Visualize the effects of reducing traffic accidents through Automated Driving and Driving Assistance(FY2019-FY2020) Report of Results Summary version

Japan Automobile Research Institute

Report contents

Purpose of this project

【 Government policy 】

- To put vehicles with Level 2 driver assistance system into practical use on ordinary roads (in 2020)
- To put Level 3 automated vehicles into practical use on highways (in 2020)
- To put Level 4 automated vehicles into practical use on highways (around 2025) etc.

【 Society's expectations 】

Expectations are rising for the practical application and spread of automated driving technology and driving assistance technology.

【 Purpose of this project 】

Fostering social acceptance is necessary for the smooth implementation of automated vehicles and vehicles with driver assistance system in society

↓

In this project, we use a traffic flow simulation to estimate the effect of traffic accident reduction according to the prevalence of automated vehicles and vehicles with driver assistance system.

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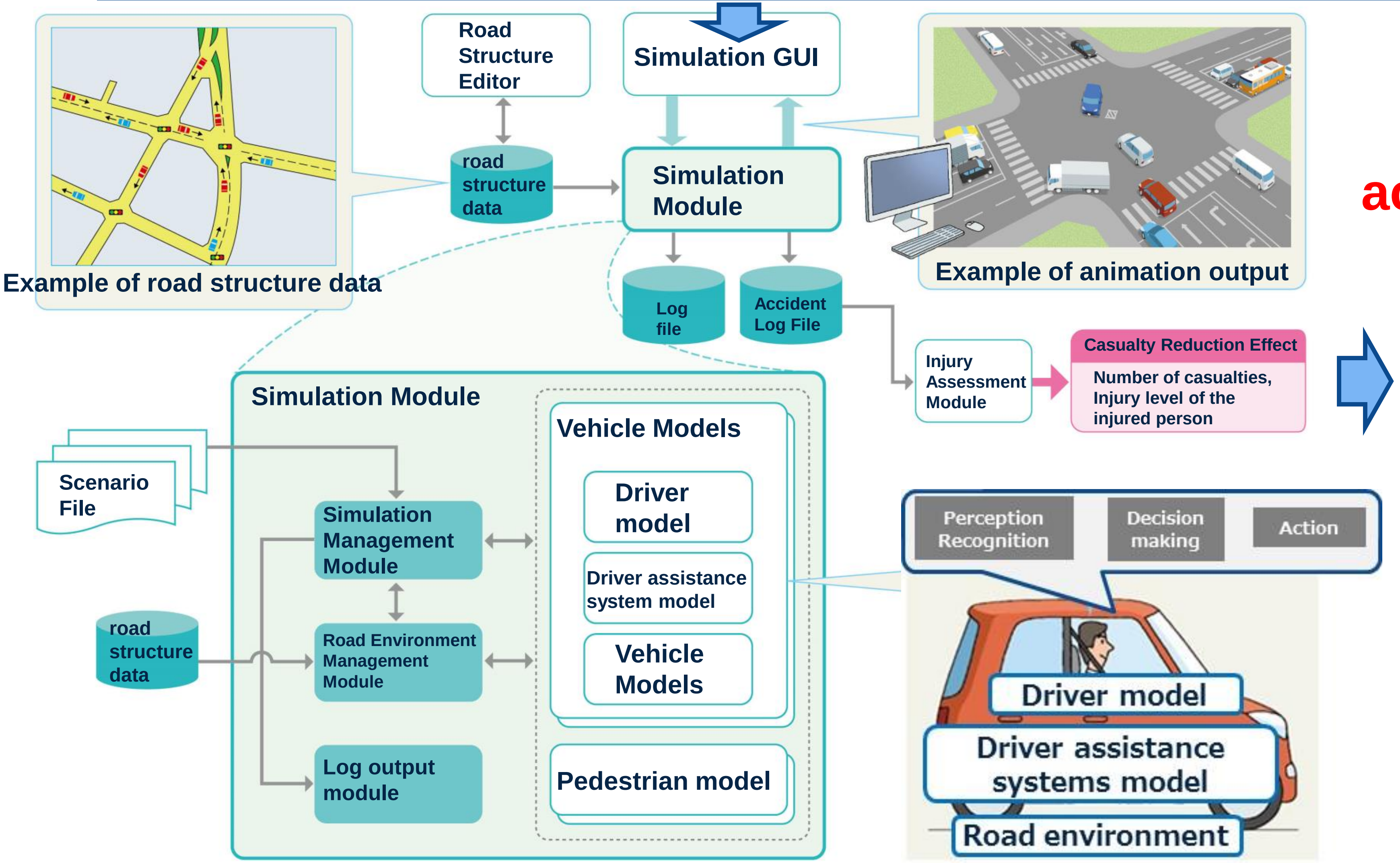
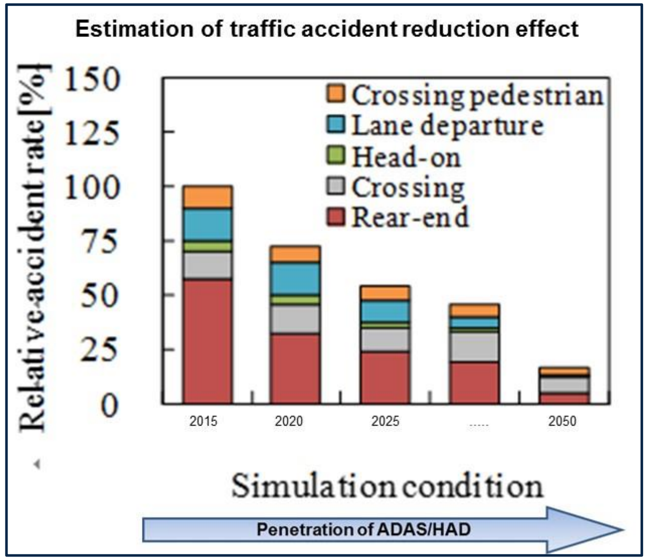
Overview of the entire simulation

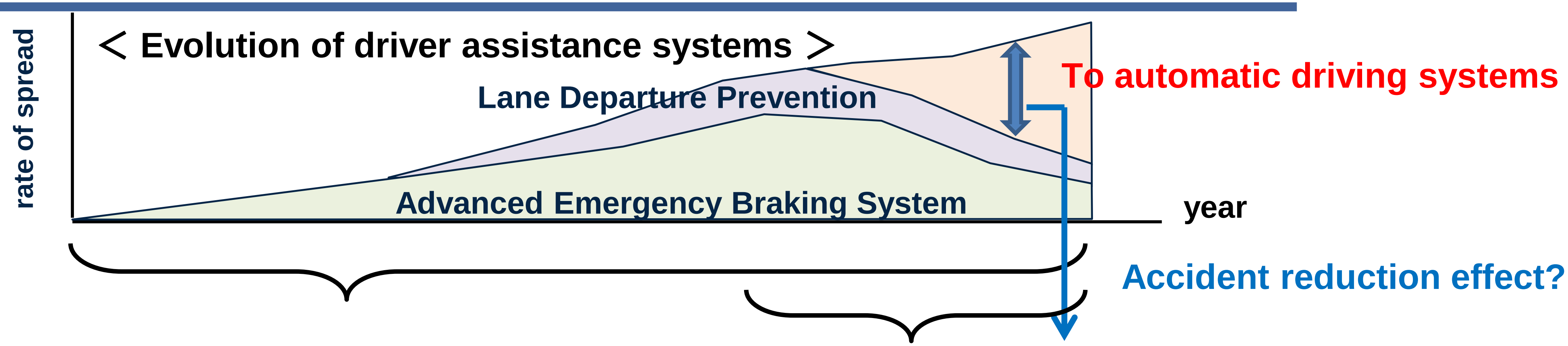
Parameters for assumptions (models, dissemination scenarios, etc.)



Estimation of traffic accident reduction effect



Positioning of the simulation



Existing Simulation	SIP Development Simulation
Traffic accident scene reproduction	**Multi-agent traffic environment reproduction**
For product Development: Competitive area (sensor specifications and control logic)	For policy making : cooperative area ⇒ **Strategies for the popularization of automated driving**
Micro Simulation (Reproduce a limited place and time)	**Macro Simulation** (Assume all areas and times)
Traffic participants act according to the predetermined scenario	**1) Multi-agent** Each traffic participant behaves independently and influences each other **2) Error behaviors such as looking aside are also implemented.** (Causes of accidents)

Project summary

SIP Phase 1（2015～2018）	SIP Phase 2（2019～2020）
"Development and substantiation of simulation technology for estimation of detailed traffic accident reduction effects"	"Visualizing the Effects of Traffic Accident Reduction "
・Establish simulation technology ・Develop behavioral models for traffic participants ・Validation of the simulation technology (Preconditions are tentatively defined)	Improvement of simulation accuracy ①Enhance the accuracy of the behavioral models ②Establish preconditions

①Enhance the accuracy of the behavioral models

Expand the pedestrian behavior model and establish a new bicycle behavior model

②Establish preconditions

A. Set dissemination scenarios (＊)
B. Set signal indication and traffic regulation information
C. Pedestrian and bicycle models and traffic settings
D. Set speed information

(＊)From the "Study of the Impact of Automated Driving on Reducing Traffic Accidents and on Others"

3. Setting of Assumptions　0. Determine the car model to be simulated.

Organize the following data and determine the car models to be simulated in as much detail as possible so that highly accurate reduction effects can be estimated.

①ITARDA Accident data

car model	Usage	GVW
small car	bus	
Ordinary car		
light vehicle	passenger vehicle	
small car		
Ordinary car		
light vehicle	cargo	
small car		3.5t or less
		Over 3.5t
Ordinary car		3.5t or less
		Over 3.5t
Special Vehicles		3.5t or less
		Over 3.5t
Large Special Vehicles		
motorbike		
bicycle		

②Dissemination scenario (Impact study)

car model	Usage	GVW
small car	bus	
Ordinary car		
light vehicle	passenger vehicle	
small car		
Ordinary car		
light vehicle	cargo	
small car		3.5t or less
		Over 3.5t
Ordinary car		3.5t or less
		Over 3.5t

③National Road and Street Traffic Information Survey (MLIT)

car model	Usage	contents
bus		2number
light vehicle		50～59　500～599
Ordinary car		3,5number
light vehicle	cargo	40～49　400～499
small car		4number
Ordinary car		1number
Special Vehicles		8number
freight and passenger car		

■Setting up a car model

car model	Usage	contents
small car	bus	2number
Ordinary car		
light vehicle	passenger vehicle	50～59　500～599
small car		5number
Ordinary car		3number
light vehicle	cargo	40～49　400～499
small car		4number
Ordinary car		1number
Special Vehicles		8number
motorbike		
bicycle		

※However, there is no scenario for the spread of special-purpose vehicles and motorcycles.

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A. Set dissemination scenarios

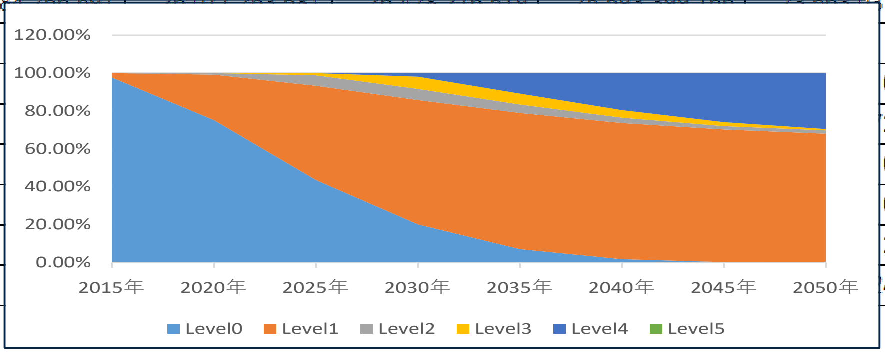
Converted the mileage of the "Impact Study" into the penetration rate of the simulation.

		Distance traveled [vehicle km].							
car model	Automatic driving	2015	2020	2025	2030	2035	2040	2045	2050
Passenger Light vehicles	C0	19,612,984,234	15,657,055,859	9,586,978,203	4,605,018,708	1,623,478,347	390,013,895	59,301,922	5,272,624
	C1	474,417,749	5,269,971,772	12,017,902,497	17,110,167,010	19,516,298,255	20,011,312,815	18,993,529,031	17,108,689,883
	C2	0	271,357,478	331,594,216	259,162,351	148,591,884	56,271,738	12,792,511	1,598,175
	C3	0	194,231,972	1,292,181,037	1,290,980,457	920,646,902	472,965,437	160,271,665	33,157,530
	C4	0	0	263,690,419	1,488,326,777	1,301,426,942	889,449,555	426,384,116	130,032,455
	C5	0	0	0	430,601,394	2,121,757,969	1,868,857,554	1,271,945,477	607,531,232
	C6					445,063,281	2,739,405,524	4,669,174,445	5,676,756,083
合計		20				26,077,263,581	26,428,276,519	25,593,399,166	23,563,037,983
		Combine C1 and C2 and convert to SAE level							
car model	Automatic driving	2015	2020	2025	2030	2035	2040	2045	2050
Passenger Light vehicles	Level0	9,612,984,234	15,657,055,859	9,586,978,203	4,605,018,708	1,623,478,347	390,013,895	59,301,922	5,272,624
	Level1	474,417,749	5,541,329,250	12,349,496,713	17,369,329,361	19,664,890,139	20,067,584,553	19,006,321,542	17,110,288,059
	Level2	0	194,231,972	1,292,181,037	1,290,980,457	920,646,902	472,965,437	160,271,665	33,157,530
	Level3	0	0	263,690,419	1,488,326,777	1,301,426,942	889,449,555	426,384,116	130,032,455
	Level4	0	0	0	430,601,394	2,121,757,969	1,868,857,554	1,271,945,477	607,531,232
	Level5								56,083
		20			25,18				7,983
Passenger Light vehicles	Level0	97.64%	73.19%	40.81%					0.02%
	Level1	2.36%	25.90%	52.57%					2.61%
	Level2	0.00%	0.91%	5.50%					0.14%
	Level3	0.00%	0.00%	1.12%					0.55%
	Level4	0.00%	0.00%	0.00%					2.58%
	Level5	0.00%	0.00%	0.00%					4.09%

Category to SAE level

Converting mileage to penetration rate

Dissemination rate image for each year



Note: In the dissemination scenario provided this time, the dissemination rate of SAE level 5 is assumed to be 0 [%] until FY2050 because it is difficult to predict at this time.

B. Set signal indication and traffic regulation information (1/2)

In order to perform more accurate simulations, the following information is set on the map data for the area to be simulated①signal indication information and ②traffic regulation information in the area to be simulated are set in the map data.

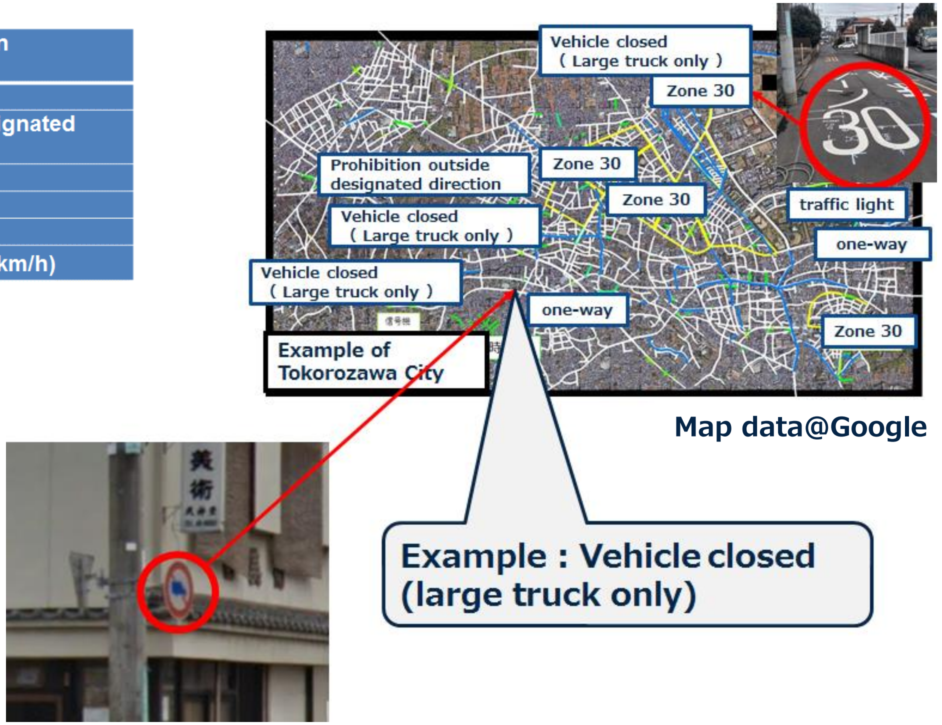
①Signal indication information (include pedestrian signals)

Map data@Google

Example of Tokorozawa City, Saitama Prefecture
(○ : setting points)

② traffic regulation information

Type of traffic regulation information
Vehicle closed
Prohibition outside designated direction
One-way
Pause
Traffic light
Zone 30 (Max. speed 30km/h)



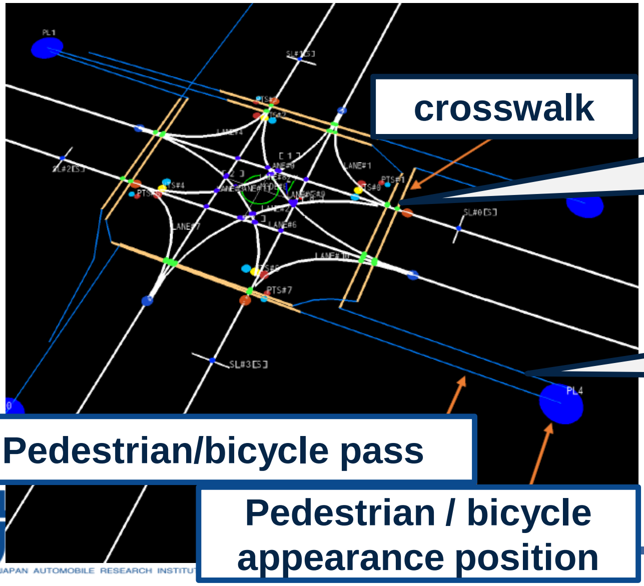
Map data@Google

C. Pedestrian and bicycle models and traffic settings

Expand the types of pedestrian accidents and establish a new bicycle behavior model to reproduce major bicycle accidents

【 Types of accidents reproduced in the simulation of this project 】

Traffic participants	SIP Phase 1	SIP Phase 2 (this project)
Pedestrian	Single road crossing only	Single road crossing + Crossing signal intersection (only second party)
Bicycle	-	Head-on, Left turn involved, and right straight accidents(only second party)



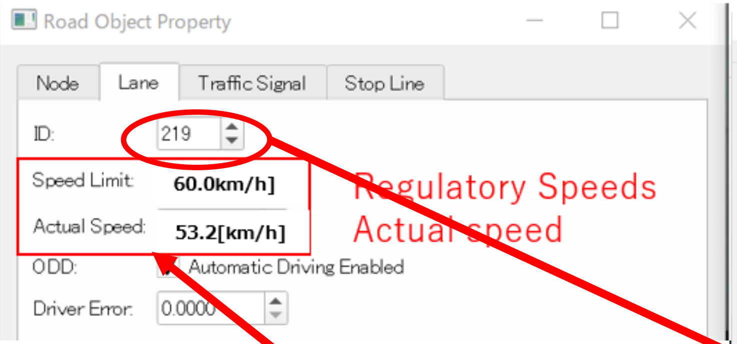
Set the signal for pedestrian at the intersection

Set pedestrian/bicycle path at the intersection

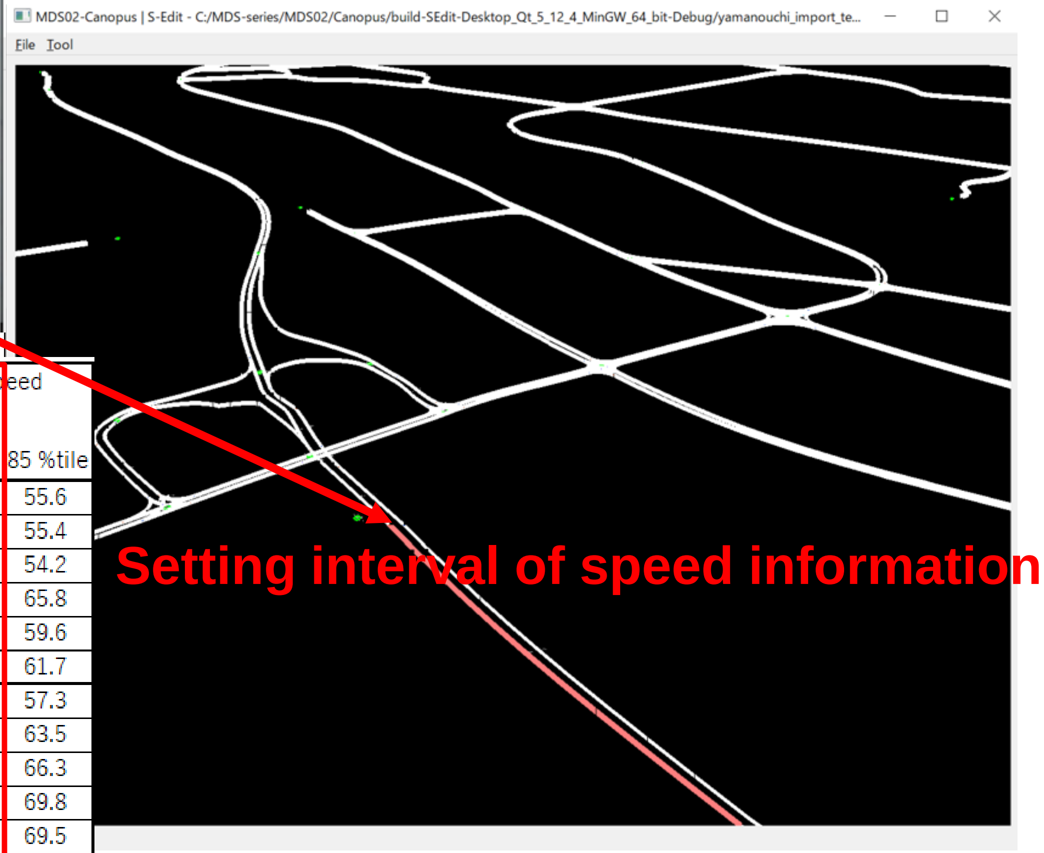
Conducted on-site traffic volume surveys mainly at accident-prone points in each model area, and set pedestrian and bicycle traffic volumes on maps.

D. Set speed information

Set the regulatory speed (designated speed or legal speed) and actual speed on the map data



No.	Region	Number of lanes	Central separator	Pedestrians Traffic volume (12 hours during the day.)	actual speed average	actual speed 85 %tile
①	Urban areas	two lanes	-	much	44.0	55.6
②				not much	44.8	55.4
③		four lanes	With central separation	much	43.2	54.2
④				not much	53.6	65.8
⑤			No central separation	much	48.6	59.6
⑥				not much	49.4	61.7
⑦	Non-urban areas	two lanes	-	much	46.9	57.3
⑧				not much	53.2	63.5
⑨		four lanes	With central separation	much	54.7	66.3
⑩				not much	57.0	69.8
⑪			No central separation	much	53.7	69.5
⑫				not much	54.6	68.4



Designated speed and legal speed are set based on the actual designated speed and legal speed in each model area.
The actual speed was set with reference to the "Research and Study Report on the Determination of Regulatory Speeds in Fiscal 2008".

Simulation results

4. Setting up the conditions for running the simulation

(1) Reproduction of realistic traffic flow

Confirmation of reproducibility of traffic flow in each model city calculated in E.

(2) Realistic reproduction of the accident situation

Reproduction of the accident occurrence situation in each model city obtained in F.

(3) Calculating the number of accidents caused by automated driving (driver assistance) systems

Using the simulation environment described in (1) and (2) above, calculate the number of accidents that occur in each model city according to the diffusion rate of automated driving (driver assistance) systems calculated in G.

(4) Estimation of accident occurrence in the model area

Estimates of accident occurrence in each model region, assuming that the accident reduction fact … gions.

Set the simulation execution conditions E. to G. for simulation execution.

(5) Estimate t … f accidents in the model regions

5.Confirmation of simulation results

(1) Reproduction of realistic traffic flow

Confirmation of reproducibility of traffic flow in each model city calculated in E.

(2) Realistic reproduction of the accident situation

Reproduction of the accident occurrence situation in each model city obtained in F.

(3) Calculating the number of accidents caused by automated driving (driver assistance) systems

Using the simulation environment described in (1) and (2) above, calculate the number of accidents that occur in each model city according to the diffusion rate of automated driving (driver assistance) systems calculated in G.

(4) Estimation of accident occurrence in the model area

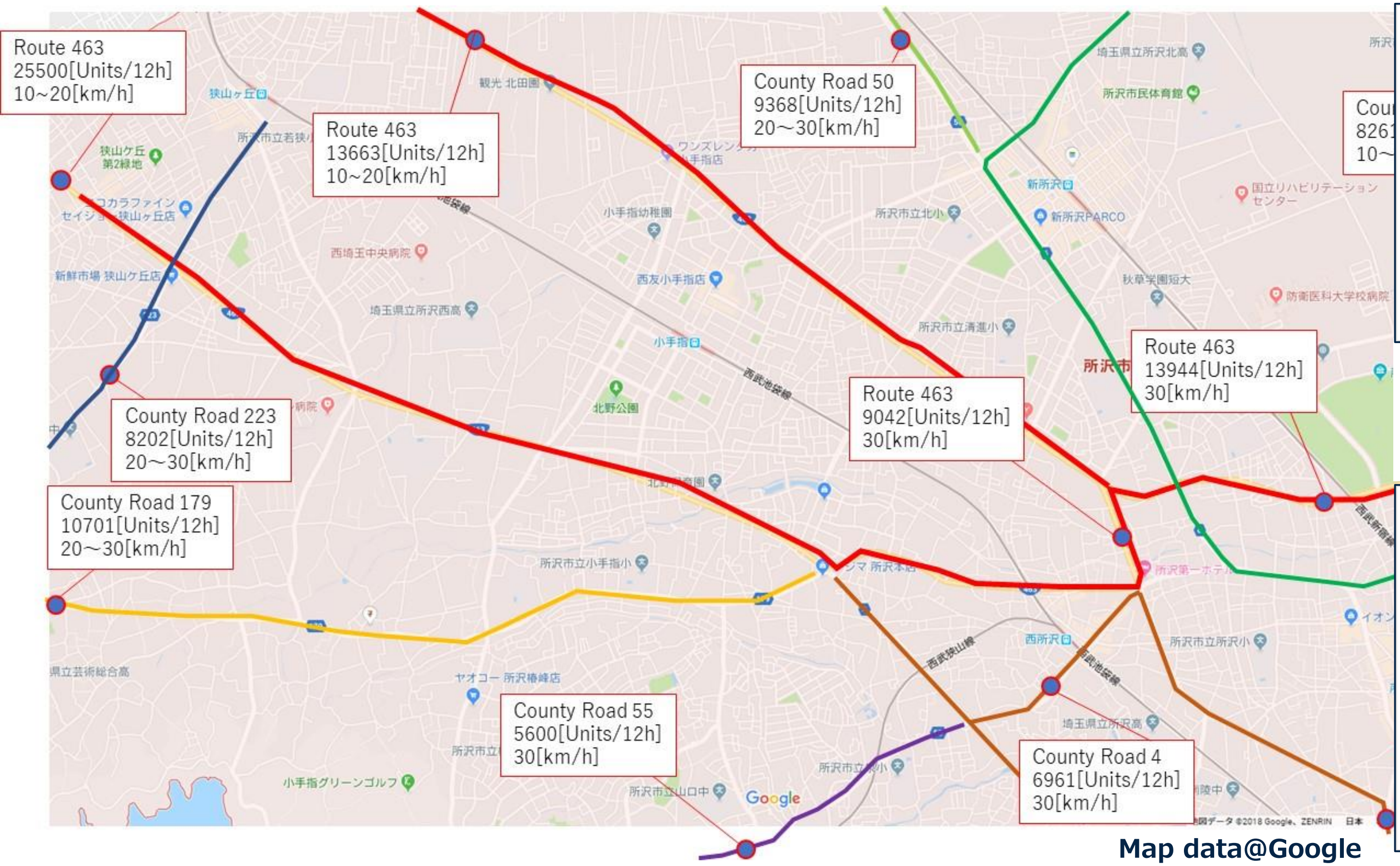
Estimates of accident occurrence in each model region, assuming that the accident reduction factors obtained for the model cities are applicable to all model regions.

(5) Estimate the number of accidents nationwide by summing the number of accidents in the model regions

①Reproduction of realistic traffic flow

Confirmation of reproducibility of traffic flow in each model city calculated in E.

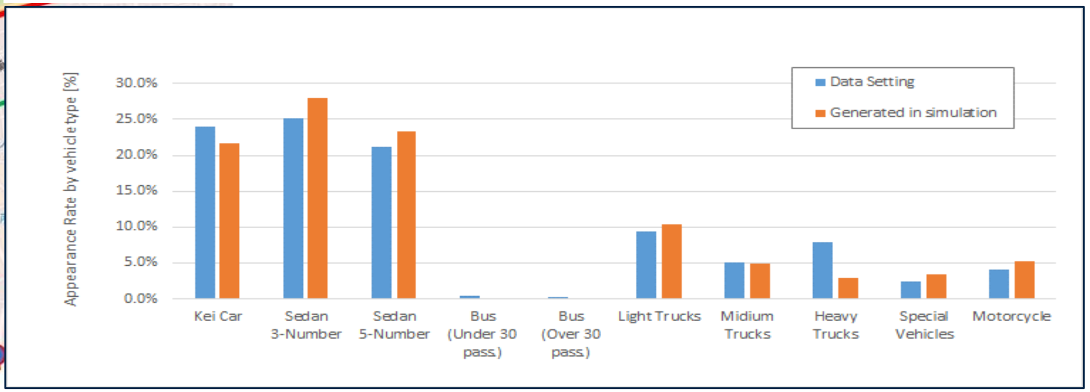
【 (Large city) : Tokorozawa City 】



Map data@Google

Traffic volume at observation point

Traffic volume by vehicle category at observation point ①

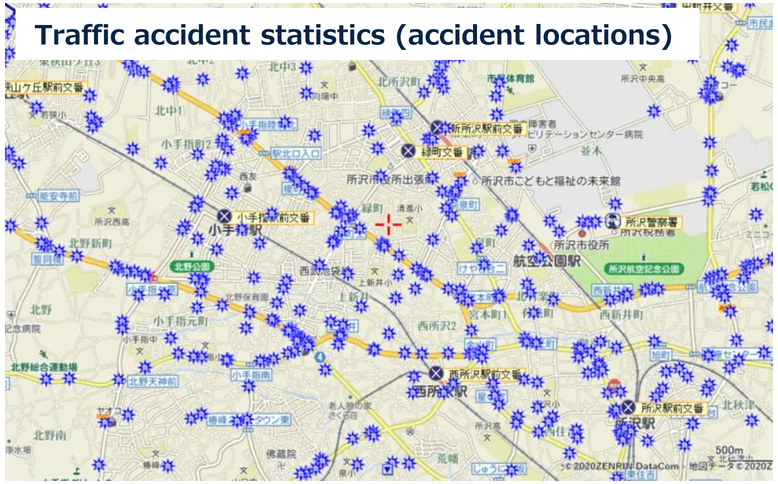


Confirmed that the simulation reproduced the traffic flow that reflected the characteristics of the 1-hour daytime traffic volume at major points within the simulation area (error less than 10 [%]).

Source: Ministry of Land, Infrastructure, Transport and Tourism: National Survey on Road and Street Traffic Conditions_General Traffic Volume Survey

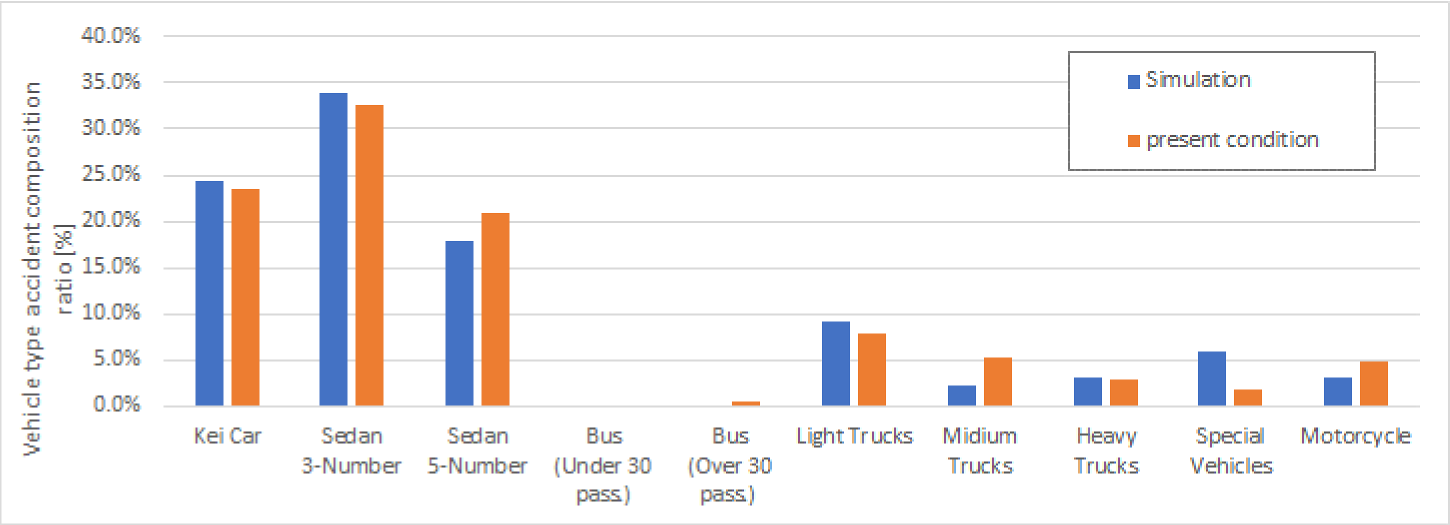
②Realistic reproduction of the accident situation

【 (Large city)： Tokorozawa City 】



Source]Saitama Prefectural Police: Incident Occurrence Map

Map data@Google



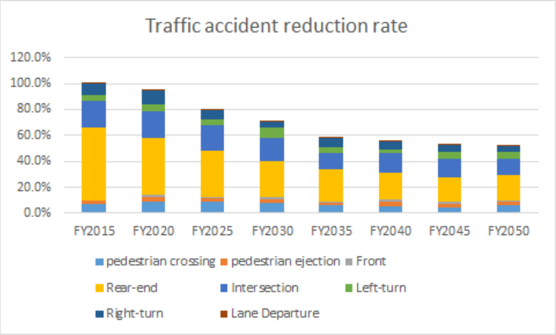
Note: The simulation reproduces on a map the main trunk lines, branch lines, and daily roads around the station.

Confirmation of validity by comparing the simulation results with accident locations indicated by traffic accident statistics (2015-2017)

③Calculating the number of accidents caused by automated driving (driver assistance) systems

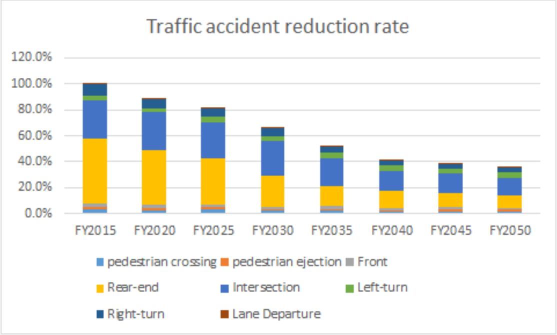
Simulations were run for each model region, and the effects of reducing traffic accidents were estimated for each.

Large city: Tokorozawa City (Saitama Prefecture)



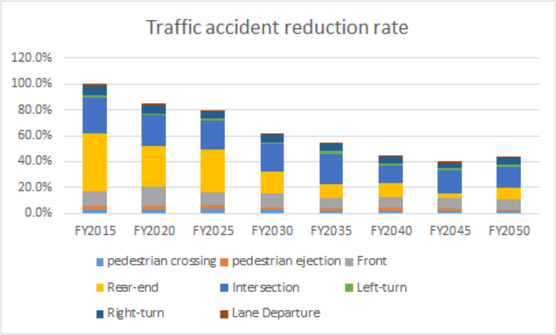
【 Accident reduction effect 】

Local City：Joso City (Ibaraki Prefecture)



【 Accident reduction effect 】

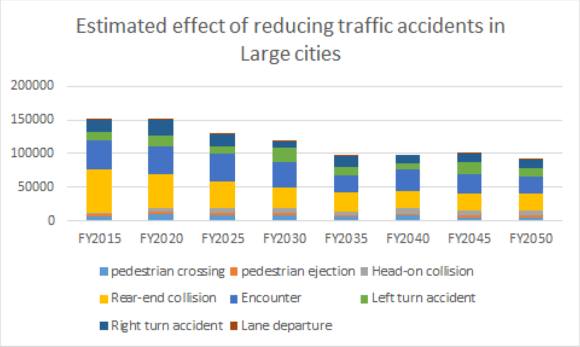
Depopulated area: Yamanouchi Town (Nagano Prefecture)



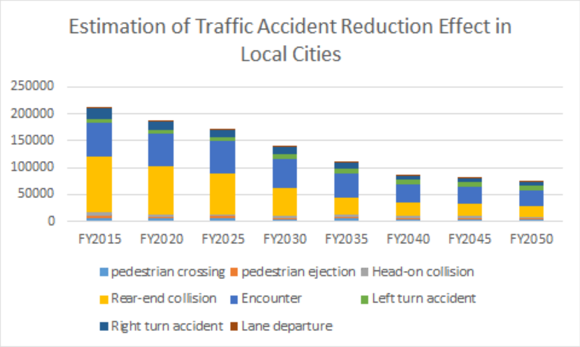
【 Accident reduction effect 】

④Estimation of accident occurrence in the model area

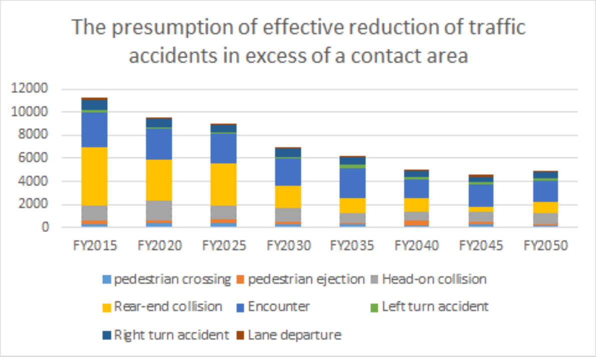
Large city: Tokorozawa City



Local City：Joso City



Depopulated area: Yamanouchi Town

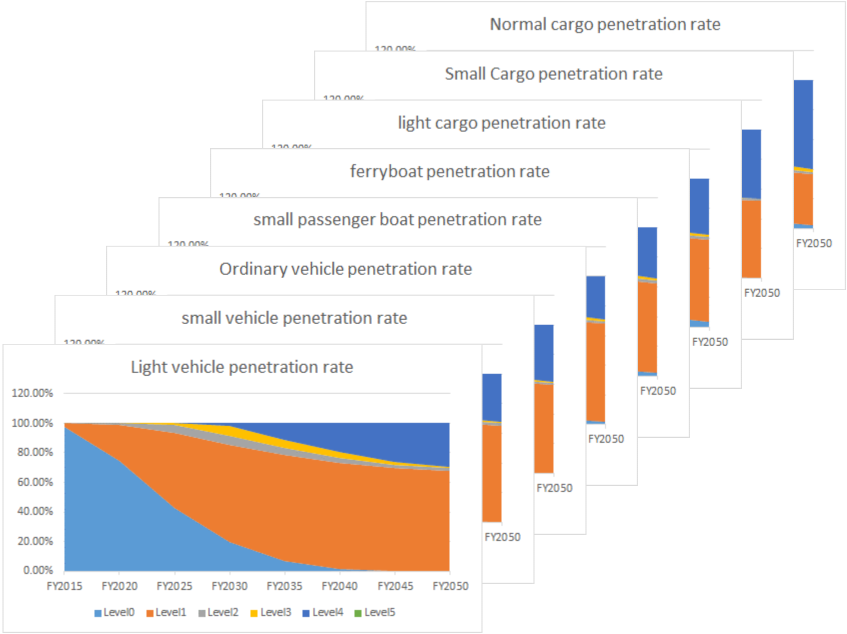


(1) Accident reduction coefficients were calculated from the simulation results by diffusion scenario and accident type for each model region.
(2) The calculated accident reduction coefficients were used to estimate the effect of reducing the number of accidents.

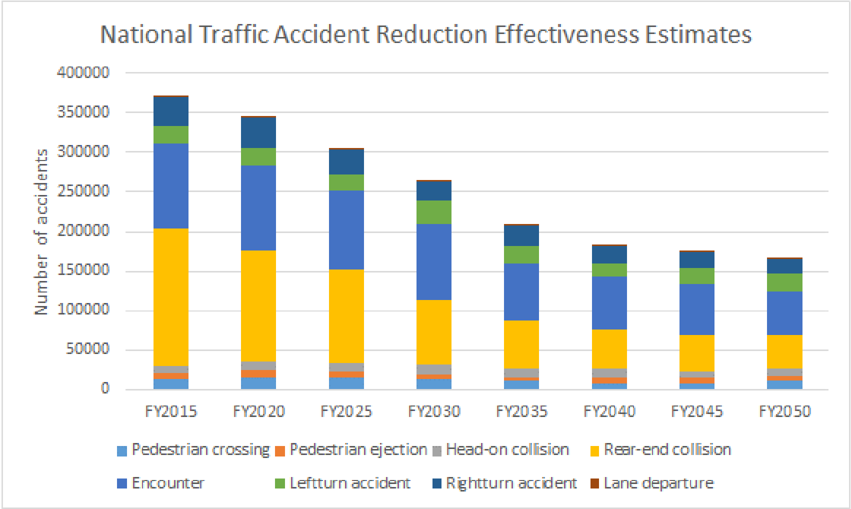
⑤Estimate the number of accidents nationwide by summing the number of accidents in the model regions

Based on the reduction effect in each model region, the effect of reducing traffic accidents on a national scale was estimated based on national traffic accident statistics data.

【 Scenario of automated driving diffusion (national average) 】



【 Effectiveness in reducing accidents on a nationwide scale 】



The reduction effect of the spread of the system can be confirmed. The reduction effect is small for pedestrian crossing and collision accidents. This is thought to be due to the fact that the penetration rate of Level 3 and above is low, and that the automated driving system model implemented in this study assumes only autonomous sensors and cannot respond to sudden jumps out of sight.

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