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Information using Cloud and other technologies toward Social Implement in the point of V2N view (SIP second's field of test result)

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ABSTRACT

We introduce SIP(strategy innovation promotion program) activities based on the results of research and development conducted from FY 2018 to FY 2022, we studied the traffic signal information center that receives signal information nationwide from the National Police Agency's traffic signal information aggregation system and transmits it to servers of operators, etc., for social implementation. In addition, we studied improvement measures for issues related to signal provision technology using cloud computing, etc. that were identified by FY2022, and conducted experiments to verify the improvement in signal information accuracy that can be achieved by improving the signal information accuracy of signal controllers from 1 second to 0.1 second, and confirmation of signal recognition timing difference for transition from one color(ex. green) to next yellow color within ±300mili-second could be achieved based on the performance of the communication interface data output by the traffic signal controller and the editing method of the traffic signal prediction information(SPAT) ,and also latency from signal control via traffic signal information aggregation system to autonomous vehicle system accomplish up to 1.6second(calls Δd for short).

Also what seconds needed to be providing signal information before the self-driving car reaches the intersection?

Even if the communication retransmission time is taken into account for Δt, it can be realized within 8.0 second.

Another point of view of pedestrian point, it is possible to acquire the time after pressing

the push button for pedestrians to pass, and to provide signal information,
so that safe driving support is also possible for pedestrians.

Background

UTMS Society Japan and cooperatives companies were jointly commissioned to conduct the project. The contents and results of each theme are as follows.

Theme 1: Research and Development for Signaling Information Provision Using the Cloud, etc. (Study on Technical Requirements for Signaling Information Centers, etc.)

The following four items were implemented

a) Study on technical requirements for signal information centers

b) Study on integrated distribution of information other than signal information (e.g., traffic regulation information)

c) Study on reduction of communication delays of signal information (one-stop communication)

d) Study on reducing the functions of the National Police Agency's signal information aggregation system

Theme 2: Research and development on the provision of signal information using the cloud, etc. (study on integrated distribution of information other than signal information for example traffic control information, etc.

The following three items were implemented.

a) Study on integrated distribution of information other than signal information (e.g., traffic control information)
b) Study on the linkage of signal information and high-precision 3D maps
   Verification of improvement of signal information accuracy (control system, centralized system)
c) Study on reduction of communication delay of signal information (control system, centralized system)

Theme 3: Research and Development for Signaling Information Provision Using the Cloud, etc. (Verification of Improvement in Accuracy of Signaling Information and Study on Reduction of Communication Delay of Signaling Information, etc.)

The following two items were implemented.

a) Verification of the accuracy of signal information (control system and controller system)

b) Study on reduction of communication delay of signal information (control system and controller system)

Approach and method

We have been tried three methods.

First is the method by which upcoming SPAT information is created at traffic control centers. Second is the method by which upcoming SPAT information is created by traffic signal controllers. Applicable to traffic signal controllers that are remotely controlled from traffic control centers (using common traffic signal control Protocol (DATEX-ASN) Third is the method by which the current traffic light information and upcoming SPAT information are created by traffic signal controllers at each intersection as Fig1.

FY2022 we had completed Field of test at Nara prefecture.

We introduce three method of conducting SPAT information as Fig2

Experimental system is shown at Fig.1 Center Control method: 9(3), Concentration method: 6(3), Signal control based method: 5,3intersections has the multiple experiment

The Fig3 shows intersections in Nara Prefecture where signal information is provided

Orange means control method intersection. Blue means pedestrian push button control intersection. Green means Concentration method and involving green arrow intersection

We use common protocol MQTTS and also activating TLS1.3 for secure communication. Showing in Fig4.

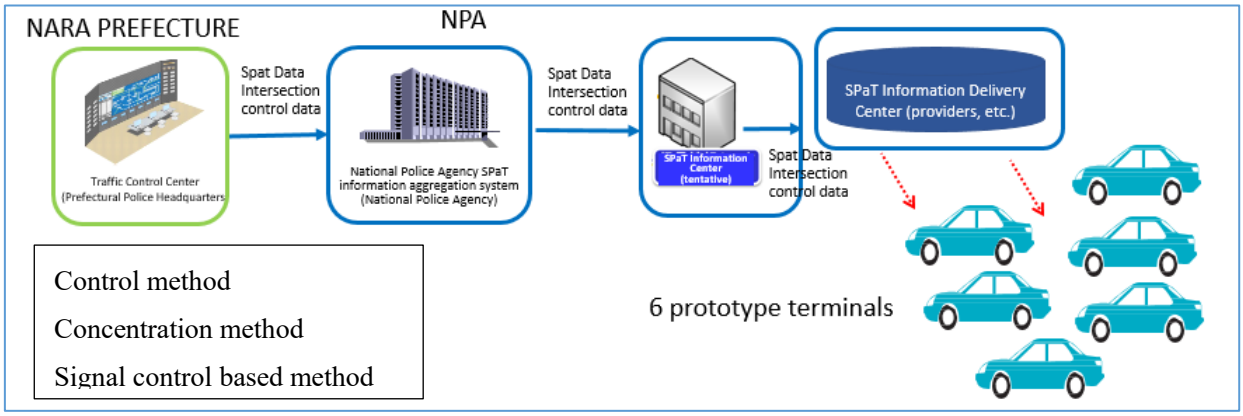

Fig1 2022 FOT system structure

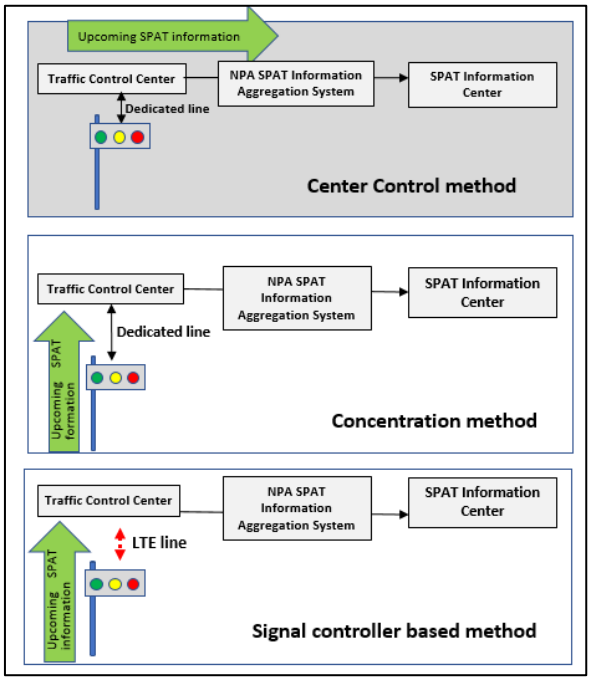

Fig2 Three method of creating SPAT information

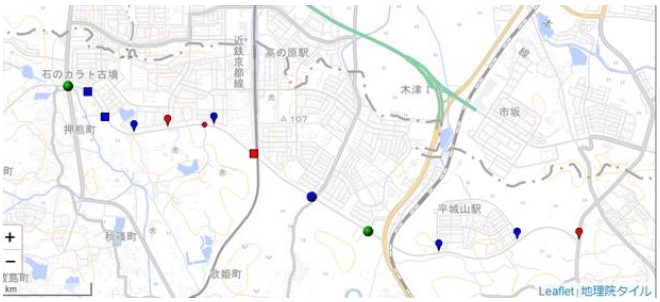

Fig3 2022 FOT intersections

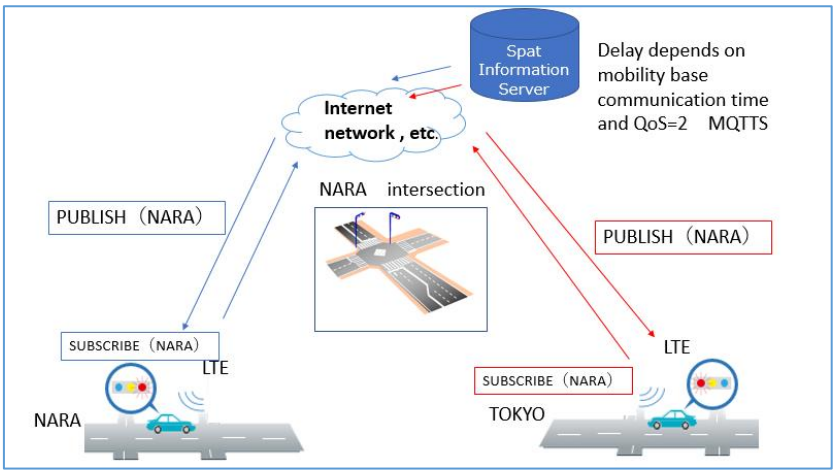

Fig4 Using MQTTS for getting SPAT Information

Result:

a) Δt and Δd experiment

We investigation of Δt and Δd (processing + communication delay)

Δt means when autonomous vehicles can receive SPAT information data from system approach near the intersection. We aimed 9S because in Japan Green color from start bigger than 15seconds.Time from the start of the cycle to the end of green bigger than the time for the upcoming SPAT information to reach the OBU + Δt was confirmed.

We show Fig5 inter-equipment data flow diagrams and values at evaluating the first method Center Control method. Every method results are shown below.

Processing and communication delay by using Control method at Fig6.

Processing and communication delay by using Concentration method at Fig7.

Processing and communication delay by using Concentration method at Fig8.

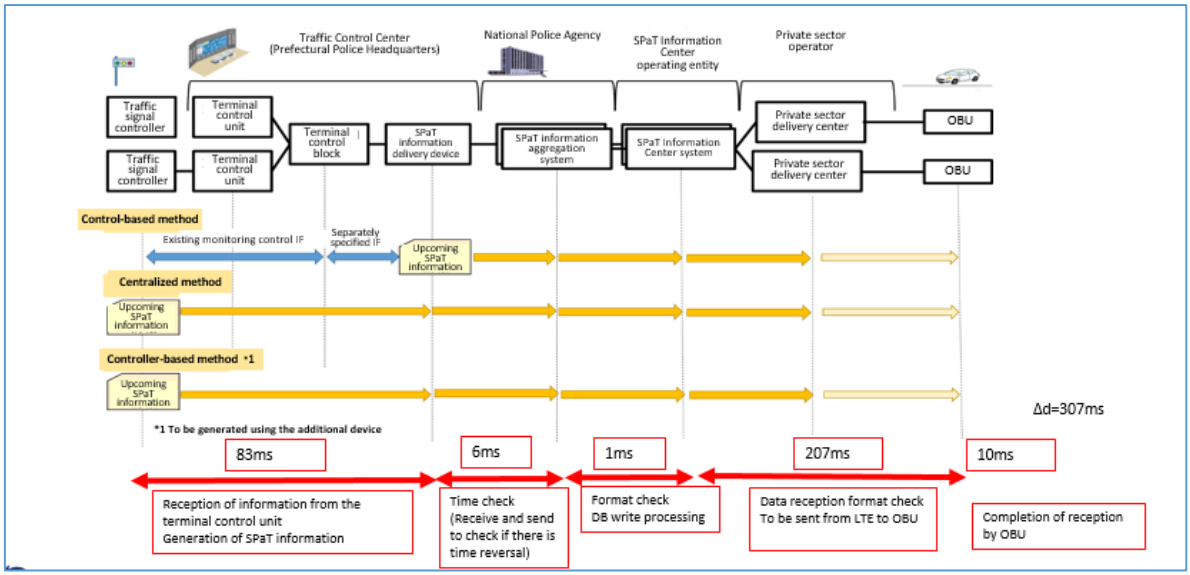

Fig5 inter-equipment data flow diagrams and measurement values

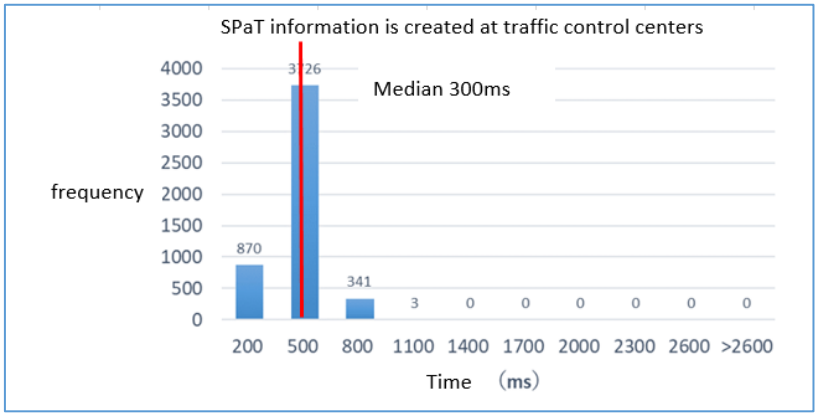

Fig6 Δd Control method result 2022 FOT system structure

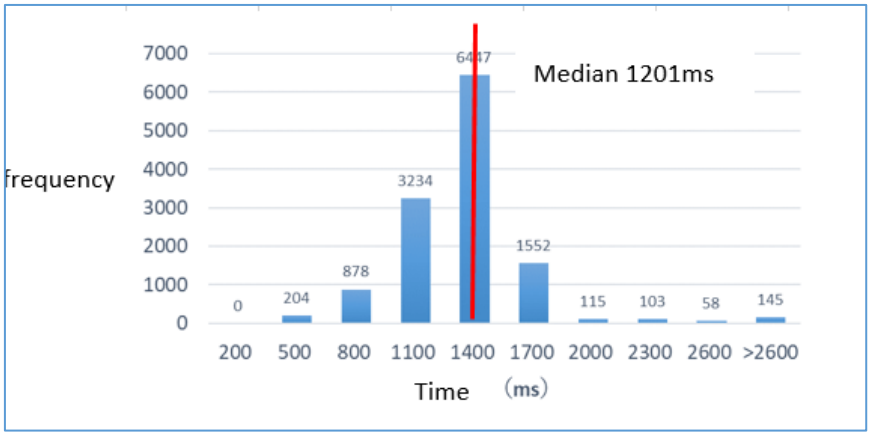

Fig7 Δd Concentration method result 2022 FOT system structure

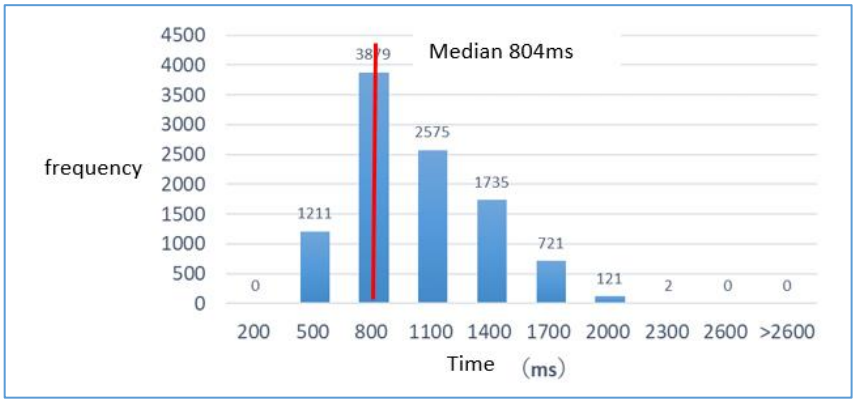

Fig8 Signal control based method result 2022 FOT system structure

The contents described so far are arranged in Table 1.

Describing the three methods feature and comprehensiveness in terms of functions, cost comparison, differences in road signal light colors and system display, and intermediate values from signal information generation to arrival at the receiving terminal.

Table1 Result comparison of three methods

method	function	feature	cost	result delay time (medium) between creating Spat information timing to	result Difference between signal color and system(aimed ±300ms)	problem
Control method (Spat created by Traffic Contorol Center using signal message of signal control)	○	Only revice of Traffic signal control	◎	300ms	-150ms~200ms	Difficulty in predicting offset tracking for different traffic light manufacturers (requires use of AI functions)
Concentration method (Need to implement data message and software of newly Spat's definitoin of stabndard DATEX-ASN message set)	○	Renovation of signal controller software and Constant change on the central unit side	○	1201ms	-150ms~200ms	Software update for traffic lights (high cost)
Signal control based method Need to implement MQTTS message and software	○	Renovation of signal controller software and MQTT environmental implementation	△	804ms	-233ms~200ms	Installation costs and LTE line quality

b) SPAT information for pedestrians

We show as Fig9 signal color changing time by time experimental result.

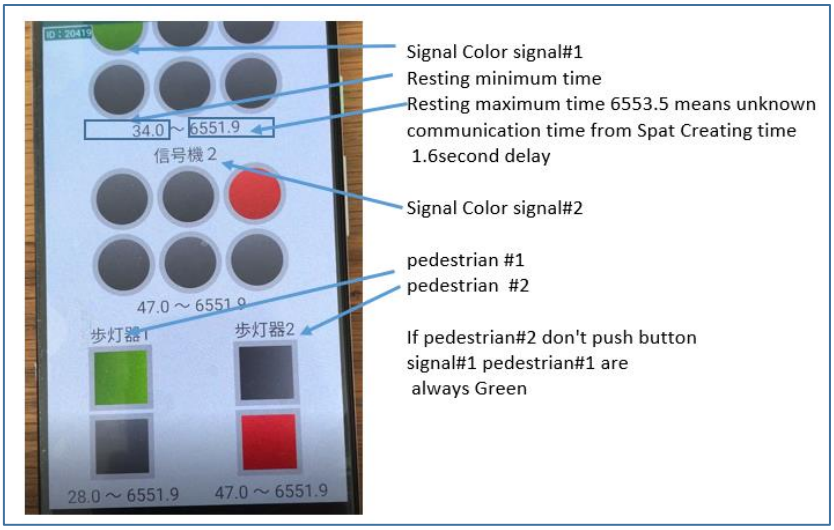

Fig9 Pedestrian Control method

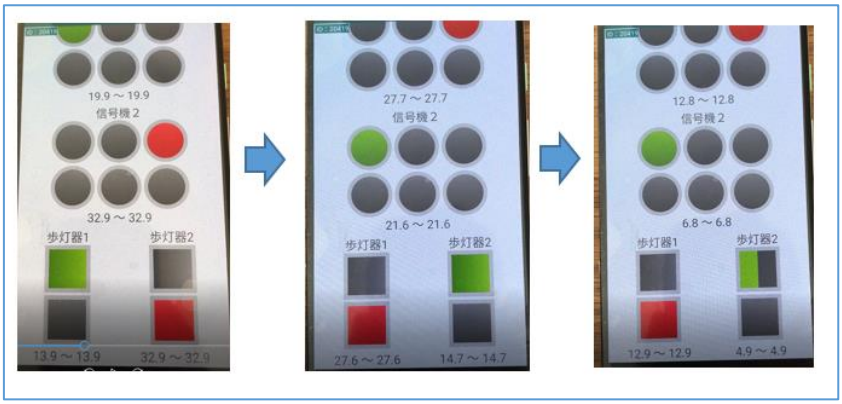

Fig10 Color Changing flow

Above Fig10 from left picture to center picture to right picture

This data flow is

If pedestrian#2 push button, signal control is beginning color control execution.

Minimum and maximum remaining seconds is same.

Pedestrian#2 red color remains 32.9Sseconds.

Next Signal#2 and pedestrian#2 both colors is changing red to green, and also pedestrian knows flash timing, pedestrian recognizes remaining of green flash remains of seconds.

c) Signal recognition timing difference for transition between signal control and receiving car terminal up to ±300ms

We measured the timing difference at the intersection in Nara prefecture experimental point. The signal, the center, the OBU vehicle terminal, and the GNSS clock are managed in absolute time, and the remaining seconds are displayed considering the difference between the signal information generation time and receiving time.

The error in the absolute time of each device includes the signal device and light color lighting error (±100ms), time error of the in-vehicle terminal (±66ms), and the in-vehicle terminal display timing (±50ms).

We show at Fig11 experimental result.

Below left picture means remains of red color 0.0second but display timing is delay 0.1S

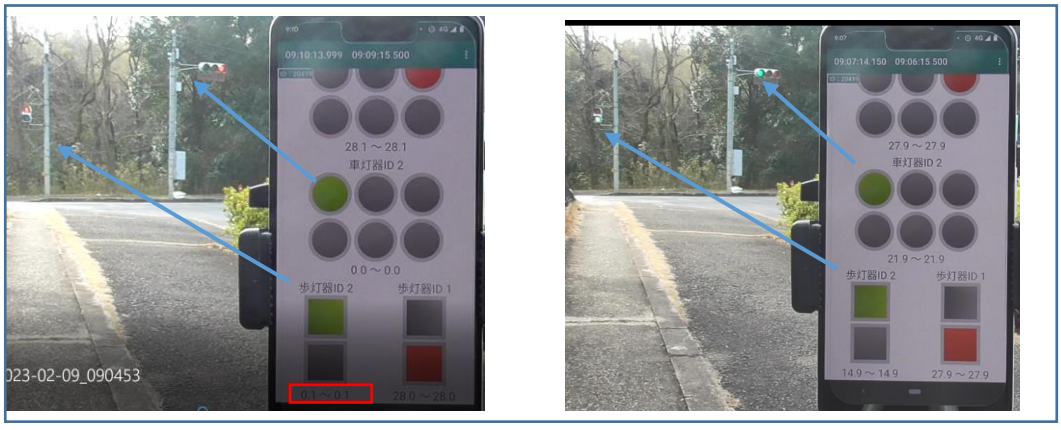

Fig11 Transition difference time from Red to Green is 0.1S

Future View:

We shall improving Signal Phase and Timing information (SPAT) provision technology using cloud computing and other technologies.

We also study on Social Functional Requirements (Necessity) of SPAT etc.

We must construct document as is social functional requirements (necessity) of the traffic signal prediction information's conditions for implementing entities

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