Internet Technology-based Road Information Systems

- ITS/Win: ITS for Winter Transport Revolution -

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SUMMARY

The Hokkaido Development Bureau is currently promoting ITS technology R&D intended for cold climates called "**ITS/Win Research Program**". The Program aims to improve the safety and efficiency of winter transport, and focuses especially on Internet technology. The ITS/Win is featured by active use of the Internet and by public/private joint research projects initiated in December 1996, from open application. In this paper, we report the results of a road information provision experiment using the Internet technology that was made in Hokkaido, including the Greater Sapporo WHITE-NET Experimental Project and the Mountain Pass Image Transmission Experiment. We also propose a method to use **XML technology: Road Web Markup Language (RWML)** in the road information field and consider the impact of Internet technology on ITS.

INTRODUCTION

Hokkaido is the northernmost island of Japan. Its 5.69 million people possess 3.38 million vehicles. The capital of Sapporo, population 1.77 million, is in one of the heaviest snowfall areas of the world, where the per-winter accumulated snowfall reaches 480 cm. The Hokkaido Development Bureau (HDB) is the road authority, which manages a total of 6,300 km of national highways in Hokkaido. In response to the Japanese National ITS Promotion Plan(1), which was announced in July 1996, we are researching the direction of use and development of ITS technology suitable for Hokkaido. Winter roads in cold, snowy regions have problems, such as slippery snowy/icy road surfaces, and reduced visibility due to snowstorms, that create severe driving conditions for vehicles. Also, the winter road management includes labor-intensive maintenance works of snow removal and road surface control. In other words, this is a field where ITS holds great potential. The technology development of the ITS/Win Research Program focuses on the active use of advanced information technology to reduce the social cost and to improve the safety level of winter traffic. Especially, we are aiming to fully use the Internet, which is now on the way to being established as information infrastructure in our society.

SOCIAL CHANGES DUE TO THE INTERNET

The US Department of Commerce issued a report in April 1998 that says the Internet, whose communication traffic doubles every 100 days, is the driving force of economic development(2). The Japanese Ministry of Posts and Telecommunications reported the number of Internet users in Japan as 11.55 million people in 1997 and estimated this number would rise to 41.36 million people (41% of all households) in 2005 in the "1998 WHITE PAPER, Communications in Japan(3)".

The expansion of the Internet has reduced the cost of disseminating information almost to zero. Today, individuals can easily disseminate information to masses of people by sending the same e-mail to many people, contributing a message to a mailing list, and making a homepage. This is the beginning of drastic change. Formally, the functioning of society was based on person-to-person (or one-to-one) communication. However, society was made to change due to the emergence of person-to-mass (one-to-many) communication. "Sharing information" is the key word of the new type of society. Society then focussed on the potential to share information via networks. The Intranet, which uses the Internet technology to share information within an institution, has rapidly spread among advanced businesses.

In addition, the focus today is on introducing CALS (material purchase and bidding by on-line network) and EC (electric commerce) and the Extranet, in which an Intranet is constructed to share information among organizations and businesses with close mutual relations. The changes in communication from person-to-person to person-to-mass have resulted in a shift in social structure from hierarchical to networking, where much emphasis is on individuals and where each can reach self-fulfillment in a society where each member may belong to various strata of various networks.

GREATER SAPPORO WHITE-NET EXPERIMENTAL PROJECT

Since studded tires were banned by law, very slippery road surfaces have appeared, and higher levels of winter road management have been required in Greater Sapporo. In addition, since January 1996 when a record-breaking snowfall halted urban functions three to four days in a row, requiring the mobilization of the Self-Defense Forces to recover them, a new set of appropriate measures has been pursued to maintain the road network, as well as provide information.

In August 1997, the "Hokkaido Liaison Conference on Winter Road Management Planning" composed of the HDB, the Hokkaido Government, the City of Sapporo and the Hokkaido Branch of Japan Highway Public Corporation, set up the "Task Force on Greater Sapporo Advanced Road Information Use". From the viewpoint of realizing efficient and intelligent road management specially for winter, the task force pledged cooperation in research and a review on appropriate methods for organizations to share information toward concerted operations, as well as the provision of information to road users. The "Greater Sapporo WHITE-NET Experimental Project" is the Extranet that is an access-controlled homepage to share information within the four road authorities above plus the regional road and weather organizations and snow removal contractors.

On this homepage, weather forecast information, including snowfall, and frozen roads, as well as road monitoring camera images and weekly road maintenance operation schedules for model road sections, were uploaded. In addition, when snowstorms were forecast, electrical meeting rooms were opened and real-time operational information was exchanged. The system proved to be quite effective. Some 2,700 accesses were recorded between November 28, 1997, and March 20, 1998. From the results of interviews of users, the system was highly evaluated for its effectiveness.

The WHITE-NET Project aimed to share information between different institutions and organizations by using the Extranet. By using Internet technology exclusively, a highly open and expandable system is possible to be constructed. Although issues common to the Internet remain, such as security and certainty of communication, it can be developed in the future into an information system under which road and traffic authorities, public transport, local municipalities, disaster prevention institutions, medical institutions, telecommunication and broadcasting businesses and related institutions can share information on the extent of snow disasters affecting roads, traffic and other urban functions, or it can be merged into a comprehensive urban information service(4).

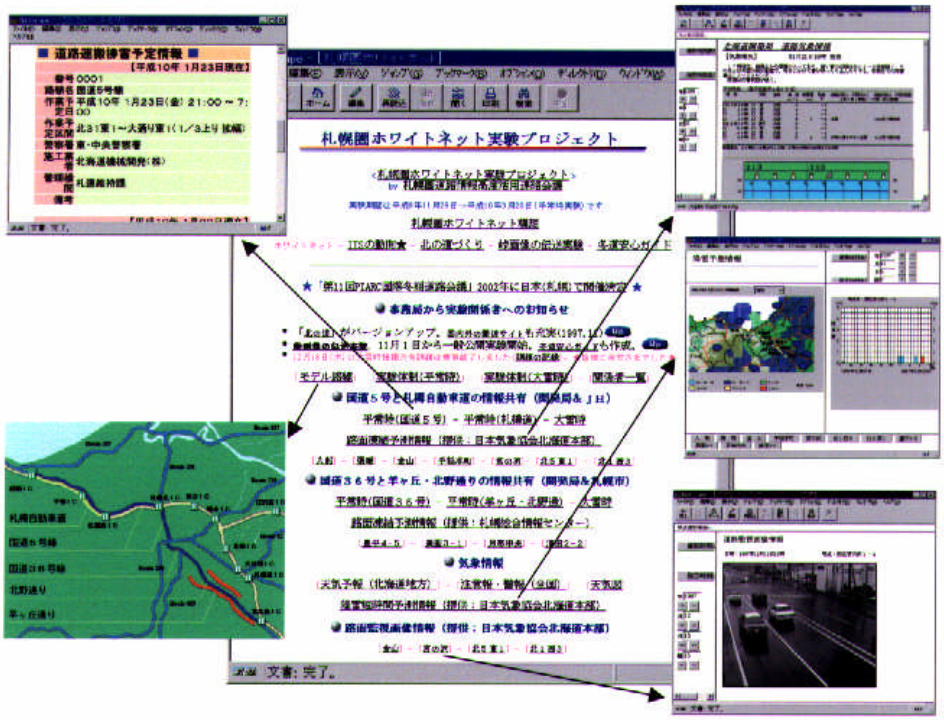


Figure 1 Greater Sapporo WHITE-NET Experimental Project, Winter of 1997/98

MOUNTAIN PASS IMAGE TRANSMISSION EXPERIMENT, WINTER OF 1997/98

In general, road information is provided via variable message signs, roadside highway advisory radio, and radio programs by Japan Road Traffic Information Center and radio broadcast stations. However, each of these methods has some problems. For example, to obtain information from a variable message sign or roadside highway advisory radio you need to go to the site, and radio information is limited to audio information and thus

is difficult to form an intuitive image of the road condition.
Weather conditions at mountain passes in cold, snowy regions are very severe, and particularly at the beginning and the end of winter the weather tends to be quite different from low lying areas. If obtaining real-time road information, including images, from various places via the Internet is possible, reviewing travel plans, including route selections and departure time adjustments, will then be possible, and it will be possible to make safety-minded provisions for mountain pass driving. Such an intelligent road information system is expected to reduce the chances of meeting dangers on winter roads, and thus is expected to reduce the number of winter traffic accidents.

The "Mountain Pass Image Transmission Experiment" is an experiment to provide information such as road images and conditions at three mountain passes (Nakayama, Nissho and Sekihoku passes) with severe winter weather conditions in Hokkaido via WWW server on the Internet. In the winter of 1996/1997, the information was provided only to monitors such as regional road stations, city, town and village municipalities, and bus and truck companies. Then, in the winter of 1997/1998, the system was opened to the public and a questionnaire survey was conducted on the homepage.

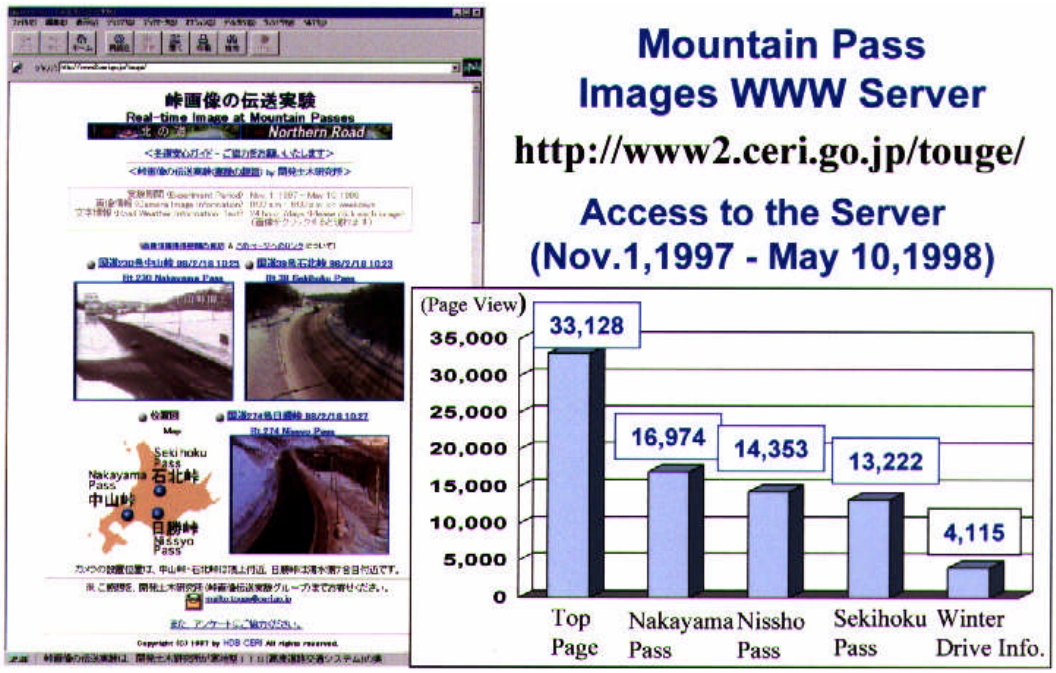


Figure 2 Mountain Pass Image Transmission Experiment, Winter of 1997/98 (http://www2.ceri.go.jp/touge/, Nov.1, 1997 - May 10, 1998)

The total number of page-views (Nov. 1, 1997 to May 10, 1998) was 33,128, which averages approximately 173 visits per day. Also, the questionnaire produced the following interesting results: commenting on the system, approximately 94% of 309 respondents selected "Easy to use" or "Relatively easy to use". Approximately 92% of respondents replied "Useful for safe driving", and about 84% of them answered, "They may change their travel route depending on what mountain images they see". As for the effect of this system, most respondents selected "It can reduce the uneasiness of driving

because it shows the mountain pass road conditions before driving". The system has been accepted very positively. With regard to places to access the system in the future, most respondents chose "Michi-no-eki or road station (rest area)" and "railroad station/airport/ferry terminal"(4). The affiliation of the respondents shows that 85% of the respondents were males under age 50. This is the same as the issue of Internet today and the system is expected to be widely used when more simple equipment is developed and widely used so that Internet can be used by more women and the elderly.

CONSEQUENCES OF ROAD INFORMATION PROVISION VIA INTERNET

The popularization of the Internet also has given an impact to ITS-related projects. Provision of road information via Internet is no longer at the experimental stage in advanced regions in ITS but is already at the systematic deployment stage.

The advantages of providing road information via Internet are: 1) a user can access the latest information wherever and whenever, if the user has a information device linked with the network; 2) it is easy to understand because of maps and images; and 3) the information provision side does not need to consider equipment, communication cost and maintenance of the receiver side, which is one of the most advantageous features of the Internet. In addition, the fact that prospects are infinite towards the development of a car multi-media system cannot be overlooked.

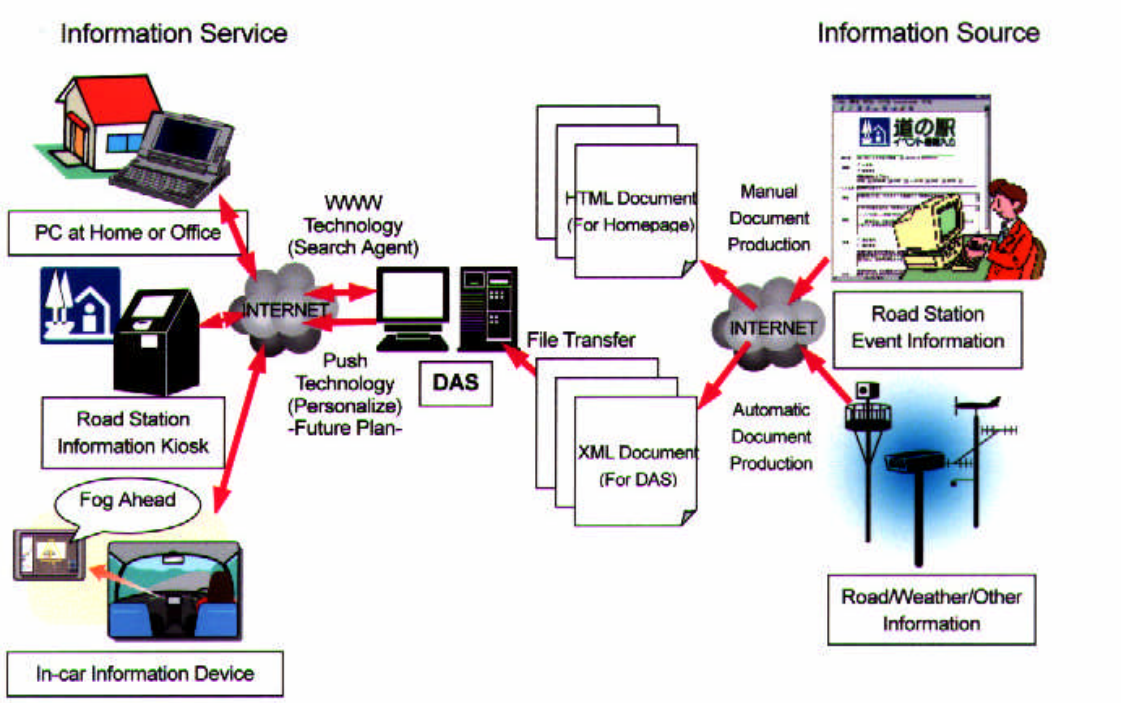
Recently, various automobile and electric appliance manufacturers have launched information services for vehicles in Japan. Most of them link in-car information device with a network using cellular phones to provide road and other information. In addition, the manufacturers aim to provide web access and e-mail service. Each gives consideration for the safety of operating by such means as an audio interface. In the near future, linking with GPS (global positioning system) is planned to be used for emergency notification, such as accidents, vehicle breakdowns, and sudden illness. Some companies have proposed the specification of personal computers mounted on automobiles this year. To say that the era of the network-connected car is approaching is no exaggeration.

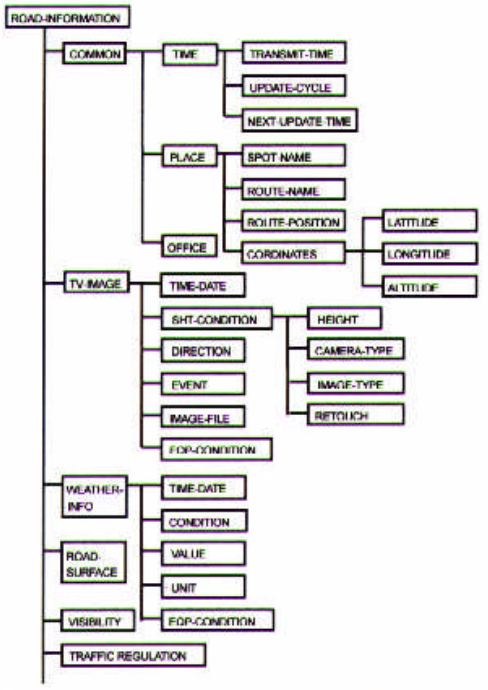
When the era of such a network-connected car arrives, we can estimate that information provided for drivers will be higher value added: road information provided by road authorities via Internet will be utilized combined with other information. The potential to develop a new industry will arise.

DEVELOPMENT OF XML TECHNOLOGY-BASED DRIVE ADVICE SERVER

The Drive Advice Server (DAS) is basically an on-demand server that can provide the most suitable (personalized) information for the driver, who requests the information from a database whose data are collected from various information sources on the Internet. Two types of DAS are currently under development: one for fixed terminals and the other for mobile terminals. Fixed terminals are PCs at home, office and kiosks at Michi-no-eki or road stations. Travel planning will be made easier by DAS information on road and weather conditions, traffic regulation and the like. By adding

tourist information to the information source, it can also be used as a travel advice system. Mobile terminals are network-connected in-car information devices. DAS information is personalized based on the location and interest of the driver who is using the terminal to make the request. Audio, text and image information can be provided to the requester via mobile communication network. This enables the driver to select a safe route and time, and avoid dangerous locations and situations.





Mountain Pass Information XML DTD

Mountain Pass Homepage Image

Figure 3 Development of XML Technology-based Drive Advice Server (DAS)

The prototype of this system is now under examination. **Figure 3** shows the concept of the DAS information system. Sensor information collected at weather stations and road monitoring cameras set at mountain passes and other locations are processed into XML (RWML: Road Web Markup Language) documents that have been specially defined for road information provision use, as well as into HTML (Hyper Text Markup Language) documents for the homepage. Information input manually, such as event information input by the person in charge at Michi-no-eki or road stations, will be processed in the same way.

While using road information in the form of conventional HTML, such as in the "Mountain Passes Image Transmission Experiment", is limited to the information on homepages, data provision in the form of RWML documents will allow various modifications of the data. In addition, its notable feature is that, as long as the definition is the same, the data sources can be distributed on the network.

Because HTML describes the way data is shown on homepages, dealing with the content as data is difficult. In contrast, XML allows structured data to be described, and secondary use of the data on the information receiving side is possible. Thus it can be widely used for many purposes. In our experiment, we transmitted XML data to construct a database on the DAS side. DAS can provide information suitable for the user by searching for appropriate information upon a request from the terminal. For example, when the origin, destination and departure time are specified, road information and tourist information on the route, which have been searched from different data sources, are displayed. **Figure 3** also shows the tree of DTD (Document Type Definition) of the XML document used in the experiment.

By using standardized descriptions of data, a variety of information on the road conditions, weather and local events can be combined for active use. This enables a local district, where ITS infrastructure has not been constructed, to use the conventional infrastructure to construct a regional ITS at a low cost and in an efficient way. For further details of RWML, please refer to the "Proposal on RWML (http://www2.ceri.go.jp/eng/its-win/rwml.htm)" in the homepage of the Civil Engineering Research Institute of the Hokkaido Development Bureau.

This experiment is being conducted jointly by Omron Corporation, Nagoya Electric Works Co., Ltd., and Mitsubishi Electric Corporation.

CONCLUSION AND FUTURE PROSPECTS

In this era of global mega-competition, to build a sustainable society in a cold, snowy region, improving the efficiency and safety of winter roads, is essential, while overcoming issues related to aging and the environment. ITS is expected to be an efficient tool to cope with such an environment. Through advanced use of information, we are aiming to avoid collisions with harsh winter weather conditions, and to promote the smart use of the roads. That is essential for ITS, which uses intelligent information

technology that makes the most of existing stocks. Only after resolving the issues of safety and efficiency of winter transport by means of ITS revolution in cold regions will such regions engage in competition with elsewhere in the world.

The Internet, whose popularization is explosive, is expected to be established as an element of social infrastructure within five to ten years. In the field of ITS, the active use of Internet technology will also be a key. For a region without a dedicated ITS infrastructure, the Internet will provide a highly effective and realistic measure to construct a regional ITS. Especially, such open technology as XML, which promotes sharing and modifying information, will provide an infinite potential for a road information system.

In the ITS/Win Research Program, we are examining various road information systems in which Internet technology, including XML, is fully used. Also, we organized "ITS/Win FS Workshop", a workshop for the feasibility-study of ITS in cold regions to discuss the concept of regional ITS in Hokkaido. In addition, a cyber workspace for joint research projects called "ITS/Win Virtual Laboratory" was constructed on the Internet, which is partly used for regional ITS information exchange. We will open our examination and discussion through our homepage: ITS in Hokkaido (http://www2.ceri.go.jp/eng/its-win/).

In 2002, the XIth PIARC International Winter Road Congress will be held in Sapporo. We expect the Internet to be a social information infrastructure used in every aspect of our life in Hokkaido by the time of the Congress. The Bureau plan to make the most advanced road information system using the Internet technology toward the congress, and intends to more actively promote information exchange with all cold, snowy countries of the world, such as North America and Northern Europe, with whom we can share the issues of safety and efficiency of winter transport.

ACKNOWLEDGMENTS

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REFFERENCES

(1) National Police Agency, Ministry of International Trade and Industry, Ministry of Transportation, Ministry of Posts and Telecommunications, Ministry of Construction; Japanese National ITS Promotion Plan, July 1996.
(2) US Department of Commerce; The Emerging Digital Economy, April 1998.
(3) Ministry of Posts and Telecommunications; 1998 WHITE PAPER, Communications in Japan, May 1998.
(4) Yasuhiko Kajiya; "Utilization and Impact of the Intetrnet in the Field of Road Information", Japanese Society of Civil Engineer, Vol.83 May 1998.