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Historical Analysis of the ITS Progress of Japan

Kohei Koide[1] · **Takeshi Oishi**[1] · **Katsushi Ikeuchi**[1]

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Abstract Although road traffic has supported high economic growth after the war, it has also caused serious social problems about traffic accidents, traffic congestion, and environmental pollution. Information and communication technology (ICT), such as computers, mobile communications, and digital information processing, has made rapid progress, in the second half of the 20th century. Intelligent Transport Systems (ITS), which were developed using ICT, has contributed to improvement of road traffic problems, in recent years. Many ITS related people in the government, universities, and private companies and so on, have built the history of the ITS progress, making efforts and ingenuity to improve road traffic problems by ITS. In this paper we contribute improvement of road traffic problems, by clarifying the influential factors and the strong points of ITS of Japan through analyzing the history of the ITS progress of Japan.

Keywords History of ITS progress · Influential factors and strong points of ITS · Improvement of road traffic problems

✉ Kohei Koide
k-koide@cvl.iis.u-tokyo.ac.jp

Takeshi Oishi
oish@iis.u-tokyo.ac.jp

Katsushi Ikeuchi
ki@iis.u-tokyo.ac.jp

[1] ITS Center, Institute of Industrial Science, The University of Tokyo, 4-6-1 Komaba, Meguro-ku, Tokyo 153-8505, Japan

1 Introduction

ITS of Japan has accomplished remarkable progress by the promotion organization of government initiative, industrial, and academic sectors cooperation. The "Mission Critical System" is defined in this paper as a representative ITS of Japan which consists of several practical use systems. One is the route guidance system called the Car Navigation System and Vehicle Information and Communication System (VICS). Another is the fee collection system of the highway called Electronic Toll Collection system (ETC.). Others are Universal Traffic Management System (UTMS), and the "Cooperative Driving Safety Support System" consisting of Advanced Safety Vehicle (ASV), Driving Safety Support Systems (DSSS), and "ITS spot". The "Mission Critical System" of ITS of Japan has spread across the country. ITS of Japan is evaluated topmost in the world, for kind and their technological high level of systems.

Now in Japan, advanced development projects of ITS are being promoted. One is the project on the "Cooperative Driving Safety Support System" which aims at automatic vehicle operation. Another is the study project about the new utilization system of traffic data called "Probe Information", which aims at decreases in traffic accidents and traffic congestion. These projects are being promoted targeting at the Tokyo Olympic Games in 2020.

In this paper, we would like to clarify the influential examples, influential factors, and the strong points, of ITS of Japan which significantly contributed to the ITS progress of Japan, by analyzing the history of the ITS progress of Japan, towards improvement of road traffic problems. In Section 2, we explain the necessity of reduction of the social losses attributed to road traffic. In Section 3, the outlines of the history of the ITS progress of Japan are explained. In Section 4, influential

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examples of ITS of Japan are selected, based on the history of the ITS progress of Section 3. In Section 5, we identify the influential factors and the strong points of ITS by analyzing the influential examples. Finally, in Section 6, we propose the way of thinking of future ITS promotion.

2 Social Losses Attributed to Road Traffic, and Improvement Potentialities by ITS

The National Police Agency (NPA) announced that the number of traffic accidents in 2013 was 629,021 and the death toll was 4,373, and the number injured was 781,494 [1]. Even though the numerical values in recent years have been trending downward, it is still a big social problem. According to an investigation by the Cabinet Office, the economic loss attributed to all traffic accidents is estimated to be 6,750 billion yen per year, as of 2004 [2]. According to investigation of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), wasted time attributed to traffic congestion in Japan was 3,810 million man hours / year, in 2002. Also, in 2006, it was 3,310 million man hours / year. If converted into monetary value, the estimated loss was about 10~12 trillion yen per year [3]. CO2 emissions from the transportation section have been decreasing from the peak of 267 million tons in 2001, to 227 million tons in 2012 [4]. Though this numerical value has attained the "Governmental Goal Achievement Plan", since the CO2 problem also includes an economic side like the emission trading, thus continuous CO2 reduction is being desired.

Accurate numerical values about traffic congestion and environmental pollution, and the improvement potentialities of them by ITS are difficult to estimate. However, the improvement potentialities were estimated by experiments and computer simulations by the government so far. For example, about the improvement potentialities by ASV, MLIT announced the improvement potentialities using the traffic accident data for the year 2009. According to the results, approximately 1,000 fatal accidents and 180,000 injury accidents could be avoided by installations of ASV [5]. These numbers are equivalent to nearly 20 % of the actual death toll and injuries in 2009.

Concerning social loss caused by traffic congestion, the VICS center announced in 2006 that the economic effect of the improvement of congestion by VICS was estimated by an experiments and simulations [6]. These numbers are equivalent to nearly 7 % of the actual wasteful time, and nearly 1 % of the CO2 emissions in 2006.

From the experimental results and computer simulation results mentioned above, it is shown that ITS has improvement potentialities of social losses attributed to road traffic. However, at the moment, the improvement effect of ITS is very small compared with actual social losses attributed to road traffic. Therefore we think it's necessary to make an effort to expand the effect of ITS.

3 The History of the ITS Progress

3.1 Early Stage (1960s–1980s)

ITS began in the 1960's. The US Electronic Route Guidance System (ERGS), the European Autofahrer Leit und Informations system (ALI), and the Comprehensive Automobile traffic Control System (CACS) of Japan, are said to be the initial ITS systems. Each of these three systems had a route guidance service as the main function. In the 1970s, for the purpose of relief of traffic congestion etc., CACS project constructed the experimental system which had digital communications function between the ground side and vehicles, and provided the route guidance information to vehicles. CACS became a forerunner of ITS of Japan.

In the 1980s, ITS of Japan began the development of the "Intelligent Road Traffic System" by ITS related ministries and agencies of NPA, the Ministry of International Trade and Industry (MITI), the Ministry of Transport (MOT), the Ministry of Posts and Telecommunications (MPT), and the Ministry of Construction (MOC). ITS related ministries and agencies, based on the trend of the US and European ITS development projects, started up the ITS experiment system development projects individually by the promotion organization of governmental, industrial, and academic sectors cooperation. These systems are listed as follows: Super Smart Vehicle System (SSVS) of MITI, Road/Automobile Communication System (RACS), Advanced cruise-assist Highway System (AHS), and Advanced Road Traffic Systems (ARTS) of MOC, Advanced Mobile Traffic Information and Communication Systems (AMTICS), and Universal Traffic Management Systems (UTMS) of NPA, and Advanced Safety Vehicle (ASV) of MOT. On the other hand, private companies also promoted the development and the spread, of the Car Navigation System, in the 1980s and afterwards.

RACS and AMTICS were unified into VICS early in the 1990s, and developed into the practical use system in 1996. At the ITS World Congress held in Yokohama in 1995, these experimental systems were generically named ITS.

3.2 First Stage (1990s–2004)

The government established the "Advanced Information and Telecommunications Society Promotion Headquarters" in August 1994, and decided to tackle the realization of an advanced information and telecommunications society. This Headquarters enacted the "Basic Policy towards an Advanced Information and Telecommunications Society" in February 1995, and decided that ITS was one of the fields which the government should tackle [7].

In response to this, ITS related ministries and agencies, first enacted the "Information Implementation Indicator in a Road, Traffic, and the Vehicles Field" in August 1995, and

continuously enacted the "Comprehensive Plan for ITS" in July 1996 [8] [9]. In this study, we will call these plans the "ITS National Strategy". According to the "Comprehensive Plan for ITS", Nine development fields were decided as targets of the plan, and the "First stage" of ITS of Japan started.

In the 2000s and afterwards, VICS and ETC. which were defined as development fields in the "Comprehensive Plan for ITS", became widespread steadily by the ITS measures in the "Road Traffic Policy". Namely, national deployment of service areas, and increase of the number of in-vehicle units were realized.

The "e-Japan Strategy" was announced by the IT Strategic Headquarters in January, 2001. The "e-Japan Priority Policy Program" which showed a concrete way of advancing the "e-Japan Strategy", was enacted in March, 2001. [10] [11]. Thereby, the development and the spread of ITS was quickly promoted as part of the "IT Strategy". The state of the art of ITS of Japan was announced to the world at the "ITS World Congress Nagoya, Aichi" in 2004, and at the "EXPO 2005 AICHI, JAPAN" in 2005. In the meantime, the Car Navigation System, VICS, and ETC. spread all over the country and UTMS also spread through the local governments in Japan.

3.3 Second Stage (2005–2012)

ITS of Japan went into the "Second stage" after the "ITS World Congress Nagoya, Aichi", held in 2004. In the "Second stage", the spread of individual systems was expanded. ITS became indispensable to everyday life. The "Guideline of ITS Promotion", which was announced in 2004 by the "Japanese ITS Promotion Meeting", decided the target of ITS. Target goals included topics such as "safety and relief", "environment and efficiency", and "comfort and convenience" [12].

In January, 2006, the "IT Strategic Headquarters" enacted the "New IT Reform Strategy". This strategy named a clear target of creating the safest road traffic society in the world [13]. The "Cooperative Driving Safety Support System" was selected as the development theme in the "New IT Reform Strategy" for realizing the safest road traffic society in the world. A plan for verification experiments on public roads in the 2008 fiscal year, and national deployment of this system from the 2010 fiscal year was determined expressly in the "New IT Reform Strategy". The promotion project of this plan was the "ITS-Safety 2010". In this project, DSSS of NPA, Smartway of the MLIT Road Bureau, and ASV of the MLIT Road Transport Bureau, were developed strongly by a joint government-private sector organization. Smartway was evolved into "ITS spot". After this project, the practical implementation of the "Cooperative Driving Safety Support System" was progressed rapidly.

In parallel to "New IT Reform Strategy", the "Grant acceleration project" of the Cabinet Office also started in 2008 [14]. The "Grant Acceleration Project" was one of the projects of Council for Science and Technology Policy, and the project of "realization of safe and efficient road traffic systems using information and communication technology" was selected for the ITS related project. In this project, Aomori, Kashiwa, Yokohama, and Toyoda were selected as model experimental cities. In each city, developments and experiments of the "Cooperative Driving Safety Support System", the automatic driving technologies, and the practical use of "Probe Information" were continued until the 2012 fiscal year.

Moreover, the "Promotion project of energy ITS" of the Ministry of Economy, Trade and Industry (METI) had also started in the same year [15]. The Truck platooning system and the advanced route guidance system, etc., using automatic driving technologies, have been developed for the purpose of reduction of driving energies in the "Promotion project of energy ITS". This project was advanced in cooperation with the "Grant Acceleration Project" until the 2012 fiscal year.

3.4 Progress Trend of the Latest ITS (2013-)

The latest remarkable IT strategies were the "New Strategy in Information and Communication Technology" announced in May 2010, and the "Declaration to be the World's Most Advanced IT Nation" announced in June, 2013 [16] [17]. These strategies were announced from the "IT Strategic Headquarters".

Both strategies presented long-term targets to reduce fatalities of traffic accidents to 2,500 or fewer by the year 2018, and to sharply reduce traffic congestion by 2020. In response to the "Declaration to be the World's Most Advanced IT Nation", "Cooperative Driving Safety Support System" which put automatic driving into view, and the utilization of traffic data called "Probe Information", are being developed.

The ITS World Congress held in Tokyo, in October 2013 was the 3rd one held in Japan. Discussions were active on the theme of automatic driving technologies and "Probe Information", and the World Congress was success greatly.

Figure 1 shows the history of the ITS progress of Japan including R&D projects, strategies, events, etc.

4 Selection and Analysis of Influential Examples of ITS of Japan

In this section, we select the influential examples of ITS of Japan from the history of the ITS progress, mentioned in Section 3. We also identify the influential factors by analyzing influential examples. Furthermore, we make clear the strong points of ITS of Japan by accumulating influential factors.

In general, in the case of large-scale social system, like ITS, there were various problems which should be solved for the ITS progress from the start-up of development projects until the spread of the practical use systems.

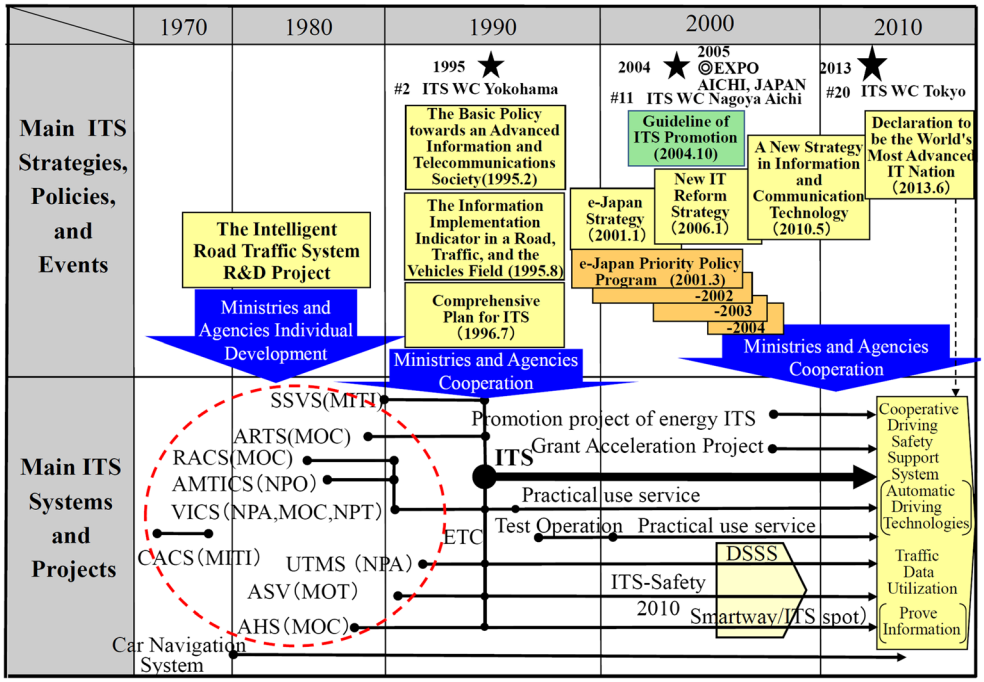

Fig. 1 History of the ITS progress of Japan

Examples of the problems were as follows: Development of organization and element technologies, in the "Early stage". System development and practical implementation of equipments and breakthrough of a period between development and the spread called "Valley of Death", in the "First and Second stages". In this section, we find influential examples, along the history of the ITS progress from the "Early stage" to the "Second stage".

4.1 Selection of the Influential Examples

We propose that the influential example is the ITS measures which significantly contributed to the ITS progress of Japan. We will select various ITS measures which have been implemented to solve the problems for the ITS progress of Japan in the fields of organizations, technologies, equipments, systems, the spread, and so on, as the influential examples, by the evaluation of plural viewpoints. Each ITS measure is evaluated for its contribution to the ITS progress of Japan, from the following viewpoints: Promotion of practical use, Common infrastructure and Technical tradition, System popularity, System effect, Economic revitalization, and Industrial competitiveness. In this study the following ITS measures which received high evaluation by this evaluation system were selected as influential examples.

Influential example #1

The "Intelligent Road Traffic System R&D Project" which established the foundation of ITS of Japan (Early stage)

Influential example #2

The challenge to the Car Navigation System of private companies which accelerated the progress of the car-electronic technologies of Japan by leaps and bounds (Early and First stages)

Influential example #3

The "ITS National Strategy" and "IT Strategy" which strongly contributed to the ITS progress of Japan by the continuous enactment and announcement of their strategies (First and Second stages)

Influential example #4

The "Road Traffic Policy" which steadily implemented ITS measures that were enacted by the "ITS National Strategy" and the "IT Strategy" (First and Second stages)

4.2 Identification of Influential Factors

In this part, we show the facts that these four influential examples significantly contributed to the ITS progress of Japan, and identify the influential factors from these facts.

4.2.1 The "Intelligent Road Traffic System R&D Project" Which Established the Foundation of ITS of Japan

The "Intelligent Road Traffic System R&D Project" developed initial ITS experimental systems of Japan, such as CACS, RACS, AMTICS, ARTS, SSVS, AHS, ASV, UTMS. ITS related ministries and agencies developed individually those systems according to their purposes, from in the 1970s to the 1990s (See Fig. 1). They felt the sense of

crisis in the US and European ITS development trends after in the 1980s and they launched their own R&D projects belonging to the "Intelligent Road Traffic System R&D Project". Typical model of the promotion organization of government initiative and industrial, academic sectors cooperation was born in this project. Also, Japanese government, the industry, and the academia could get political and technical knowledge about ITS, from the specific activities of the ITS development of the US and Europe. Furthermore, many ITS related technologies, such as digital communication technologies and the shortest route guidance algorithm, were developed in this project and inherited to the "Mission Critical System" of ITS after. These are reasons why this project played a very important role to establish the foundation of ITS of Japan.

We think main influential factor of the influential example #1 is the establishment of the promotion organization of government initiative and industrial, academic sectors cooperation. This organization is considered to be a influential factor because it was evaluated highly by ITS related people overseas and subsequently similar types of organizations were inherited in the national ITS projects of Japan [18]. In addition, with respect to the development of systems, the R & D subsidy system by the government also is said to be the influential factor because this system made it easy for universities and private companies to participate to the ITS national projects and strengthen the power of R&D. Besides, foresight and competitiveness of ITS related ministries and agencies that launched the "Intelligent Road Traffic System R&D Project" in a timely manner were said to be the hidden influential factor.

4.2.2 The Challenge to the Car Navigation System of Private Companies Which Accelerated the Progress of the Car-Electronic Technologies of Japan by Leaps and Bounds

One of the forces that evolved the ITS of Japan to the top world level is said to be the development of the car-electronic technologies by private companies. In the 1970s and the 1980s, private automobile manufacturers and electrical or electronics manufacturers participated in the "Intelligent Road Traffic System R&D Projects", and accumulated the power of the car-electronics technologies. Since the 1980s, these companies challenged the Car Navigation System which was a previously untapped field. The car-electronics technologies of manufacturers accumulated by the government projects were evolved rapidly through combining with the "Optimizing Technology" of Japan, such as miniaturization, higher performance, and cost reduction. The progress of this car-electronics technologies, made a significant contribution towards the development and the spread, of the "Mission Critical System" of ITS.

From the above, one of the influential factors that greatly evolved ITS of Japan, was the progress of electronics technologies which was an important technology in the "Early and First stages". We think the influential factor of the influential example #2 was the fusion between the accumulated car-electronics technologies and the "Optimizing Technology" of a specialty of a Japanese company. The fusion between the accumulated car-electronics technologies and the "Optimizing Technology" of a specialty of a Japanese company could be listed up as the influential factor of the influential example #2. However, we would like to propose the vitalities and technical capabilities of Japanese private companies that continued promoting tenaciously the development of the Car Navigation System through many years, as a most basic influential factor, in the "Early and First stages" [19].

4.2.3 The "ITS National Strategy" and "IT Strategy" Which Strongly Contributed to the ITS Progress of Japan by the Continuous Enactment and Announcement of Their Strategies

The ITS development in Japan, the US, and Europe started in earnest after the 1st ITS world conference in 1994 was held in Paris. The "Advanced Information and Telecommunications Society Promotion Headquarters", enacted the "Basic Policy towards an Advanced Information and Telecommunications Society" as a first Japanese "ITS National Strategy" in 1995. In response to this, ITS related ministries and agencies enacted the "Information Implementation Indicator in a Road, Traffic, and the Vehicles Field", in 1995 and also enacted the "Comprehensive Plan for ITS" in 1996. The direction of R&D and deployment of ITS of Japan was determined by these ITS National Strategies.

From 2001, the "IT Strategic Headquarters" enacted various IT Strategies, for more than a decade continuously, such as the "e-Japan strategy", the "New IT Reform Strategy", the "New Strategy in Information and communication technology", and the "Declaration to be the World's Most Advanced IT Nation". These ITS measures developed by the "ITS National Strategy" and the "IT Strategy", led ITS of Japan steadily and strongly, since 1995. In the "First and Second stages", the "ITS National Strategy" and the "IT Strategy" is said to be the influential example of ITS, for the reason of the strong leadership, the planning ability, and implementation ability of the Headquarters. To be concrete, the "Advanced Information Communication Society Promotion Headquarters" enacted the several ITS National Strategies in a short term from 1995 to 1996. Also, the "IT Strategy Headquarters" enacted several IT Strategies continuously, for a long time. Furthermore, ITS related ministries and agencies evolved ITS of Japan to the present high level by implementing many ITS measures by strong policy driving force.

4.2.4 The "Road Traffic Policy" Which Steadily Implemented ITS Measures that were Enacted by the "ITS National Strategy" and the "IT Strategy"

NPA, MLIT Road Bureau, and MLIT Road Transport Bureau are responsible for the "Road Traffic Policy". In the "First and Second stages", these ministry and agency steadily implemented the various ITS measures, such as development of the "Mission Critical System" and the breakthrough of "Valley of Death" in their "Road Traffic Policies", and contributed to the ITS progress of Japan. We show the following ITS measures which were implemented by the "Road Traffic Policies" as the concrete influential examples.

1) The practical implementation of the "Mission Critical System" of ITS

   The "ITS National Strategy" and the "IT Strategy" advocated strongly the necessity of promote practical implementation for the "Mission Critical System" of ITS, such as VICS, ETC., ASV, and UTMS. As a result, the development and the spread, of the "Mission Critical System" of ITS were progressed, in a timely manner, by the "Road Traffic Policies" of NPA and MLIT. In other words, the influential factor was that the ITS measures were implemented efficiently and effectively, by the cooperation of the "Road Traffic Policy" and the "ITS National Strategy"/ "IT strategy"., just like two wheels of a car.

   In addition, the each "Mission Critical System" of ITS of Japan has a single specification in each systems, and system users have higher information literacy. We think these characteristics are also the hidden influential factors for ITS of Japan.

2) The promotion of traffic safety related measures

   Traffic safety measures were regarded as important in the "Road Traffic Policy". The "Traffic Safety Facilities Maintenance Business" and "Traffic Safety Basic Plan" were implemented repeatedly as a long-term plan in the "Road Traffic Policy". These Plans gave indirect aid to the ITS progress. Particularly, it is remarkable facts that the "Traffic Safety Basic Plans" were implemented at the same timing as the IT Strategies. We think that this cooperation boosted the promotion of ITS measures of safety.

3) The construction of infrastructure systems for the "Road Traffic Information"

   Traffic control centers of the general roads and highways have been developed since the 1960s by the "Road Traffic Policy".

   Also for the purpose of centralized management of the road traffic information of general roads and highways, the "Japan Road Traffic Information Center" (JARTIC) was established in 1970. Thus, in Japan, the system that any people can access the road traffic information of the main roads in Japan in real time has been completed. Also, the development of the digital road map database by the "Road Traffic Policy" has helped to strengthen the Japanese road traffic information infrastructure.

   We think that Japanese information infrastructures, mentioned above, can be said to be the influential factor of the "Road Traffic Policy", because these are unique to Japan and played a big role in the ITS progress of Japan.

5 Study of Influential Factors and Strong Points of ITS of Japan

5.1 A Summary of the Influential Examples and the Influential Factors

We can summarize the relationship between each influential example and influential factor, as follows, using results of sector 4. The Influential example #1 on the government organization view point is the "Intelligent Road Traffic System R&D Projects".

The promotion organization of government initiative and industrial, academic sectors cooperation should be placed on a main influential factor.

The influential example #2 is the challenge to the Car Navigation System of private companies which corresponds to the influential examples #1. We think that the main influential factor of the influential example #2 should be the vitalities and technical capabilities of private companies.

On the other hand, about the "ITS National Strategy and "IT Strategy", of influential example # 3 on the Strategy and the Policy view point, we think that the political promotion powers of the "Advanced Information and Telecommunications Society Promotion Headquarters" and the "IT Strategy Headquarters", should be the main influential factors. The political promotion powers include leadership, planning capability, and implementation power. In addition, on the same view point, about the "Road Traffic Policy" of the influential example # 4, we think that the timely cooperative promotion by the "Road Traffic Policy" and the "ITS National Strategy"/ "IT strategy".

The relationships among influential examples and influential factors which contributed the ITS progress of Japan are shown in Fig. 2. This shows that, two kinds of forces promoted efficiently and effectively the practical implementation of the "Mission Critical System" of ITS. One is the force of organizations and technologies, of the government, universities, and private companies, and another is the force of the strategies and policies, of the government.

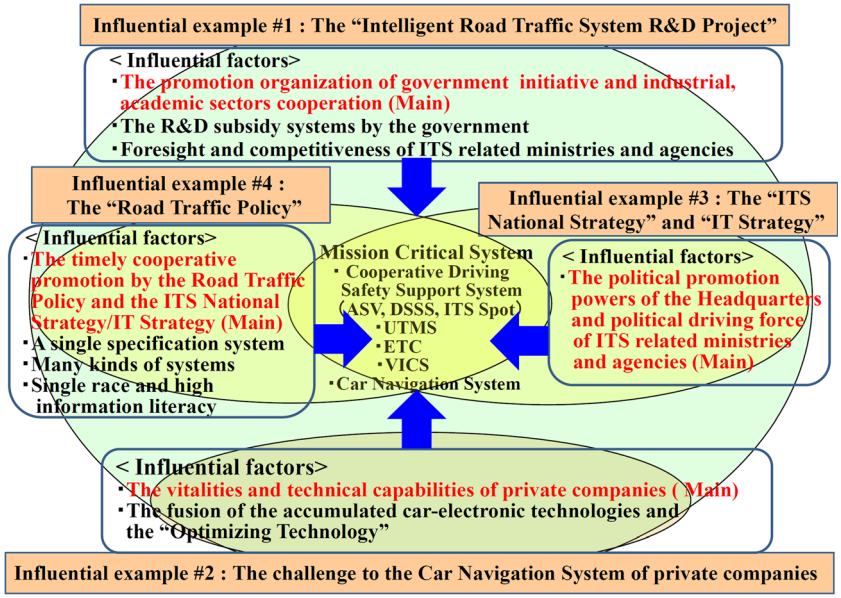

Fig. 2 Relationship among influential examples and influential factors

5.2 The Strong Points of ITS of Japan

From Fig. 2, we think that influential factors could be classified into organization, technology, system, strategy, policy, personnel, etc. Thus, we can represent strong points of ITS of Japan structurally in Fig. 3, by using small influential factors in addition to main influential factors. From Figs. 2 and 3, we think that one of the strong points of ITS of Japan is "Four Advanced Foundations" that support the ITS environment of Japan. Another is the "Cooperative Promotion Organization" that can produce strong promotion powers. The details are as follows.

5.2.1 The Promotion Organization of Government Initiative and Industrial, Academic Sectors Cooperation

The current cooperative promotion organization which can synthesize powers of concerned organizations is the strong point of ITS of Japan. This organization includes strong leadership, planning capability, and implementation power, of the current "IT Strategic Headquarters". Also this organization includes strong political driving force of ITS related ministries and agencies. Furthermore, universities and private companies etc., have strong powers of R&D and the spread, of ITS of Japan.

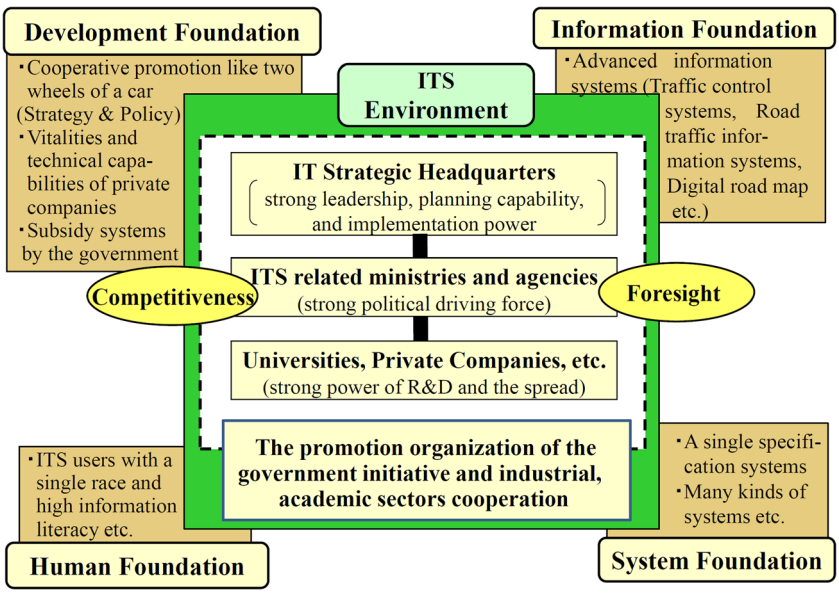

Fig. 3 The strong points of ITS of Japan

5.2.2 Four Strong Foundations Supporting the ITS Environment of Japan

From the resulting influential factors, the foundation supporting the ITS environment of Japan, are classified into four types of following

1) The development foundation
   There were following political, technical, and systematical ITS measures in Japan which pushed forward the practical implementation of the "Mission Critical System" of ITS of Japan. One was the cooperative promotion like two wheels of a car which was the combination of "Road Traffic Policy" and the "ITS National Strategy" / "IT strategy". This cooperative promotion accelerated the practical implementation of the "Mission Critical System" of ITS in cooperation politically. Second, the vitalities and technical capabilities, of the private companies of automotive, electrical or electronics technically accelerated the practical implementation of the "Mission Critical System" of ITS of Japan. Third, the subsidy systems by the government to private companies made it easy for them to participate in the government ITS Projects. These ITS measures constructed the strong development foundation of ITS of Japan.
2) The information foundation
   The "Road Traffic Policy" developed several advanced information systems, such as the traffic control system, the road traffic information system, and the digital road map, for a long term, in the whole country. These are not seen much in the US and Europe, are the Japan-specific foundation systems. ITS of Japan had an extremely high advantage that could develop new ITS related systems, on the foundation, in comparison with the US and Europe.
3) The system foundation
   The "Mission Critical System" of ITS had many kinds of systems and were spread in the whole country. These systems were developed with a single national specification of each system. It was very convenient for both the system user and system supplier, to add new systems to existing "Mission Critical System".
4) The human foundation
   It is said that ITS users of Japan are in a single race, and have a high information literacy by the use experience of information equipment, such as a recent Smartphone and the Car Navigation System. From this fact, it is said that Japanese people have social acceptance nature to advanced ITS services, and can also use advanced ITS goods.

   In this way, ITS of Japan has been promoted by the organization of governmental, industrial, and academic sectors cooperation on the ITS environment which has been supported by the four foundations which are the development, information, system, and human foundations.

6 Way of Thinking of Future ITS Promotion

As mentioned in sector 2, although many kinds of ITS are in practical use in Japan at present, the improvement effect by ITS is not enough, compared with the volume of the actual social loss attributed to road traffic. Expansion of the ITS effect is necessary from now on.

In the following section we propose a way of thinking about future ITS promotion in a manner that leads to an expansion of the ITS effect.

6.1 Way of Thinking of Expansion of the ITS Effect

6.1.1 Expansion of ITS Effect by Upgrading the "Mission Critical System"

The direction of upgrading are considered to be integration or combination, by several "Mission Critical System". Representative of this example which is already in practical use is "ITS spots". This is the example of the effect expansion by integration of VICS and ETC. Improved communication performance of a radio beacon can realize more accurate dynamic route guidance in the wider area than VICS. This integration has the potential to reduce wasted time.

There is the next generation DSSS which is a combination of the new 700 MHz band radio beacon and the existing light beacon, as the experimental system example. This combination intends to cover the safety area and efficiency area which could not be covered by light beacons previously, by new radio beacons. In addition, the combination of "ITS spot" and the Adaptive Cruise Control (ACC) is expected to reduce wasted time resulting from traffic jams on the highway.

By the integration or combination of the existing "Mission Critical System", these upgraded systems are intended to produce new effects or expansion of current effects, which could not be achieved by a single system.

6.1.2 Creation of New ITS Effect by the Development of the New Systems

Currently, the study of the utilization of the "Probe Information" is being performed by the "Declaration to be the World's Most Advanced IT Nation". ITS related ministries and agencies as well as the private companies such as automobile and contents companies, are gathering "Probe Information" and studying the utilization of it individually. The utilization of "Probe information" has stochastic component; the greater the kind and amount of data, the greater improvement of the utilization effect. For example, use of a common database, which ITS related ministries and agencies and private companies built together using their "Probe Information," will expand the ITS effectiveness.

6.2 Application of the Strong Points of ITS of Japan, and the Future Subjects

We think the development of the upgrading and the new "Mission Critical System", are easy in the case of using the strong points of ITS, such as current promotion organization and foundation systems, of ITS of Japan. However, the "Mission Critical System" has been developed and managed by one ITS related ministries and agencies, except a part, so far. For future expansion of ITS effect, as mentioned earlier, the integration or combination of the "Mission Critical System", and the public-private cooperative systems are effective. In other words, ITS related ministries and agencies cooperation, and the public-private cooperation, are even more important points for the expansion of ITS effect.

At the same time as the ITS developments in Japan requires competition among ITS related ministries and agencies, requires also cooperation among them in timely manner. The construction of the cooperation system is the future subject. ITS related ministries and agencies should jointly enact and propose ITS measures which extend beyond that of the individual administrative frameworks.

7 Conclusion

We did this study for the purpose of reduction of social losses attributed to road traffic expected at present, by using ITS. In this paper, we derived the influential factors and strong points of ITS by analyzing history of the ITS progress of Japan, and applied strong points to the future ITS promotion policy, and showed the process which makes improvement effects by ITS of Japan increase.

As discussed in sector 5, ITS of Japan has two kinds of strong points. One is the "Four advanced foundations" that support the ITS environment of Japan. Another is the "Promotion organization of the government initiative and industrial, academic sectors cooperation" that can produce strong promotion power of practical implementation of ITS. The four foundations are the development, the information, the system, and the human infrastructures that are native to Japan. The promotion organization is the combination organization of the "IT Strategy Headquarters", ITS related ministries and agencies, universities, and private companies which promote the planning, development, and spread of ITS of Japan.

As discussed in Sector 6, upgrading the existing "Mission Critical Systems" of ITS, and developing new ITS systems are effective for increase of improvement effects of ITS by applying the strong points of ITS to the future ITS promotion policy. Concretely, it is important to develop a comprehensive system by integration or combination using the existing "Mission Critical Systems" and also to develop a new ITS system, by the cooperation of ITS related ministries and agencies. Also it is important to make efforts to maximize improvement effects of the comprehensive system and the new ITS system.

We think that the fountainhead of the strong political driving force of ITS related ministries and agencies is the competitiveness among them. At the same time as the ITS progress of Japan requires competition among ITS related ministries and agencies, requires also cooperation among them in timely manner. We think that ITS related ministries and agencies should establish a new cooperation promotion organization to strengthen the current promotion organization of ITS of Japan. The new cooperation promotion organization should aim to build a common target and enact the comprehensive ITS measures which extend beyond the individual administrative frameworks of ITS related ministries and agencies.

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Kohei Koide received his BE and ME degrees from Kyoto University in 1972 and 1974. He previously worked in the ITS field of Toyota Motor Corporation. After working at Toyota, he joined the graduate school of the University of Tokyo, and is currently a PhD student. His research interests include the ITS policy theory.

Takeshi Oishi is an Associate Professor at Institute of Industrial Science, the University of Tokyo. He received the B.Eng. degree in Electrical Engineering from Keio University in 1999, and the Ph.D. degree in Interdisciplinary Information Studies from the University of Tokyo in 2005. His research interests are in 3D modeling from reality, digital archiving and augmented/mixed reality.

Katsushi Ikeuchi is a Professor at the University of Tokyo. He received his B.Eng. degree in Mechanical Engineering from Kyoto University in 1973 and his Ph.D. degree in Information Engineering from the University of Tokyo in 1978. After working at the MIT Artificial Intelligence Laboratory as a postdoctoral fellow for three years, MITI Electro-Technical Laboratory as a research fellow for five years, and the CMU Robotics Institute as a faculty member for ten years, he joined the University of Tokyo in 1996. Dr. Ikeuchi chaired a dozen major conferences, including 1995 IEEE-IROS (General), 1996 IEEE-CVPR (Program), 2003 IEEE-ICCV (Program), 2009 IEEE-ICRA (program). His community service also includes IEEE RAS Adcom (98-04, 06-08), IEEE ITSS BOG, IEEE Fellow Committee (2010–2012), and 2nd VP of IAPR. He is an Editor-in-Chief of the International Journal of Computer Vision, and a fellow of IEEE, IEICE, IPSJ, and RSJ. Through these research activities and community service, Dr. Ikeuchi received the IEEE PAMI-TC Distinguished Researcher Award (2011) and the Shiju Housho (Medal of Honor with Purple ribbons) from the Japanese Emperor (2012).