Road Web Markup Language - XML for Road-related Information Distribution -

Yasuhiko Kajiya*, Yuji Yamagiwa, Yasuhiro Kudo*****

***Director of Civil Engineering Research Institute of Hokkaido**
Hiragishi 1-3-1-34, Toyohira-ku, Sapporo 062-8602, JAPAN
Tel: +81-11-841-5553, Fax: +81-11-841-9747, E-mail: ykajiya@ceri.go.jp
****Civil Engineering Research Institute of Hokkaido**
*****Nagoya Electric Works Co., Ltd.**

ABSTRACT

The Civil Engineering Research Institute of Hokkaido and Joint Research Group have been developing XML-based Road Web Markup Language since late 1997. In the summer of 2003, we opened to the public RWML Version 1.0, which is compatible with the XML Schema. RWML employs XML to describe road-related information including weather and regional tourist information, according to time and location along the route. This paper reports the effects of RWML on road-related information distribution via the Internet and the specification of Version 1.0.

INTRODUCTION

The Civil Engineering Research Institute of Hokkaido (CERI) and its joint research group have been developing an XML-based road web markup language (RWML) since late 1997 *(1)*. In the summer of 2003, we made RWML Version 1.0, which is compatible with the XML Schema. The specification was made open to the public for its diffusion *(2)*. RWML employs XML to describe road-related information including weather and regional tourist information, according to time and location along the route. This paper reports the effects of RWML on road-related information distribution via the Internet and the specification of Version 1.0.

OBJECTIVE OF RWML DEVELOPMENT

Diffusion of the Internet and Increasing Needs for Road Information

The Ministry of Public Management, Home Affairs, Posts and Telecommunications of Japan released the Communications Usage Trend Survey in 2002 *(3)*. It showed that Internet use had risen to 69.42 million people in Japan by the end of 2002. The users exceeded 50% of the nation's population (54.5%) for the first time. The percentage of households with an Internet user was 81.4%. The Internet has become an integral part of the information infrastructure in Japan.

Many national highway offices are using the Internet to supply winter mountain pass information and other types of information for safe and pleasant driving. The Ministry of Land, Infrastructure and Transport adopted a rating of information disclosure in May 2003. This was used to rate performance of the road administration bodies. The Ministry also released the numbers of visits to websites of national highway office sites and other organizations. Frequently visited national highway offices have been found to promptly provide types of information wanted by road users (icy road surface and snowfall information in winter, road control) information during disaster such as suspension of traffic closure, information on local bus operation, and so on). The Ministry encouraged its subordinate road administrative organizations to provide such information *(4)*. Thus, Internet-based road information provision is expected continue to increase.

Challenges Confronting Distributability of Road Information

Road-related information provision via the Internet is increasing, but the information provided by road administrators from their webpages is limited to that regarding only their own area of jurisdiction. Major ITS service providers are the only ones who collect information from multiple sources and compile value-added information for provision to users. Data exchange and sharing among related organizations entails tremendous effort, because they all have to unify information description methods and data formats and to conduct experiments to achieve interoperability via the dedicated network.

In general, drivers want to acquire information provided by various organizations. They want not only road information, but also weather, regional, and tourist information. Transportation businesses and emergency medical service personnel need very detailed information on road conditions. The desired media for information provision are varied. Of course, these include variable road information message boards and terminal devices at Michi-no-ekis (roadside stations). But they also include personal computers, cellular phones, on-vehicle information systems (car navigation) and the like. In this way, the needs for road information have diversified and the required types of road information and provision media have come to differ by road user.

The information provision system used to be designed to perform centralized management of various types of data to meet the diverse needs of users. Such a system requires a great deal of work for coordination among organizations, and the cost and time for system construction and operation are also substantial.

In addition, to provide information to many devices, the system needs to be compatible with each of them. Not only is such a system redundant and inefficient, but also it is too large. It cannot meet changing user needs and provide information satisfactorily.

Emergence of XML (Extensible Markup Language) Technology

Internet websites are described by Hyper Text Markup Language (HTML), which was developed to accurately describe size and layout of text and images on websites and to which page of which server each link will take you. XML extends the description method of HTML. The procedure for extension is generalized and defined in XML, to make HTML a machine-oriented language (machine-readable). A pair of tags "< >", between which text data is inserted, allows users to understand the type and usage.

XML has much potential, including: 1) making a large amount of information usable via the Internet; 2) allowing data to be distributable via the web, the core element of the Internet; 3) sufficient scalability to cover small applications and global services; and 4) helping to ease construction of quality, value-added information services, which could lead to the creation of new industries. The language has been standardized on a global scale by the international World Wide Web Consortium (W3C).

Development and Applications of RWML

CERI and its joint research group developed an XML-based markup language for description of road-related information, which we named Road Web Markup Language (RWML).

TABLE 1 Central Server-dependant System and RWML-based Distributed System

	Traditional Central Server-dependent System	Proposed RWML-based Distributed System
Coupling	Tight	Loose
Connectability	Method needs to be determined for connection between the central server and information providers.	Information is provided and obtained by WWW and RWML for connection.
Usability	Upon authorization by the central server, information can be acquired according to the specified method.	Information can be acquired from WWW servers of information providers.
Extensibility	For every extension, the system of the central server needs to be modified.	All information providers can provide information in whatever ways available.
Responsibility	The responsibility is centered on the central server.	The responsibility is distributed across all information providers.
Diversity	The central server demands fairness and neutrality such that free information provision is limited.	Each information provider can provide information on its own responsibility. Users can choose information as they need it.

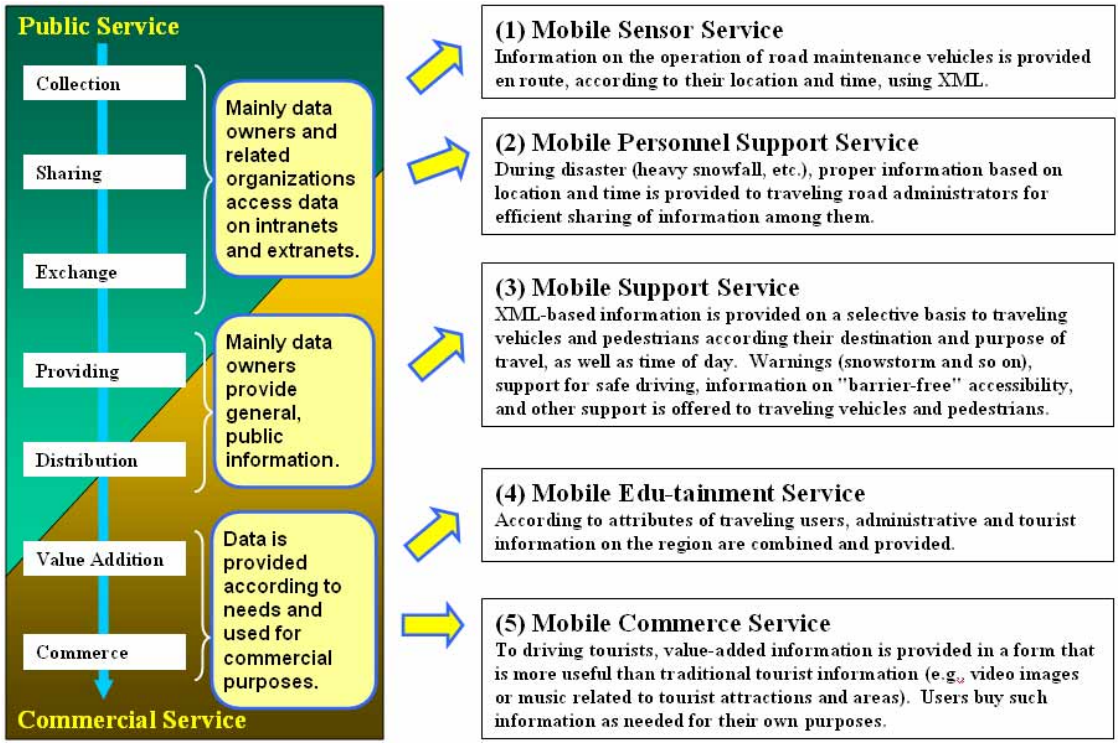

FIGURE 1 Applications of RWML

Using RWML allows the application of an information provider to select road-related information scattered across the Internet and to compile it as needed for provision to users. Also, data can be selected on the basis of user location, preference, and information need, and different types of data can be combined for provision. Table 1 compares the traditional centralized system and the proposed RWML-based distributed system.

RWML can be applied in a wide range from road information collection to provision. Figure 1 depicts the application range of RWML in each stage from data collection to provision. RWML can demonstrate its high potential when it is used to provide different users with different types of data posted on the web, by re-distribution and value addition depending on user needs.

OUTLINE OF RWML

Basic Policy of RWML

RWML was developed to make road-related information freely distributable and usable on the Internet. Use of RWML should be made as free as possible, and restrictions on use should be as few as possible. However, development of many disparate versions could diminish compatibility, and such confusion must be avoided. Thus, the research group has decided to allow free use of RWML in any system or product as long as the language is credited and there is no unauthorized modification, editing or conversion of all or part of the RWML code, or unauthorized use or change of the RWML name (see the RWML website for conditions to use RWML).

Types of Information

RWML specifies the following items for road, weather, disaster, and regional information:

1. Road information
   - Road weather
   - Road surface condition
   - Monitored image

- Congestion
- Road control/closure
- Traffic flow
- Travel time
- Site-specific information
- Road administrator

2. Weather information
   - Current weather
   - Forecast
   - Warnings and cautions
3. Disaster prevention information
   - Earthquake
   - Volcanic eruption
   - Flood
4. Regional information
   - "Country Message," or messages from locals
   - Event
   - Tourism
   - Scenic information

Basic Tags of RWML

The previous subsection lists items of information specified in RWML Version 1.0. Because the needs for information change over time, it may become necessary to add new items. It is not efficient to define data structure and type for each added item of information. If such a definition were made for each added item, the integrity of the specification would not be maintained.

In RWML Version 1.0, the framework for description of all information items is defined as "basic tags." Each information item inherits these basic tags for its definition. Figure 2 shows the structure for the basic tags of Version 1.0. Figure 3 shows an example of data described by Version 1.0.

Employment of such a method has made it easier to define newly added information items. The structure of the specification itself is simple and extendable.

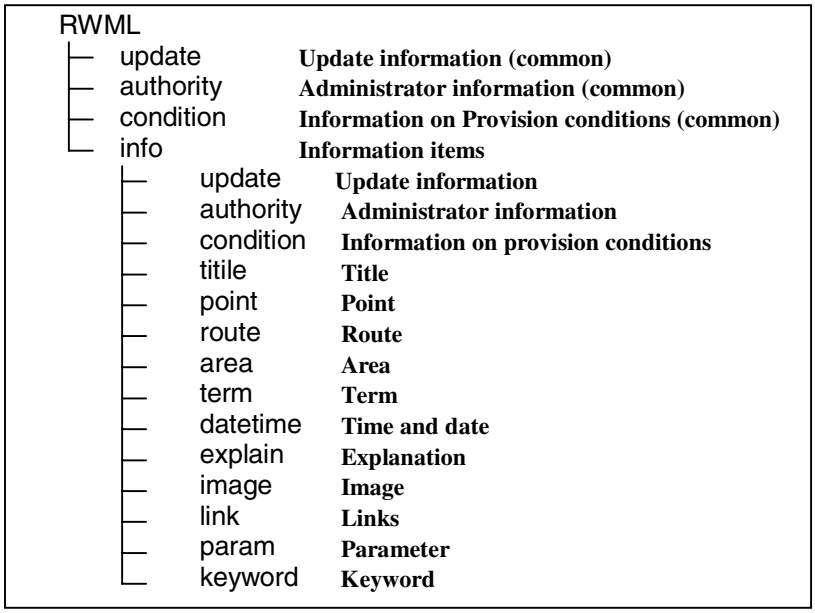

FIGURE 2 Structure for the basic tags of RWML Version 1.0

In addition, Version 1.0 has an affinity with object-oriented programming languages, which will facilitate the development of applications. To implement RWML processing, base classes should be implemented by processing the basic tags, and classes inherited from the base classes should be implemented to

process respective information items. An application that deals with only the types of information handed by the basic tags needs only a processing function for the basic structure tags. In this case, without changes to the program, the application is capable of handing unknown information items that may be introduced in future. Let us assume that there is an application that can search for information on an arbitrary location based on longitude and latitude and display the title of the location and its information. Because longitude, latitude, title, and other elements are already provided as elements of the basic tags (Figure 3), the application does not need to have the definition of each information item in order to process all the information.

```
<RWML version=" 1.0" >
 <info category=" road-info" type=" road-surface" >
  <point>
   <latitude>41,30,00</latitude>
   <longitude>142,15,00</longitude>
  </point>
  <route>
   <route-name>National Highway 230</route-name>
    <route-position>10.0KP</route-position>
  </route>
  <title> Road surface information on National Highway 230</title>
  <explain type=" message" > Watch out for compacted snow</explain>
  <param type=" surface" code=" num" val=" 3" > Road surface: Compacted snow</param>
   <param type=" surface-temperature" unit=" ℃" val=" -7.5" > Road surface temperature:-7.5℃
</param>
   <param type=" surface-salt" unit=" %" val=" 13.5" > Road surface salinity:13.5%</param>
 </info>
 <info category=" regional-info" type=" event-info" >
 <point>
   <latitude>42,10,00</latitude>
   <longitude>142,00,00</longitude>
 </point>
 <route>
  <route-name>National Highway 230</route-name>
    <route-position>12.4KP</route-position>
 </route>
 <title> Ice Festival in XXXX Town</title>
 <term start-day=" 2003-02-01" end-day=" 2003-02-07" > February 1 - 7</term>
 <explain type=" outline" >Please come to the Ice Festival!</explain>
 <link href=" http://server/page.html" > Homepage of XXXX Town</link>
 </info>
```

FIGURE 3 Example Data of RWML Version 1.0

Compatibility with the XML Schema

Version 1.0 of RWML is compatible with the XML Schema. It can select data of numerical values and dates, in addition to text, which streamlines data digitization and application development. Version 1.0 employed methods that simplify the application development process. For example, it defines the data type for values of attributes for each element. This is clearly defined in the specification if data are those that are automatically interpreted by an application or that will be displayed for users.

The XML Schema can define a higher-level data structure than DTD. It can better describe the structure of the basic tags of Version 1.0, according to the specification.

Also, the XML Schema supports namespaces, so it can handle different document files in an integrated manner. This feature allows extension of the application by combination of XML with Simple Object Access Protocol (SOAP), for use as an XML Web Service. This would be very useful.

Furthermore, the XML Schema describes its own structure by XML itself. Software package applications compatible with the XML Schema can be used with RWML Version 1.0 (Figure 4).

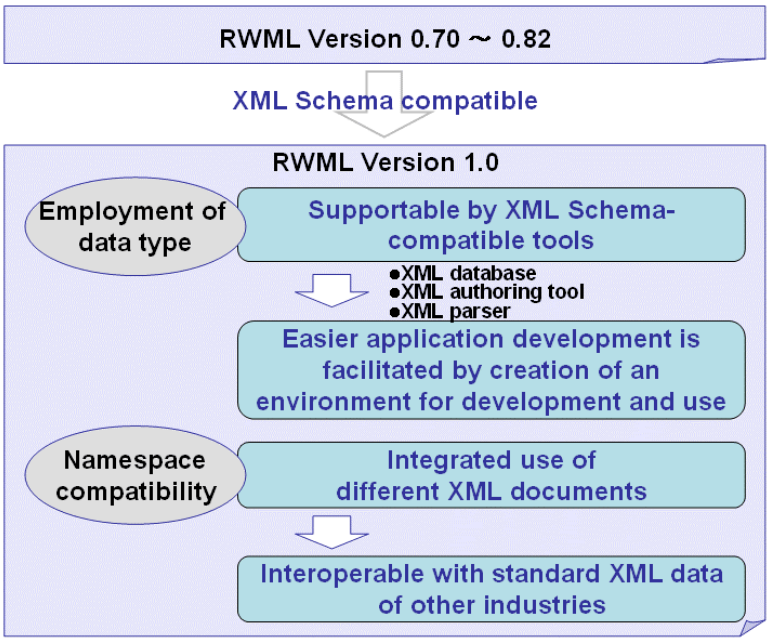

FIGURE 4 Advantages of XML Schema

DEVELOPMENT AND REVISIONS OF RWML

Specification Development through Joint Research by Public and Private Organizations

Development of RWML was initially started at the end of 1997 by the Civil Engineering Research Institute of Hokkaido Development Bureau (formerly CERI). It was in fact examined in "Research on Development of Internet-based Road Information System," which was conducted from fiscal 1996 through 1998. Participants in this research project were widely recruited from the private sector by open invitation.

In preliminary experiments, the usability of roadside weather sensors and road monitoring camera images was examined. In June 1998, a working group was established to develop a working specification of RWML. In July 1999, RWML Version 0.70 was made and released on the Internet *(2)*. After text editing and other corrections, Version 0.71 was published in October 1999 *(2)*.

Revisions of the Specification based on Field Experiments

From fiscal 2000 through 2002, CERI conducted the "Research on Application of Advanced Information/Communication Technologies for Mobile Terminal Devices," for which public advertisement was made to recruit participants. As part of this research project, four field experiments were performed. The "Niseko-Yotei E-Route Experiment" and "Niseko-Yotei-Toya E-Route Experiment" were conducted in 2001 and 2002, respectively. The aim was to identify the potential of information provision to drivers during the summer travel season in Hokkaido. Also, the "Smart Sapporo Snow Information Experiment" was conducted twice, once in 2002 and again in 2003, to smoothen urban winter traffic in Hokkaido through information provision *(5),(6),(7)*.

For these experiments, monitors were recruited from the public. Information was supplied to their cellular phones and personal computers via Internet, in order to evaluate the effects of information provision on transportation behavior. These were large-scale experiments with many monitors: 2,000 for the Niseko-Yotei-Toya E-Route Experiment in 2002, and 615 for the Smart Sapporo Snow Information Experiment in 2003.

For data exchange between servers in the experiment, RWML was employed to build the system. The experiments ended without any major problems. These experiments have verified the practical application of RWML.

In October 2001, we released RWML Version 0.80, whose specification incorporates additions and changes made to the information items based on the results of the "Niseko-Yotei E-Route Experiment" of the same year *(2)*. Version 0.81 integrated changes made for the "Smart Sapporo Snow Information Experiment" in 2002. Version 0.82 combined changes made for the "iseko-Yotei-Toya E-Route Experiment" in 2002. This version was used in the "Smart Sapporo Snow Information Experiment" in 2003. (Version 0.81 and 0.82 were not open to the public.)

Formulation of RWML Version 1.0

After a series of corrections and changes, information items of RWML were fixed. Because during experimental system construction difficulties were pointed out in development of applications to process RWML, this problem was recognized to be an obstacle for wide use of RWML.

To simplify the structure of the RWML specification, we decided to overhaul the structure of RWML. Based on Version 0.82, development of Version 1.0 was launched.

We introduced the basic tags and compatibility with the XML Schema in Version 1.0. They contributed to easier application development and to enhanced extensibility of the specification. Now that Version 1.0 has been published on the dedicated website *(2)*, we welcome reader opinions and comments.

CONCLUSIONS

For road-related information to be easily distributable and usable via the Internet, we developed and published RWML Version 1.0, which complies with the XML Schema. To assist dissemination of RWML, the joint research group is considering improvements to the specification that would enhance usability and facilitate integrated application development.

ACKNOWLEDGEMENTS

We would like to express our gratitude to the organizations cited below for their invaluable support. In addition, we would like to thank regional road administrators and their related organizations for their invaluable cooperation in the field experiments.

- RWML Joint Research Group (FY2000 to 2002): Sumitomo Electric Industries, Ltd.; Toshiba Corporation; Nagoya Electric Works Co., Ltd.; the Hokkaido Branch of Japan Weather Association; Nippon Koei Co., Ltd.; Fujitsu; Hokkaido Development Engineering Center; Hokkaido Road Management Engineering Center.
- RWML Joint Research Group Secretariat (FY2000 to 2002): Highway Industry Development Organization, Central Consultant Co., Ltd., Nihon Unitec Co., Ltd.

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