

Achievements of Nagano ITCS/PTPS

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SUMMARY

The aim of PTPS (Public Transportation Priority Systems) implemented as one of the urban traffic management systems (UTMS) at the winter Olympic games held in Nagano Prefecture in February 1998, was to support the smooth operation of the games by controlling traffic signals to ensure punctual operation of Olympic vehicles transporting Olympic people such as athletes and officers concerned directly with the games.

The roads controlled were also used daily by the citizens of Nagano City, so control constants also had to be designed considering these conditions.

This paper outlines this system operated by the Nagano Prefectural Police Headquarters.

INTRODUCTION

Severe traffic jams were forecasted to occur during the period of the Olympic games because of the concentration of domestic and overseas Olympic people, spectators, etc., in addition to ordinary traffic. In particular, the city of Nagano and its outskirts were considered to have difficult traffic problems during the period of games because Olympic facilities (playing fields and museums, players' village, media village, parking lots, etc.) were to be concentrated there.

Under these circumstances where sudden, sharp increases of traffic volume had to be controlled safely and efficiently, the Nagano Prefectural Police Headquarters cooperated with the Nagano Winter Olympic Game Organization Committee (NAOC) to establish a "Nagano Olympic traffic management plan," including traffic regulation plan, total traffic volume suppression plan, traffic guide plan, and transportation operating plan.

The PTPS in these Olympics supported this traffic control plan through signal control operations. Its aims included to ensure the punctual arrival of Olympic vehicles, minimizing adverse effects to civil life, and smoothing the operation of public roads and operation of the games, in principle.

PTPS CONTROL FUNCTIONS

The control functions consist of two types: Macroscopic control and microscopic control. Fig. 1 shows the control concept.

MACRO CONTROL

Macro control is a priority coordinated signal control whereby official cars and vehicles that are driven on a transportation route are given a preferential right of way.

In this mode, a time of day control system was adopted. This was because the time of day control system was more advantageous than a traffic responsive control system, as follows:

A traffic regulation plan, to be applied temporarily during the Olympic period, had already been determined, so traffic demand could be estimated beforehand. All traffic conditions would not always be reflected by vehicle detectors because of lane restrictions, temporary traffic stops, etc. In addition, a traffic responsive control system might produce control losses such as control delays and disturbances in the coordinated signal control due to offset-following operation.

Macro Control (Priority coordinated signal control)

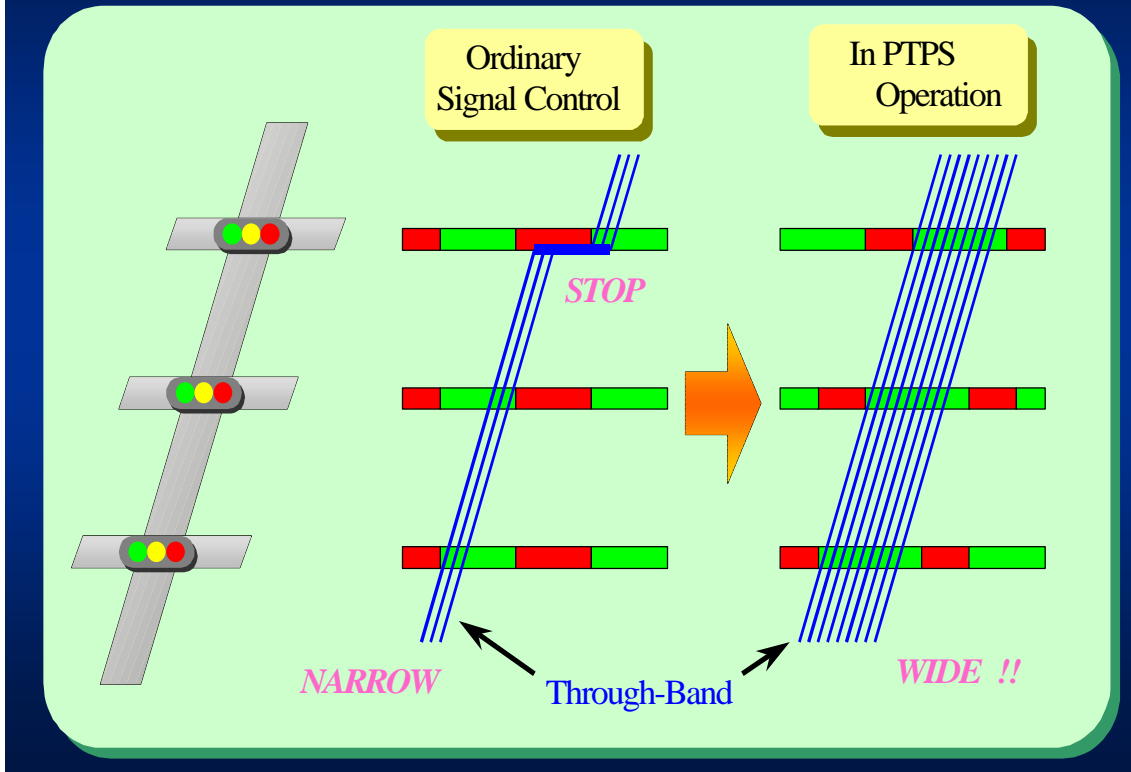


Fig. 1 Conceptual view of PTPS signal control

MICRO CONTROL

The micro control system was aimed at relieving Olympic vehicles being driven outside the through-band of the macro control because of driving conditions, by means of a vehicle actuated control where by phases at an intersection were extended or shortened.

The infrared vehicle detectors developed under the UTMS concept were used as detectors for identifying Olympic cars and vehicles in this control mode. One of the reasons for the selection was the Olympic vehicles included small and large vehicles, so an ordinary bus detector which discriminated a vehicle by its dimensions, could not function normally. Instead, the infrared vehicle detector could identify whether a vehicle was related to the Olympic vehicles or not, according to the vehicle ID number.

PLANS FOR PTPS

Traffic signals were controlled during the Olympic period by jointly applying macro and micro control modes for Olympic vehicles, and time of day control mode was effected all day long. To make the most of these control systems and modes, various constants had been planned previously.

REORGANIZED SUB-AREA CONFIGURATION

The sub-areas were reviewed because traffic flow and volume were forecasted to change due to the effects of the traffic regulation plan and the transportation operating plan to be applied during the Olympic period.

As a result, 81 sub-areas normally used were reorganized into 89 sub-areas for the period.

ADDING THE NUMBER OF SIGNAL CONTROL PATTERNS

Olympic vehicles were classified in advance according to transportation objects (players, officials, VIP, and spectators), and transportation routes were also different. Consequently, a variety of signal control patterns depending on priority levels of transportation objects was required, when a number of games were held at once and several transportation routes crossed at an intersection, etc. In addition, it had to be prepared to define signal control patterns to cope quickly with unexpected conditions such as a sudden change of weather or a traffic accident.

Consequently, the conventional 15 patterns were increased to 59 patterns with sub-area units.

CONSTANTS FOR MACRO CONTROL

Macro control was applied to 89 sub-areas and 296 signals (including 227 central signals and 69 interlocked slave signals) in urban Nagano.

Cycle

Cycle lengths were extended as much as possible, to achieve a priority coordinated signal control of Olympic routes. Making cycle lengths longer brought the following advantages when a priority control system was applied:

Assuring a split in a preferred direction

At a wide road, it was impossible to reduce the split for the sub-road to ensure pedestrians' crossing time, but an increment to the cycle length could be provided to assure a split in the preferred direction.

Increased offset effects in the preferred direction

In an urban area with intersections close to each other, an equal offset was basically a simultaneous offset. At this time, the distance a car could be driven without encountering stop signals was proportional to a green signal time (split).

Split

The equal, main-road preferred, and sub-road preferred patterns were created for a cycle. For a preferred road in particular, the maximum split was given to the road provided the time needed for pedestrians to cross in seconds was reserved.

Offset

The equal, up preferred, and down preferred patterns were created to make a cycle. In a preferred pattern, the maximum through-band width was given in the preferred direction.

INTERSECTIONS SELECTED FOR APPLICATION OF MICRO CONTROL

Necessary conditions for intersections where micro control was to be applied included those on the Olympic routes where Olympic vehicles were driven and where trunk roads crossed.

As a result of the study, six intersections on a loop line were selected.

DAY-CHANGE SIGNAL CONTROL PATTERNS DURING THE OLYMPIC PERIOD

A control pattern for each sub-area was decided according to the day schedule of the Olympics, and transportation routes were configured. Although a time of day control system was applied, the pattern for an event was changed four times of before it began, during the event, after the event, and the rest of time. Change time intervals were normally more than 30 minutes. If shorter, more offset-following operations might be caused by a pattern change, resulting in adverse factors affecting system, such as a coordinated signal control disturbances.

Evaluation of PTPS

Traffic conditions with PTPS applied during the Olympic period are compared as follows with normal traffic conditions. All summary data per day are the total from 7:00 to 21:00, the time period with traffic regulations applied, or mean data.

EFFECT OF REDUCING TOTAL TRAFFIC VOLUME

One of the goals of the total traffic volume suppression plan was to decrease traffic volume by 30% from ordinary traffic volume, during the Olympic period. Therefore, the total traffic volume was calculated as a product of the number of driving vehicles and kilometers for major roads in the city of Nagano, and was compared to normal value. Because vehicles other than Olympic vehicles were suppressed in terms of total traffic volume, the total traffic volume during the Olympic period was classified into “general vehicles only” and “total vehicles” including Olympic ones, and compared. The evaluation results are shown in Fig. 2.

As seen in Fig. 2, the ratio of the traffic volume of “general vehicles only” per day during the Olympic period on major roads in Nagano City was 74%, which was close to the goal of 70%.

This might explicate that the traffic control plan was achieved smoothly.

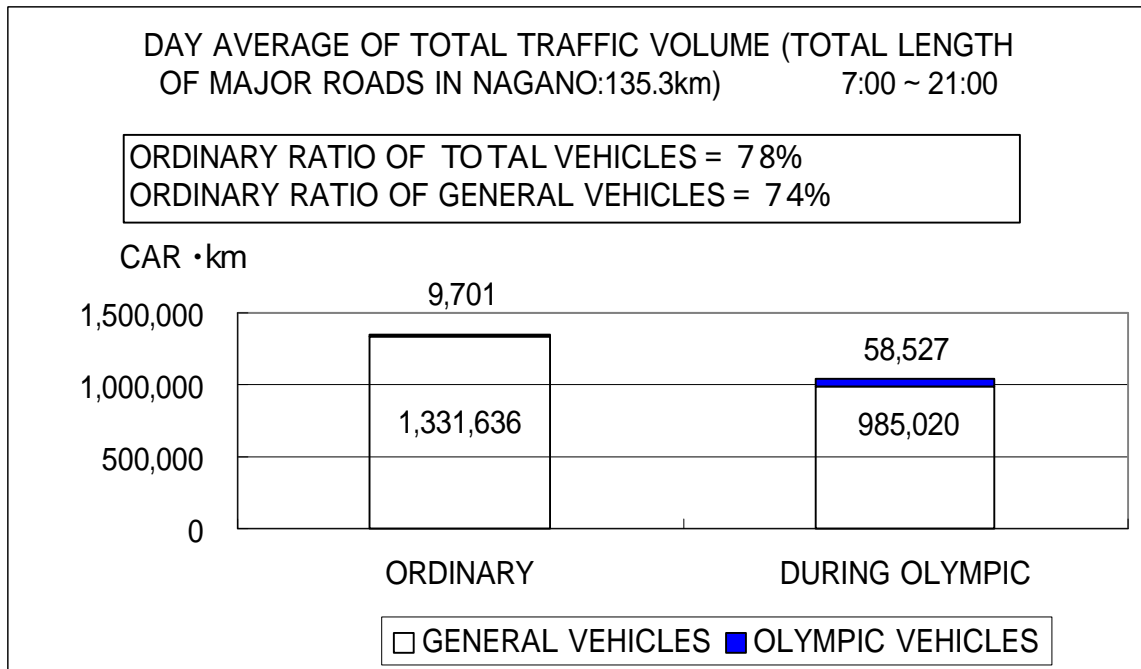


Fig. 2 Day average of total traffic volume (total on major roads in Nagano)

EFFECTS OF MACRO CONTROL

Macro control means a coordinated signal control to give preference to Olympic vehicles on Olympic routes. Therefore, the effects were compared to ordinary values on major Olympic routes in Nagano. The evaluation results are shown in Table 1. As shown in Fig. 2, travel time improvements in the loop line, an Olympic route, were 6.8% and 8.0% for clockwise and counterclockwise directions, respectively. This would be an effect resulting from the Olympic traffic regulations and the vehicle preference system control.

Table 1 Comparison of travel times on each road

LOOP LINE (OLYMPIC ROUTE)				
PERIOD	CLOCKWISE		COUNTERCLOCKWISE	
	TRAVEL TIME	IMPROVEMENT	TRAVEL TIME	IMPROVEMENT
		RATIO (%)		RATIO (%)
7-Feb-98	0:47:49	9.2	0:50:44	9.8
8-Feb-98	0:48:20	8.9	0:48:45	13.3
9-Feb-98	0:47:38	9.6	0:49:43	11.6
10-Feb-98	0:50:53	3.4	0:53:01	5.7
11-Feb-98	0:46:44	11.3	0:48:27	13.8
12-Feb-98	0:48:48	7.4	0:49:40	11.7
13-Feb-98	0:49:12	6.6	0:52:27	6.7
14-Feb-98	0:48:06	8.7	0:52:24	6.8
15-Feb-98	0:45:34	13.5	0:50:27	10.3
16-Feb-98	0:49:53	5.3	0:51:52	7.8
17-Feb-98	0:46:40	11.4	0:51:22	8.7
18-Feb-98	0:51:38	2.0	0:52:13	7.1
19-Feb-98	0:50:32	4.1	0:54:24	3.3
20-Feb-98	0:51:49	1.6	0:55:30	1.3
21-Feb-98	0:51:54	1.5	0:54:39	2.8
22-Feb-98	0:50:09	4.8	0:52:14	7.1
AVERAGE DURING OLYMPIC TIME	0:49:06	6.8	0:51:45	8.0
NORMAL TIME	0:52:41	-	0:56:14	-

$$\text{Improvement ratio (\%)} = \frac{\text{Normal travel time on road} - \text{Travel time on road during Olympics}}{\text{Normal travel time on road}} \times 100$$

EFFECTS OF MICRO CONTROL

The times for waiting for signals and the number of stops on signals for Olympic vehicles at the total six intersections with micro control means were compared between control “applied phases” and “not applied phases.”

As a result, the total time waiting for signals by Olympic vehicles during the Olympic period was reduced by 370,056 seconds (102 hours 47 minutes and 36 seconds), and the total number of stops at signals was reduced by 4,701 times.

If the control had not been applied, signal awaiting times and signal stop times could not have been reduced, so values directly demonstrate improvement effects.

CONCLUSIONS

Conventionally, PTPS has brought some successful results during demonstration tests. The system was practically applied to a large-scale event in the form of the Olympics, and considerable success was achieved, together with contributions from the traffic management plan. Therefore, the system has been proved to offer a good effect for the smooth operation of traffic on roads, and also on a practical level.

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