The Dynamic Route Guidance System of Nagano UTMS

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ABSTRACT

The 18th Winter Olympic Games were held in Nagano Prefecture, Japan from February 7 through 22, 1998. Under instruction from the National Police Agency (NPA), Universal Traffic Management Society of Japan(UTMS Japan) introduced the UTMS (Universal Traffic Management Systems) in cooperation with the Nagano Prefectural Police Headquarters（NPPH）to smoothly control traffic, especially Olympic-related vehicles, during the Olympic Games ([1]). Since infrared beacons, the key infrastructure of the UTMS, not only provide two-way communication with in-vehicle units but also detect vehicles, they enable traffic flow to be more accurately measured and specified vehicles to be notified and controlled. NPPH installed many infrared beacons on routes to be used by Olympic-related vehicles and vehicle ID transmitters on all such vehicles,

half of which were also equipped with in-vehicle units with built-in display.

The road network for the Olympic Games was constructed so that most Olympic-related vehicles could use a loop road around the central part of the city. As a result, drivers were required to select a clockwise or counterclockwise route when entering the loop. The Nagano DRGS (Dynamic Route Guidance Systems), a sub-system of the Nagano UTMS, supported drivers in selecting routes by providing travel time information for each route for Olympic-related vehicles which transmitted their destinations.

This thesis describes the concept and system configuration of the Nagano DRGS and quantitatively evaluates the operation results.

The Nagano DRGS was developed by simplifying the CDRGS (Centrally Determined Route Guidance Systems), which UTMS Japan has been studying and developing since 1993, with the aim of for putting it into practical use.

INTRODUCTION OF NAGANO UTMS

The traffic control policy of Nagano UTMS was to ensure that players and Olympic-related personnel could move around smoothly and to minimize congestion on residents, while NPPH developed a "Nagano Olympic Games Traffic Control Plan" for traffic regulation and demand control.

NPPH decided to introduce the UTMS for smoothly managing Olympic-related vehicles in cooperation with UTMS Japan in addition to enforcing traffic restrictions and control. The UTMS refers to a new traffic control system developed by NPA as a project relating to the ITS (Intelligent Transport Systems) promoted by the government.

While NPPH installed many infrared beacons, UTMS Japan requested an automobile manufacturer, which is one of its member and a gold sponsor of Olympic-related passenger cars, to install in-vehicle units. Since infrared beacons not only provide two-way communication with in-vehicle units but also detect vehicles, they enable the UTMS to precisely understand traffic situation including the travel time of each vehicle equipped with an in-vehicle unit. The more in-vehicle units there are, the more effective the UTMS is. In practice, however, the percentage of vehicles having such units is small, although the number is rapidly increasing. In order to satisfy the purpose of the Nagano UTMS, it was very important to install in-vehicle units on as many Olympic-related vehicles (about 2,400 in total) as possible.

The Nagano UTMS was designed by integrating the Nagano Dynamic Route Guidance Systems (DRGS) and the Mobile Operation Control Systems (MOCS) for Olympic-related vehicles into the Integrated Traffic Control Systems (ITCS), the Advanced

Mobile Information Systems (AMIS) and the Public Transportation Priority Systems (PTPS), which were already maintained by NPPH. Under such circumstances, the Nagano DRGS was intended to provide such information as travel time to destination and level of congestion using simplified graphics for Olympic-related vehicles which transmitted their destinations.

CDRGS IN UTMS

UTMS Japan has been studying and developing the CDRGS since 1993 ([2]). With this system, an infrared beacon transmits the optimum routes to a vehicle's destination immediately after the vehicle transmits its destination when passing under it. This optimum routes is calculated based on the latest traffic information and predicted travel time, and any destination nationwide can be specified. Tests aimed at putting it into practical use have been conducted in Tokyo since 1996, gradually proving its effectiveness and practicality. In the third verification test conducted in March 1998, CDRGS-equipped vehicles succeeded in reaching their destinations 11.0% quicker than general vehicles operated by drivers who independently selected their routes using real-time traffic information on car navigation equipment. These results conform with those of the previous two tests. The results of the third verification test will be presented at another session of this Seoul convention.

At present, the CDRGS only provides vehicles with the shortest possible routes, but when in-vehicle units are more widely used, the system will be capable of assigning traffic among road networks, thereby making more effective use of them and greatly reducing traffic congestion. With this in mind, we are developing the system step by step.

Designed to cover all complicated road networks, the full-scale CDRGS is especially effective in large cities. In Nagano, however, a simplified system, explained below, was introduced.

CHARACTERISTICS AND DESIGN POLICY OF NAGANO DRGS

CHARACTERISTICS OF ROAD NETWORKS

The Olympic-related roads on which route guidance was available had the following characteristics:

1) The road network for the Olympic Games was configured so that most vehicles could use a loop road around the central part of the city. As a result, drivers were required to

select a clockwise or counterclockwise route when entering the loop. They generally took unforked roads to their destinations once they exited the loop.

2) Since traffic conditions during the Olympic Games were expected to be completely different due to traffic restrictions, it was not always possible to predict them precisely, although measuring them was possible.

3) Drivers of Olympic-related vehicles were expected not to know the roads very well since most of them were volunteers.

Under such circumstances, a simplified system was introduced for route guidance during the Nagano Olympic Games.

INFORMATION SUPPLYING POLICY

Taking the above characteristics into account, the system was designed to supply the latest travel time to destination via a clockwise or counterclockwise route instead of predicted travel time and congestion information for vehicles entering the loop.

1) Route travel time

The latest travel time to a destination on each route is supplied using simplified graphics of the road network.

The travel time using the loop road is supplied when the destination is near it, or to a junction on the loop road and from the junction to the destination when the destination is some distance away.

Fig. 1 shows an example of the latter.

2) Congestion status

Turns part of the loop road display red (fully congested) or orange (slightly congested) (see Fig. 1).

3) Travel time to destination

Only the latest travel time to a destination from a point where no route is required to be selected is supplied.

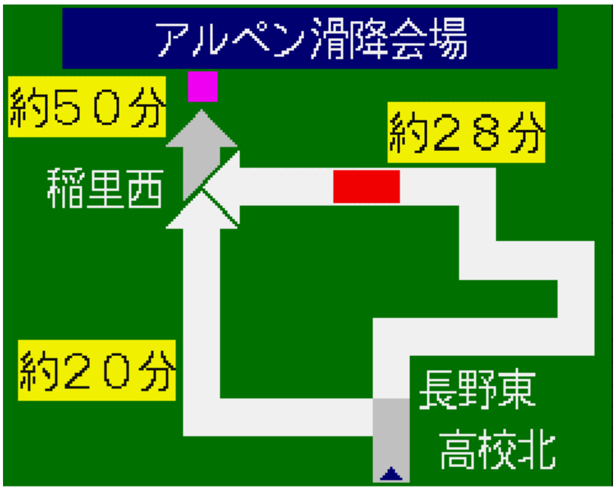

Fig. 1: Typical Simplified Graphics

4) Information in English

Route travel time and destination names are supplied in English at certain points.

For travel time to destination as mentioned in 3), information was also displayed in English on the screen.

SYSTEM CONFIGURATION

System Flow

Fig. 2 shows the system configuration overview. The Nagano DRGS sub-system functioned as part of the traffic control system of NPPH and consisted of Nagano DRGS central computer and a display desk.

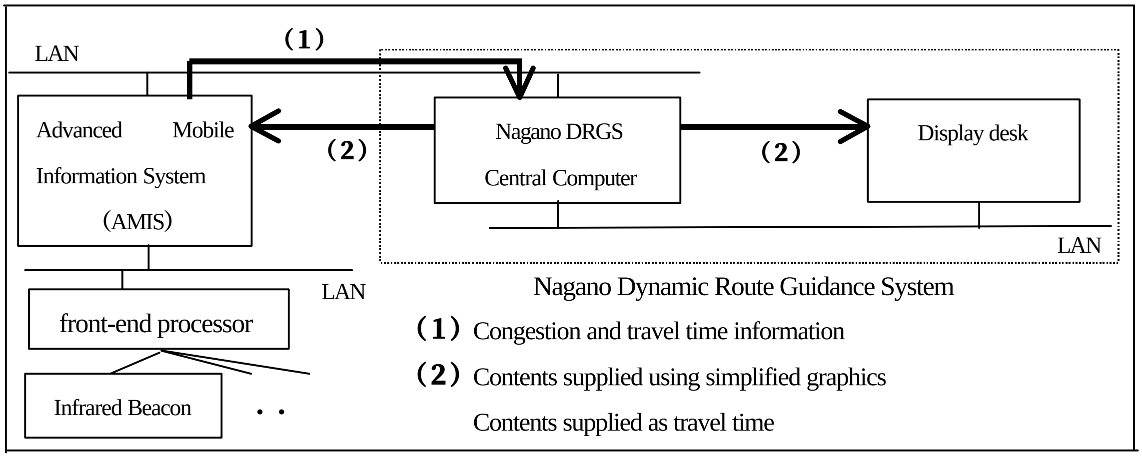

Fig. 2: System Configuration

The system was designed to collect travel time and congestion information for each link from the AMIS, calculate travel time from information supply points to each destination and integrate it into a pre-drawn simplified graphics.

The system was only intended to supply the latest estimated travel time since it was designed for a short-term event and was not meant to predict accurate travel time supplied to drivers. Travel time of 30 minutes or less was supplied in 1 minute units and that of more than 30 minutes in 5 minute units, with the information being updated every five minutes.

The information generated and supplied by the Nagano DRGS was transmitted to the AMIS, which sent it along with other information to each infrared beacon. Each infrared beacon is designed to transmit simplified graphics corresponding to a destination to the in-vehicle unit immediately after the destination code is received.

The traffic control center is capable of monitoring the contents of information supplied to in-vehicle units on the display desk. Travel time for the main sections on the target road network can also be observed at the same time.

Simplified Graphics

Since travel time from Nagano DRGS information supply points to destinations was to be supplied using simplified road network graphics, they needed to be pre-drawn.

Infrared beacons for supplying Nagano DRGS information were installed on routes likely to be frequently used by Olympic-related vehicles and various sites set as most-likely destinations from each point, resulting in approximately 800 combinations of Nagano DRGS information supply points and destinations.

Fig. 3 shows the Olympic road network and major Nagano DRGS destinations. Half of them were designed to supply only one travel time to a destination and the rest to supply loop road route information using simplified graphics. The graphics to be supplied by the latter type were designed to clearly show the loop road and connections to the site so that they could be commonly understood from any supply point.

In addition, each display was arranged so that the direction of travel faced upward. Fig. 1 shows a typical example of such graphics.

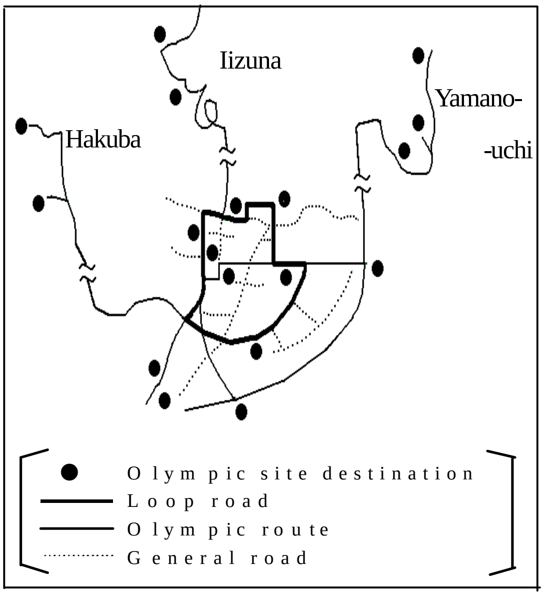

Fig. 3: Olympic Road Network and Nagano DRGS Destination

System Scale

Although in-vehicle units were installed on all 2,370 Olympic-related vehicles participating in the Nagano UTMS, route guidance was only available on 980 vehicles equipped with in-vehicle units having built-in displays of the 1,520 Olympic-related passenger cars.

Thirty seven infrared beacons were installed for supplying Nagano DRGS information and thirty two destinations were available.

MAN-MACHINE INTERFACE ON IN-VEHICLE UNIT

The Nagano UTMS function was added to the map database of readily available car navigation equipment.

Since predetermined destinations were preset in the in-vehicle unit, the destination code was transmitted every time the vehicle passed under an infrared beacon once the driver had selected a destination when starting out, enabling Nagano DRGS information to be received from the Nagano DRGS infrared beacons. After the in-vehicle unit received Nagano DRGS information, other information being displayed was interrupted to show it for 30 seconds.

NAGANO DRGS OPERATION RESULTS

During the Olympic Games, the Nagano DRGS was properly operated and all communications between infrared beacon and in-vehicle unit were recorded for analysis later.

Nagano DRGS information was supplied at the approachs to the loop road from four main access routes. Fig. 4 shows the results of route guidance at one such point.

	1) Counterclockwise route selection ratio when faster					2)Clockwise route selection ratio When faster				
	1 to 5 min.	6 to 10 min.	11 to 15 min.	16 to 20 min.	More than 20 min.	1 to 5 min.	6 to 10 min.	11 to 15 min.	16 to 20 min.	More than 20 min.
No. of vehicles supplied with information	41	11	5	1	0	55	12	8	2	0
No. of vehicles which selected the route	24	7	0	1	0	24	2	3	1	0
Selection ratio	58.5	63.6	0	100	0	43.6	16.7	37.5	50	0

Fig. 4: Clockwise vs. Counterclockwise Route Selection ratio

The figure shows the routes selected to head for the ice hockey site from the Olympic village and indicates the change in route selection ratios according to travel time difference between clockwise and counterclockwise routes. For the counterclockwise route, the quicker the route, the more vehicles selected it. For the clockwise route, however, less vehicles selected it when the time difference exceeded five minutes.

There were few cases in which sufficient samples for variation analysis were obtained from combinations of information supply points and destinations. In addition, there were very few cases in which the ratio varied between routes since the travel time for one of them was always shorter even when enough samples were obtained. This was not only because of the geographic relationship between information supply points and destinations but also due to the fact that traffic was less than usual and little congestion occurred during the Olympic Games. This indicates that traffic was managed extremely well during the Games.

As shown in Fig. 5, the percentage of vehicles with preset destinations gradually declined from approximately 65% at the start to 50% at the end of the Games. This was probably because drivers became aware that there was little traffic congestion. Quite a number of drivers, however, still used Nagano DRGS information for checking travel time to their destinations.

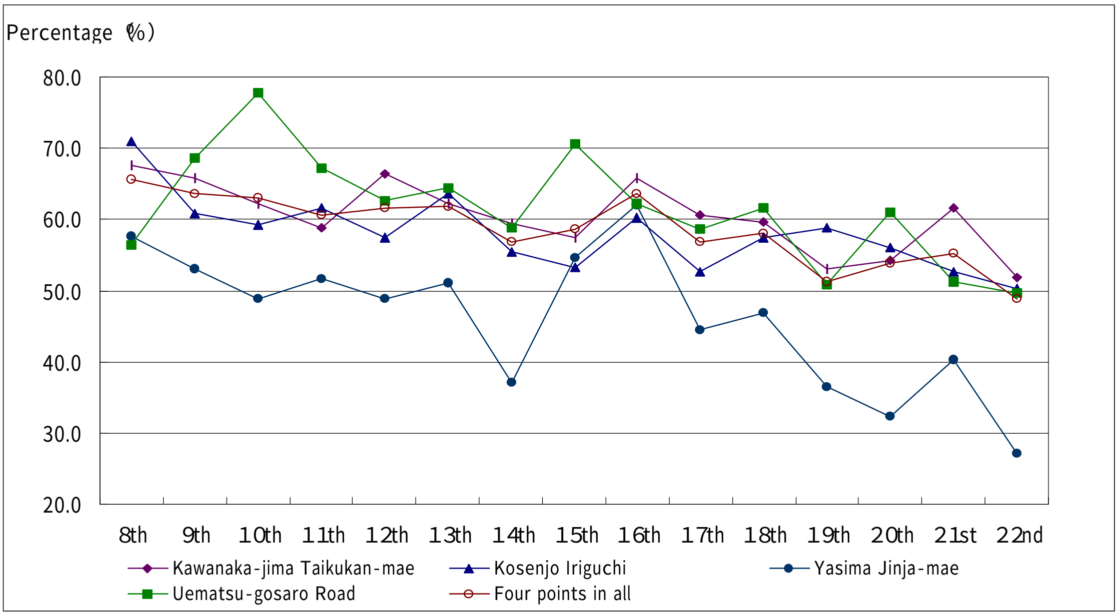

Fig. 5: Percentage of Vehicles with Preset Destinations

A survey of volunteer drivers showed that 83% of them thought that the dynamic route guidance information would be generally helpful in the future, indicating high expectations for it.

ACKNOWLEDGEMENT

It was our great pleasure to see this system put into practical use without any significant accident or failure. We would like to express our deepest gratitude to NPA and other related organizations for their invaluable guidance and cooperation over a long period of time it took to construct this system.

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