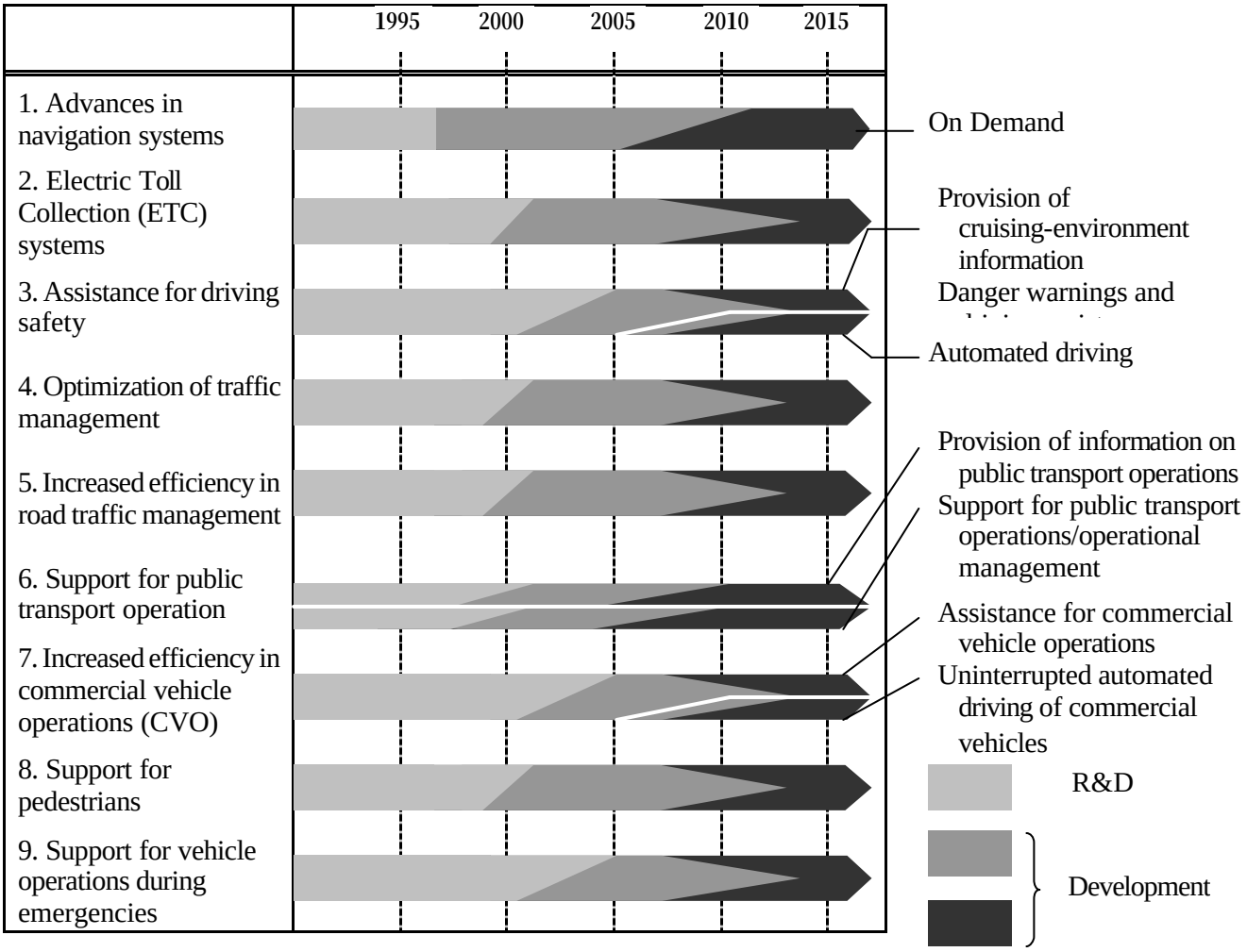
Chapter II　Ideal future image of ITS info-communications systems

1. Ideal future image of ITS presented in the "Comprehensive Plan for ITS in Japan"

(1) ITS development and deployment plan

The "Comprehensive Plan for ITS in Japan" presents the ITS development and deployment plan concerning each of its predetermined nine R&D areas as shown in Fig. 2-1. Specifically, the Comprehensive Plan has set target realization times for the systems covered by the nine areas, referring to successful cases of systems implementation, progress in R&D activities as well as the effort being made overseas for the development of similar systems.

Fig. 2-1　ITS development and deployment plan



(Source: "Comprehensive Plan for ITS in Japan")

(2) Public association with ITS

The Comprehensive Plan predicts how the Japanese public will associate with ITS in their daily life in the 21st century, as follows.

In Phase 1 around the year 2000, when ITS is still in its start-up stage, people will begin to appreciate the benefits of ITS services through use of VICS, which is already in operation, or ETC, whose introduction is imminent, or other services to follow.

In Phase 2 around the year 2005, a variety of ITS user services will successively be implemented, following the services realized in Phase 1. This tide is anticipated to exert a revolutionary impact on the entire transportation system. For example, route-guidance systems will begin operation, leading users to their choice of destinations, and punctuality of public transport systems will be assured, dramatically improving convenience of transportation users.

In Phase 3 around 2010 (the time of the further ITS advancement), both the legal and social frameworks will be further developed in order to make ITS an integral part of the social system. By this time, the influence of ITS on society will be widely perceived and appreciated by the Japanese public.

In Phase 4 around 2010, ITS will be fully developed. With all ITS systems up and running along with the availability of nationwide fiber-optic cables, creation of an advanced info-communications society will be finalized, leading to an innovation in the social system.。

Fig. 2-2 The public's association with ITS

Phase 1 (around the year 2000) Start-up of ITS [ITS services such as navigation systems will become partially available.]
○Indication of traffic congestion or best driving routes on navigation systems will reduce travel time and increase driving comfort. ○Introduction of ETC service will alleviate bottlenecks at toll gates.

Phase 2 (around the year 2005) Revolution in transportation system [Variety of user services will be launched.]
○It will become possible for users to choose the best driving route or public transport method in reaching their destinations. ○Crashes and traffic accidents on highways and general roads will decline, and rescue operations will be carried out more swiftly. ○Ensured punctuality of public transport systems and improved freight services will dramatically increase the convenience of public transport.

Phase 3 (around the year 2010) Automated driving -- realization of a dream [Advances in ITS and developments in the social framework]
○Developments will be made in the legal and social frameworks in order to make ITS an integral part of the social system. ○Automated driving will go fully operational.

Phase 4 (after the year 2010) Revolution in the social system [Maturation of ITS]
○All systems designed for ITS will be fully developed. ○Automated driving will become a standard service. ○Death toll from crashes and traffic incidents will decline dramatically, and concurrently traffic congestion especially in urban city areas will be alleviated. ○Reduced economic-activity-related traffic volume will help harmonize the relationship between the transport system and the near-roadway environment, and eventually with the global environment.

(Source: "Comprehensive Plan for ITS in Japan")

2. Ideal future image of ITS info-communications systems

(1) Examinations on the ideal future image of ITS info-communications systems

This section presents the outlook for the ITS info-communications systems development concerning each of nine R&D areas set out in the "Comprehensive Plan for ITS in Japan." This has given a basis for the definition of the ideal future image of ITS info-communications systems, as below.

As the first step, examinations were made on the development trends of various mobile communications systems and car multimedia technologies, which can be adopted as ITS info-communications systems. Following this, the outlook for the ITS info-communications systems development in each R&D area was examined for three phases (five-year span each) from 2000 to 2015, with a special emphasis on the types of information required for each R&D area. In this process, references were made to the current progress in the Comprehensive Plan's ITS development/deployment plan, in addition to the visions presented in the previous section, "The public's association with ITS."

Then, fundamental core technologies crucial to the realization of those systems were chosen based on the outlook for the R&D areas.

Apart from that, another R&D area, "Use of car multimedia services in an advanced info-communications society," was newly adopted as the 10th R&D area.

This adoption was based on the recognition that studies must be conducted concerning adaptability of info-communications systems to the transportation system, with which people has close connection in their daily life.

This section will also define the direction of ITS info-communications systems advancement based on the outlook for each R&D area, and clarify the ideal future image of info-communications systems, while also taking their interoperability with various other networks into consideration.

(2) Developments in mobile communications systems and others

Prominent systems seen being adopted as ITS info-communications systems are as follow.。

(a) Cellular phone and the Third-generation Mobile Communications System "IMT-2000"

At present, several traffic information services are already available with use of data transmissions via cellular phone.

Such services currently have limitations in terms of their data transmission speeds (from 9.6 kbps to 28.8 kbps); however, a jump in the transmission speed (up to 2 Mbps on a static condition) is expected for IMT-2000 when introduced in 2001, enabling transmission of simple motion pictures.

(b) Multimedia Mobile Access Communications (MMAC) systems

Efforts are being made to realize some of Multimedia Mobile Access Communications (MMAC) systems by around 2002 -- the ultrahigh-speed wireless LAN and high-speed wireless access systems. The former enables high-speed transmission of up to 156 Mbps in an indoor, near static setting. The latter enables communications outdoors at a level of several ten Mbps upon travel at walking speed.

Another plan is also being pursued to realize the "ultrahigh-speed multimedia mobile communications systems" by 2010 for improved convenience upon use of MMAC. If realized, the systems will achieve the maximum transmission speed of 156 Mbps even while moving at a very high speed.

Realization of these systems is seen enabling advanced usage of multimedia information with ITS.

(c) Terrestrial broadcasting, satellite broadcasting

Currently available broadcasting-based ITS service is VICS, which uses analog FM multiplex broadcasting. Use of digital terrestrial and satellite broadcasting for ITS is also planned in the near future.

These digital broadcasting systems excel in frequency-use efficiency and the ability to transmit bulk data compared to conventional analog broadcasting systems. Thus, hopes run high for use of these systems not only for traffic information distribution, but also as an information tool that covers broad areas while offering various ITS information in data and motion pictures.

(d) Proprietary systems

One example of proprietary systems is MCA radio, a business-use radio system widely adopted in the distribution industry. Recent years have increasingly seen unified use of such proprietary systems and information processing devices, particularly in the distribution sector. Increased data transmission use by these proprietary systems is also anticipated for the future as digitalization progresses.

(e) The Internet

The Internet is thought to have very high latent user demand as an interactive network facilitating free distribution of a wide variety of information.

The Internet still has some technical problems that have made difficult accesses from fast-moving cars. Nonetheless, the Internet holds a great potential of becoming the core of ITS networks in the future.

(3) Developments in car multimedia systems

Recent years have seen a rapid progress in the development of car multimedia systems. The following is a brief synopsis of recent developments in the field of car electronics, which has provided a basis for the advancement of car multimedia systems, in addition to a synopsis of recent trends in the introduction of intra-vehicle information networks.

Car multimedia technology has been booming thanks to developments in the car electronics field. In the beginning, car electronics had been applied to the most basic car control devices, for recharging, ignition and so on. In the next step, wide adoption of microcomputers began and sensor technologies became advanced, enabling tuning of functional controllability of all devices to an optimal level.

Meanwhile, vigorous efforts to meet such legal requirements as limitations on exhaust fumes resulted in a shift of control methods, from individual unit control to unified control of all units. This also led to the development of the power train control method, which controls the engine and gearshift in unison, as well as of the vehicle position control method, which controls car moves following steering operations. Obstacle detection, inter-vehicle distance control and other new technologies have also been made possible through combined use of on-board radars and various other sensors.

In addition, networking of all on-board units inside control devices -- in other words, building of intra-vehicle LAN -- has enabled shared use of sensor signals and control data, allowing control of all the units to be carried out more extensively and comprehensively.

Today's car navigation systems are seen evolving into much more comprehensive devices in an effort to meet the needs of ITS services. First, stand-alone navigation systems will be integrated into, or will encompass, communications systems. Then these systems will enable communications between intra-vehicle LANs (to be standardized) and roadside devices/other vehicles, through use of "intelligent" multifunctional on-board devices. Eventually, the systems are anticipated becoming reflective of outdoor conditions to vehicle operations.

Fig. 2-3 Projection of developments in car electronics technology

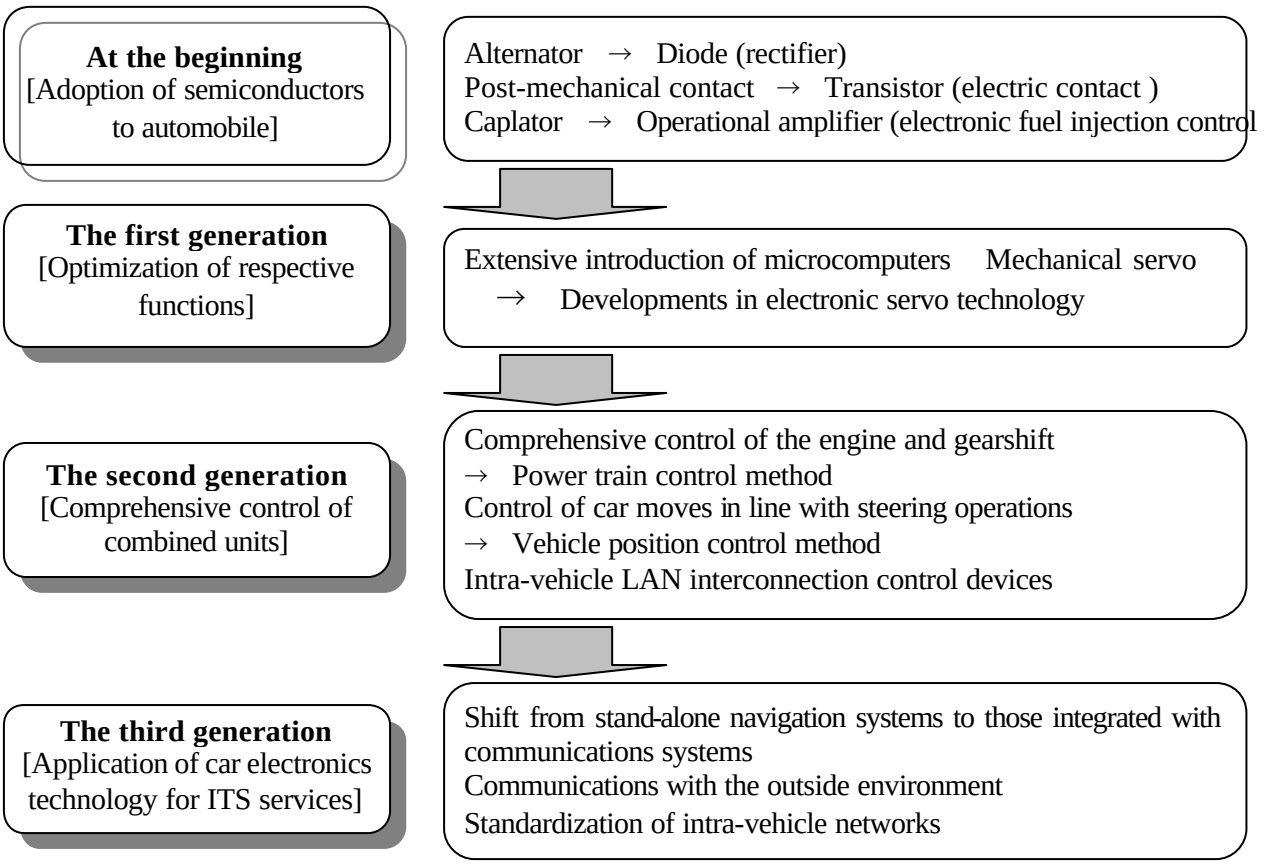


Fig. 2-4 History of car electronics development

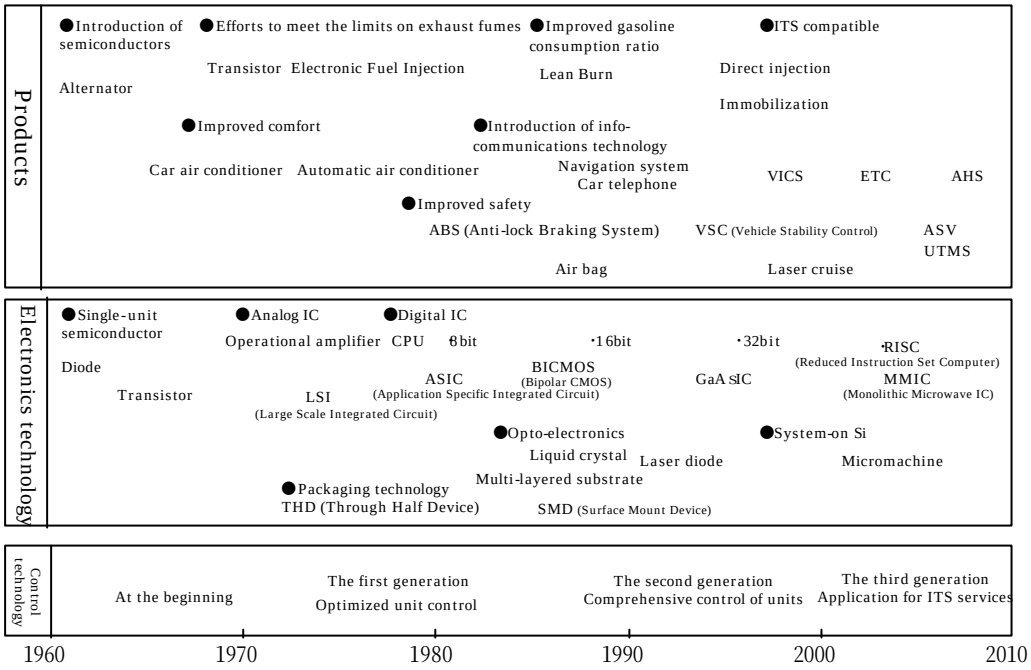
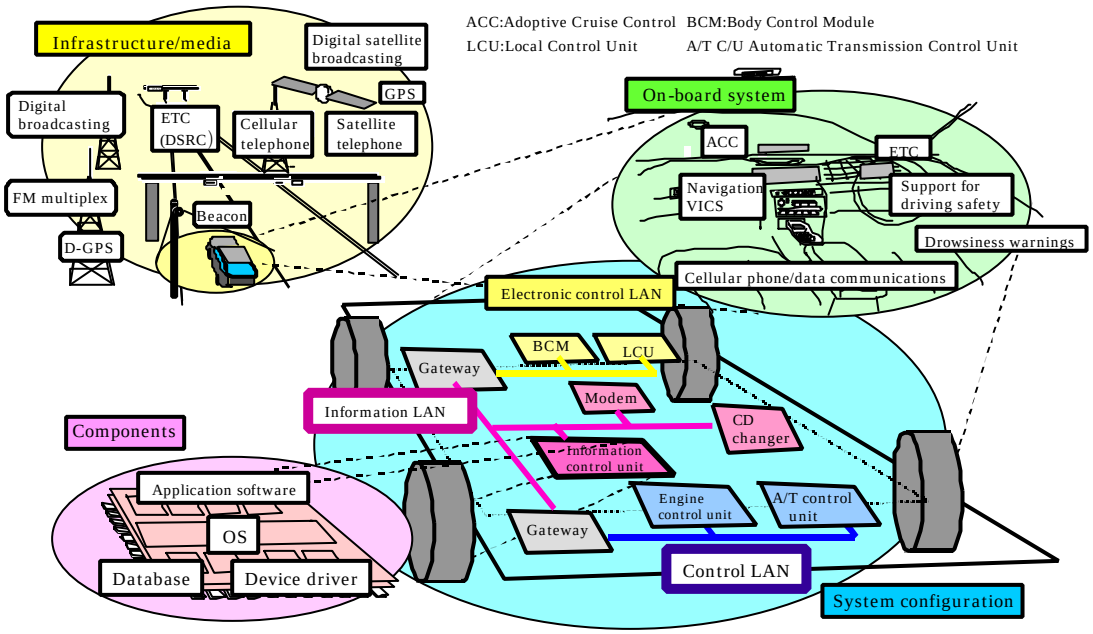


Fig. 2-5 Developments in car electronics technology and introduction of IT (information technology) to vehicles



(4) Outlook for the development of ITS info-communications systems in respective ITS R&D areas

The following are the brief outlooks for the development of ITS info-communications systems in the nine ITS R&D areas presented in the Comprehensive Plan, in addition to the newly set 10th R&D area, "Use of car multimedia services in an advanced info-communications society."

① Advances in navigation systems

Information handled	Road traffic information, optimal route information, travel time at the time of traffic congestion, parking-space availability information, parking-space reservation information, destination information, weather reports, information from other sources, route guidance, exchanges of route information between moving vehicles
Development outlook	Year 2000 Advances in existing systems such as VICS Advances in information-reception type navigation systems Year 2005 Development of navigation systems into the request-type systems that allow search of non-traffic-related information as well Year 2010 and after Development of navigation systems into the on-demand systems capable of information exchanges between moving vehicles Evolving of navigation systems into ones that are applicable for automated driving
Examples of technology indispensable for systems realization	Advanced location detection/tracking technology, on-board device technology, digital map technology, wireless agent technology, advanced human-machine interface technology, media interface technology, best-route information analysis technology, transportation conditions prediction technology, information coding technology, database search technology, and so on

② Electric Toll Collection (ETC) systems

Information handled	On-board ETC device user data, on-board device transaction records, contract data, entrance information, exit information, barrier information, travel records, itemized detail of ETC service use, and so on
Development outlook	Year 2000 Full-fledged use of ETC on toll roads Realization of stand-alone ETC systems through use of ETC technology for versatile purposes (e.g., parking-lot entrance management, toll collection at gas stations, drive-through shopping, vehicle operation management at the ferry gate, freight management for instance by tagging truck loads) Year 2005 and after Progress in integration of on-board car navigation systems and on-board ETC systems Enabled downloading of various data onto on-board ETC systems。 Realization of multi-purpose wireless IC cards that are accessible to various other information networks
Examples of technology indispensable for systems realization	Wireless agent technology, security/authentication/encryption technologies, varied networks interconnection/control technology, data management technology, multi-mode terminal technology, antenna sharing technology, and so on

③ Assistance for driving safety

Information handled	Road environment information, driver's conditions, vehicle conditions, front/side vehicles information, roadway information such as road-surface conditions, conditions of pedestrians passing by, and so on
Development outlook	Year 2000 Provision of driving conditions information as well as danger warnings on particular spots at intersections, tunnels and branches, where there is high demand for driving safety support information. Year 2005 Progress in the development of driving support systems that use inter-vehicle communications, radars, lane markers and so on Realization of distribution car systems that use automatic driving support technology Year 2010 Advances in driving support services by realization of uninterrupted long-distance communications Year 2015 and after Realization of automated driving systems in most types of vehicle including commercial cars (to be applied for vehicle's lane changes, joining into main lanes or branching out, as well as at interchanges, intersections, parking lots and other locations)
Examples of technology indispensable for systems realization	On-board radar technology, light-radio hybrid communications technology, advanced location sensor/tracking technology, quality of service (QOS) control technology, roadside-vehicle/inter-vehicle communications technology, image recognition/creation technology, security/authentication/encryption technologies, and so on

④ Optimization of traffic management

Information handled	Traffic volume information, speed limit information, traffic congestion locations, traffic congestion time, traffic light control information, lane control information, disaster information, traffic control information, information on sites of traffic accidents, moving pictures of traffic accident sites
Development outlook	Year 2000 Realization of traffic light control systems applicable for best route guidance Year 2005 Progress in the development of systems that can distribute moving pictures of crashes or other emergencies to surrounding vehicles Year 2010 Evolving of these systems into ones that are applicable for automated driving
Examples of technology indispensable for systems realization	Optimal route information analysis technology, security/authentication/encryption technologies, roadside-vehicle/inter-vehicle communications technology, and so on

⑤ Increased efficiency in road traffic management

Information handled	Road traffic information, travel time at the time of traffic congestion, traffic control information, special vehicles' position information, road surface information, information on recovery from disasters, weather reports, and so on
Development outlook	Year 2000 Progress in advancement of existing systems and of information-reception type systems Year 2005 Progress in the development of systems capable of receiving road management information and other data in moving pictures Year 2010 Evolving of these systems into ones that are applicable for automated driving
Examples of technology indispensable for systems realization	Advanced location detection/tracking technology, varied networks interconnection/control technology, and so on

⑥Support for public transport operation

Information handled	Road traffic/transportation information, location data in coordinates, transit information, seat reservation information, operational conditions, and so on	
Development outlook	Year 2000	Progress in the development of systems that gather public transport operational conditions in real time and provide the information on street electronic boards and other specific spots Progress in the development of systems that allow tracing of public transport vehicle locations and routing thereof to customers in response to requests Progress in the development of systems that control the special traffic signals designed to prioritize public transportation vehicles, and that improve the convenience of public transportation users as a result
	Year 2005	Progress in the development of information provision systems that can be accessed from various other information networks
	Year 2010	Evolving of these systems into ones that are applicable for automated driving Realization of data sharing with other transportation bodies, thereby improving quality of services
Examples of technology indispensable for systems realization	Advanced location detection/tracking technology, optimal route information analysis technology, varied networks interconnection/control technology, distributed database control technology, and so on	

⑦Increased efficiency in commercial vehicle operations (CVO)

Information handled	Road traffic information, operational condition information, freight information, other transportation bodies' operational conditions, weather reports, and so on.	
Development outlook	Year 2000	Advances in physical distribution EDI (electronic data interchange) systems, vehicle/goods routing request systems and operation management systems, which are all applicable for freight services Realization of freight management for instance by tagging truck loads
	Year 2005	Construction of the distribution data exchange platform, which will be developed into the systems that enable access to overall distribution information including goods/vehicle locations from various other networks Advances in vehicle operation management systems, total delivery systems and comprehensive distribution systems by use of realtime information in moving pictures Utilization of driving support systems compatible with inter-vehicle communications, radars, lane markers and other technologies Realization of distribution car systems that have adopted automated driving support technology
	Year 2010	Evolving of these systems into the driving support systems that are capable of providing bulk information such as images
Examples of technology indispensable for systems realization	Advanced location detection/tracking technology, transportation conditions prediction technology, optimal route information analysis technology, digital map technology, varied networks interconnection/control technology, wireless agent technology, and so on	

⑧Support for pedestrians

Information handled	Best route information, location information, facility information, destination information, pedestrian-use traffic light control information, emergency reports, and so on	
Development outlook	Year 2000	Realization of route guidance by use of texts/voice as well as of systems providing destination information and other sources of data at particular spots Realization of route guidance and traffic light control (extended time period) for the elderly and hadicapped
	Year 2005	Progress in the development of information provision systems that enable access to moving picture information and various other networks Shift from sporadic systems to unified group of systems in a line or area formation
	Year 2010	Realization of moving-picture-based route guidance and destination information provision
	Year 2015 and after	Evolving of these systems into advanced and human-friendly systems that use voice recognition, agent communications and AI technology Evolving of these systems into hazard prevention systems that coordinate with vehicles' automated driving systems
Examples of technology indispensable for systems realization	Advanced location detection/tracking technology, intelligent human-machine interface technology, terminal ultraminiaturization technology, optimal route information analysis technology, digital map technology, display device technology, and so on	

⑨Support for vehicle operations during emergencies

Information handled	Emergency location information, emergency vehicle move control information, road traffic information, optimal route information, travel time at the time of traffic congestion, traffic light control information, near-miss information, and so on	
Development outlook	Year 2000	Realization of automated emergency report systems that identify vehicle locations during emergencies and call police or other bodies for rescue Realization of traffic light control systems that can be applied for optimal vehicle route guidance at emergencies Realization of automated report to police from stolen cars
	Year 2005 and after	Progress in the development of systems capable of transmitting moving pictures and of reporting emergencies to surrounding vehicles
Examples of technology indispensable for systems realization	Optimal route information analysis technology, advanced location detection/tracking technology, digital map technology, high-speed routing technology, QOS control technology, varied networks interconnection/control technology, security/authentication/encryption technologies, and so on	

⑩ Use of car multimedia services in an advanced info-communications society

Information handled	Traveler/tourist information, shopping information (through electronic account settlement), entertainment information, administrative service information, disaster prevention information, weather reports, public transport seat availability information, banking information, public facility reservation information, Internet information, and so on	
Development outlook	Year 2000	Realization of en-route information provision services in texts, data or voice that deal with travelling, sightseeing and recreation information
	Year 2005	Realization of multi-mode terminals capable of accessing moving pictures and various networks using just one single terminal
		Progress in the development of systems that enable en-route online shopping inside vehicles as a result of widespread use of multi-purpose wireless IC cards
		Enabling of public transport seat reservation from vehicles thanks to realization of electronic secretary technology
	Year 2010 and after	Realization of human-friendly car multimedia technology, which can be applied for automated driving
Examples of technology indispensable for systems realization	Wireless agent technology, QOS control technology, security/ authentication/encryption technologies, media interface technology, light-radio hybrid communications technology, on-board terminal technology, intra-vehicle network system, multicast route technology, and so on	

(5) Direction of developments in ITS info-communications systems

The following is the expected future development trends of ITS info-communications systems in brief.

① Larger volume, realtime information and its increased multimedia use

【Current status】

Wireless networks have disadvantage in terms of achievable transmission speeds compared to wired networks, and thus wireless networks now handle light data transmissions such as of voice and low volume data

【Direction of development】

In early 2000, it is thought that diversified multimedia systems capable of handling high-speed transmissions and high-volume data can be realized, enabling users to enjoy realtime high-quality data/image information.

② Networking

【Current status】

Currently available ITS info-communications systems, including such ITS-specific systems as VICS and ETC, are operated on a stand-alone basis.

【Direction of development】

Further internetworking with other systems as well as sharing of information among networks will be promoted, allowing users to enjoy diversified and advanced ITS services in unison.

③ Advances in on-demand, interactive technology

【Current status】

Information flow is mostly one-sided, from control centers to vehicles only. The databases currently available have limited issue coverage.

【Direction of development】

Technological development will allow users to access the Internet and other network services with simple operations, even from the fast moving vehicles. And systems will evolve into ones enabling users to obtain necessary information interactively.

④ Multiple use of devices and human-friendlier systems

【Current status】

Each service requires special devices tailored for the service. In addition, there is a limit on vehicle's inside space.

【Direction of development】

Higher functionality and further multiple usage will be pursued upon developing devices in line with increased multimedia availability. This will be followed by the maturation of the human-machine interface, making ITS more safe and friendly to drivers.

(6) Ideal future image of ITS info-communications systems

This section presents the ideal future image of ITS info-communications systems, based on the direction of developments in ITS info-communications systems, presented in the previous section.

As mentioned before, some ITS-specific systems such as VICS and ETC are already in operation or in the process of being put in service. Since ITS should provide information to extensive areas, it utilizes other media, such as broadcasting (which is distributing very public-oriented traffic information), cellular phone, various types of amateur radio, GPS (global positioning system), among others.

In addition, those media anticipated to be used for ITS include IMT-2000 and the Next-generation Internet (both enabling highly-reliable, high-speed data transmission) as well as digital terrestrial/satellite broadcasting.

It is very important to utilize the most appropriate info-communications networks depending on the types of information required for respective user services (e.g., information volume, transmission speed, reliability, realtime possibility, interactivity, information coverage areas), when ITS user services are increasingly advanced and diversified.

Conversely, when seen from viewpoint of the ITS info-communications systems, this is to achieve ITS information's smooth distribution among users via variety of networks and systems. From the users' standpoint, this means that a wide variety of services will become available on the info-communications platform that offers them more choice.

Under the circumstances, efforts are to be made to ensure system compatibility among various ITS info-communications systems as well as between them and other info-communications networks, in addition to ensuring interoperability for ITS-specific systems and various other systems. It is anticipated that these moves, in addition to increasing the systems' ability to handle larger volume data for multimedia purposes, will eventually lead to the creation of the "ITS info-communications platform" (see Fig. 2-5 and Fig. 2-6).

For realization of the ITS info-communications platform, it is crucial that a smooth distribution of ITS information be achieved, while attempting to involve existing networks as much as possible. To this end, ITS info-communications systems should be developed, taking into consideration the direction of communications-and-broadcasting convergence while making full use of the remarkable features available for ITS information and various other info-communications networks.

Fig. 2-6 Image of ITS info-communications systems

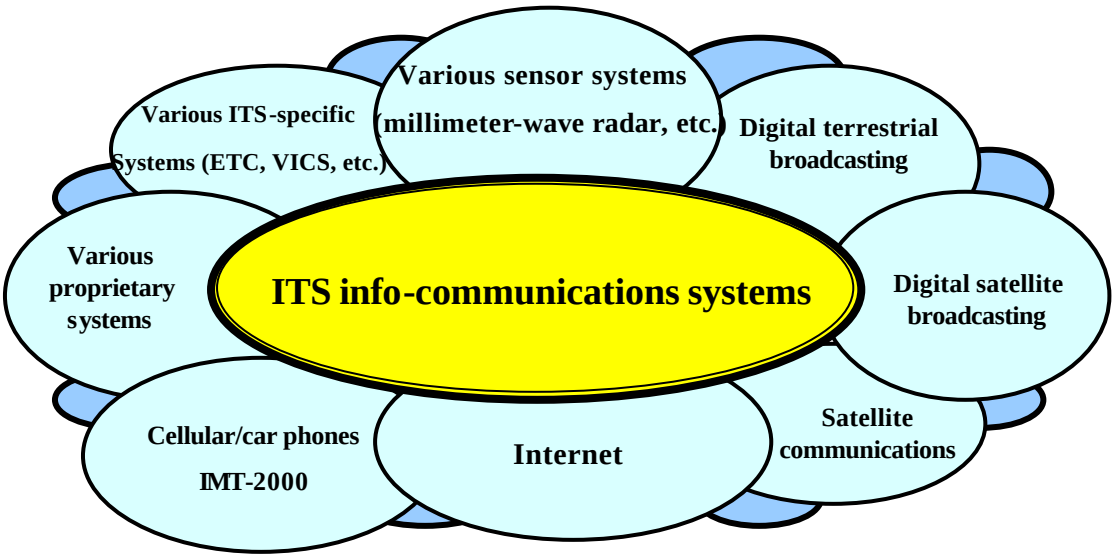
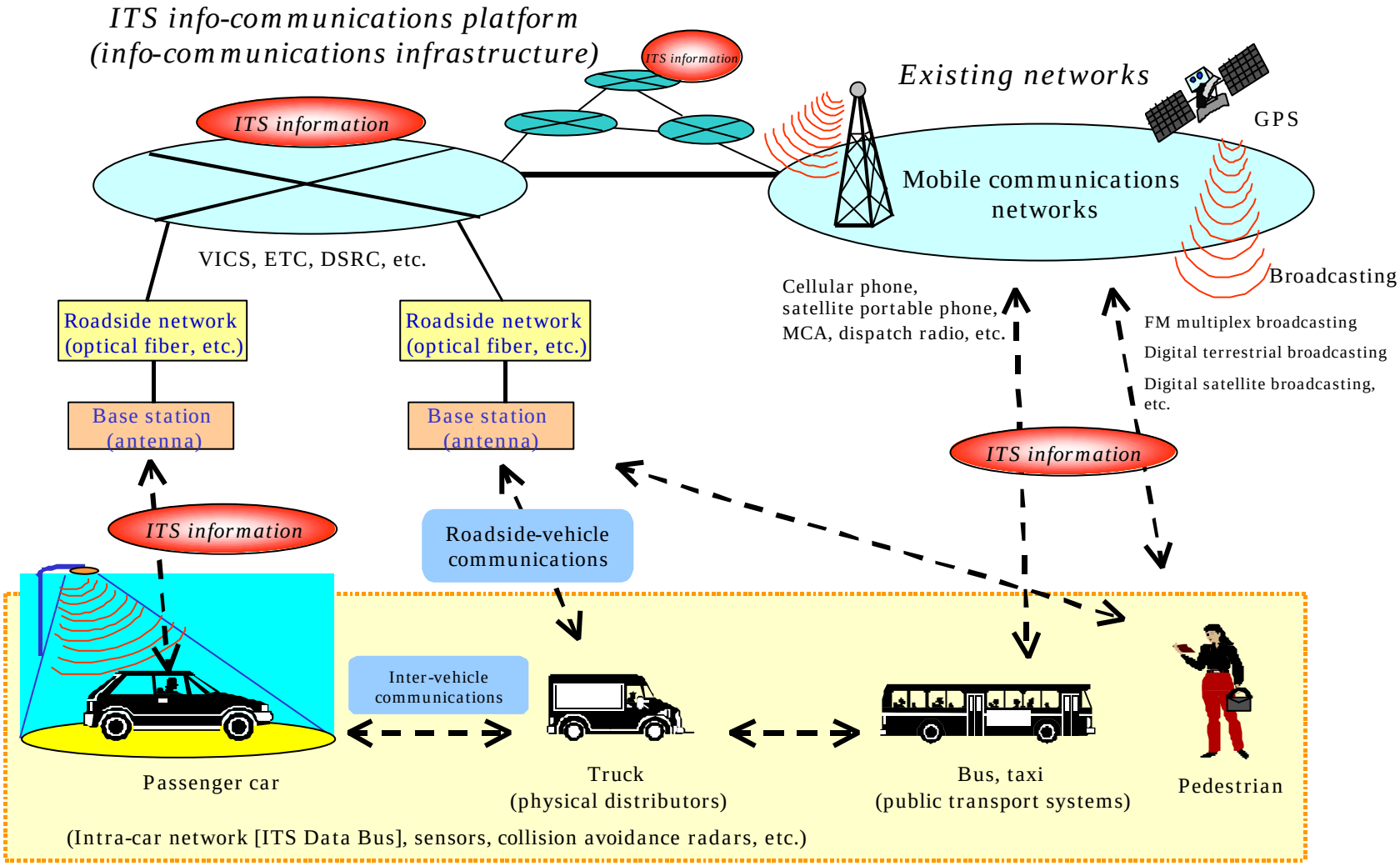


Fig. 2-7 Ideal future image of ITS info-communications systems



（7） Ideal future image of ITS info-communications systems

Summing up the preceding examinations, the ideal future images of ITS info-communications systems are shown in three phases until 2010 below:

○ Phase 1 (year 2000: the start-up stage)

Conventional stand-alone systems will be advanced for multiple purposes and gain multiple functions.

○ Phase 2 (year 2005: the development stage)

Those systems will evolve into ones that provide a variety of services not only on their own, but also through interconnected networks. Specifically, information handled will include pictures and images, in addition to voice and data, which users can request and obtain on-demand in real time.

In line with these developments, the high functionality and multiple use capability of ITS devices will also be pursued, transforming into human-friendly and driving-safety-concerned systems.

○ Phase 3 (year 2010: the mature stage)

Advances will further be made in the systems, thereby enabling seamless information distribution and then transforming them into comprehensive systems with variety of functions, including support for automated driving