NVML: NaVigation Markup Language

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(Manuscript received June 23, 2003)

The spread of mobile appliances such as cellular phones and PDAs (Personal Digital Assistants) and the development of positioning technology based on GPS (Global Positioning System) and base-station information have led to the development of Location Based Services (LBSs). NVML (NaVigation Markup Language) is an XML proposed by Fujitsu for describing navigation information such as the position and route of a moving object (e.g., a human or a car) and related information. This paper introduces NVML as an example of an XML for LBSs and describes some NVML systems and applications.

1. Introduction

Broadband Internet use over cable using ADSL (Asymmetric Digital Subscriber Line) and optical fiber is rapidly increasing. Now, because of IMT-2000 (International Mobile Telecommunication 2000) and wireless LANs, the broadband Internet is also expanding in the wireless environment. As a result, mobile users now have access to the rich contents of the Internet and special mobile services.

Mobile appliances such as cellular phones and PDAs (Personal Digital Assistants) have liberated us from the restrictions of time and place because they enable us to access e-mail and the Web anytime, anywhere. Another important benefit of modern mobile communications is that users can obtain information about their current location and also inform others about their location, which is an especially valuable capability in emergency situations.

A key requirement for realizing a seamless Location Based Service (LBS) that integrates various appliances, systems, and services is a common data specification. To meet this requirement, Fujitsu has proposed the NVML (NaVigation Markup Language). NVML is an XML for describing navigation information such as the position and route of a moving object (e.g., a human or a car) and related information.[1)-4)] In this paper, we introduce LBSs and NVML and explain how NVML differs from other specifications. Then, we describe some systems and applications of NVML.

2. Overview of NVML

2.1 Location Based Services (LBSs)

An LBS can be conveniently categorized using the following viewpoints:

1) Is the target position in the LBS the position of a moving object such as a human or a car, or is it the position of a fixed object such as a mountain, road, or building?
2) Is the position data used by someone at the target position or at another position? An example of the first case is the use of a cellular phone to obtain information about nearby facilities. An example of the second case is anti-theft surveillance of vehicles using a PHS (Personal Handy Phone) or GPS (Glo-

bal Positioning System).

3) Is the target a position or a route? Here, a "route" is the displacement of the position of a moving object and is not necessarily a road or any other fixed structure. When a person is walking or traveling by car, the route is a road; when a person is traveling by bus or train, the route is a bus or train route. An example of a position-based LBS is GPS, which can be used, for example, to find position at sea. Some examples of route-based LBSs are a car-navigation system and a system that enables a transportation company to monitor the movements of its vehicles.

2.2 Basic features of NVML

Fujitsu's NVML is an XML for describing navigation information such as the position and route of a moving object (e.g., a human or a car) and related information.[1)-4)] **Figure 1** shows an example of NVML navigation data (hereafter called NVML data).

NVML data basically consists of a sequence of "navi" elements and "guide" elements. Each navi element is composed of a "point" element or a "route" element optionally accompanied by an "info" element. When the moving object passes a point or route specified in a navi element, the information related to the point or route is output. On the other hand, each guide element is composed of a point element optionally accompanied by an info element. When the moving object approaches a point specified in a guide element, the information related to the point is output. **Figure 2** shows the relation between navi and guide elements.

By combining a point or route with related information, NVML can describe various types of navigation information, for example, a travel route between two positions, the route from the closest train station to a shop, delivery routes, and sightseeing courses.

NVML data is text data, and each element (e.g., "Tokyo Station") is marked up by tags (e.g.,

```
<nvml version = "1_0_0">
  <head>
    <title>      Mt. Fuji Tour    </title>
    <category>   Sightseeing      </category>
    <transport>  car              </transport>
    <duration>   5 hours          </duration>
    <distance>   100 km           </distance>
    <expense>    5,000 yen        </expense>
  </head>

  <body>
    <navi>
      <point>
        <name>       Tokyo Station     </name>
        <latitude>   N35.40.39.0       </latitude>
        <longitude>  E139.46.18.1      </longitude>
      </point>
      <info>
        <text>       This is Tokyo Station.    </text>
        <voice>      Let's Start!              </voice>
        <image src = "tokyo-station.jpg"/>
      </info>
    </navi>
      …
    <navi>
      <route>
        <name>       Toumei Highway  </name>
        <category>   highway         </category>
        <means>      car             </means>
      </route>
    </navi>
    …
    <guide>
      <point area = "10km">
        <name>       Mt. Fuji          </name>
        <latitude>   N35.21.35.0       </latitude>
        <longitude>  E138.43.55.80     </longitude>
      </point>
      <info>
        <text>       Mt. Fuji          </text>
        <voice>      This is Mt. Fuji! </voice>
        <image src = "mt-fuji.jpg"/>
      </info>
    </guide>
      …
  </body>

</nvml>
```

Figure 1
Example of NVML data.

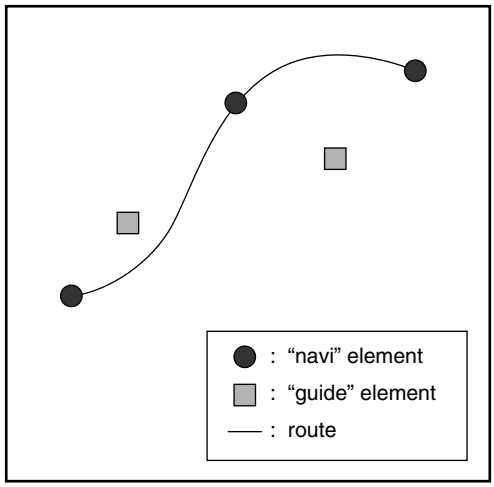

Figure 2
"navi" elements and "guide" elements.

<name> and </name>). This makes NVML data easy to read, write, and edit and also makes it easy for computers to retrieve and process.

2.3 Advantages of NVML

There are several XML specifications related to LBSs. The POIX (Point Of Interest eXchange Language)[5] is a specification for exchanging the position information of a fixed or moving object. The RWML (Road Web Markup Language)[6] is a specification for describing a variety of information, for example, road information, weather information, and local information (e.g., information about local history, festivals, etc.). G-XML (Geospatial-eXtensible Markup Language)[7] and GML (Geography Markup Language)[8] are specifications for describing maps, the positions of fixed objects, the positions and routes of moving objects, and the boundaries of towns, fields, and other features. NVML can be used to describe not only the positions and routes of moving objects but also other related information by using text, voice, and images. This information can be rendered as HTML with voice and images, so mobile appliances can easily process it using their basic functions. Of course, if necessary we can transmit the original data and link it to the corresponding positions and routes by using, for example, the namespace technique.[9]

3. NVML systems and application examples

3.1 NVML systems

Hereafter, we will call a system that accepts or outputs NVML data an "NVML system." **Figure 3** shows a typical NVML system. The left side shows appliances, the middle shows a server that generates NVML data, and the right side shows content servers that provide a variety of information related to points and routes. The user first specifies the points of departure and destination using an appliance. Then, the server finds a route between the two points, retrieves various types of information (e.g., road information, weather information, and local information) about the route, and then associates the information with various points on the route. The current position extracted by GPS can be used instead of specifying the departure point, and it is also possible to choose a recommended course stored in the NVML database instead of specifying points.

By transferring NVML data over the Internet or via a medium such as a floppy disk or memory card, it becomes possible to use a navigation service seamlessly. For example, you can use a car navigation system when traveling by car and then switch to a cellular phone or PDA when you leave the car. In addition, by using an NVML server, you can retrieve information about the route such as weather, traffic, and sightseeing information and also convert the NVML data to produce, for example, an HTML table of data or a map in SVG (Scalable Vector Graphics) format,[10] according to the type of appliance being used and your personal preferences.

NVML data can be used with any type of LBS navigation hardware and map software. Points and routes described using NVML data can be displayed by projecting them onto a map using the latitudes and longitudes of each point and route.

Figure 4 shows a display image of the NVMLPlayer, which is an NVML client applica-

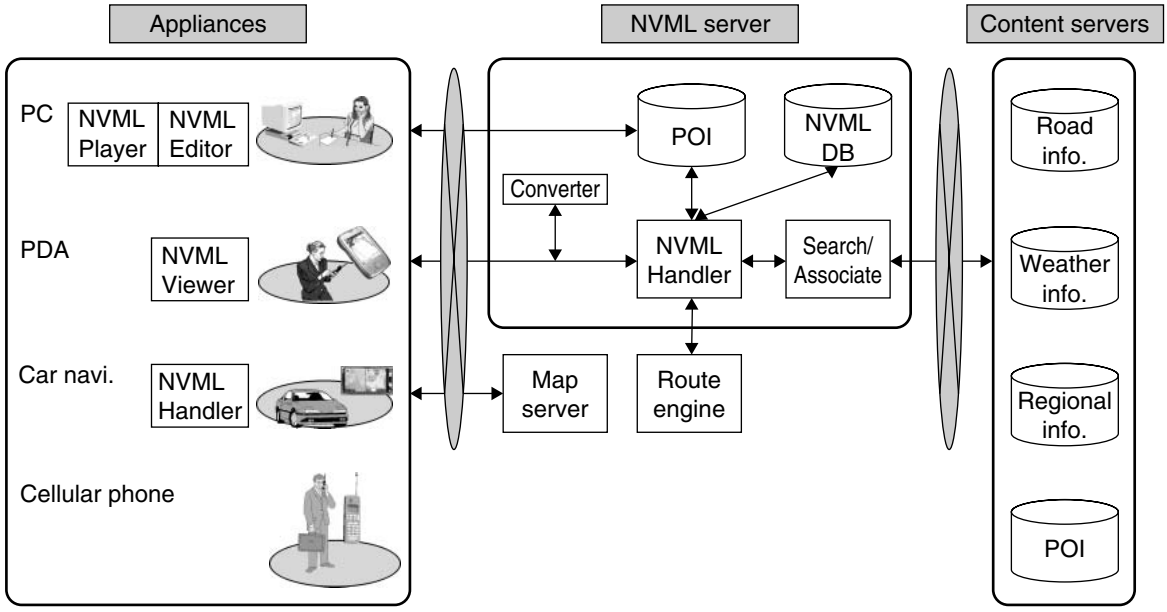

Figure 3
Typical NVML system.

Figure 4
Image displayed by NVMLPlayer on a PC.

tion for PCs that can display points and routes on a map and can simulate a navigation by outputting related information, for example, text, voice, and images. **Figure 5** shows a display image of the NVMLViewer, which can simulate a navigation on a PDA and also navigate using GPS. **Figure 6** shows a table-style Web page that has been rendered from NVML data using XSL (Extensible Stylesheet Language).[11] The diagram in the upper right of the page is a map in SVG format that was also rendered from the NVML data.

3.2 Application examples

NVML can be applied to various types of transportation, for example, walking and travel by car, bus, train, airplane, or ship. Also, as mentioned in the previous section, NVML data can be used with any type of LBS navigation hardware and map software. Moreover, it can be converted to various other data types. Because of these features, NVML can be applied to a wide range of systems and services.

For business trips and field maintenance, you can check your destination using a PC in an office and then drive to the destination using a car navigation system. When you arrive and leave the car, you can switch to cellular phone and continue to use the same NVML data. To give another example, to dispatch delivery trucks, you can plan the optimal courses of the trucks and display their courses. For sightseeing and traveling, you can recommend a course at a travel agency, simulate it at the airport, or publish it as a travel guide by using the same NVML data.

Moreover, a system for acquiring a route and information associated with that route from content servers can also be implemented by using

Figure 5
Image displayed by NVMLViewer on a PDA.

Figure 6
Web page rendered from NVML data displayed on a PC.

NVML. Road, map, and POI (Point Of Interest) data can be stored on the content servers, so it is not necessary to periodically visit, for example, a car center, to renew such data. With these capabilities, we could build, for example, a network-type car navigation system. The Association of Electronic Technology for Automobile Traffic & Driving (JSK) has written a draft specification for the standardization of information delivery services that calls for the use of NVML. Also, the effectiveness of a service that delivers information to in-vehicle equipment using IMT-2000 was confirmed in a road test.[12)]

Fujitsu has developed a navigation information service system in a joint research project it is conducting with the Civil Engineering Research Institute of Hokkaido (CERI).[13)-16)] The NVML server of this system retrieves road, weather, and local information as RWML (Road Web Markup Language) data from content servers of the joint-research organization and the experiment committee. The NVML server then associates the information with the route, converts it to the appropriate data format, and then delivers it to PCs and PDAs. Figures 4 to 6 show display images of the system's client application.

In the future, we will consider how to integrate various Web services with NVML systems according to position and route. For example, a bus guide service could be called up automatically when a user is close to a bus stop, or a restaurant guide service and navigation service could be automatically started at lunch time.

4. Conclusions

In this paper, we introduced our NVML (NaVigation Markup Language) for realizing LBSs (Location Based Services), especially navigation information services. XML is being used not only to describe the documents and data of the information world but also to indicate the positions of fixed objects and the positions and routes of moving objects in the real world. LBSs are typical examples of XML applications, and NVML can be regarded as a mediation between positions and routes in the real world and information about those positions and routes. NVML links the real world to its corresponding information, and we expect it to become an integral part of the Ubiquitous Network Society.

Acknowledgement

Some of the application examples described in this paper were developed by Fujitsu in a joint research project with the Civil Engineering Research Institute of Hokkaido (CERI) and as a result of Fujitsu's participation in the investigation for the standardization of information services that was conducted at the Association of Electronic Technology for Automobile Traffic & Driving (JSK).

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