improvement of road management operations
34 Optimization of traffic regulation implementation
35 Efficiency improvement of disaster restoration/reconstruction
36 Management of special vehicles
37 Getting hold of driving vehicles transporting dangerous substance
38 Supply of traffic regulation information
39 Public transportation operation/supply of transfer information
40 Utilization support of taxi and demand buses
41 Implementation of priority passage of public transportation
42 Supply of public transportation operation status
43 Supply of commercial vehicle operation status
44 Supply of information of freight handled by commercial vehicles
45 Supply of operation status information of other agencies
46 Continuous automatic driving of commercial vehicles
47 Supply of information of facilities and routes
48 Route guidance
49 Ensuring pedestrian safety through control of traffic signals
50 Ensuring pedestrian safety through coordination with vehicles
51 Getting hold of location information of pedestrians
52 Report in case of emergency
53 Emergency vehicle guidance, rescue operation support
54 Utilization of physical distribution information in advanced information communication society
55 Utilization of multimodal related information
56 Function coordination with ITS

Infrared Beacons

The Universal Traffic Management Systems (UTMS 21) plan promoted by the police is one of ITS. Infrared beacons are the key infrastructure of that plan. The National Police Agency commenced the installation of infrared beacons in 1992, which increased to approximately 18,000 units in Japan at the end of 1997. We intend to continue to install them in Japan to deploy various systems.

Infrared beacons are installed approximately 5.5 m high above the ground, as shown in the right photo. Their specifications are shown in the right bottom table. Infrared beacons are capable of two-way communications and detection, using infrared technology. Since near infrared light emitting devices are used, they can be produced at a very low cost. Accordingly it enables us to install a large number of infrared beacons and as a result in-vehicle navigation units are expected to be popularized easily.

Infrared beacons have the following features.

① Detects vehicles driven at speeds between 0 and 120 km/h.

② Compatible with Advanced Mobile Information Systems, Dynamic Route Guidance Systems, and other systems.

③ Free of mutual interference even on narrow roads in Japan due to very high directivity of communication media.

④ Capable of high-speed data communications.

At present, information from VICS is supplied to in-vehicle navigation units via infrared and radio beacons. Compared with radio beacons installed on expressways, infrared beacons installed on surface roads have the following advantages.

① Infrared beacons are capable of information collection and vehicle detection.

② Infrared beacons have high information transmission capacity.

③ Infrared beacons do not require to be licensed under the Radio Law.

④ Infrared beacons can be installed at a lower cost.

By introducing infrared beacons with these advantages, the National Police Agency offers traffic information service more accurately than before (improvements in measurement of travel times, congestion status, etc.). There will be a variety of possible application as installation locations of infrared beacon increase in number in the future.

Some systems are already put into practice, such as Public Transportation Priority Systems (PTPS) and Mobile Operation Control Systems (MOCS) introduced in Sapporo, Hokkaido Prefecture, which were also used during the Winter Olympic Games held in Nagano in February 1998. In addition, Driving Safety Support Systems (DSSS) are introduced very soon. We have high hopes for increased deployment of other systems using infrared beacons in the future.

Infrared vehicle detectors


Infrared vehicle detector head emits infrared ray in the direction of the road surface. Vehicles are detected by comparing vehicle and road surface reflected rays. These detectors are also used in two-way communication with in-vehicle navigation units.

Infrared Beacon Specifications

Emission wavelength	Downlink	800〜900nm
	Uplink	900〜1,000nm
Communication area (outline)	Downlink	Width3.5 m × depth3.7 mm × height1.0-2.0 m
	Uplink	Width3.5 m × depth1.6 mm × height1.0-2.0 m
Transmission speed	Downlink	1,024Kbps
	Uplink	64Kbps
Transmission capacity	Downlink	10KB (70Km/H)
	Uplink	276B (70Km/H)

International standardization

In recent years, the term ISO has started to appear often on newspapers and corporate advertisements. This is because the wave of internationalization is storming its way into the Japanese society, and occasions are increasing where it is prerequisite that ISO standards are satisfied at international competitive bidding.

This ISO refers to the International Organization for Standardization, which is a non-governmental organization aiming at promotion of establishing international standards for the manufactured products and the management system of corporate operation.

The ISO was inaugurated in 1947, and has 118 member countries at present. Japan has been its member since 1952. The top of this organization is the annual general assembly, and there is the board of directors consisting of 18 countries. Beneath it lie Technical Committees (TC) for deciding international standards in each area. Beneath them lie Working Groups (WG) and Sub Committees (SC). (TC = 185 areas, WG = 2,022, SC = 611)

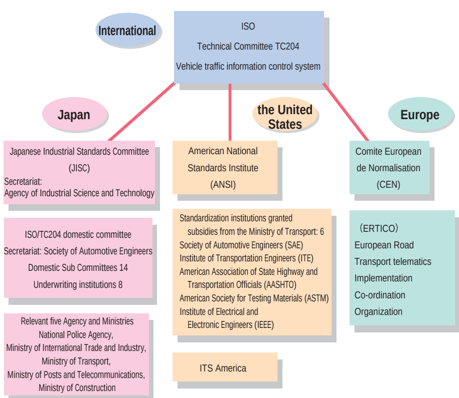
Among a number of TCs, TC204 is in charge of traffic information control system. Namely, this TC204 is substantially responsible for international standardization of ITS. The areas which TC204 (refer to the left bottom structure) works on preparation of international standards are inter-city and urban traffic systems in road traffic. All the ground traffic systems (railroad, vessels, etc.) excluding air are covered.

In establishment of each system of UTMS21 (PTPS, MOCS, AMIS, DSSS, etc.) promoted by the National Police Agency, the infrared beacon becomes the key infrastructure. For example, the road traffic information from VICS is supplied to vehicles (in-vehicle navigation units) from infrared beacons installed on roadside. For this reason, beacons play an important part which carry out communication in the narrow area of infrared beacons. ISO/TC204/WG15 (refer to the right bottom table) takes charge of the international standardization of infrared beacons.

The liaison office for international standardization in Japan is the Agency of the Industrial Science and Technology in the Ministry of International Trade and Industry (refer to the right above table). Regarding ITS/TC204, a domestic commission is set up, under which working groups (WG1-WG15) are organized. Five ministries and agencies, namely, the National Police Agency, the Ministry of International Trade and Industry, the Ministry of Transport, the Ministry of Posts and Telecommunications, the Ministry of Construction, participate in this domestic commission as observers. They review the orientation of Japan as a whole.

At present, the National Police Agency intends to play an active part all over the world continuously with the aim of international standardization of infrared beacons which are the key infrastructure for the UTMS21 concept.

Standardization Organizations Related to ITS



WG names and domestic underwriting institutions for ISO/TC204

WG1	System Architecture	JSK (Association of Electronic Technology for Automobile Traffic and Driving)
WG2	Quality and Reliability Requirements	Society of Automotive Engineers of Japan
WG3	TICS Databases Technology	Japan Digital Road Map Association
WG5	Fee and Toll Collection	Highway Industry Development Organization
WG6	General Fleet Management	Highway Industry Development Organization
WG7	Commercial / Freight	Road Management Technology Center
WG8	Public Transportation / Emergency	Japan Institute of Construction Engineering
WG9	Integrated Transport Information,Management and Control	Universal Traffic Management Society of Japan
WG10	Traveler Information Systems	Universal Traffic Management Society of Japan
WG11	Guidance and Navigation Systems	Society of Automotive Engineers of Japan
WG13	Human Factors and Man-Machine Interface	Society of Automotive Engineers of Japan
WG14	Vehicle / Road Warning and Control Systems	Society of Automotive Engineers of Japan
WG15	Dedicated Short Range Communications for TICS Applications	Electronic Industries Association of Japan
WG16	Wide Area Communications / Protocols and Interfaces	Electronic Industries Association of Japan
Research sub committee		Society of Automotive Engineers of Japan

ISO/TC204 Organization Structure

WG No.	WG Name	Scope of Covering	UTMS Participation
WG-1	System Architecture	Establishment of a framework for clarifying specific external conditions of the system regarding the Transport Information and Control System (TICS)	○
WG-2	Quality/ reliability	Overall review of safety/reliability from the system to parts relevant to hardware and software regarding TICS	○
WG-3	Database technology	Establishment of database where all the information groups of the traffic related areas are stored and compatibility is high	
WG-4	Automatic Vehicle/Freight Identification	Establishment of system specifications and number structures for identifying the vehicle and freight by transmitting and receiving identification numbers	◎
WG-5	Toll collection	Establishment of information / communication / control / IC card settlement in the automatic toll collection system	○
WG-6	General Fleet Management	Establishment of efficient fleet management technology for own company's vehicles including freight transportation	○
WG-7	Commercial / Freight	Establishment of electronization / informationization technology of commercial vehicles / freight management taking into consideration trade / international physical distribution	

UTMS activity status:
◎: participate mainly in the domestic and overseas review as a domestic underwriting institution
○: experts are dispatched and participate in domestic and overseas review
TICS: Transport Information and Control System = traffic information control system

WG No.	WG Name	Scope of Covering	UTMS Participation
WG-8	Public Transportation / Emergency	Establishment of information communication technology regarding public transport/emergency vehicles	○
WG-9	Integrated Transport Information, Management and Control	Systematization of information exchanges among centers and between a center and a roadside unit regarding TICS	◎
WG-10	Traveler Information Systems	Establishment of technology to supply effective traffic information to travelers	◎
WG-11.1	In-vehicle Unit Determined Route Guidance	Establishment of system technology to calculate the optimal route in the in-vehicle unit based on the map database and traffic information	
WG-11.3	Centrally Determined Route Guidance	Establishment of route guidance system technology for calculation / recommendation from the control center by utilizing real time data and statistical data	◎
WG-14	Vehicle/Road Warning and Control Systems	Establishment of vehicle driving control technology to avoid accidents and improve convenience against external factors such as traffic, weather, and road status	
WG-15	DSRC for TICS Applications	Establishment of DSRC (Dedicated Short Range Communications) technology between the vehicle and roadside units or between vehicles required for TICS	○
WG-16	Wide Area Communication / Protocol and Interfaces	Establishment of TICS technology utilizing communication covering wide area such as automobile telephone	

Integrated Traffic Control Systems (ITCS)

The traffic control system on surface roads was introduced in traffic control centers operated by the Prefectural Police Headquarters. About 170 centers have been installed and being operated at the end of 1996.

The traffic control system is a unified system for ensuring safe and smooth traffic flow. The National Police Agency works in close cooperation with the Universal Traffic Management Society of Japan (UTMS) for further improvements of the traffic control centers.

The Japanese traffic control system is one of the world's best systems supported by advanced, up-to-date information processing and electronics technologies. The basic functions of the traffic control system are as follows:

① Information collection

Collects traffic information automatically, such as traffic volumes and congestion, using various sensors.

② Signal control

Carries out link coordination and area controls for precise traffic flow control.

③ Information supply

Provides information such as traffic congestion status and traffic regulations via information boards and other devices.

Drivers obtain traffic information from radio or information boards as they drive on roads. Information may be "xx-km congestion up to yy." In some times, however, they might be able to drive smoothly without congestion or experience a worse case than expected. Information sent from roadside ultrasonic or image processing vehicle detectors is collected at traffic control centers, and then processed in various ways. Time lags occur before processed information is provided on information boards and other devices. This is the reason for differences between supplied information and actual experience.

To improve the situations as above, the need is for establishment of a positive traffic control system. It carries out traffic demand management rather than simple implementation of policies, such as how to deal with traffic flow in a passive manner as practiced conventionally. Integrated Traffic Control Systems (ITCS) meets the need.

ITCS uses two-way communications between infrared beacons and vehicles and advanced information collection sensors such as digital image processing detectors, as well as existing sensors. It makes the most of collected information efficiently. The aims of ITCS are to optimize signal control automatically and to supply traffic information automatically. ITCS is the core of the UTMS 21 plan.

Examples of Traffic Control Systems

Controlled area

Signal controlled area incl. sub-centers541.4km^2

Major equipment

Computer and peripherals	35sets	Character information boards	179units
Traffic wall map	1set	Preset message boards	28units
System consoles	31units	Formulated information boards	56units
Signal controllers linked to the computer	6,876units	Variable road signs	0units
Vehicle detectors	15,372heads	Roadside radio transmitters	159sites
CCTV cameras	426units	Sub-center	1site

TOPICS MODERATO

British SCOOT (Split, Cycle and Offset Optimisation Technique) and Australian SCATS (Sydney Coordinated Adaptive Traffic System) have been renowned as signal control systems for area traffic control. Since no particular attention has been given to naming of our signal control, there have been few chances that the Japanese signal control system, which could be the world's most excellent signal control system, had international reputation.

Therefore, we intend to review and further improve various types of advanced signal control systems adopted in each prefecture. This improved signal control named MODERATE (Management by Origin-DEstination Related Adaptation for Traffic Optimization), is at the center of ITCS, which plays the core role in UTMS.

In 1997, the Universal Traffic Management Society of Japan held EPMS demonstration testing in Shizuoka Prefecture. Data obtained by the test show that carbon dioxide emission is minimized when vehicles drive at approximately 35 km/h. This means that safe and smooth traffic flow achieved by sophisticated signal control will greatly help counteract the global warming trend. This is considered to be a topic that will draw more attention, in addition to the economic effect produced by elimination of congestion as usually mentioned.

An outline of MODERATE is shown in the attached table. Splits at major intersections are calculated every 5 or 2.5 min in 1% units. This signal control system was already implemented in some advanced prefectures and is contributing greatly to the alleviation of congestion.

Functions of MODERATE (Management by Origin-DEstination Related Adaptation for Traffic Optimization)

Item	Standard function	Extended function
Locations of detectors	At 150-, 300-, 500-, 750-, and 1,000-m locations on each incoming road before stop lines at major intersections. ● Measures congestion at all locations. ● It is recommended to measure traffic volumes on each lane at 150-m location (30-m location for right-turn lane).	● Installation of detectors in close proximity to stop lines for measurement of saturation flow rate and detection whether a vehicle is present. ● Installation in downstream sections at intersections for the measurement of congestion ahead.
Information collection via detectors	Synchronous collection with cycles (collection of information about traffic volumes and occupancy rates in synchronization with signal cycles)	
Traffic indexes **For deciding cycle lengths** **For deciding split values** **For deciding offset patterns** **Saturation flow rate**	Intersection load factor Incoming road load factor Degree of saturation and congestion lengths in up and down lanes in offset control units Semi-automatic measurement (settings/automatic measurement)	Load factors of movement* Automatic measurement
Phase	Fixed (selection from 4 types)	Automatic (variable) formulation according to load factors of movement* and by microscopic sensor actuated control
Subarea **Combination timing** **Combination method** **Cycle length decision-making method** **Control target**	Every 15 or 5 min Subareas are combined when the difference in cycle lengths is less than a pre-set value. Use the longest cycle length of the subareas to be combined as the cycle length of the new subarea. Minimize delay times and the number of times vehicles have to stop. Reduce the likelihood of accidents.	
Cycle length **When to change** **How much to change** **Decision-making method** **Control target**	Every 15 or 5 min Increments are calculated. Set values (5 or 10 s) are used as decrements. Function of intersection load factor (the sum of load factors of critical incoming roads) and loss time <Under non-saturation condition>Minimization of delay times <When traffic is oversaturated>Maximization of traffic flow	Every cycle Function of intersection load factor (the sum of load factors of critical movement*) and loss time
Split control **When to change** **How much to change** **Decision-making method** **(Control target)**	Every 5 or 2.5 min Calculations in 1% units (every phase) (Major intersections) <Under non-saturation condition> Proportional distribution according to load factors of critical incoming roads (minimization of delay times) <When traffic is oversaturated> Minimize total delay times by maximizing total traffic flow. Equalize travel times on critical incoming roads for each phase. (General intersections) Determine split values, linking with cycle lengths (with some seconds secured for pedestrians crossing).	Every cycle Calculations in 1% units (every movement*) (Major intersections) <Under non-saturation condition> ● Proportional distribution according to load factors of critical movement* (minimization of delay times) ● Reduce waste green signal lengths by sensor actuated control for the presence of vehicles
Offset pattern **When to change** **How much to change** **Decision-making method** **Control target**	Every 15 or 5 min In addition to 7 patterns, selection of a congestion offset pattern or calculated offset pattern is made, or a real-time offset pattern is automatically generated. <Under non-saturation condition>Minimize delay times and the number of times vehicles have to stop. Reduce the likelihood of accidents. <When traffic is oversaturated>Minimize delay times in directions not congested and also minimize the number of times vehicles have to stop. Alternatively, restrain incoming traffic to intersections.	
Microscopic sensor actuated control	● For gaps ● For recalls ● For buses ● For vulnerable groups ● For high speeds ● For driver dilemma ● For pedestrians	● For congestion ahead ● For the presence of vehicles ● For link with railway crossings

* Movement: In this context, movement is defined as moving directions of vehicles or pedestrians that are classified by directions, lanes, rights-of-way, etc.

Advanced Mobile Information Systems

1 Advanced Mobile Information Systems

Advanced Mobile Information Systems are known as AMIS, an acronym for the systems.

AMIS provide drivers with real-time traffic information such as congestion, accidents, roadworks, and travel times to destinations, using various media including infrared beacons and information boards. The aims of AMIS are to allow traffic flow to decentralize autonomously, eliminate traffic congestion, and better drivers' psychological states. AMIS is intended to achieve higher effects by offering a greater degree of choice to drivers.

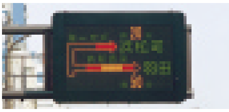
2 Information Supply Means

AMIS supply traffic information via information boards, radio broadcasts, automatic answering telephone and fax services (see also page 60) as previously done. In addition, a new system, Vehicle Information and Communication System (VICS) (see also page 90), began to provide traffic information to car navigation systems in 1996.

3 Relationships between AMIS and VICS

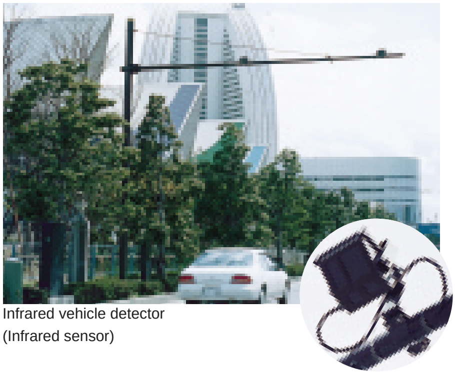
AMIS refer to the whole systems that supply traffic information. AMIS include VICS, which is one of traffic information supply means.

VICS is, in other words, a constituent of AMIS in traffic information supply activities carried out by the police, the traffic administrator.



Variable message board

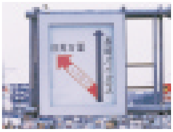
Small (character) information board



Infrared vehicle detector
(Infrared sensor)

Formulated information board

Travel time information board



Variable road sign

Character information board/preset message board

Roadside radio transmitter
(Radio broadcasts)

Telephone/fax
Automatic answering machine

Character-based display

●Level 1●

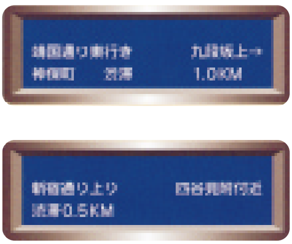


Diagram-based display

●Level 2●

Map-based display

●Level 3●

VICS

1 VICS Overview

VICS is an acronym of Vehicle Information and Communication System.

It is an ITS project promoted by the National Police Agency in cooperation with the Ministry of Posts and Telecommunications and the Ministry of Construction. Traffic information collected by local police headquarters and road administrators is transmitted to Japan Road Traffic Information Center and then to the VICS center. The VICS center edits and processes the traffic information. The three media below are used to supply the processed traffic information to in-vehicle navigation systems and other devices.

- Infrared beacons (infrared ray)
- Radio beacons (quasi-microwaves)
- FM multiplex broadcasts (NHK FM broadcasts)

2 Three Media

Information is supplied via infrared beacons, radio beacons, and FM multiplex broadcasts making the most of advantages each medium has (see the table). Specifically, infrared beacons are capable of lane dedicated and high-speed transmissions, so they are installed on surface roads.

Table Characteristics of Media

Medium	Infrared beacon	Radio beacon	FM multiplex broadcast
Transmission rate	1Mbps	64Kbps	16kbps
Service area	Repeated minimal zones		Wide area
1 unit (1 station)	3.5m	60～70m	10～50km
Effective information volume	Equivalent to approx. 10,000 letters (per location)	Equivalent to approx. 8,000 letters (per location)	Equivalent to approx. 50,000 letters (per 5 min)
Service site	Surface roads	Expressways in general	NHK FM receiving areas

3 VICS Information Service Areas

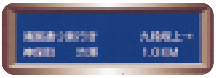
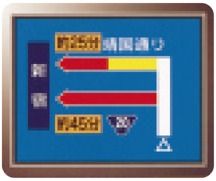
VICS services were available on surface roads in 9 prefectures (Tokyo, Saitama, Chiba, Kanagawa, Nagano, Aichi, Kyoto, Osaka, and Hyogo) and on expressways throughout Japan at the end of 1997.

We intend to expand service areas gradually. It is scheduled that VICS service will be expanded on surface roads throughout Japan by the end of 2000.

4 The Number of Installed Infrared Beacons

The number of installed infrared beacons was approximately 18,000 in Japan at the end of 1997. This number is scheduled to increase to approximately 30,000 by the end of 2000.

VICS service menu and information contents

	Level 1	Level 2	Level 3
	Character-based display Supplies information in letters.	**Diagram-based display** Supplies information in diagrams.	**Map-based display** Supplies information based on VICS links.
	 Via beacons  Via FM multiplex broadcasts	 Via beacons  Via FM multiplex broadcasts	
Radio beacons	Sectional travel time information Incident regulation information SA/PA information	Congestion information Sectional travel time information Incident regulation information SA/PA information	Congestion information Link travel time information (Expressway information only) Sectional travel time information Incident regulation information SA/PA information
Infrared beacons	Congestion information Sectional travel time information Incident regulation information Messages (emergency information)	Congestion information Sectional travel time information Incident regulation information Parking information	**Without uplink:** Congestion information Sectional travel time information Incident regulation information Parking information **With uplink:** Congestion information Link travel time information Sectional travel time information Incident regulation information Parking information
FM multiplex broadcasts	Congestion information Sectional travel time information Incident regulation information	Congestion information Sectional travel time information Incident regulation information	Congestion information Link travel time information (Expressway information only) Sectional travel time information Incident regulation information Parking information

Public Transportation Priority Systems

1 Public Transportation Priority Systems

Public Transportation Priority Systems constitute a sub-system of UTMS and are known as PTPS, an acronym for the systems.

PTPS secure bus lanes and carry out priority signal control for buses, thereby ensuring priority passage for high-volume public transportation. In this way it intends to allow high-volume public transportation to operate efficiently and to give passengers increased facilities. PTPS aim to encourage people to use high-volume public transportation rather than their privately owned vehicles and to suppress traffic demands.

2 Systems Overview

Infrared beacons receive bus-specific IDs when buses pass under them provided that buses are equipped with in-vehicle units for communications with infrared beacons.

Infrared beacons then send bus-specific IDs to the traffic control center. The center carries out signal control so that buses can go without having to stop at signals ahead (by lengthening green signal display or shortening red signal display).

PTPS also display expected travel times to destinations in buses, show expected arrival times of buses at bus stops, and issue warnings to other vehicles in bus lanes.

3 Advantages of PTPS

The conventional priority signal control for buses is actuated when a vehicle with a great length is detected, giving priority to trucks as well. PTPS give priority only to buses.

Moreover, PTPS send bus-specific IDs obtained via infrared beacons from in-vehicle units to traffic control centers. This information can be transmitted to bus operating companies from the traffic control centers. Bus companies can then carry out mobile operation control (driving locations, times, etc.).

4 Actual Installation Cases

PTPS were installed in the following sites.

(1) April 1996: Commencement of operation in Sapporo (Hokkaido Prefectural Police Headquarters)
PTPS and MOCS were introduced in fixed-route buses.

(2) February 1998: Operation for the Winter Olympic Games in Nagano (Nagano Prefectural Police Headquarters)
AMIS, PTPS, DRGS, and MOCS were introduced in the vehicles involved in the games.

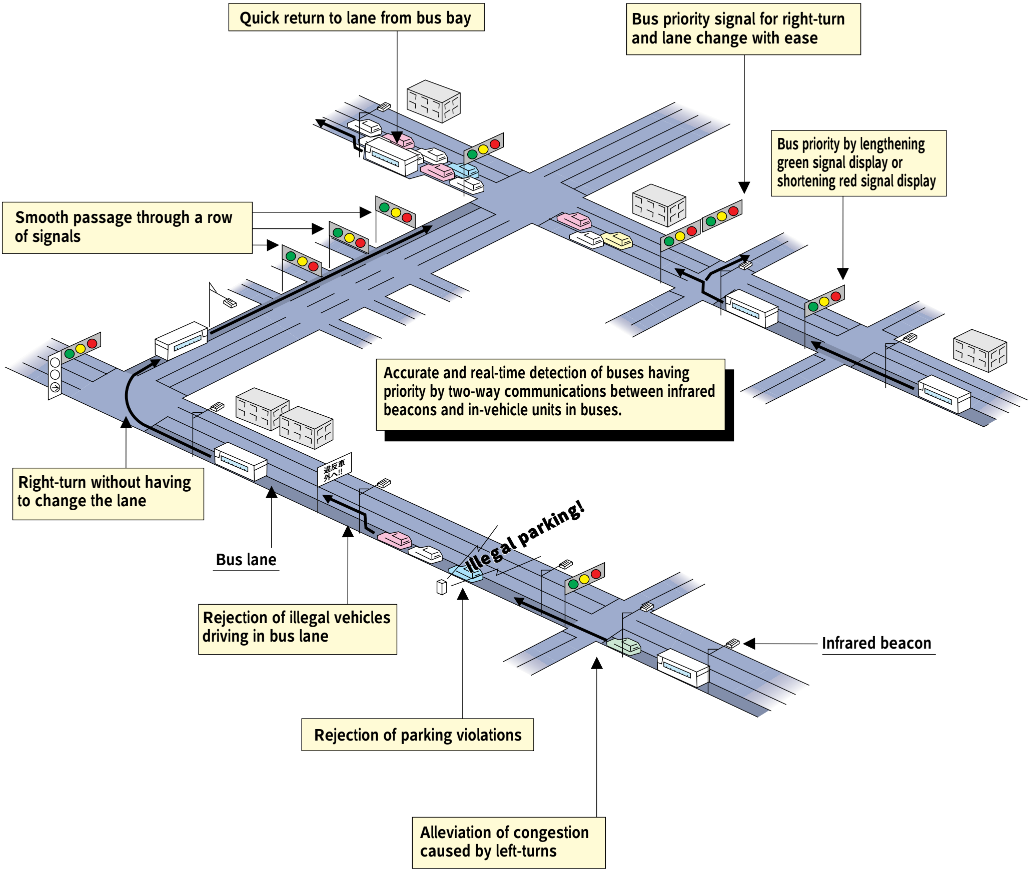
(3) May 1998: Commencement of operation in Tokyo (Metropolitan Police Department)
PTPS were introduced in fixed-route buses.

(4) 1998: Commencement of operation is scheduled in Hamamatsu (Shizuoka Prefectural Police Headquarters)

Hamamatsu is designated as an Omnibus Town (a project of urban development for making the most of buses and other public transportation).

For detailed information, see Topics on page 94.

Outline of PTPS



Examples of Public Transportation Priority Systems

1 Overview

PTPS were introduced and commenced operation in a 5.7-km section on Route 36 in Sapporo city, Hokkaido Prefecture in April 1996. Bus priority lanes were established on a time basis from 7:30 to 9:00. Infrared in-vehicle units were installed in 212 buses owned by a bus company.

2 Service Types

Needless to say, bus priority signal control is carried out, which PTPS originally intend to offer. Moreover, MOCS functions are also implemented to support bus operations including the following.

- Bus locations: The aim is to enable collection of data on bus operating conditions.
- Oncoming bus displays: These displays inform people at bus stops of oncoming buses.
- In-vehicle displays: These displays inform passengers of travel times and other information.

3 Effects

In this case of Hokkaido, the introduction of PTPS yielded the following results.

- Travel times in the PTPS section decreased by 6.1%.
- The number of times buses have to stop at signals decreased by 7.1%.
- The time buses have to stop at signals decreased by 20.1%.
- Traffic volumes on the PTPS route in rush hours decreased by 20.8%.

* No specific congestion occurred because traffic flow was disseminated to other routes.

- Bus users increased by 9.9%.

The survey was conducted during the period between 7:30 and 9:00 on weekdays in May 1996.

Indeed, ninety percent of bus drivers and users replying to a questionnaire recognized that PTPS were effective for improvements in facilities.

Because of these favorable effects plus requests of bus drivers and users, changes were made in the project by the end of March 1998.

- The PTPS section was extended from 5.7 km to 10.3 km.
- Installation of infrared in-vehicle units increased from 212 buses to 240 buses.

4 Introduction to Other Areas

PTPS were introduced together with AMIS, MOCS, and DRGS in Nagano as the Winter Olympic Games were held in February 1998. (See also page 114.)

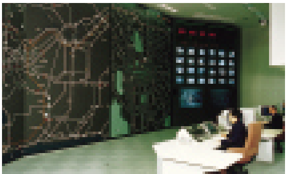
In May 1998 in Tokyo, infrared in-vehicle units were installed in 26 prefecture-operated buses to introduce and operate PTPS in a section approximately 10 km long on a route from Hamamatsu-cho to Tokyo Big Sight.

There are many municipal organizations and bus companies who have much interest in PTPS and MOCS. Consideration is given everywhere for introduction of PTPS to improve the facilities of public transportation.

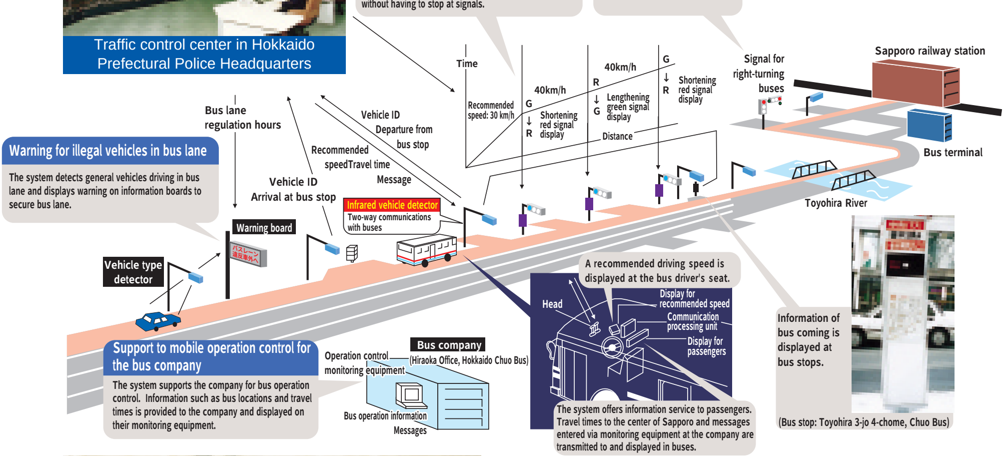
Example (the case in Sapporo)

Infrared vehicle detector

Display for recommended speed



Traffic control center in Hokkaido Prefectural Police Headquarters



Head

Display for recommended speed

Mobile Operation Control Systems

1 Mobile Operation Control Systems

Mobile Operation Control Systems constitute a subsystem of UTMS and are known as MOCS, an acronym for the systems.

MOCS help the transportation industry (bus, taxi, truck, and related companies) to learn present and past operating conditions of their vehicles. By controlling their vehicles fitly, MOCS intend to improve the flow efficiency of persons and commodities and also to sophisticate the road transportation business.

2 System Overview

In-vehicle units are installed in the vehicles of transportation companies to communicate with infrared beacons. Infrared beacons receive individual IDs and other data when vehicles pass under infrared beacons. Received information is sent to the traffic control center.

The center sends transportation companies received individual IDs and other data, reception time, and locations of infrared beacons that vehicles passed. Transportation companies use these sets of information to display current locations, operation history, and the like in maps and charts on their terminal devices. Efficient mobile operation control is thus achieved.

3 Advantages of MOCS

Before MOCS, companies needed to satisfy several requirements if they wished to implement mobile operation control. An expensive in-vehicle unit was required in each vehicle. In addition, radio equipment to receive signals sent from them needed to be installed at their headquarters and branches or on roads.

With MOCS, expenses are limited to the installation of inexpensive in-vehicle units, communications with the traffic control center, and other small sums. Transportation companies can collect vehicle location information at a low cost.

4 Actual Cases of Installation

MOCS were installed in the following sites.

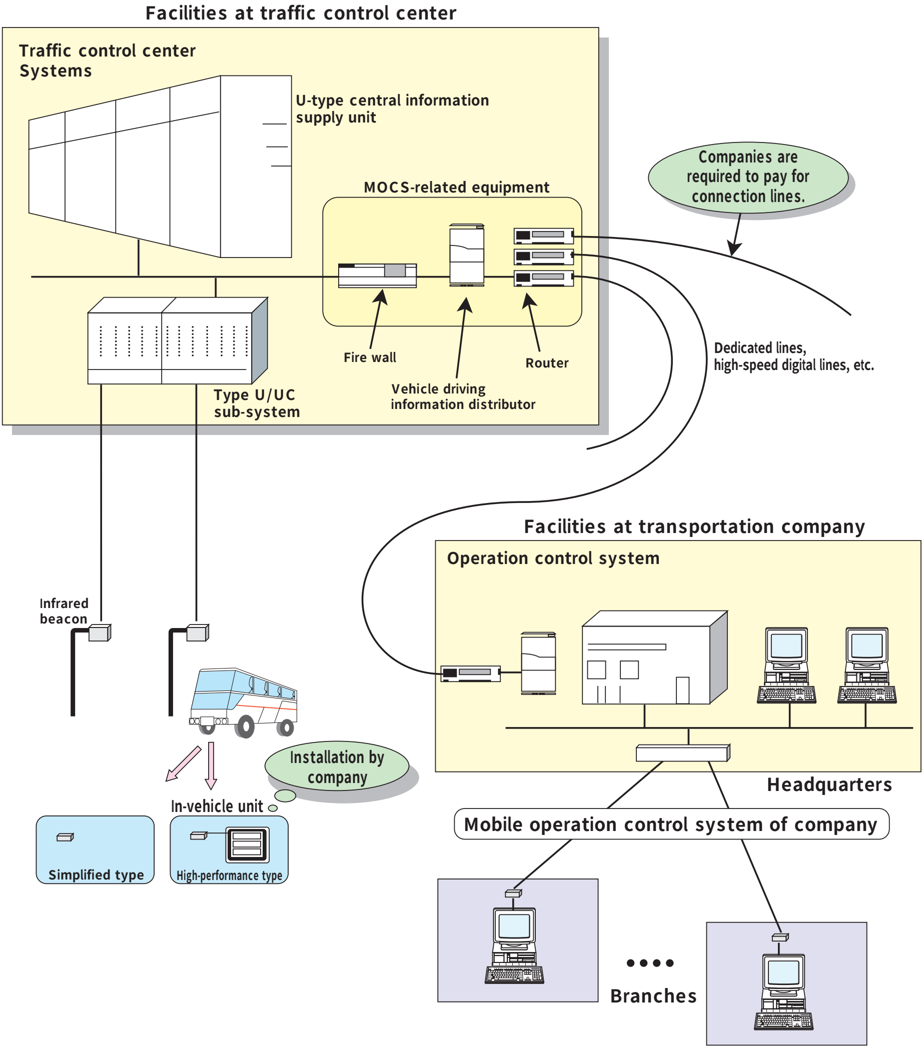
(1) April 1996: Commencement of operation in Sapporo (Hokkaido Prefectural Police Headquarters)

PTPS and MOCS were introduced in fixed-route buses.

(2) February 1998: Operation for the Winter Olympic Games in Nagano (Nagano Prefectural Police Headquarters)

AMIS, PTPS, DRGS, and MOCS were introduced in vehicles involved in the games.

Outline of MOCS



Dynamic Route Guidance Systems

1 Dynamic Route Guidance Systems

Dynamic Route Guidance Systems constitute a sub-system of UTMS and are known as DRGS, an acronym for the systems.

DRGS use the two-way communication function of infrared beacons. Drivers provide DRGS with destination information via vehicle navigation systems. DRGS then guide drivers individually to their optimum routes.

DRGS are expected to alleviate traffic congestion by decentralizing traffic flow and reducing the number of cruising vehicles looking for their routes.

2 Differences between Different Types of Vehicle Navigation Systems

There are two types of route guidance. One is to guide drivers according to the shortest driving distance, and the other, according to the shortest travel time.

The former selects simply the route of the shortest distance without due regards to congestion or travel time.

The latter is further classified into those that calculation is carried out by vehicle navigation systems and those that calculation is performed at the traffic control center.

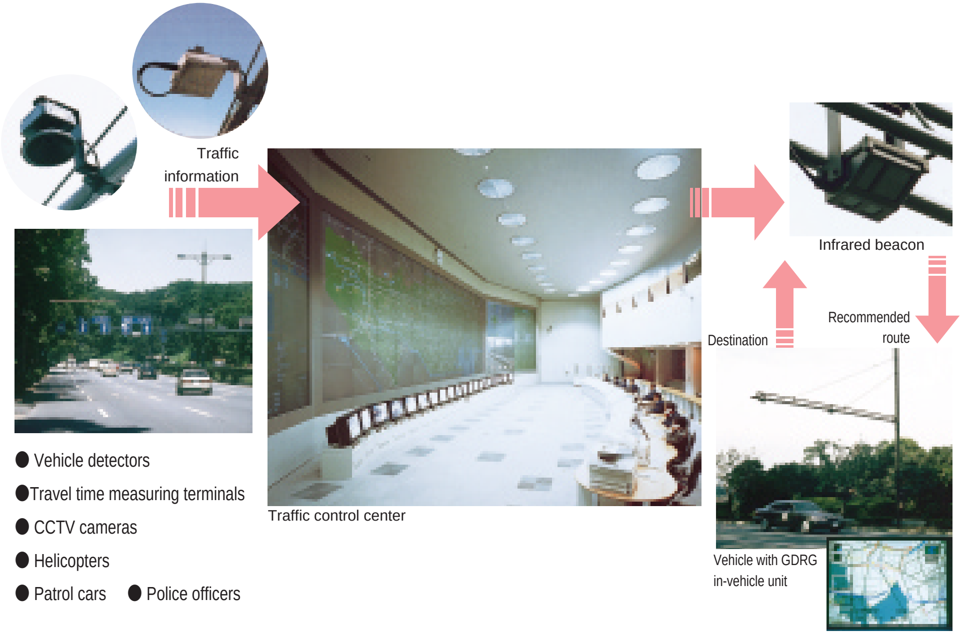
DRGS, which fall into the latter, calculate the route of shortest travel times to destinations without burdening in-vehicle units, making the most of information collected at the traffic control center. The selected routes are transmitted to vehicle navigation systems via infrared beacons.

Although those that vehicle navigation systems perform calculations guide drivers according to travel times, the volumes of information stored in them are far less than that available to the traffic control center.

3 Actual Cases of Installation

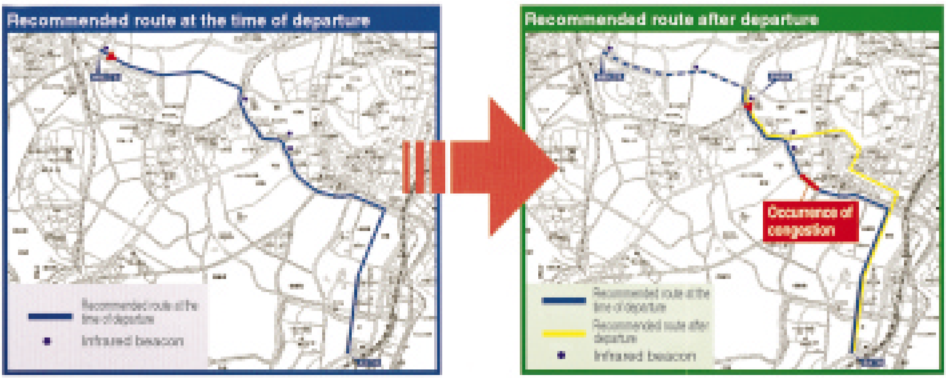
DRGS have been tested in Tokyo since 1996. (See also page 100.)

Surface roads within a 4 km-by-4 km area about the center of Tokyo were selected for testing in 1996, which, in 1997, expanded to a 20 km-by-20 km area about the center of Tokyo including the metropolitan expressways. On each occasion DRGS vehicles, VICS vehicles, taxis, and general vehicles were used for driving tests. DRGS proved to be effective in each test.



Real-time information supply about recommended routes

Recommended routes may change in every minute depending on traffic conditions. For instance, in a demonstration test starting from Shinjuku 3-chome and arriving at Shiba 5-chome, the infrared beacon at Shinjuku 3-chome recommended the route indicated in blue shown below. Since, after departure, congestion occurred on that route, the infrared beacon at Yotsuya Mitsuke recommended the route in yellow shown below.



Demonstration Test of Dynamic Route Guidance Systems

1 Overview

Three demonstration tests were conducted in a period from 1996 to 1998.

(1) First demonstration test (End of October 1996)

A 4 km-by-4 km area about the center of Tokyo was set up as a route guidance area for testing, in which 100 infrared beacons were used.

The starting point and goal were Shinjuku and Shiba in Minato-ku. Six groups, each group consisting of as shown below (4 vehicles in total), were tested in 30 runs in total.

- CDRG vehicle: One that drives according to the route guidance calculated at the traffic control center and provided via infrared beacons. (CDRG: Centrally Determined Route Guidance)
- VICS vehicle: One that drives according to the driver's decision in the light of congestion information displayed on the in-vehicle unit.
- Taxi : One that is driven by an experienced driver who is familiar with the traffic conditions.
- SRG vehicle: One that drives the shortest-distance route to the destination. (SRG: Static Route Guidance)

(2) Second demonstration test (End of February 1997)

Six pairs of starting point and destination were selected in the same area as used in the first demonstration test. Five groups were tested in 60 runs in total, each group consisting of a CDRG vehicle, a VICS vehicle, a taxi, and an SRG vehicle.

(3) Third demonstration test (End of March 1998)

A 20 km-by-20 km area about the center of Tokyo was set up as a route guidance area for testing, in which 180 infrared beacons were used.

While the first and second demonstration tests were conducted simply on surface roads, the third demonstration test involved metropolitan expressways.

Three pairs of starting point and destination were selected, including Sengoku 1-chome and Kakinoki-zaka. Six groups were tested in 108 runs in total, each group consisting of a CDRG vehicle, a taxi, and an SRG vehicle.

2 Test Results

Test results are shown in tables on the right.

The entire test results from the first to the third show that CDRG is superior to others in comparison of travel times.

The taxis were driven by drivers with 20 years or more of experience in driving in Tokyo. The figures indicate that ordinary persons can drive more efficiently than professional drivers can if they use CDRG.

3 Expected Developments

In the three demonstration tests, CDRG proved to be excellent as route guidance provided via infrared beacons within a limited range of distances. We consider that it is necessary to verify route guidance to remote areas.

To implement optimum route guidance is a significant challenge. DRGS are the means that can meet the challenge. We intend to put them into practical use as soon as possible.

Results of the first demonstration test

CDRG vehicles won in most cases. Excellence of CDRG could be expected.

Table Percentages of shortest travel times

Vehicle type	Percentage
CDRG vehicle	53.3%
VICS vehicle	26.7%
Taxi	13.3%
SRG vehicle	6.7%

Test vehicle

Results of the second demonstration test

CDRG vehicles marked the shortest average travel time, thereby proving the suitability of CDRG.

Table Average travel times of all courses

Vehicle type	Average travel time	Travel time reduction rate
CDRG vehicle	44 min 58 s	–
VICS vehicle	46 min 05 s	2.5%
Taxi	47 min 22 s	5.3%
SRG vehicle	48 min 12 s	7.2%

Results of the third demonstration test

CDRG vehicles traveled 1 min 17 s (2.3%) faster than taxis and 7 min 2 s (12.4%) faster than SRG vehicles on average. The suitability of CDRG was also verified in route selection involving both surface roads and metropolitan expressways.

Table Average travel times of all courses

Vehicle type	Average travel time	Travel time reduction rate
CDRG vehicle	56 min 38 s	–
Taxi	57 min 55 s	2.3%
SRG vehicle	63 min 40 s	12.4%

Environmental Protection Management Systems (EPMS)

Environmental problems, as represented by global warming, have been a matter of worldwide concern in recent years. The COP3, held in Kyoto in December 1997, agreed that CO_2 emission be decreased to the level in the year 1990. It has also been pointed out that air pollution by NOx and suspended particulate matter (SPM) is serious, particularly in the area along road with heavy traffic.

Environmental Protection Management Systems (EPMS) is intended to mitigate these environmental pollution problems. Based on various environment pollutant measurements taken by environment sensors (devices for measuring pollutants) installed on the roadside, EPMS controls the traffic flow in a limited area and provides traffic information to vehicle drivers to take other route for traffic flow dissemination. The aim is to prevent traffic congestion and decrease environmental pollution, thereby protecting the health of pedestrians and residents along roads.

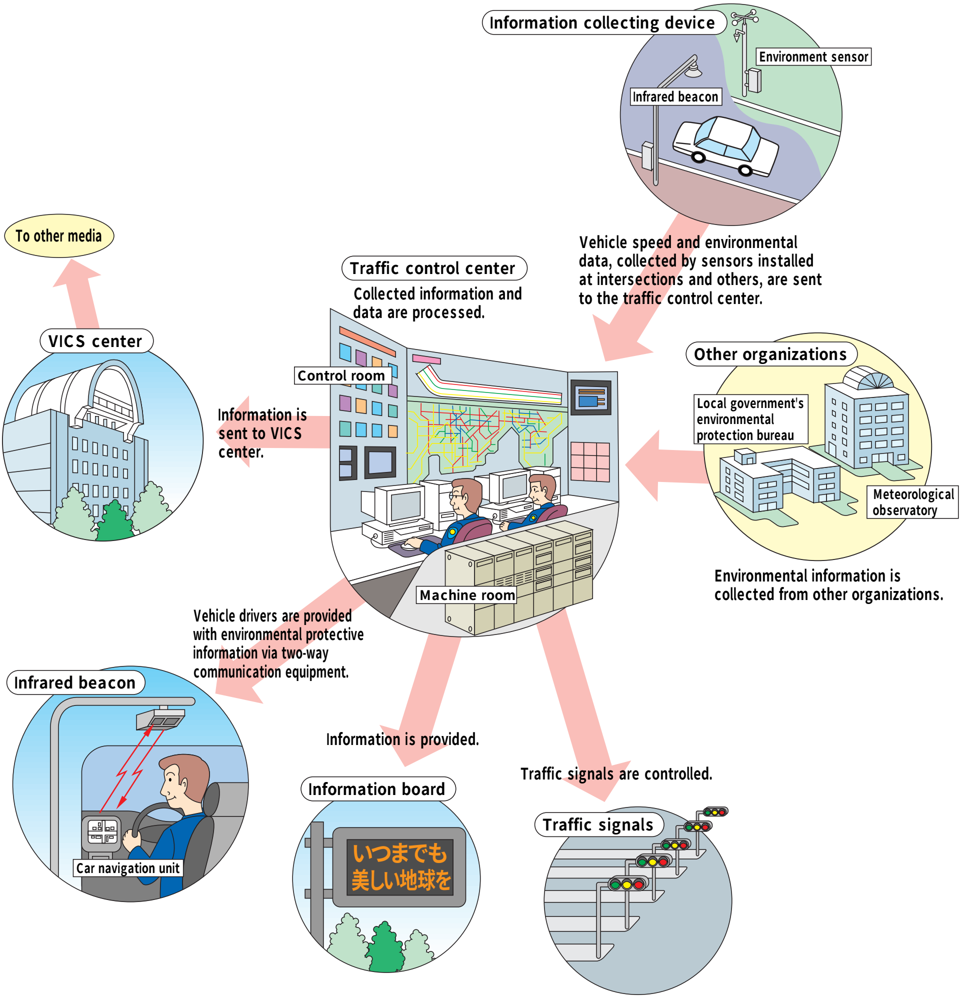
Verification test of EPMS has been conducted since 1996 in Shizuoka city, Shizuoka prefecture, to identify correlation between traffic data and pollution data. For this test, pollutant-measuring devices have been installed on the roadside and at intersections to measure pollutants. During the test, traffic flow is controlled intentionally to cause local congestion or smooth flow. This control is attained by manually changing split and offset values at the traffic control center. The following data are measured:

- Pollution data (CO_2, NOx, CO, SPM)
- Traffic data (Traffic volume, Rate of road occupancy, Vehicle speed, Number of diesel-engine vehicles, etc.)
- Meteorological data (Direction of wind, Wind velocity, Temperature, Humidity, Daylight hours, etc.)

As shown in figures in page 105 (Relation between vehicle speed and CO_2, and Relation between vehicle speed and NOx), the test reveals that there is certain correlation between vehicle speed and pollutant concentrations, indicating that CO_2 and NOx concentrations by the roadside could be decreased by controlling vehicle speed.

In the future, the measurement target will be expanded to include noise and vibration as well as other air pollutants, such as CO and SPM.

Configuration of EPMS



TOPICS Verification Test of EPMS

Basic study of Environmental Protection Management Systems (EPMS) was started in 1994 and completed in early 1996. Verification test has been conducted since late 1996 in Shizuoka city, Shizuoka prefecture.

In the basic study, correlation between various traffic data and air-pollutant concentration was theoretically analyzed, based on the emission factor formula per unit time, a simple vehicle-running model developed for this study, and the relation between vehicle speed and exhaust emissions on the assumption that only one vehicle is running. The following results were obtained:

① Each air-pollutant concentration is almost proportional to the traffic volume.

② Analysis using realistic vehicle speed and realistic vehicle-to-vehicle distance reveals that each air-pollutant concentration is the lowest when vehicle speed is between 40 and 50 km/h.

The objective of the verification test is to verify the above-mentioned results of theoretical analysis. For the test, traffic signals are intentionally controlled to enable groups of vehicles to run within a certain speed range, and to decrease the frequency at which each vehicle must be stopped and started.

The test site shown in right above map was selected mainly for the following reasons:

① Wind velocity in Shizuoka city is generally low and constant throughout the year.

② Air pollution data observed in Shizuoka city by the municipal and prefectural agencies reveals that the concentrations of air pollutants, such as CO, NOx and suspended particulate matter (SPM) are relatively stable at around environmental standard values.

③ Daily traffic on the roads does not change significantly from day to day.

④ Percentage of the number of heavy vehicles in the entire traffic is almost constant.

Measurement items for the verification test are as follows:

① Pollution data (CO_2, NOx, SPM) ② Traffic data (Traffic, Rate of road occupancy, Vehicle speed, Number of diesel-engine vehicles) ③ Meteorological data (Wind direction and velocity on the roadside, Temperature, Humidity, Daylight hours, Precipitation, Other weather conditions)

For the test, traffic signals along each test road are intentionally controlled for a particular time of a particular day, for comparison between controlled and uncontrolled data. The following control methods are used:

① Inflow limitation split ② Complete priority offset ③ Complete reverse offset ④ Successive stop-and-go offset ⑤ Inflow limitation split/complete priority offset

The results obtained thus far can be summarized as follows:

① There is a certain correlation between vehicle speed and the NOx and CO_2 concentrations on the roadside.

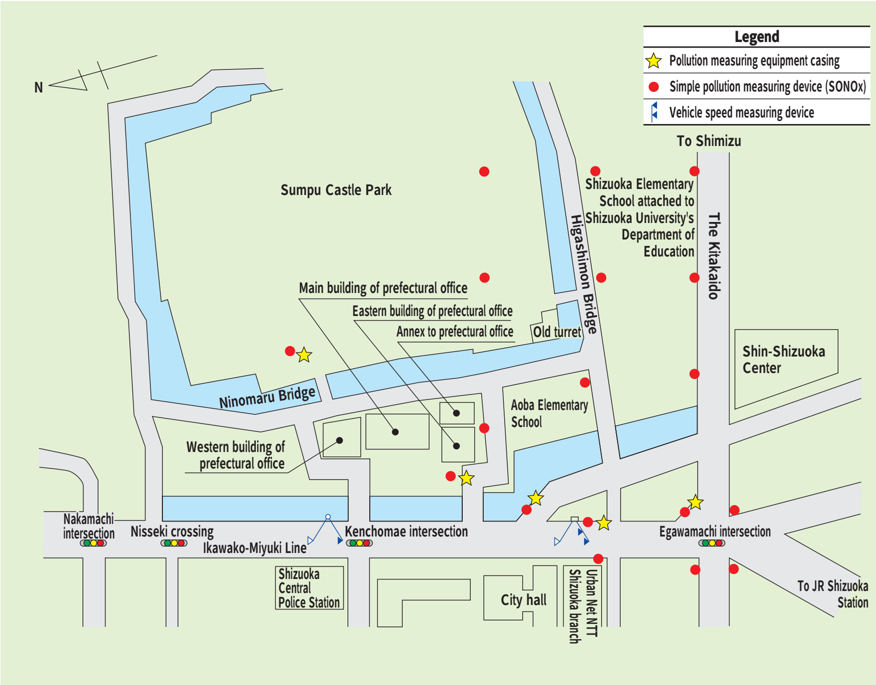
② When the local mean wind velocity exceeds 3 m/s, the above correlation tends to be lost due to dispersion of natural wind and rain.

③ The NOx concentration measured at about 30 m perpendicularly distant from the roadside is nearly half that measured on the roadside. The NOx concentration is reduced in inverse proportion to the square of distance from the road.

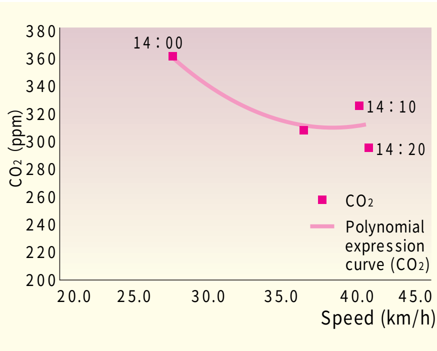
These results prove the effectiveness of EPMS, indicating that roadside air pollution by automotive exhaust emissions can be reduced if the speed of vehicles running on the road is restricted within a specified range by controlling traffic signals from the traffic control center. Atmospheric influence of automotive exhaust emissions is obvious, within some 30 m range from the roadside. If EPMS is introduced, however, pedestrians and residents along the road can be protected from air pollution caused by exhaust emissions.

In the future, the measurement target will be increased to include vibration and noise as well.

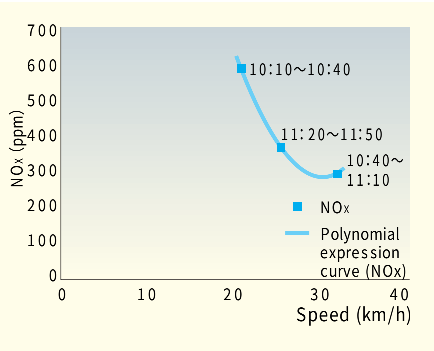
Measuring Device Installation Points in Test Site



Relation between Vehicle Speed and CO_2 Concentration



Relation between Vehicle Speed and NOx Concentration



Driving Safety Support Systems (DSSS)

The aging of the population accelerates year by year in Japan. Aging of society will come in the 21st century when one person out of four is 65 years old or older. Those who are related to road traffic also need to tackle the issue of inevitable aging of society. What is called for is construction of a society in which road traffic is adapted to the elderly. Development of various systems in a positive manner is of vital importance.Today, drivers who are 65 years old or older account for 7% (approximately 5 million) of the whole licensed drivers (approximately 70 million). The number of deaths caused by road traffic accidents was 9,924 in 1997 among which deaths of the elderly accounted for 32% (3,145). The number of deaths caused by failure to stop was 402, of which 32% were attributed to elderly drivers. Accidents are increasingly caused by driver errors. Those that occur at intersections, in particular, during right-turning and nighttime longitudinal collisions, have increased in number.Judging from the characteristics of these accidents, it is assumed that decision making required at intersections under complicated situations is burdensome to elderly drivers whose reflex time increase with age. The provision of traffic safety facilities aims to lighten the burden of decision making, create a traffic environment in which drivers can drive with ease, and deter accidents caused by elderly drivers.We also continue to study driving safety support functions and other extended functions available by using IC cards as driver's licenses.

1 Examples of Driving Safety Support Systems

Systems below are being studied as Driving Safety Support Systems.

(1) Crossing collision warning system

This system detects oncoming traffic at intersections not provided with signals. Warnings are given to drivers via information boards or in-vehicle units at some points before intersections.

(2) Right-turning accident prevention system

This system detects oncoming vehicles including motorcycles in the opposite lanes and provides information to right-turning vehicles at intersections. It is effective for deterrence of collisions with moving motorcycles that are in drivers' blind spots.

(3) Hazardous zone avoidance control system

When signals turn amber, drivers of vehicles approaching intersections may force their ways through or apply brake abruptly, taking the risk of causing accidents. This system provides vehicles with information about signal changes beforehand via infrared beacons to deter such accidents.

(4) Pedestrian support system

Pedestrians come across the traffic of automobiles at intersections and pedestrian crossings. This system alerts drivers by letting them know of the presence of pedestrians.

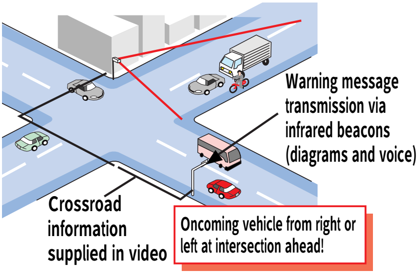
Information is supplied to drivers by displaying on information boards before intersections or by sending information in letters and voice to in-vehicle units via infrared beacons. Thus it becomes possible to deter traffic accidents such as contacting, catching under wheels, or collisions caused by non-confirmation of safety or carelessness. Burden on elderly drivers in decision making may then be lightened.

2 Pedestrian safety support system

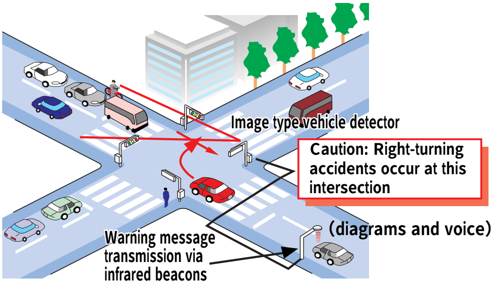
This system is intended for the elderly and the disabled. Small information terminals capable of two-way communications via infrared ray are used to supply pedestrians with information about areas around them in letters or voice. A plan is also underway to construct a system using similar information terminals to provide detailed information to persons in health about the streets around them.

Examples of driving safety support systems

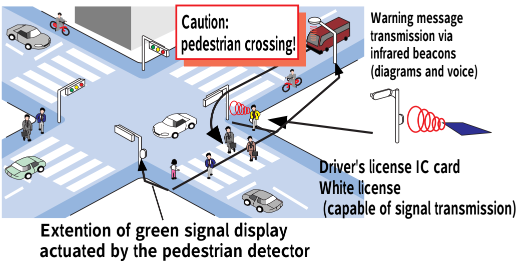
Crossing collision warning system



Right-turning accident prevention system



Pedestrian support system



Examples of information supply unit

Help System for Emergency Life Saving and Public Safety (HELP)

While the death toll by traffic accidents was under 10,000 for the successive two years of 1996 and 1997, the number of traffic accident case recorded a new high for the last successive five years, with the injured recording the 900,000 range for the successive three years. The National Police Agency has been struggling to improve this situation by shorting time lag between occurrence of an accident and calling of rescue, with a wish to help as many lives as possible. For this purpose, the Agency has been engaged in R&D of Help System for Emergency Life Saving and Public Safety (HELP).

The outline of HELP envisaged at present is as follows (refer to the right concept).
When a traffic accident occurs, the location data obtained by the global positioning system (GPS) is sent automatically or manually from the in-vehicle terminal to the HELP Center (temporary name), in addition to oral information reported via the mobile or cellular phone. Based on the oral information given by the reporter, staff at the HELP Center contacts a local rescue organization and connects the reporter's phone line to the organization as necessary.

① In-vehicle terminal:

Two types of in-vehicle terminals are in consideration at present: the type with a manual emergency push-button, and the type with automatic communication function based on an impact sensor etc.

② HELP Center:

Staff at this Center receives accident information from an in-vehicle terminal, and if necessary, contacts a rescue organization and connects the reporter's phone line to the organization.

HELP is in the process of development at present. To confirm the effectiveness of this system in reducing the time lag between occurrence of an accident and communication to the temporary HELP center, verification test was carried out in October 1997, in Tokyo. On the assumption that a traffic accident occurred during daytime, the time until the HELP Center received the accident information was measured in the test.

The result of the verification test is as follows:

① In-vehicle terminal: Average of 59 s

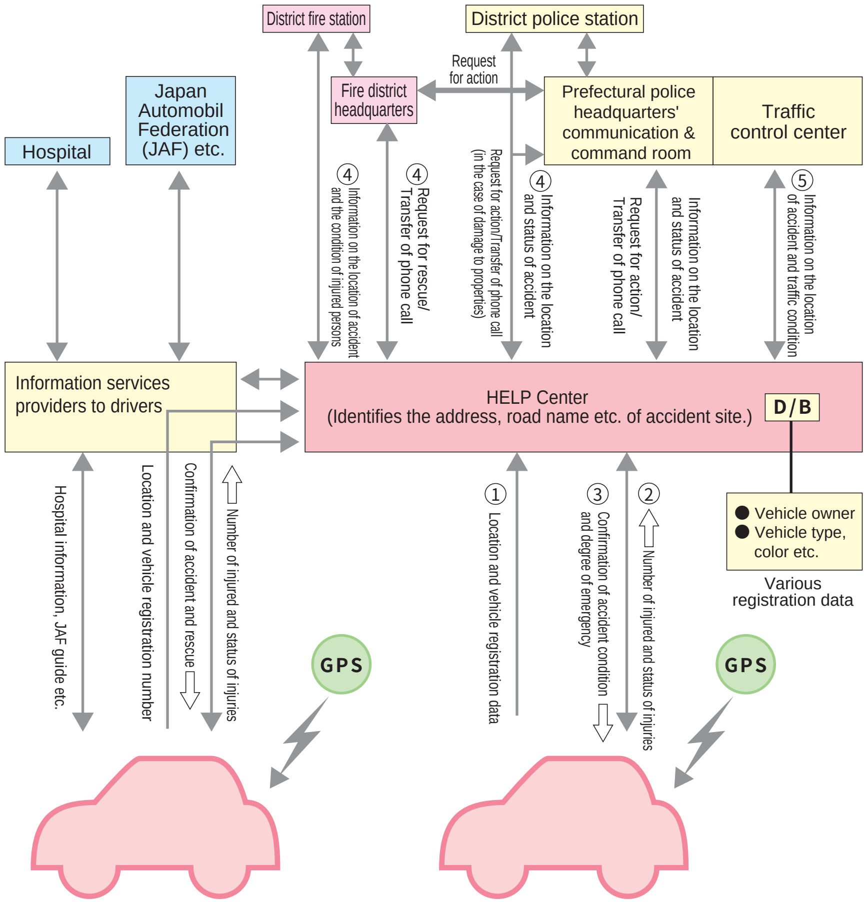
② Pay phone: Average of 84 s

③ Cellular phone: Average of 101 s

Clearly, HELP can reduce the time lag between occurrence of an accident and reporting, by an average of 42 seconds.

The National Police Agency has been making every effort to develop and introduce practical HELP as early as possible, with the aim of minimizing traffic accident fatalities, as eagerly desired by various sectors.

Concept of HELP



■ Communication Process Flow

① Vehicle location, registration number etc. are sent to HELP Center.

② The number of injured persons, the status of injuries etc. are explained orally.

③ HELP Center confirms the accident and the rescue.

④ HELP Center informs the police and/or fire stations of the location and condition of accident as well as other necessary items, requests for rescue, and transfers the reporter's phone call to the police or fire station, which then communicates directly with the reporter.

⑤ HELP Center reports the accident to the traffic control center.

TOPICS Emergency Communication System in Europe and America

Emergency communication systems operated in Europe and America are presented in the following.

Telematic Alarm Identification on Demand (TeleAid) System, developed by Daimler-Benz in cooperation with the German government, has been put to test service since October 1997. Daimler-Benz plans to launch full-scale operation of TeleAid System in 1998, expecting that this system will substantially reduce the casualties by traffic accidents.

Outline of TeleAid System is as follows (refer to the right above figure).

① When in-vehicle push-button is pressed, or when sensor signal for airbag expansion etc. is detected, the in-vehicle GSM cellular phone automatically calls Service Operation Center (SOC) to notify an emergency.

② When SOC answers, the system provides SOC with the user identification number as well as the vehicle location detected by the in-vehicle GPS terminal.

③ SOC staff checks the detailed vehicle-related information displayed along with the reporter's face on the monitor, and talks directly with the reporter if necessary.

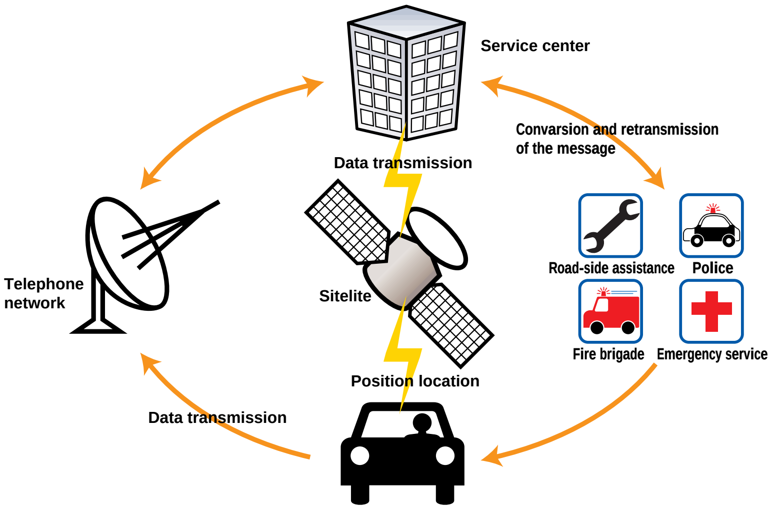
④ SOC staff contacts the appropriate district police station judged based on the vehicle location, and reports the detailed information.

This system is to be installed as option in Benz's class-S and class-E vehicles at the factory. The price of in-vehicle equipment dedicated for this system is some ¥52,000. Each membership driver is required to pay a monthly membership fee of about ¥1,000.

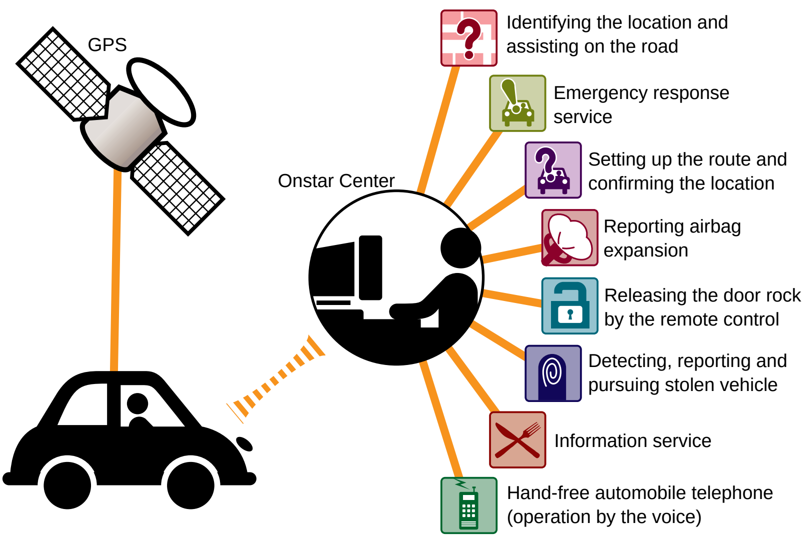
For the time being, this system will be available in Germany alone, although Daimler-Benz considers expanded use in the U.K., France and Italy.

Emergency communication systems developed in the U.S. include GM's Onstar and Ford's RESCU, both of which have already been in practical service.

Tele Aid System



Emergency commuication system operated by the automobile industries



Intelligent Integrated ITV Systems

Intelligent Integrated ITV Systems (IIIS) is designed to deter illegal parking and control traffic signals, based on the images sent from TV cameras which collect traffic information. IIIS also provides drivers with visual traffic information via infrared vehicle detectors, Internet etc. The aim is to ensure safe and smooth traffic flow, creating an environment-friendly automobile society.

TOPICS

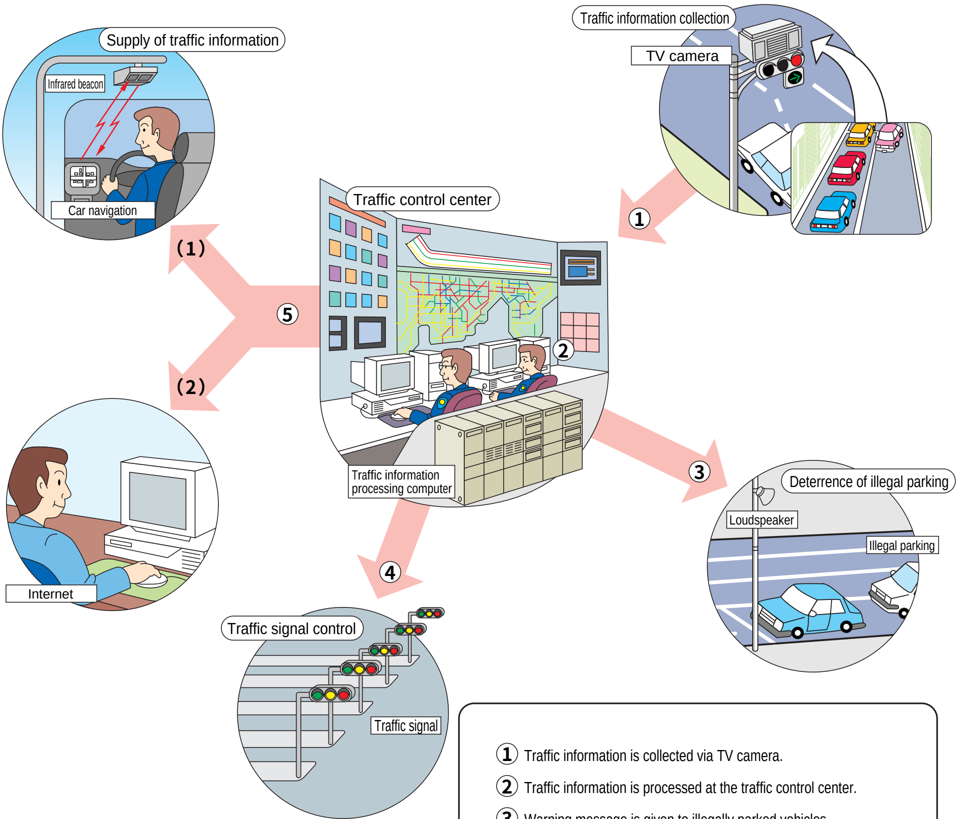
Intelligent Illegal Parking Deterrence System

The conventional illegal parking deterrence system is designed mainly for giving warning from the traffic control center or a police station through installed loudspeakers to vehicles illegally parked near intersections, and for checking the road for traffic flow and obstacles. The conventional system is cost-ineffective, since it uses expensive cameras with oscillating head and zooming function, and analog transmission line of high maintenance cost.

To overcome this problem, new intelligent illegal parking deterrence system has been developed based on the state-of-the-art digital image processing technology. This intelligent system uses less expensive stationary cameras and digital transmission line of low maintenance cost. In addition, the system controls traffic signals based on the vehicle running speed, the traffic volume, and the percentage of heavy vehicles in the entire traffic. This system also automatically detects traffic accident or congestion near intersections and automatically notifies such information to the traffic control center. The concept of the intelligent illegal parking deterrence system is shown by illustration.

Intelligent Illegal Parking Deterrence System

A: Advanced image processing technology	C: Reduced running cost
B: Multiple functions	D: Reduced installation cost



1. Traffic information is collected via TV camera.
2. Traffic information is processed at the traffic control center.
3. Warning message is given to illegally parked vehicles.
4. Traffic signals are controlled.
5. Traffic information is provided.
   - (1) Via infrared beacons
   - (2) Via Internet

UTMS in Nagano

1 Introduction of UTMS in Nagano

In February 1998, the Winter Olympic Games were held in Nagano Prefecture. Nagano is a largely mountainous prefecture. Competition sites were scattered throughout the prefecture. Accordingly, vehicular traffic was the only available transportation means there.

Since a great number of spectators were expected to come, which would turn out to be approximately 1.44 million in total while the population of Nagano City was 0.36 million, it was necessary to take suitable measures against several traffic problems. For instance, the road infrastructure was underdeveloped, congestion occurred daily in Nagano City, deposited snow was expected to impair traffic because the games were to be held in winter, and general ski tourists were expected to flood. Failure in taking proper measures would result in utter confusion. The task of prime importance was to ensure safe and smooth traffic for successful Olympic Games.

The Nagano Prefectural Police Headquarters, therefore, introduced Universal Traffic Management Systems (UTMS). UTMS contributed highly to the success of the Olympic Games by ensuring safe and smooth operation of vehicles involved in the games, which athletes and officials were onboard, and by supplying accurate traffic information to general vehicles.

2 Overview of UTMS in Nagano

The UTMS applied to Nagano consisted of 5 sub-systems of UTMS 21 including Integrated Traffic Control Systems (ITCS), Advanced Mobile Information Systems (AMIS), Public Transportation Priority Systems (PTPS), Mobile Operation Control Systems (MOCS), and Dynamic Route Guidance Systems (DRGS).

Infrared beacons, which are essential to UTMS, were installed on trunk roads for the operation of the games (414 units at 309 locations including 130 intersections). A total of 2,370 in-vehicle units were installed in the official vehicles involved. These were used for the following tasks.

(1) Signal control (ITCS and PTPS)

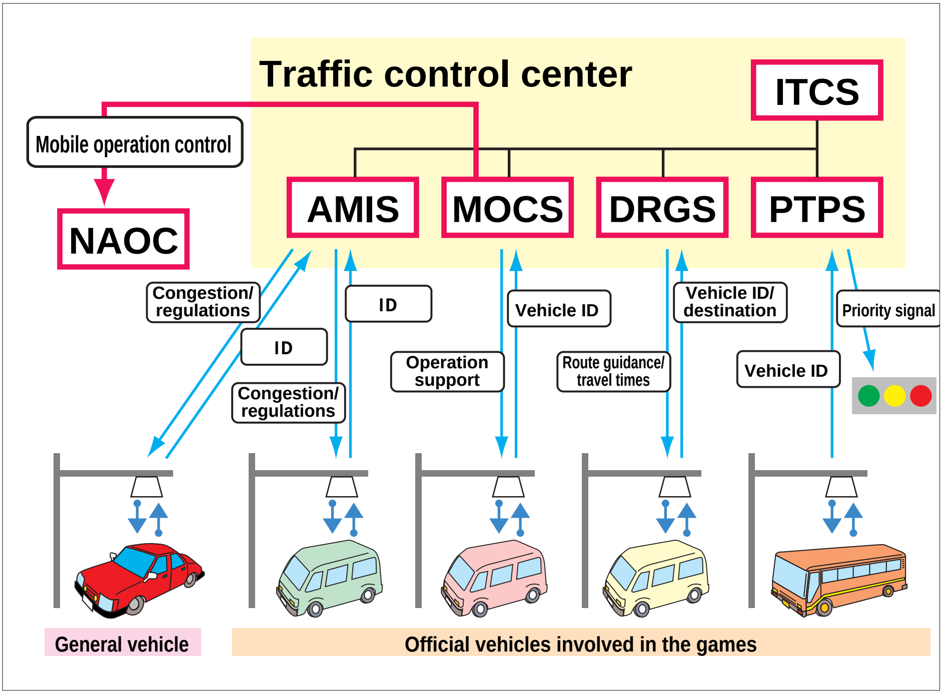
Optimum signal control was carried out according to information about traffic volumes and travel times collected by infrared beacons and other devices. In addition, priority signal control was performed based on the game schedule and ID information obtained from the official vehicles involved.

(2) Traffic information supply (AMIS, DRGS, and PTPS)

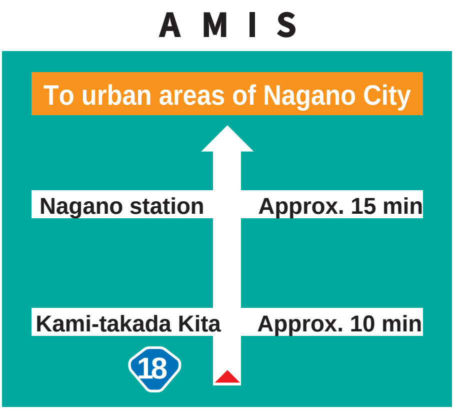
ITCS collected and processed information about congestion, travel times, and traffic regulations, which was provided to drivers via vehicle navigation systems, information boards installed on roads, telephones, faxes, and the Internet.

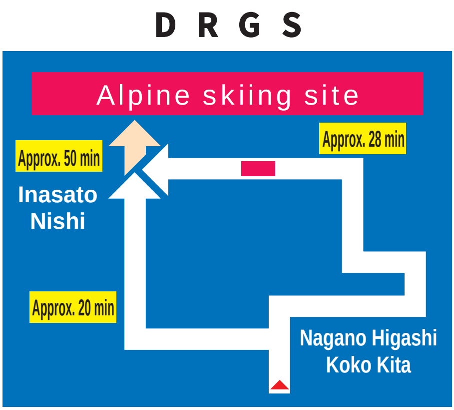
Regarding the official vehicles involved, travel times and optimum routes to their destinations were calculated using ID information obtained from them. The results were then supplied to them. To support the operation of the games, UTMS also provided the Organizing Committee for the Nagano Olympics with information about locations of the official vehicles involved.

Outline of UTMS in Nagano



Examples of information displayed on in-vehicle unit





Nagano Winter Olympic Games Traffic Measures

1 Traffic measures for Nagano Winter Olympic Games

The Nagano Prefectural Police introduced the Nagano UTMS as a measure to prevent traffic congestion during the Nagano Winter Olympic Games, and implemented traffic volume control and traffic restrictions. By taking such measures, the police realized safe and smooth traffic during the Games and thus greatly contributed to the success of the Games.

2 Total traffic volume control

According to the results of the simulation test before the Games, the total distance of traffic congestion was expected to extend to 50-70 km when official vehicles of the Games are added to the usual traffic in Nagano City. At the same time, it was predicted that the total distance of traffic congestion could be reduced to about 10 km if traffic volume was decreased by about 30 % from the usual level.

Based on these results, a campaign to reduce traffic volume in Nagano City by 30 % from the usual level was conducted as a measure to prevent traffic congestion during the Games. In this campaign, the police asked companies and households to reduce the use of vehicles for private and business use and to restrain from driving into areas near the venues of the Games.

3 To ensure the smooth operation of the official vehicles of the Games by setting up traffic restrictions

To ensure the smooth operation of official vehicles that carry athletes and officials of the Games, traffic restrictions were conducted to make these vehicles use different routes from other vehicles.

Three types of traffic restrictions were conducted according to the schedules of the games (venues and starting times): loop line restriction, route restriction, and zone restriction.

(1)The loop line restrictions include the following measures: in Nagano City, some of the loop lines connecting the athlete village, media village, and venues of the Games were closed to vehicular traffic, except for official vehicles of the Games; in other lines, lanes for the official vehicles of the Games exclusively were set up.

(2)The route restriction is: the roads to the loop lines and to the venues outside Nagano City were closed to vehicular traffic, except for official vehicles of the Games.

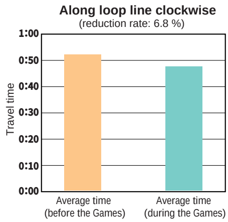
(3) The zone restriction is: the roads around each venue of the Games were closed to vehicular traffic, except for official vehicles of the Games.Moreover, to enforce these traffic restrictions in a thorough manner, advertising activities were conducted before the Games. During this event, route guidance was provided to drivers by supplying traffic information.

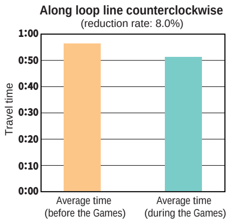
4 Effects of traffic measures

A survey on seven major intersections in Nagano City shows that the traffic volume during the Games was 54-84% of that before the Games (the target reduction rate was 30 %). The average traffic volume of general vehicles during the Games was 72% of that before the Games. The total traffic volume (containing official vehicles of the Games) was 75% of that before the Games. This shows that the target reduction rate was almost achieved. Moreover, various measures taken for the Games, such as the introduction of Nagano UTMS, reduced traffic congestion to 54.1% of the usual level. As a result, smooth traffic was realized, and almost all official vehicles of the Games moved to their destinations on schedule.According to a questionnaire survey, 87% of people involved in the Games said that the UTMS would be useful after the Games as well. This result proved the usefulness of this system.

PTPS macro-control effects

- **Prior adjustment of traffic signals according to game schedules**
- **Reduction of travel times of official busses on loop lines**





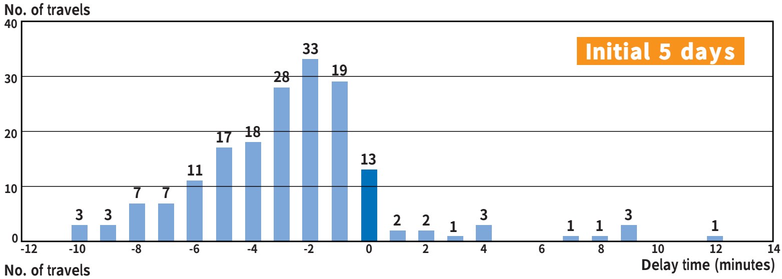
PTPS micro-control effect

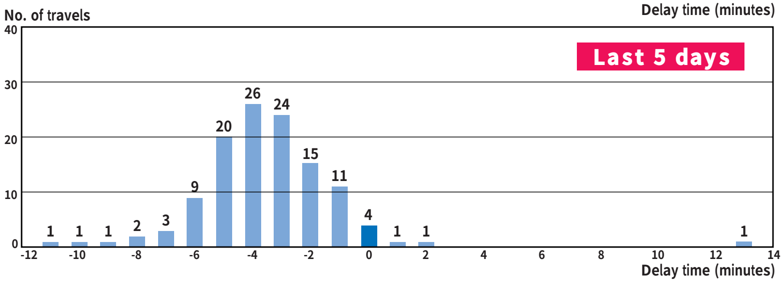
- **6 intersections on loop lines**
  (adjusted time of traffic lights for official vehicles of the Games:extended time of green lights and reduced time of red)

- **Effect of reduction of waiting time at traffic signals**
  Total no. of vehicles passing traffic signals
  106,622 vehicle-time
  No. of vehicles benefited by time reduction
  16,133 vehicle-time
  Effect of waiting time reduction
  20 seconds/vehicle-time

Effect of MOCS

Planned and actual travel times of official busses of the Games
(Loop line to skating game venue Olympic village -> M Wave: 25 minutes)

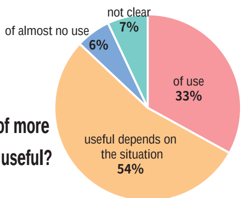




Expectations for UTMS - questionnaire survey

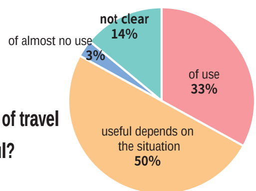
Q.17

Do you think the indication of more than one travel time will be useful?



Q.24

Do you think the indication of travel time by route will be useful?



Deployment of Optical (Infrared Ray) Communication Technology

Various optical-communication-technology-applied equipment and systems have been developed, manufactured and used in many industrial sectors recently. Optical communication between television sets and remote controllers and between personal computers and peripheral equipment are very common.

Existing applications of the optical (infrared ray) communication technology to traffic control have been mentioned as follows;

One typical application in Japan is infrared beacons, which have been installed nationwide by the National Police Agency. At present, the traffic information collected and processed by the traffic control center in each Prefectural Police Headquarters is sent to VICS (Vehicle Information Communication Systems) Center and distributed to individual in-vehicle units vie infrared beacons, FM multiplex broadcasting, etc. Infrared beacons are also used to measure the traffic volume with their detecting function. The number of infrared beacons installed in Japan is some 18,000 at present, and is expected to be increased to some 30,000 by the year 2001.

Application examples of optical communication technology outside Japan have also been investigated. As shown in the attached table, optical communication technology is applied practically to various traffic control systems, such as the emergency vehicle priority system, the public transportation operation control system, the route guidance system, the electronic toll collecton (ETC) system, the vehicle detection system, and the voice guidance system for sight-impaired persons. Some of these systems provide the same functions as do the UTMS21 systems which are promoted in Japan by the National Police Agency. Some have not yet been used in Japan for various reasons. Following are typical systems that have not yet been adopted in Japan.

① Emergency Vehicle Priority System (see right above figure)

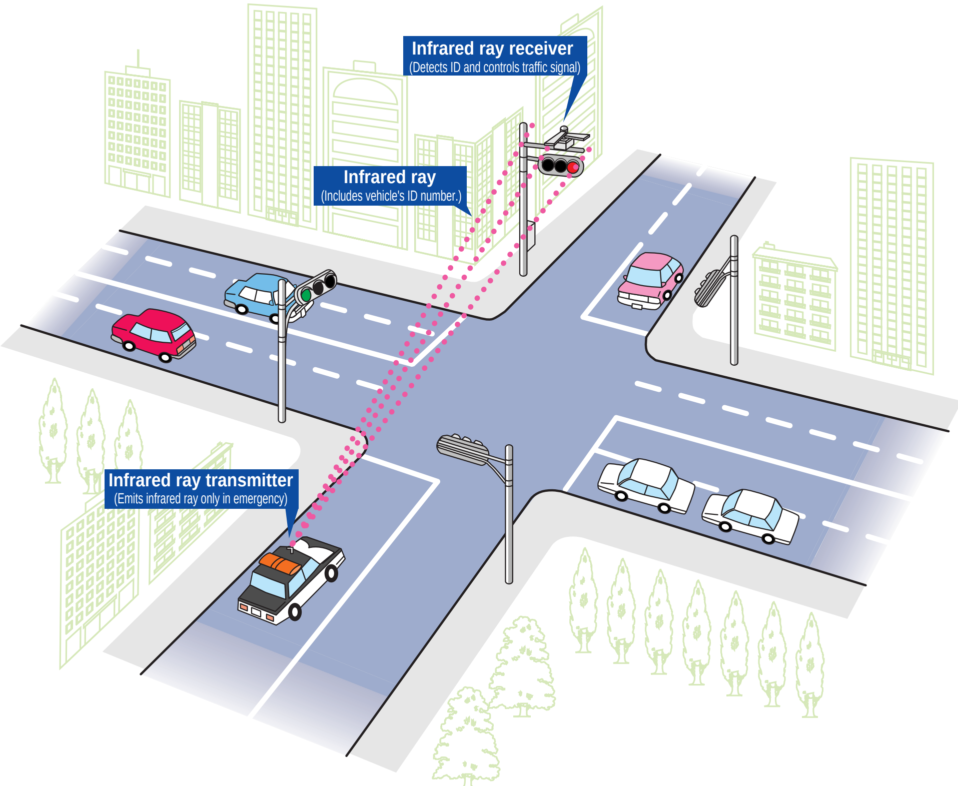
The system comprises infrared ray transmitters installed in respective emergency vehicles (Each ID number is added to the emitted ray) and infrared ray receivers installed mainly in the upper part of traffic signal poles. When an emergency vehicle equipped with an infrared beam transmitter comes to a point some 800 m before an intersection with an infrared ray receiver, the receiver catches the infrared beam emitted from the vehicle, and turns the traffic signal at the intersection green, enabling the emergency vehicle to run through the intersection safely and smoothly.

At present, this emergency vehicle priority system has been adopted in 850 cities worldwide. Infrared beam receivers are installed at some 30,000 intersections, and beam transmitters are mounted on an average of 75 emergency vehicles for each city.

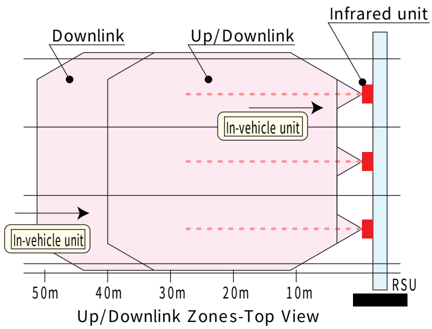
② Electronic Toll Collecting (ETC) System

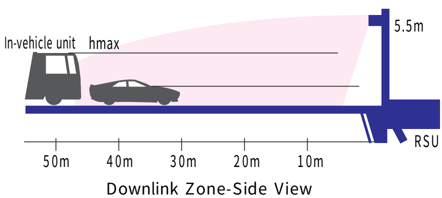
Electronic toll collecting (ETC) systems can be classified roughly in radio type and infrared ray type. The infrared ray ETC system, which is presented this time, has not been and is not likely to be adopted in Japan although it is put to practical use in many other countries.

Emergency Vehicle Priority System



Electronic Toll Collecting System Using Infrared





ITS developed by Japanese Police

ISBN4-924905-39-9

C3465

ITS developed by Japanese Police

Edited by TRAFFIC BUREAU, NATIONAL POLICE AGENCY
JAPAN TRAFFIC MANAGEMENT TECHNOLOGY ASSOCIATION

Materials provided by UNIVERSAL TRAFFIC MANAGEMENT SOCIETY OF JAPAN