# Traffic Information System and Signal Control System employed in the Nagano Olympic games

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**Abstract** The Winter Olympic Games was held in the Nagano prefecture in February1998.The article describes the measures of Nagano ITS (Intelligent Transport Systems) taken to the smooth traffic management of Nagano city and its outskirts. In the Nagano Olympic Games, the infrared beacon equipment composed of 414 sets in total was installed centered in the city as an infrastructure. How to make the most of the new traffic system was the mission of the first importance. The both-directions communication between the car navigation system carried on Olympic-related vehicles and the infrared beacon was fully used, and information such as the travel time to each destination was given to the car drivers. The performance evaluation of Nagano ITS and a modeling of the new transportation system of the Nagano city is discussed in this paper.

## 1. Introduction

The Winter Olympic Games was held in the Nagano Prefecture, Japan, in February 1998. The Olympic Games has been known as the worldwide event held at once in four years, and thus a vast number of spectators and vehicles coming from inside and outside of the prefecture be presumed to be concentrated in a specific area, bringing unforeseen traffic accidents and congestion in many cases abnormally.

For this, the 'Nagano ITS (Intelligent Transport Systems)' had been programmed for smooth traffic management.

At the occasion of Nagano Olympic Games, the infrared beacon of 414 sets in total was installed as the infrastructure selectively in and around the central city. The information on travel time duration toward the destination and route guidance were provided to the Olympic-related vehicles to make them in time of starting games, applying the bi-directional communication function between the unit of infrared beacon and on-board unit (OBU , car navigation system) mounted on the Olympic-related vehicles. Moreover, the traffic signal preemption system was employed for the Olympic-related vehicles running on the scheduled route to smooth their operation out and keep time regularly.

This paper describes on and evaluates 'Traffic Information System' and 'Signal Control System' of Nagano ITS.

## 2. Bi-directional Communication Between Infrared Beacon And On-board Unit

The Infrared beacon, having the communication zone laid on the carriageways, was installed at 5.5m above the ground to communicate by two-way with OBU equipped vehicles passing through this zone.

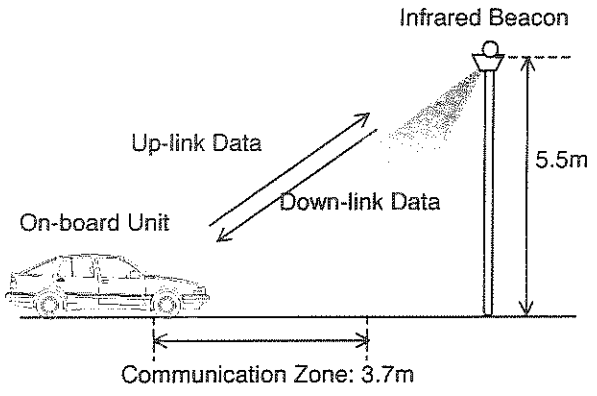



Fig. 1: Bi-directional Communication Between Infrared Beacon and OBU

It is generally called that the transmitted data from OBU to infrared beacon is 'Up-link' data, or reverse is 'Down-link' data.

### 2.1 Communication Architecture: The flow of data between Infrared Beacon and OBU

It is possible to transmit a maximum of 10KB of down-link data from an infrared beacon to an OBU when equipped vehicle is in its communication zone. And even if the vehicle passing in this zone has most 70km/h in speed, it is possible to transmit identical data by two cycle so that to avoid the communication error.

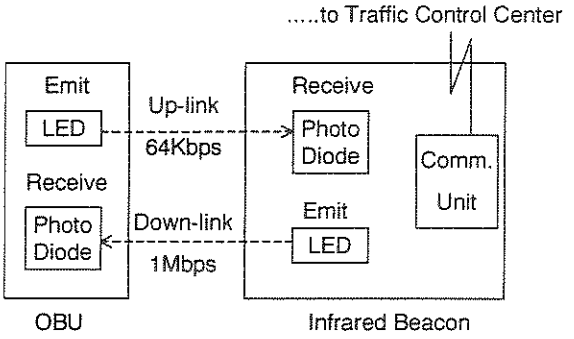



Fig. 2: Communication Architecture: Infrared Beacon – OBU

## 3. Nagano ITS

### 3.1 Information Collection

The 414 sets of infrared beacon were installed at the 309 points with 130 intersections selectively on the scheduled routes for Olympic-related vehicles to collect up-link data transmitted by Olympic-related vehicles passing in their communication zone.

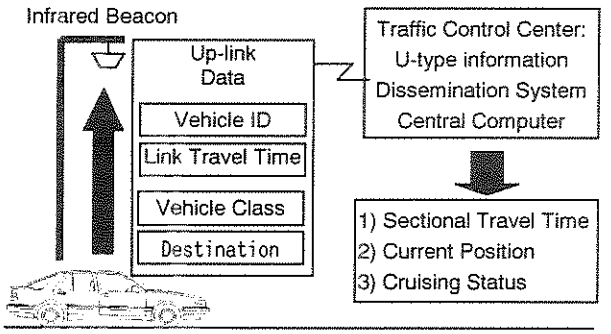



Fig. 3: The Collection of the Up-link Data

The up-link data such as vehicle ID, vehicle class and link-travel-time etc., an OBU once transmitted, are stored in the traffic control center. The sectional travel time or other useful data can be obtained from these collected up-link data. Then, traffic information on congestion and the same are provided as the down-link data from said traffic control center via infrared beacon to the OBU.

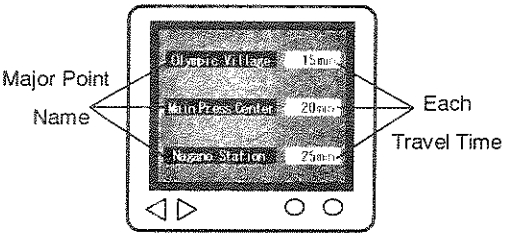
### 3.2 Information Provision

An OBU received the down-link data presents the simplified graphic on the car navigation display. The provided information can be displayed by the following three information provision modes:

- Travel Time Information provision mode;
- Route Guidance mode;
- Current Cruising Position Information provision mode.

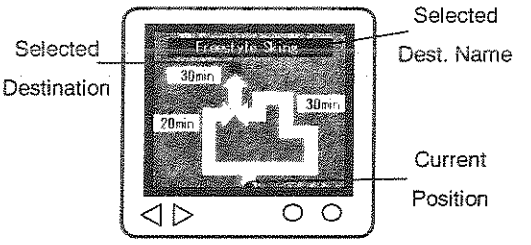
#### 3.2.1 Travel Time Information

Provides travel time for each Olympic site in the direction of travel.



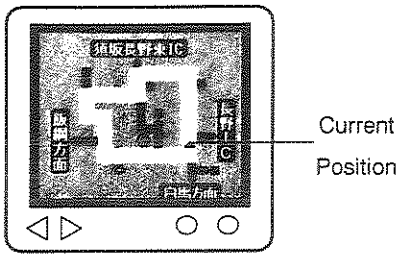

#### 3.2.2 Route Guidance

Recommends the most suitable route for driver's destination selected, when accessing to a diverging point.




#### 3.2.3 Current Cruising Position Information

Just after diverging, provide the confirmatory information if the cruise follows previous guidance and selected route is kept, by presenting the current cruising position on the simplified graphic.




### 3.3 Traffic Signal Preemption for Olympic-related vehicles

Traffic signal preemption for Olympic-related vehicles by way of controlling signals allows to keep normal operation in accordance with scheduled time table and thus eventually to ease the traffic congestion.

During the Olympic, the traffic control center had been collecting the data such as games' daily program and Olympic-related vehicles' operation status to apply for Macro Control and Micro Control, the former was systematic preemption of signal control for Olympic-related vehicles and the latter was centrally determined signal control for other vehicles being some way off the route on preemption since they influenced by the Olympic-related vehicles' up-link data.

The main objective to be controlled was the arterial road linked Olympic sites (include related facility) with each other in the central city (named LOOP-LINE).

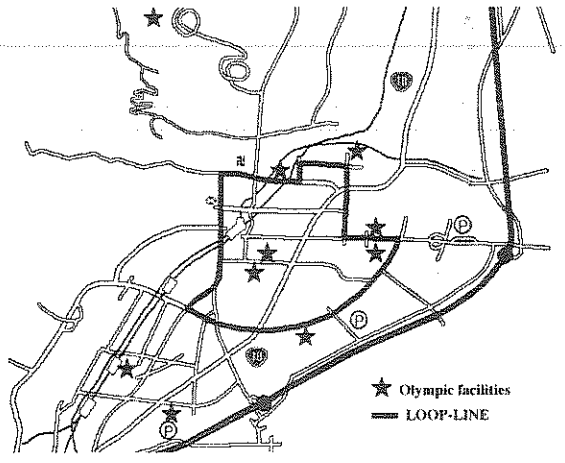



Fig. 4: The Route Map in Nagano City

#### 3.3.1 The Macro Control

As shown in the figure 5, to offset the signaling cycle according to the vehicles' cruising status at a few neighboring intersection is to control and increase the traffic volume acceptable for passing through at one time. So, this signal control system was taken.

Further, signal control extended the rate of green signal time for Olympic-related vehicles was also performed.

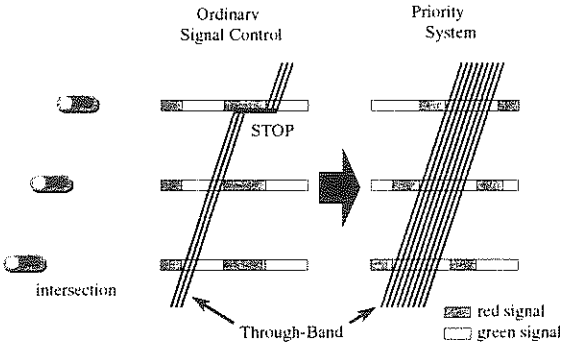



Fig. 5: The Macro Control

#### 3.3.2 The Micro Control

When the Olympic-related vehicles approached the communication zone of infrared beacon for dedicated use of micro control and installed at this side of intersection, in case that the signal in the direction of travel was currently green, this green time would be extended, or in case that it was red, this red time would be shortened.

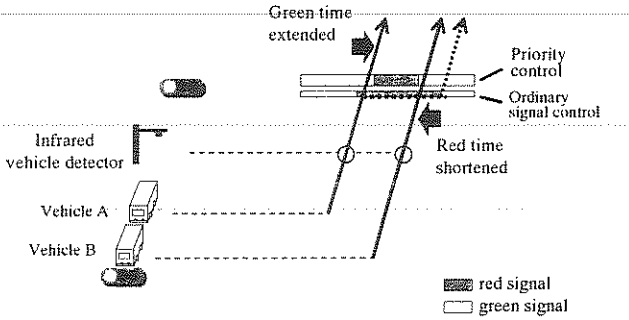



Fig. 6: The Micro Control

## 4. Comprehensive Evaluation of Nagano ITS

### 4.1 The Total Number of Up-links during the Games

The total number of Olympic-related vehicles equipped with OBU was counted for 2,370, and up-link number in total from 1/24 to 3/15 was as shown in the graph below (Olympic Games term: 2/7 ~ 2/22).

Table 1: The number of Olympic-related vehicles

| Type | Car | Bus | Total |
|---|---|---|---|
| Bi-directional functioned | 980 | 200 | 1180 |
| Only Up-link functioned | 540 | 650 | 1190 |
| Total | 1520 | 850 | 2370 |

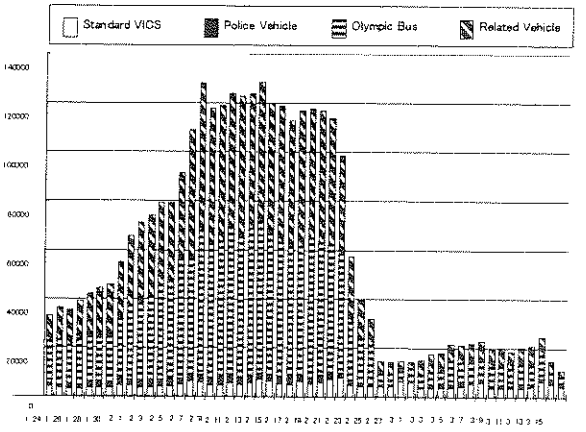



Fig. 7: The total of up-links from 1/24 to 3/15

### 4.2 The evaluation of Traffic Signal Preemption for Olympic-related vehicles

#### 4.2.1 The Micro Control

The time duration of shortened red performed for the signal control preemption for Olympic-related vehicles was 61,563 seconds and extended green time duration was 308,461 seconds, in total within the Olympic terms.

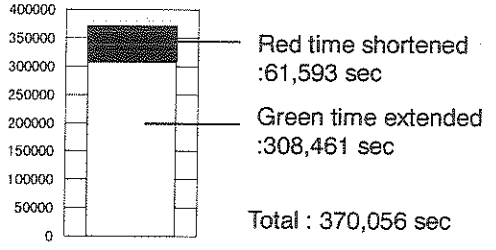



Fig.8: Shortened time duration of waiting time at signal in second

#### 4.2.2 The effect from the point of view of travel time

The time needed for one lap of loop-line was shorter than usual by two and a half minutes or more, that was the good result from effects of: traffic signal preemption, route guidance with information provision, decrease of passenger cars within this term, etc..

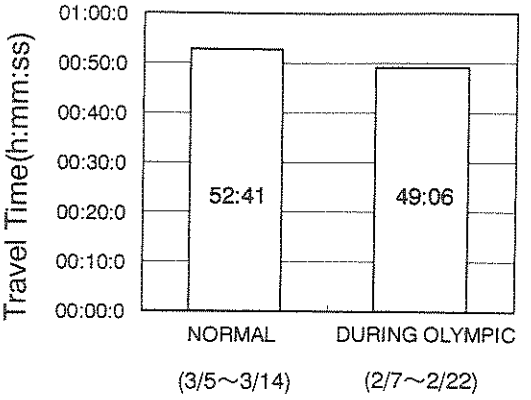



Fig. 9: Comparison of travel times

### 4.3 The Results from Questionnaire Survey

The questionnaire survey was sent out selectively for all 377 drivers of Olympic-related vehicles. The result is shown as follow:

Table 2: The result of Survey

| | Yes, very useful | Yes, sometime useful | No, little useful | Nonco mmittal |
|---|---|---|---|---|
| Is Travel Time Info. useful or not? | 33% | 54% | 6% | 7% |
| Is Route Guidance useful or not? | 33% | 50% | 3% | 14% |

## 5. Conclusion

Nagano ITS was widely accepted and performed very well. During the Olympic Games, the total of up-links and down-links was over 100,000 times a day in average, which could provide wide variety of necessary information for the Olympic-related vehicles successfully. Moreover, the signal control preemption allowed to keep priority of Olympic-related vehicles in driving, and thus could hold a normal scheduled operation.

In conclusion, Nagano ITS could contribute to the accomplishment of smooth traffic control satisfactorily. And, the questionnaire survey showed that the information provision like a route guidance using car navigation system of OBU could make many users feel useful, which might indicate further development for the future use. The more be under the traffic congestion, the more be in the demand.

## 6. Acknowledgements

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## References

Japan Traffic Management Technology Association ., ITS developed by Japanese police, 114--117, 1999.

Vehicle Information and Communication System Center ., The challenge of VICS ,1997.