Orchestrating a brighter world

NEC

Strategic Innovation Promotion Program (SIP) Phase 2/
Innovation of Automated Driving for Universal Services

A Study on V2X Communication for Achieving Use Cases of Cooperative Driving Automation

Interim Report

March 2021

NEC Corporation

1. Implementation Plan

(1) Background and Objectives

Background of research and development

- Study in SIP Phase 2
  - In the cooperative area of research and development, we will focus primarily on the development of basic technologies necessary for improving the driving environment for automated vehicles and for ensuring safety.
  - In the course of studying the development of the driving environment and other factors, we will decide on the road traffic information format and communication requirements necessary to achieve automated driving, and aim to standardize these aspects.

- Study in FY 2019
  - Survey related to communication technologies for automated driving systems
    - Detailed survey and analysis of use cases
    - Survey and analysis of discussions at companies and organizations regarding the deployment of 5GHz band V2X
  - Task Force on V2X Communication for Cooperative Driving Automation
    - Organization of use cases of cooperative driving automation (3 categories, 25 cases)

(1) Background and Objectives

Objective of research and development

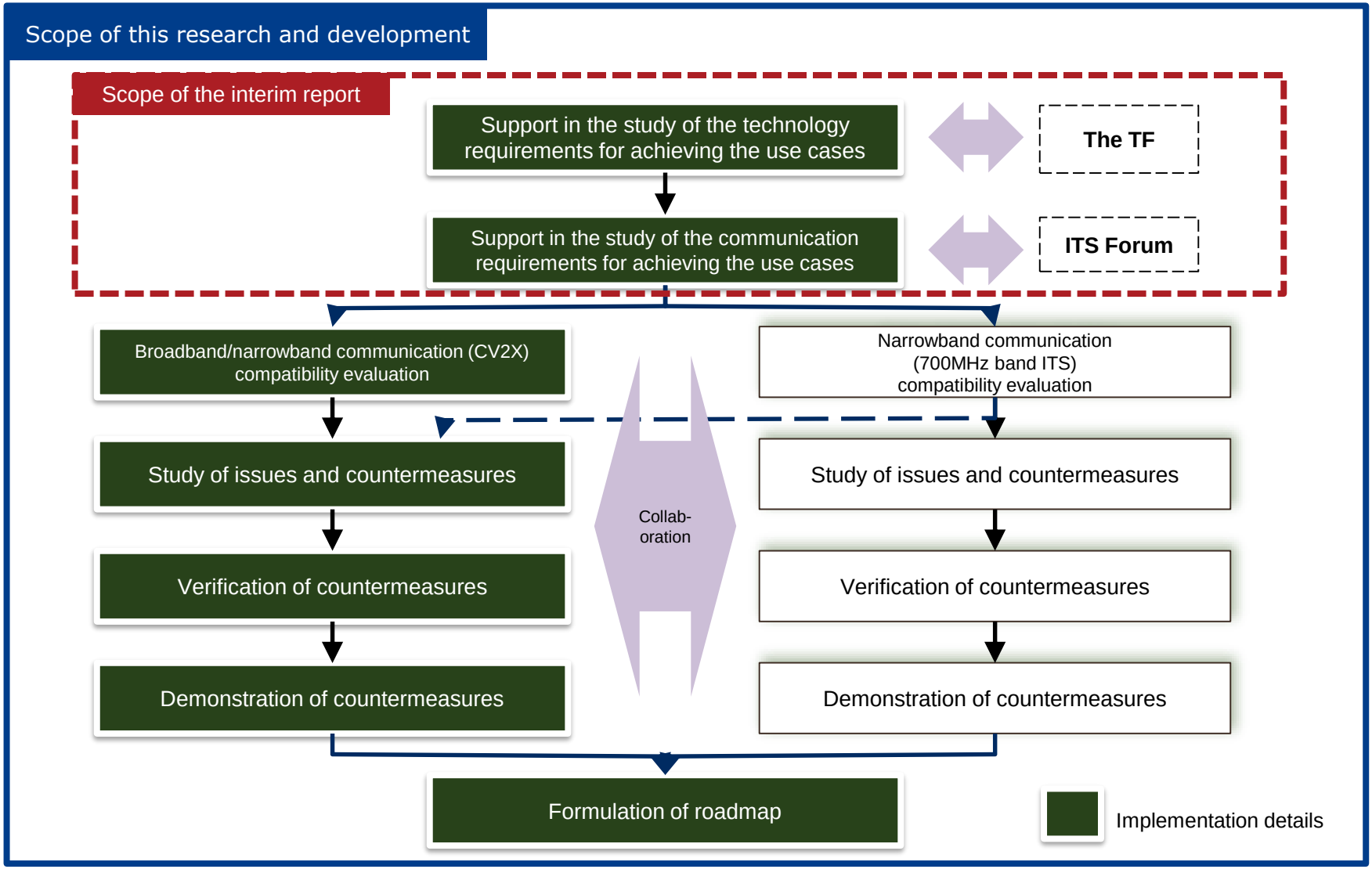
- Task Force on V2X Communication for Cooperative Driving Automation (hereinafter, "the TF")
  - Organization of use cases of cooperative driving automation (3 categories, 25 cases)

- Objective of this research and development
  - To verify the feasibility of communication technologies, including concrete specifications pertaining to wireless communication technologies for achieving use cases of cooperative driving automation.

Based on the assumption that communication technologies are expected to evolve in the future, we will formulate a roadmap identifying use cases and the concrete specifications for wireless communication technologies needed to achieve each use case.

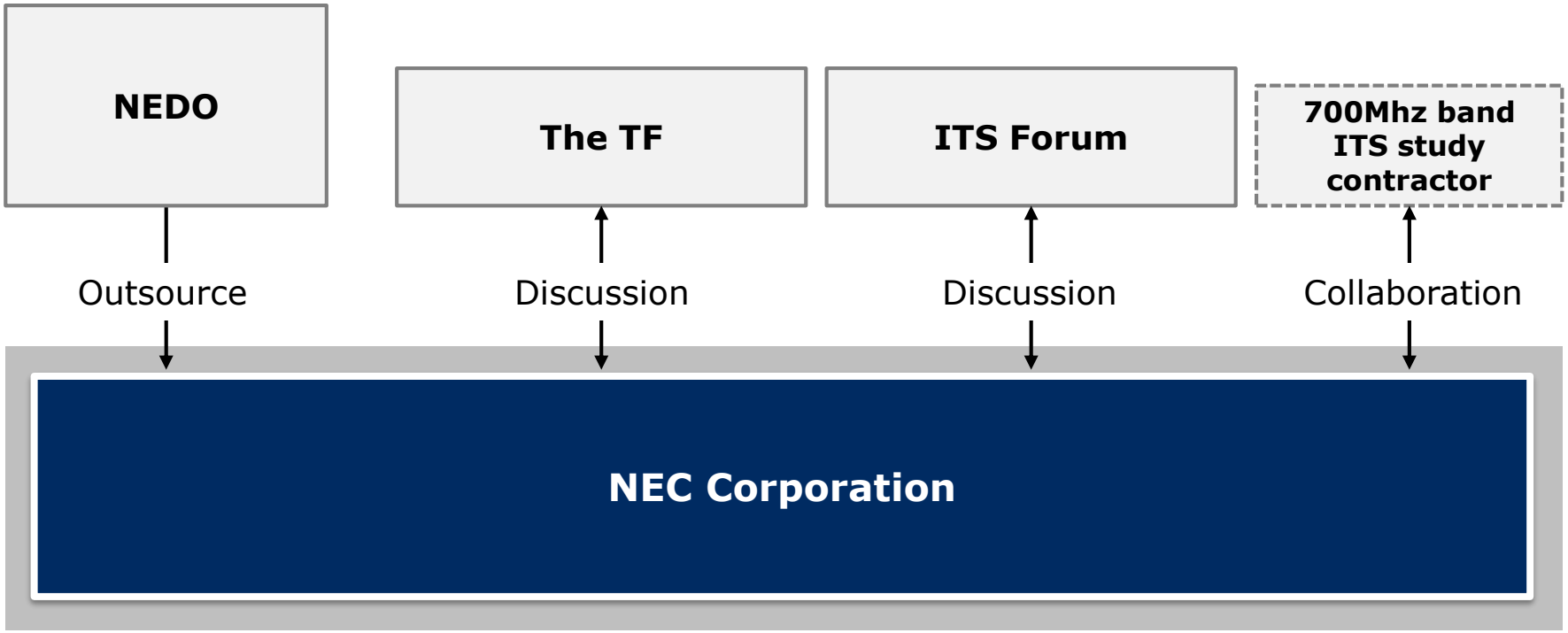
(2) Implementation Details

Implementation details and procedures



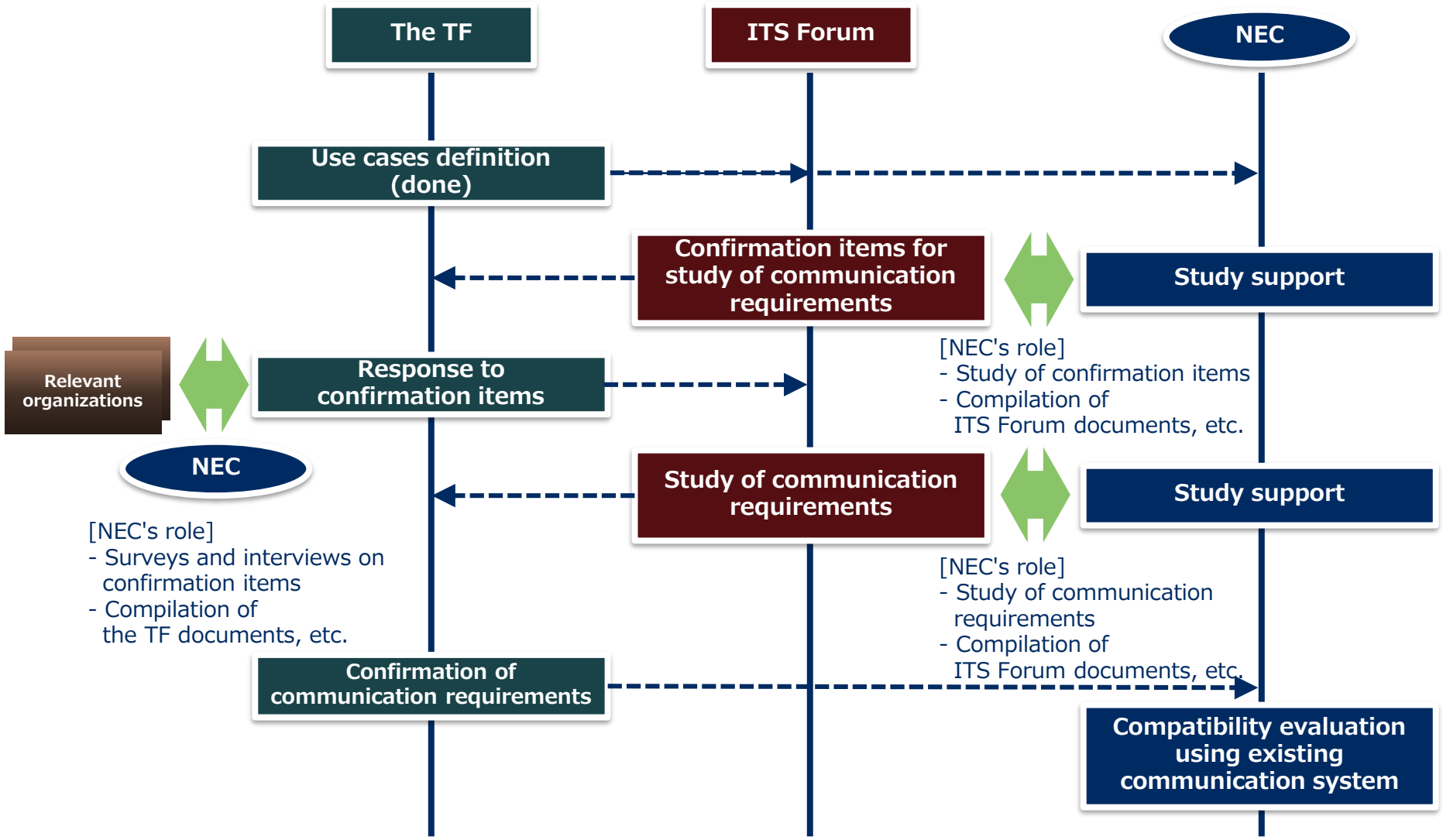
(3) Implementation Structure

Implementation structure



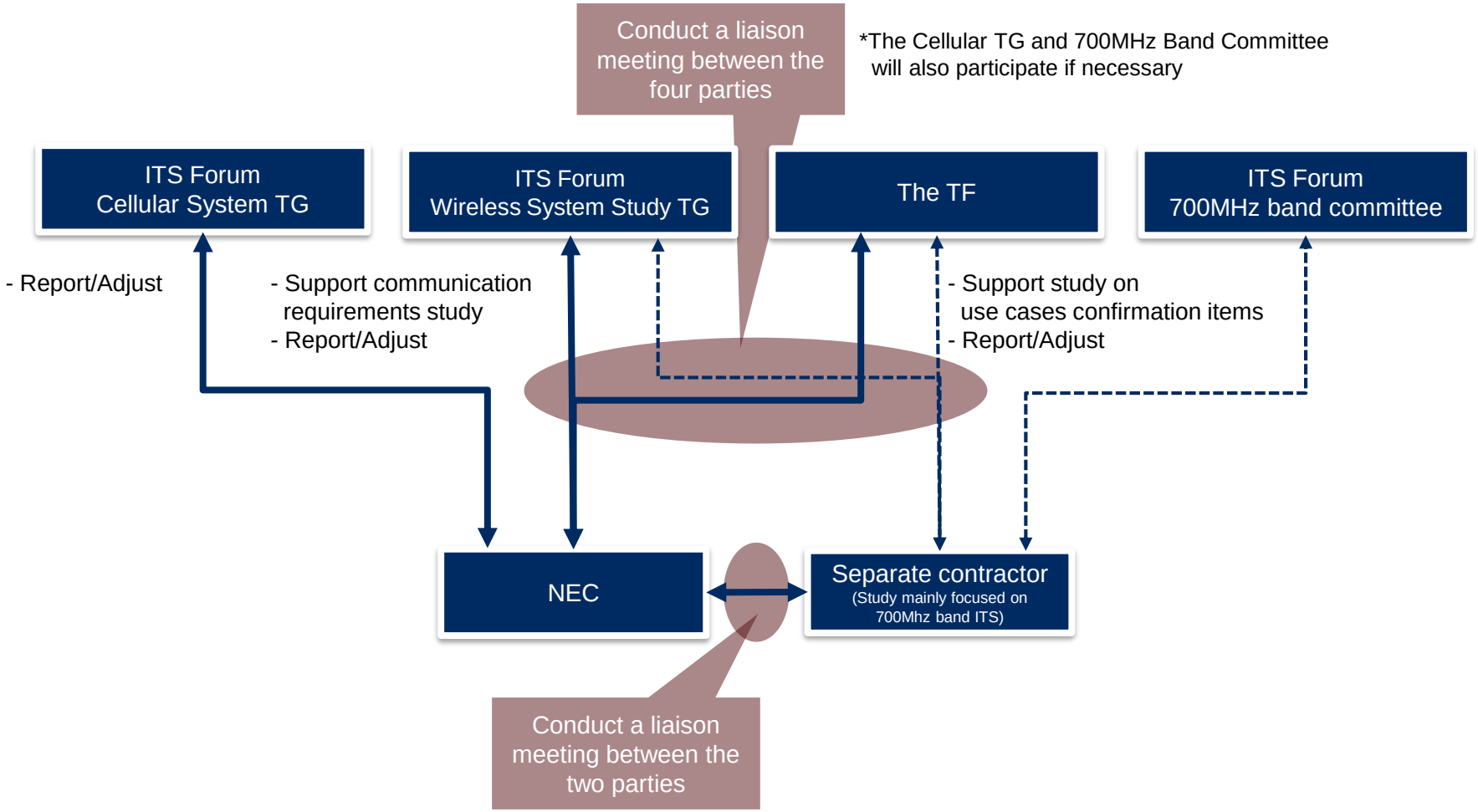
(4) Research and Development Details and Methods

Flow chart for the study



(5) Research and Development Details and Methods

Collaboration with the TF and ITS Forum



(6) Schedule

Overall schedule for this research and development

Research and development item	FY 2020 1st half	FY 2020 2nd half	FY 2021 1st half	FY 2021 2nd half
1. Compatibility evaluation using existing communication system		→		
2. Study of issues and countermeasures, and verification/demonstration of countermeasures			→	
3. Formulation of roadmap for the timing of social implementation of communication technologies necessary for the realization of an automated driving society			→	
4. Supporting the creation of reports and documents for the TF and ITS Forum		→	→	
5. Deliberation by expert panel (ITS Forum, etc.)			→	

(6) Schedule

Schedule for FY 2020

Item	November	December	January	February	March
The TF		Dec. 3 ▼ TF		Feb. 4 ▼ TF	
ITS Forum Wireless System Study TG	Nov. 16 ▼ TG	Dec. 14 ▼ TG	Jan. 14 ▼ TG	Feb. 18 ▼ TG	Mar. 18 ▼ TG
	Working group activities for study of communication requirements for achieving the use cases				
NEC	Nov. 25 ▼ Adopt				
	Support in study of technology requirements for achieving the use cases				
	Support in study of communication requirements for achieving the use cases				
			(Sequential)	Compatibility evaluation using existing communication system	

2. Results of Activities in FY 2020

Outcome Report (1/5)

Overview of outcome

- In FY 2020, we worked in cooperation with the TF and the Wireless System Study TG of the ITS Information and Communication Systems Promotion Council (hereinafter, "ITS Forum") to study the technology requirements for each use case and the concrete specifications for wireless communication technology based on these requirements. As an approach to examining the technology requirements for each use case, we prepared explanatory materials for conducting interviews with organizations and companies related to each use case to gain insight into their technology requirements. We also conducted a survey of similar use cases inside and outside Japan and organized the technology requirements. (See the following table)

  The above was reported at the TF meeting and ITS Forum as shown below.

(1) The TF meeting
- 11th TF meeting (held on December 4, 2020)
- 12th TF meeting (held on February 4, 2021)

(2) ITS Forum meeting
- 143rd Wireless System Study TG (held on December 14, 2020)
- 144th Wireless System Study TG (held on January 14, 2021)
- 145th Wireless System Study TG (held on February 18, 2021)
- 146th Wireless System Study TG (held on March 18, 2021)

Outcome Report (2/5)

Research report released by US-based SAE

- We studied and reported on J3216, a report on cooperative driving automation published by the US-based SAE in May 2020. (12th the TF meeting)

*SAE:Society of Automotive Engineers, Inc.

J3216 consists of seven chapters, and we provided an overview of chapters 4 through 7 which are of particular importance. For Chapter 4, which is focused on the definition of terms, we explained the definition of each Cooperative Driving Automation (CDA) class. From Chapter 5, a summary of the conceptual framework is provided, which we explained focusing mainly on the descriptions of the control mechanism and the organization of relationships in communication-based automated driving. Chapter 6 describes various points that are likely to be put into practice, and gives examples of what information should be included in sample messages and what should be considered when designing CDA communication. For Chapter 7, which focuses on an actual case study, we explained which CDA classes are used in use cases, such as communication of pedestrian detection information to vehicles, traffic signal control, assistance to vehicles when changing lanes, and adaptive cruise control. Finally, we explained that presenting the concept and examples of cooperative driving automation in standard specifications as done in this document could potentially promote consensus building among the parties concerned.

Outcome Report (3/5)

Interviews with organizations and companies related to each use case

- As shown in the table below, when the TF and ITS Forum held interviews with organizations and companies related to each use case, we provided support in preparing interview materials and other documents. Also, when necessary, we conducted surveys of similar use cases inside and outside Japan, and organized the responses to the confirmation items for each use case.

Table 1. Priority level 1 use cases as suggested by the TF

Priority level	Classification	Name of use case	Interviewees (Titles omitted)
1	a. Merging/lane change assistance	a-1-1. Merging assistance by preliminary acceleration and deceleration	- Japan Automobile Manufacturers Association, Inc. - National Institute for Land and Infrastructure Management, Japan
		a-1-2. Merging assistance by targeting the gap on the main lane	
		a-1-3. Cooperative merging assistance with vehicles on the main lane by roadside control	- Japan Automobile Manufacturers Association, Inc
		a-1-4. Merging assistance based on negotiations between vehicles	
	c. Look-ahead information: collision avoidance	c-3. Collision avoidance assistance by using hazard information	- Japan Automobile Manufacturers Association, Inc
	a. Merging/lane change assistance	a-2. Lane change assistance when the traffic is heavy	

Outcome Report (4/5)

Interviews with organizations and companies related to each use case

Table 2. Priority level 2 use cases as proposed by the TF

Priority level	Classification	Name of use case	Interviewees (Titles omitted)
2	a. Merging/lane change assistance	a-3. Entry assistance from non-priority roads to priority roads during traffic congestion	- Surveys of similar use cases inside and outside Japan
	c. Look-ahead information: collision avoidance	c-1. Collision avoidance assistance when a vehicle ahead stops or decelerates suddenly	- Surveys of similar use cases inside and outside Japan
		c-2-1. Driving assistance based on intersection information (V2V)	- ITS Connect Promotion Consortium, Japan
		c-2-2. Driving assistance based on intersection information (V2I)	- UTMS SOCIETY OF JAPAN
	b. Traffic signal information	b-1-1. Driving assistance by using traffic signal information (V2I)	
	g. Platooning/adaptive cruise control	g-1. Unmanned platooning of following vehicles by electronic towbar	- Personnel involved in the SIP-adus demonstration
		g-2. Adaptive cruise control and manned platooning of following vehicles using adaptive cruise control	

Outcome Report (5/5)

Interviews with organizations and companies related to each use case

Table 3. Priority level 3 use cases as proposed by the TF

Priority level	Classification	Name of use case	Interviewees (Titles omitted)
3	b. Traffic signal information	b-1-2. Driving assistance by using traffic signal information (V2N)	- UTMS SOCIETY OF JAPAN
	d. Lookahead information: trajectory change	d-1. Driving assistance by notification of abnormal vehicles	- National Institute for Land and Infrastructure Management, Japan
		d-2. Driving assistance by notification of wrong-way vehicles	- Surveys of similar use cases inside and outside Japan
		d-3. Driving assistance based on traffic congestion information	- National Institute for Land and Infrastructure Management, Japan
		d-4. Traffic congestion assistance at branches and exits	
		d-5. Driving assistance based on hazard information	
	e. Lookahead information: emergency vehicle notification	e-1. Driving assistance based on emergency vehicle information	- ITS Connect Promotion Consortium, Japan
	f. Information collection/distribution by infrastructure	f-1. Request for rescue (e-Call)	- JAPAN MAYDAY SERVICE CO.,LTD.
		f-2. Collection of information to optimize the traffic flow	- Personnel involved in the SIP-adus demonstration
		f-3. Update and automatic generation of maps	- Personnel involved in the SIP-adus demonstration
		f-4. Distribution of dynamic map information	- Personnel involved in the SIP-adus demonstration
	h. Teleoperation	h-1. Operation and management of mobility service cars	- National Institute of Advanced Industrial Science and Technology, Japan