ENGLISH TRANSLATION

700 MHz BAND INTELLIGENT TRANSPORT SYSTEMS

Experimental Guideline for Inter-roadside Communications

ITS FORUM RC-012 Ver. 1.1

Version 1.0 March 31th 2014

Version 1.1 September 30th 2017

ITS Info-communications Forum

of Japan

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Revision History

Ver.	Date	Chapter/Section	Reason	Revised Content
1.0	March 31, 2014	Establishment	Newly established	
1.1	September 30, 2017	1.1 2.1.1 2.3 3 Annex 1 Reference 1	Revised in conjunction with the revision of normative documents (ARIB STD-T109, ITS FORUM RC-010)	Refer to functions for inter-roadside communications prescribed in revised normative documents.

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Introduction

This document is a guideline which specifies specifications and interfaces for functions required for experimental testing of communications between a base station and another base station (inter-roadside communication) that is carried out in an environment where inter-vehicle communications and roadside-to-vehicle communications are implemented in accordance with the "700 MHz BAND INTELLIGENT TRANSPORT SYSTEMS" (ARIB STD-T109) version 1.2 along with the "700 MHz BAND INTELLIGENT TRANSPORT SYSTEMS - Extended Functions Guideline" (ITS FORUM RC-010) version 1.0 and is aimed for diversification of applications utilizing 700 MHz band intelligent transport systems.

After establishing this guideline version 1.0 in 2014, the necessary communication functions for inter-roadside communications, which were extracted from the previous version of this guideline, were specified in ARIB STD-T109 version1.3 and ITS FORUM RC-010 verision1.1, which were revised for the purpose of institutional maintenance with the advance of 700 MHz band intelligent transport systems. Therefore, inter-roadside communications as well as roadside-to-vehicle communications could be realized with base stations based on ARIB STD-T109 version1.3 and ITS FORUM RC-010 verision1.1. In this guideline, reference sources which have been specified regarding the communication functions for inter-roadside communications are indicated.

It is hoped that this Guideline will fully be verified by organizations and other parties which utilize the respective standards for thorough practical verification and validation testing.

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700 MHz Band Intelligent Transport Systems

Experimental Guideline for Inter-roadside Communications

Contents

Chapter 1 General Descriptions

1.1 Overview

The “700 MHz BAND INTELLIGENT TRANSPORT SYSTEMS Experimental Guideline for Inter-roadside Communications” (hereinafter referred to as "this Guideline" or "the Guideline") stipulates the specifications and interface standards applying to communication functions required for sending/receiving application data intended for testing of inter-roadside communications, in addition to application data for roadside-to-vehicle communications, by base stations. The context is a system implementing the ARIB standard for the “700 MHz BAND INTELLIGENT TRANSPORT SYSTEMS” (ARIB STD-T109) (hereinafter referred to as "the Standard") version1.2 and the earlier and the “700 MHz BAND INTELLIGENT TRANSPORT SYSTEMS - Extended Functions Guideline” (ITS FORUM RC-010) (hereinafter referred to as "the Extended Functions Guideline") version1.0 which specifies an Extended Layer for standard communication protocol functions.

Standard version 1.3 and the Extended Functions Guideline version 1.1 newly define the necessary communication functions for inter-roadside communications, which were described in this Guideline version 1.0, as well as roadside-to-vehicle communications. This Guideline version 1.1 indicates the section numbers of the Standard or the Extended Functions Guideline in which essential functions to realize inter-roadside communications have been specified.

1.2 Scope of application

A system applying the stipulations of this Guideline to a 700 MHz band intelligent transport system (hereinafter referred to as "the system") consists of a number of base stations and land mobile stations (hereinafter referred to as "mobile stations").

This system is to be operated in the 700 MHz radio frequency band where a number of base stations deployed along the roads and mobile stations installed in vehicles perform roadside-to-vehicle communications and inter-vehicle communications. In this system, the experimental implementation of inter-roadside communications is assumed.

As shown in Figure 1.1, this Guideline specifies base stations with functions to perform inter-roadside communications. This Guideline does not contain any stipulations for mobile stations.

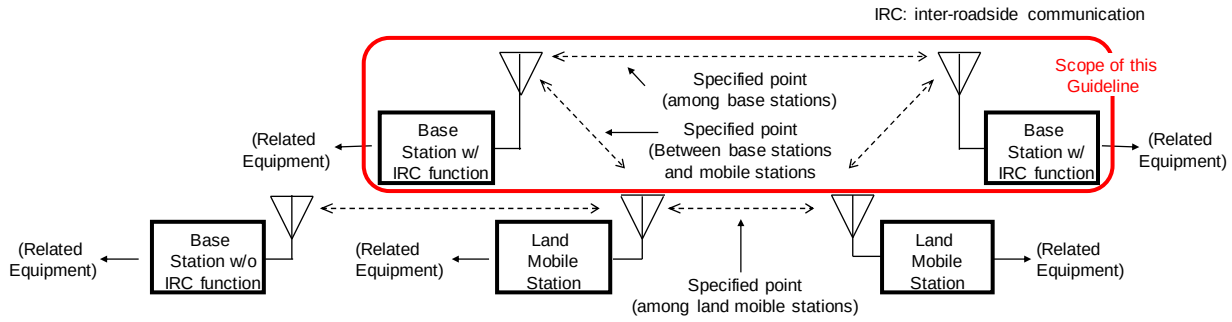

Figure 1.1 System configuration and scope of this Guideline

1.3 Normative references

Items not specifically described in this Guideline shall be dealt with in accordance with the following standards.

[1] ARIB STD-T109 700 MHz BAND INTELLIGENT TRANSPORT SYSTEMS, Ver. 1.3

[2] ITS FORUM RC-010 700MHz BAND INTELLIGENT TRANSPORT SYSTEMS - Extended Functions Guideline Ver. 1.1

Chapter 2 General System Overview

2.1 System configuration

The system consists of a number of base stations and mobile stations as specified in the Standard version 1.3 (Reference Document [1]) and the Extended Functions Guideline version 1.1 (Reference Document [2]). The requirements for a base station covered by this Guideline are as follows.

2.1.1 Base station

The base station is as specified in 2.1.1 of the Standard version 1.3 (Reference Document [1]).

However, the base stations referenced in this Guideline refer to the Roadside-to-Vehicle Communication and Inter-Roadside Communication (RVC-IRC) base stations in the Standard version 1.3, which perform communications for fixed services with a close relationship to land mobile services with the other RVC-IRC base stations, as well as mobile radio communications. Inter-Roadside Communication (IRC) is synonymous with roadside-to-roadside communication.

2.2 Radio communication method

The wireless communication method for the system is as specified in 2.4 of the Standard version 1.3 (Reference Document [1]).

2.3 Functions specified by this Guideline

This Guideline implements the following basic functions for RVC-IRC base stations. The "transmission category" mentioned below is an identifier for specifying the transmission period when an application sends application data.

(1) Specified-Period-Transmitting-Function for each transmission category (SPTF)
A function for transmitting multiple application data for roadside-to-vehicle and inter-roadside communications in a transmission period specified for each transmission category assigned to each application data.

(2) Transmission-Interval-Setting-Function for each transmission category (TISF)
A function for transmitting application data for inter-roadside communication in a longer transmission interval (multiples of a control period) than that in which application data for roadside-to-vehicle communication is transmitted.

(3) DataAssociatedInformation-Appending-Function for each

CommunicationTypeInformation (DAF)

A function for appending DataAssociatedInformation for each CommunicationTypeInformation such as roadside-to-vehicle communication or inter-roadside communication.

2.4 Preconditions

2.4.1 Preconditions related to RVC-IRC base station functions

The content of description 4 of the Standard (Reference Document [1]) shall be a precondition for realizing the functions described in 2.3.

2.4.2 Preconditions for protocol model

Figure 2.1 shows the protocol stack using the Standard Layers and the Extended Layer (hereinafter referred to as "EL") of the Extended Functions Guideline. This Guideline assumes the use of the protocol stack shown in Figure 2.1 for RVC-IRC base stations. A platform for realizing roadside-to-vehicle communications and inter-roadside communications is provided by adding or modifying functions such as EL and MAC sublayer, primitives for layers from the application to the MAC sublayer, and Inter-Vehicle Communication and Roadside-to-Vehicle Communication Control Layer management (hereinafter referred to as "IVC-RVC Layer management"). This Guideline does not cover RVC base stations and mobile stations specified in 2.1.1 and 2.1.2 of the Standard (Reference Document [1]).

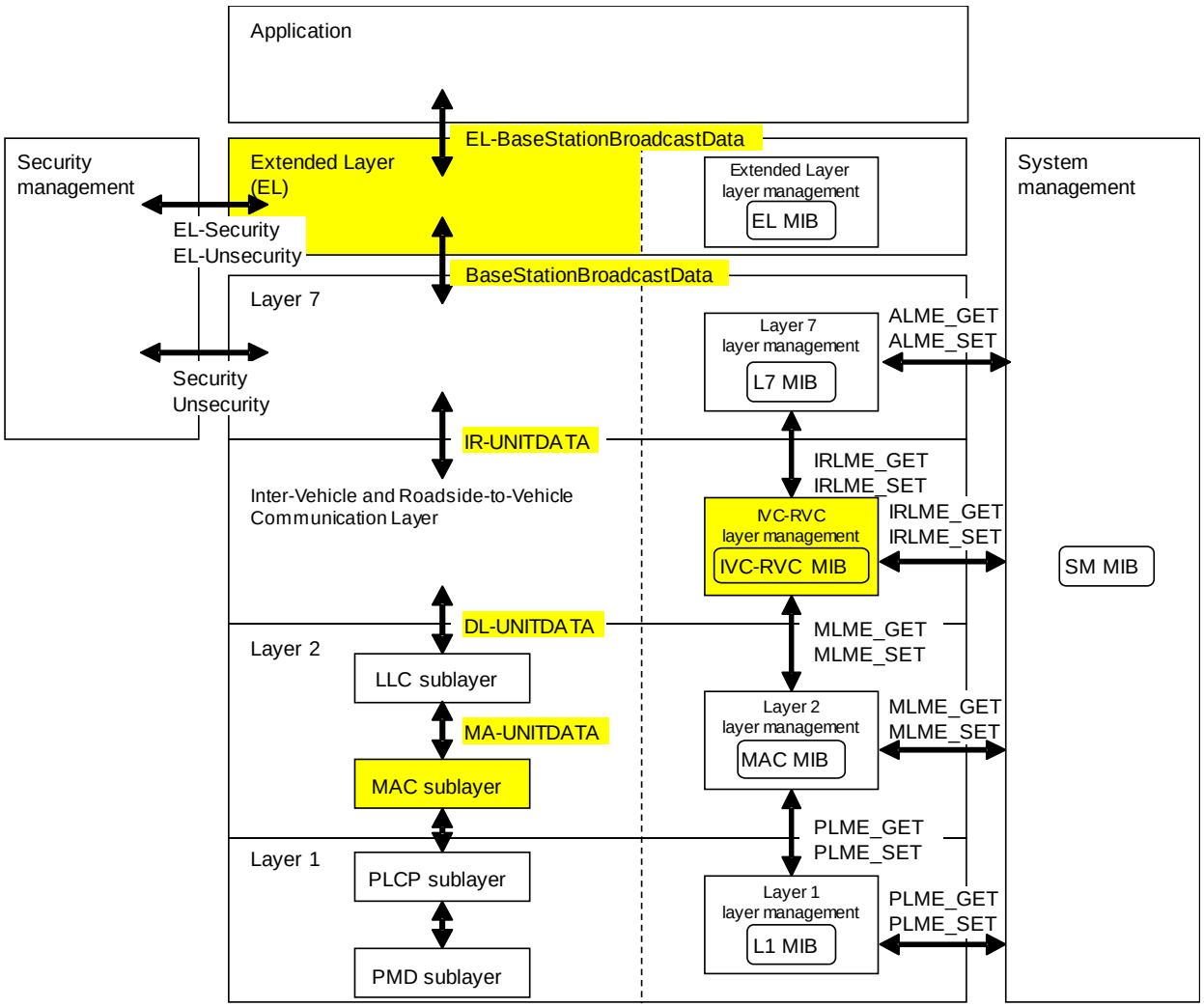

Figure 2.1　Protocol stack (RVC-IRC base station)

2.4.3　Preconditions related to security method

This Guideline does not specify a security method.

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Chapter 3　Communication Control Method

3.1　Overview

This chapter specifies items related to processing in each layer, additional interlayer primitives, and layer management required for an RVC-IRC base station to realize the functions described in 2.3. Specifically, because these key items to achieve the functions in 2.3 have been specified in the Standard version 1.3 and the Extended Functions Guideline version 1.1, these items are indicated in table 3.1.

Table 3.1　Provisions in reference documents setting forth necessary functions for achieving the functions in 2.3

(a) The Standard

Items	References	(1)	(2)	(3)
Layer 1 (physical layer)	－			
Layer 2 (data link layer)	Reference Document [1] 4.3.4.1.2		○	
	Reference Document [1] 4.3.4.2.2(1)b)2)	○		
	Reference Document [1] 4.3.4.3.6		○	
	Reference Document [1] 4.3.4.5.1(1)a)2)	○		
	Reference Document [1] 4.3.4.5.1(3)	○	○	
	Reference Document [1] 4.3.5.2.2(1)b)2)	○		
Inter-vehicle Communication and Roadside-to-vehicle Communication Control Layer (IVC-RVC layer)	Reference Document [1] 4.4.2.1.2(1)b)2)	○		
	Reference Document [1] 4.4.3.2.1(2)	○	○	
	Reference Document [1] 4.4.3.3.1(1)b)2)	○		
Layer 7 (application layer)	Reference Document [1] 4.5.2.1.3(2)b)2)	○		
	Reference Document [1] 4.5.2.1.4(1)	○		
	Reference Document [1] 4.5.2.1.4(10)	○		
	Reference Document [1] 4.5.3.2.1(1)a)	○		
	Reference Document [1] 4.5.3.2.1(1)b)2)	○		
Protocol parameters	Reference Document [1] Annex1 3.1	○	○	
Application data structure definitions	Reference Document [1] Annex2 2	○		
Abbreviations	Reference Document [1] 6.2	○	○	

(b) the Extended Functions Guideline

Items	References	(1)	(2)	(3)
Extension layer	Reference Document [2] 3.2.2.1.3(2)b)ii)	○		
	Reference Document [2] 3.2.2.1.4(9)			○
	Reference Document [2] 3.2.2.1.4(10)	○		
	Reference Document [2] 3.2.3.4.1(1)a)ii)	○		
Application data structure definitions	Reference Document [2] Annex2 2	○		

* each number of (1) to (3) in above table indicates the function in clause 2.3 ;

(1) Specified-Period-Transmitting-Function for each transmission category (SPTF)

(2) Transmission-Interval-Setting-Function for each transmission category (TISF)

(3) DataAssociatedInformation-Appending-Function for each CommunicationTypeInformation (DAF)

Annex 1　CommunicationTypeInformation

In a situation where multiple services are provided via a single wireless system, and the service standards are defined by multiple service standard developing organizations, messages conforming to different service standards will be exchanged via the wireless communication (see Figure A1.1). In the case of applications intended to provide driving safety assistance or similar, messages will be broadcast to stations in the vicinity without limiting these to a specific receiver. The application (or the facility layer) therefore requires an identification function that can determine whether a received message is required for the respective station or not. This identification function should be defined by a common specification independent of the CommunicationTypeInformation (inter-vehicle communications, roadside-to-vehicle communications, or inter-roadside communications), and it should be implemented with a minimum of required information. An experimental definition of information for such a message identification function according to a common specification is given in this section.

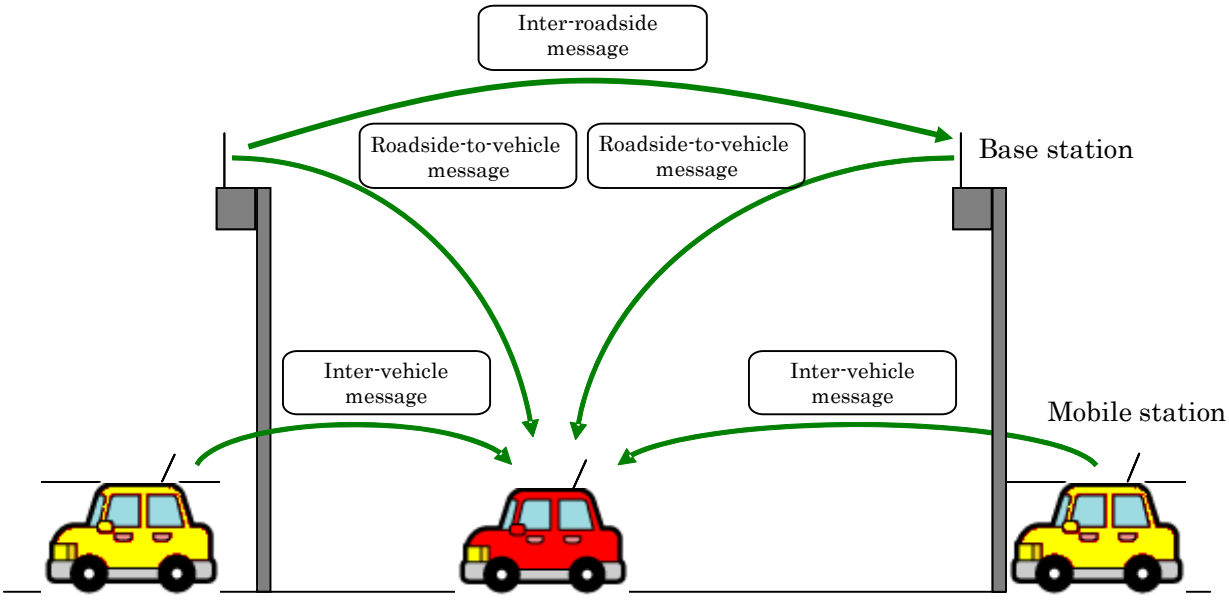


Figure A1.1　Conceptual diagram of single wireless communication system supporting various types of messages

This annex defines CommunicationTypeInformation to be used as message identification information.

1 Definition of CommunicationTypeInformation

CommunicationTypeInformation is defined as information that allows identification of what type of receiver is to use the sending message. By performing identification using CommunicationTypeInformation at a point prior to the application (communication layer), more effective processing should be possible. The information therefore is assumed not to be contained within the message but in a communication header. The definition of CommunicationTypeInformation is given in Table A 1.1. The CommunicationTypeInformation data size is 3 bits. 0 is reserved, 7 is reserved for the system, and 1 to 6 are allocated to possible communication format combinations of mobile stations and base stations. Also, in the standard (compliant document [1]), the base station includes the Roadside-to-Vehicle Communication (RVC) base station and the Roadside-to-Vehicle Communication and Inter-Roadside Communication (RVC-IRC) base station. The RVC base station performs land mobile radio communication with mobile stations. The RVC-IRC base station performs communications for fixed service which has a close relationship to a land mobile service with the other RVC-IRC base stations as well as mobile radio communications. Table A1.1 uses these terms as needed. The description of communication format allocations uses the expression "Information from xx station to yy station", but this does not indicate that the information is used only for the receiving station described in the assignment, but rather indicates the receiving station that the transmitting station assumes as the destination of the information.

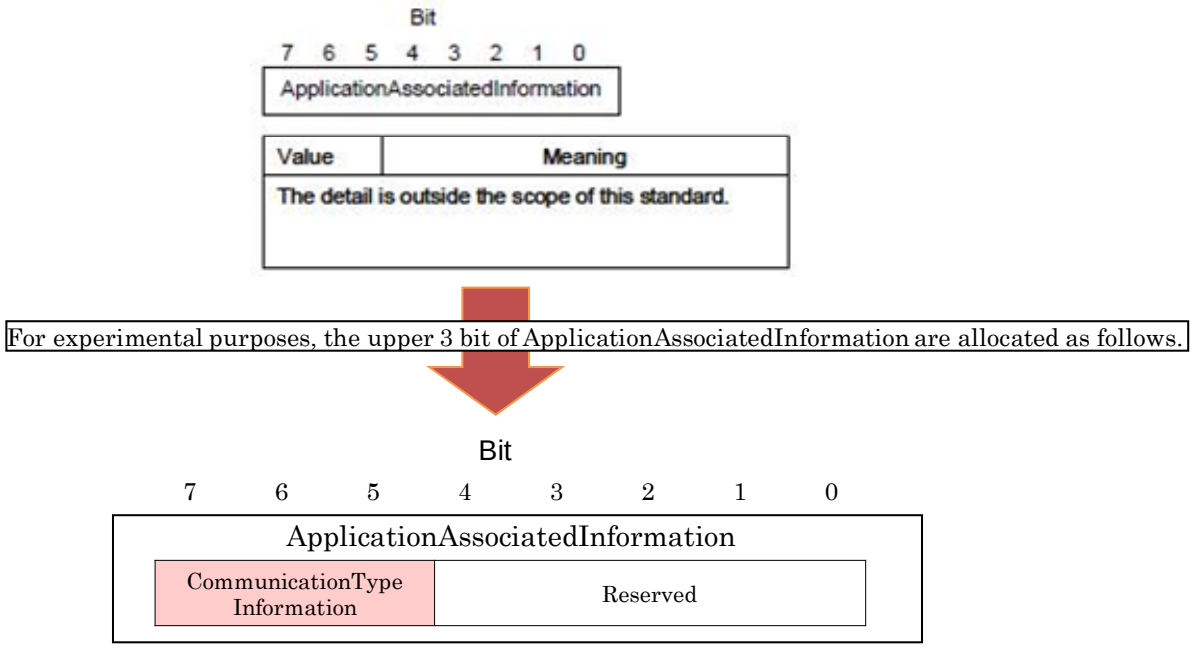
Table A 1.1 Definition of CommunicationTypeInformation

Classification	Value	Meaning
Communication TypeInformation	0	Reserved
	1	Information from mobile station to mobile station and/or base station
	2	Information from RVC-IRC base station to mobile station and/or RVC-IRC base station
	3	Information from mobile station to mobile station
	4	Information from base station to mobile station
	5	Information from mobile station to base station
	6	Information from RVC-IRC base station to RVC-IRC base station
	7	Reserved for system

2 Application of CommunicationTypeInformation

This section describes how to apply the CommunicationTypeInformation to the Standard (Reference Document [1]).

According to the Standard, ApplicationAssociatedInformation exists in the Layer 7 header, with a data size of 8 bit, but no further specification is made (it is considered outside the range of the Standard). The first 3 bits of the ApplicationAssociatedInformation are allocated to the above mentioned CommunicationTypeInformation. The structure of the ApplicationAssociatedInformation and the allocated CommunicationTypeInformation are shown in Figure A1.2.



Classification	Value	Meaning
CommunicationType Information	0	Reserved
	1	Information from mobile station to mobile station and/or base station
	2	Information from RVC-IRC base station to mobile station and/or RVC-IRC base station
	3	Information from mobile station to mobile station
	4	Information from base station to mobile station
	5	Information from mobile station to base station
	6	Information from RVC-IRC base station to RVC-IRC base station
	7	Reserved for system

Figure A1.2 Structure of ApplicationAssociatedInformation and CommunicationTypeInformation

In the Standard, the ApplicationAssociatedInformation is passed between the application and Layer 7 as one of the parameters of each primitive. An example for the flow of

ApplicationAssociatedInformation is shown in Figure A1.3. ApplicationAssociatedInformation is first generated by the application on the sending side and passed to Layer 7 via the EL (Extended Layer). In Layer 7, the information is stored in the Layer 7 header and sent out by wireless transmission via the lower layers. On the receiving side, the header is passed from the lower layers to Layer 7, and ApplicationAssociatedInformation can be extracted from it. Finally, it is passed on via the EL along with the application message (ApplicationData). By storing CommunicationTypeInformation in the ApplicationAssociatedInformation, the receiving side can use the CommunicationTypeInformation from Layer 7 to identify the message and discard messages from a communication type that is not needed.

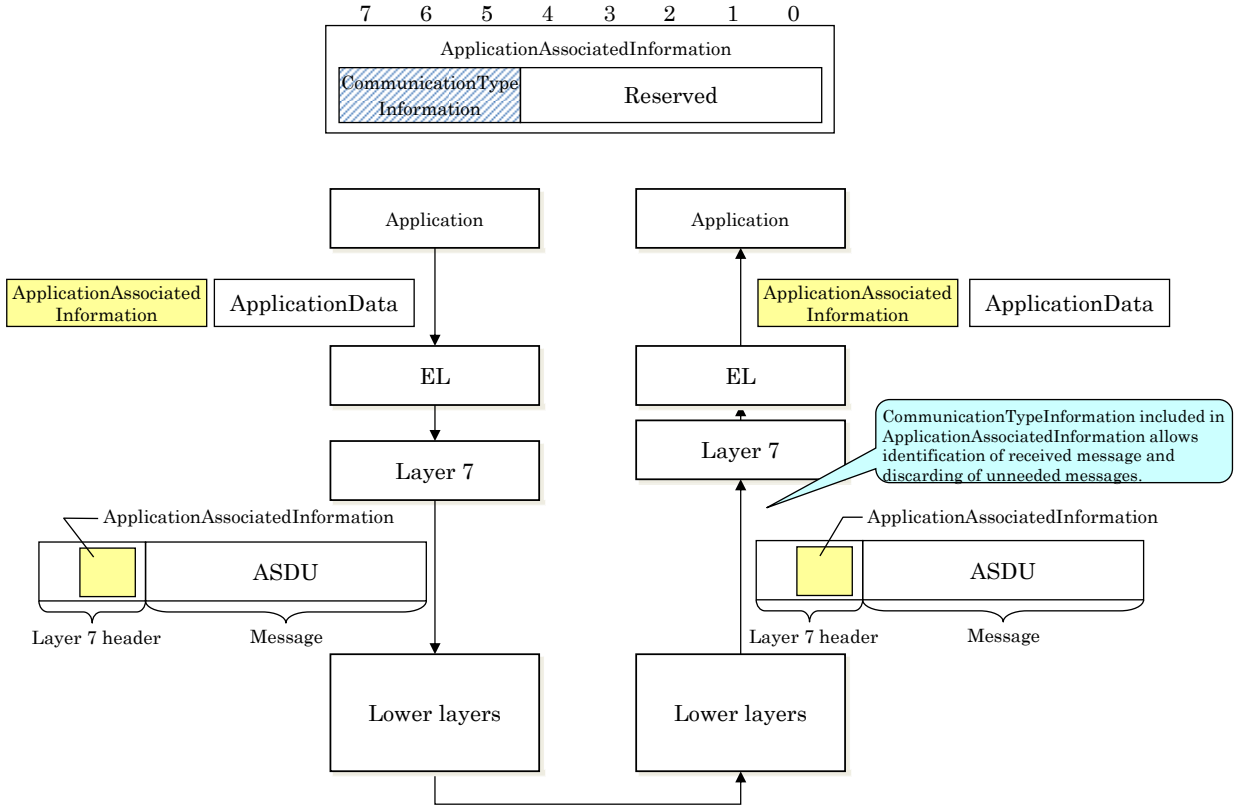


Figure A1.3 Example of the processing flow about ApplicationAssociatedInformation with CommunicationTypeInformation

Reference 1 Communication Control Example for Sharing of Roadside-to-Vehicle Communications and Inter-Roadside Communications

This reference section describes an example of how a Roadside-to-Vehicle Communication and Inter-roadside Communication (RVC-IRC) base station can perform communication control for roadside-to-vehicle communications and inter-roadside communications in accordance with this Guideline.

1 Concept of roadside-to-vehicle communications and inter-roadside communications by base station

Within the scenario envisioned by the Standard version 1.2 (Reference Document [1]) and Extended Functions Guideline version 1.0 (Reference Document [2]), a compliant Roadside-to-Vehicle Communication (RVC) base station performs roadside-to-vehicle communications aimed at accident prevention, such as providing traffic signal and traffic restriction information, information for intersections with bad visibility, and other driver assistance information to vehicles in the vicinity of an intersection.

RVC-IRC base station and applications are under consideration that would use roadside-to-vehicle communications and inter-roadside communications with the aim of assisting pleasant or environment-friendly driving. For example, such inter-roadside communications could serve for exchanging traffic signal control information between intersections in the vicinity and/or the traffic management center, thereby allowing more sophisticated traffic signal control. The concept of roadside-to-vehicle communications and inter-roadside communications by a base station is shown in Figure R1.1.

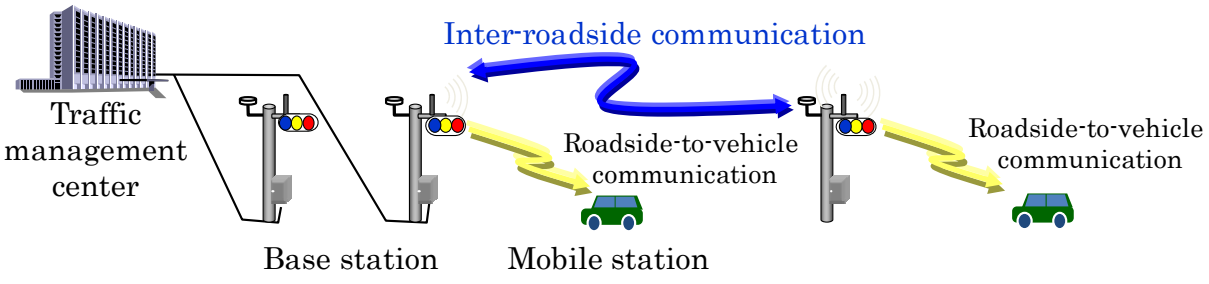


Figure R1.1 Example for roadside-to-vehicle communications and inter-roadside communications

In an application such as shown above, the information transmitted via inter-roadside communications is characterized by the fact that it will be transmitted less frequently than

roadside-to-vehicle information by a factor of up to several tens, and the amount of information per transmission will be small. Taking this into consideration, two communication control methods for making effective use of bandwidth are envisioned, as shown in Figure R1.2.

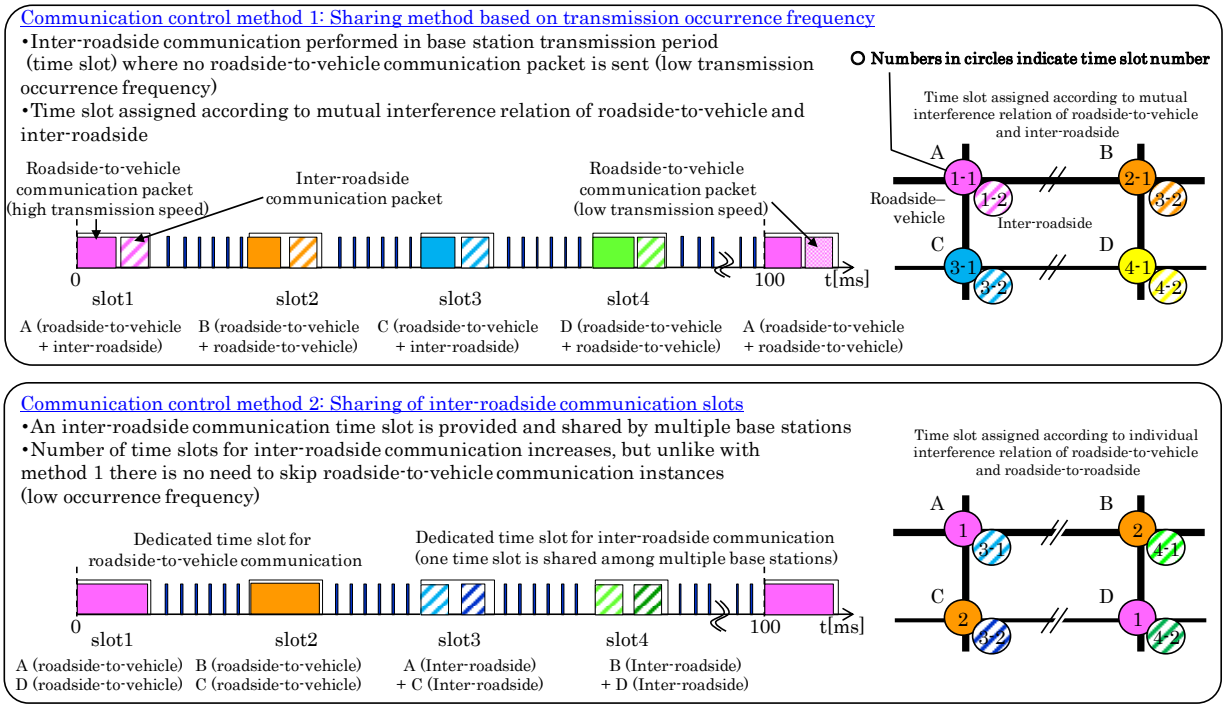


Figure R1.2 Examples for communication control by roadside-to-vehicle communication application and inter-roadside communication application

Communication control method 1 makes use of the fact that in roadside-to-vehicle communications there is information that fluctuates rapidly with time, and there is also information that will not fluctuate greatly. Information for applications designed to support driving safety will be based on rapidly changing vehicle detection data and therefore will change frequently. By contrast, information about traffic restrictions or similar will change relatively infrequently. The latter can therefore be set to a lower transmission occurrence than the former. With this method, RVC-IRC base stations send inter-roadside communication information using the roadside-to-vehicle communication period (time slot) in a control period where the latter type of roadside-to-vehicle communication information is not sent.

Communication method 2 on the other hand makes use of the fact that the data size of inter-roadside communication information is smaller than that of roadside-to-vehicle communication information, and its transmission occurrence frequency is lower. RVC-IRC base

station uses separate time slots for roadside-to-vehicle communication and inter-roadside communication and the time slot for inter-roadside communication is shared by multiple RVC-IRC base stations. An example for using communication control method 2 where multiple RVC-IRC base stations share an inter-roadside communication time slot is shown in Figure R1.3. In the illustration, time slot 16 for inter-roadside communication is made available for sharing by RVC-IRC base stations A to D. Within the same control period, time slot 16 is subdivided and used by RVC-IRC base stations A and B (or C and D). This is mutually exclusive, meaning that in a control period where base stations A and B share the time slot, it is not available to base stations C and D, and vice versa.

This Guideline assumes that one of the two communication control methods described above is used by the RVC-IRC base stations.

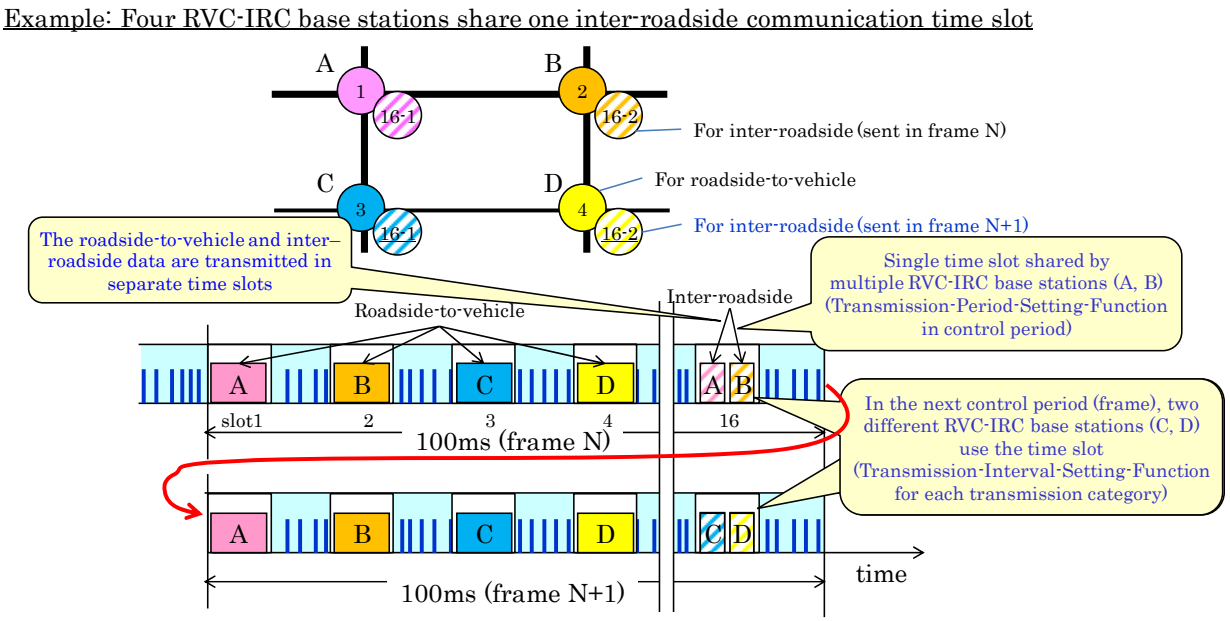


Figure R1.3　Communication control method 2: multiple RVC-IRC base stations share an inter-roadside communication time slot

2 Functions required in a RVC-IRC base station

This section describes the functions required of Layer 1 to EL in the RVC-IRC base station in order to implement the communication control methods of the preceding section.

Table R 1.1 lists the functions required of the RVC-IRC base station in order to realize the communication control methods of the preceding section. With regard to communication control method 1, functions No. 1 to No. 3 are not required, because the base station transmits inter-roadside communication information in the control period where no roadside-to-vehicle communication information is transmitted (low transmission occurrence frequency). Only function No. 4 for DataAssociatedInformation-Appending-Function for each CommunicationTypeInformation (DAF) is required. For the communication control method 2 on the other hand, all functions (No. 1 to No. 4) are required. Table R

Table R 1.1 Functions required in a RVC-IRC base station

No.	Function	Conditions.
1	Specified-Period-Transmitting-Function for each transmission category (SPTF)	Ability to transmit in a specified roadside-to-vehicle communication period for each transmission category as assigned to each data packet for roadside-to-vehicle communication and inter-roadside communication applications
2	Transmission-Interval-Setting-Function for each transmission category (TISF)	Ability to transmit inter-roadside communication application data etc. with timing shifted from other RVC-IRC base stations in control period units, using a transmission interval longer than the control period
3	Transmission-Period-Setting-Function in control period (TPSF)	Ability to share a specified transmission period within a control period with other RVC-IRC base stations
4	DataAssociatedInformation-Appending-Function for each CommunicationTypeInformation (DAF)	Ability to prevent erroneous mismatch between MSDU total number and total number field information in data associated information, when communication was normal, but multiple communication types were sent from the base station, and Layer 7 on the receiving side (base station, mobile station) has processed only information of a specific CommunicationTypeInformation (as explained in Annex 1).

The key points in this Guideline for implementing the functions of RVC-IRC base station

listed in Table R 1.1 are shown in Table R 1.2. An explanation of each function is given in the next section.

Table R 1.2 Relationship between functions mandatory for RVC-IRC base station and this guideline

No.	Function	Contents specified in this Guideline
1	Specified-Period-Transmitting-Function for each transmission category (SPTF)	Transmission in the specified period for each transmission category can be implemented as follows. An MIB variable (RTC[m].TCL) for indicating the transmission category of the allocated roadside-to-vehicle communication period and a parameter (TransmissionCategoryInformation) which is an identifier for specifying the sending roadside-to-vehicle communication period to the application data.
		By assigning a SequenceNumber of the Standard to each transmission category, MSDU corresponding to each category can be sent.
2	Transmission-Interval-Setting-Function for each transmission category (TISF)	When an application sends multiple application data with a transmission interval that is longer than the control period, it shall be possible to transmit the data in the prescribed control period in synchronizing the transmission timing on other RVC-IRC base stations. (The methods to achieve this are not specified in this Guideline.)
		If MSDU are not lined up in the MAC sublayer, sending in a control period that is allocated as a transmission opportunity to other RVC-IRC base stations shall be inhibited. This is achieved by using an N second cycle timer in conjunction with MIB variables (RTC[m].TRI, RTC[m].TRO) for specifying the transmission interval and transmission offset for each transmission category.
3	Transmission-Period-Setting-Function in control period (TPSF)	No particular points. Sharing the roadside-to-vehicle communication period for inter-roadside communication of other RVC-IRC base stations by IVC-RVC Layer MIB variables (RTC[m].TST and RTC[m].TRP) defined in the Standard.
4	DataAssociatedInformation-Appending-Function for each CommunicationTypeInformation (DAF)	Assigning data associated information DataSequence and DataTotalNumber for each CommunicationTypeInformation (see Annex 1)

2.1 Specified-Period-Transmitting-Function for each transmission category (SPTF)

See 2.1 of Description 5 in Reference Document [1].

2.2 Transmission-Interval-Setting-Function for each transmission category (TISF)

See 2.2 of Description 5 in Reference Document [1].

2.3 Transmission-Period-Setting-Function in control period (TPSF)

See 2.3 of Description 5 in Reference Document [1].

2.4 DataAssociatedInformation-Appending-Function for each CommunicationTypeInformation (DAF)

See Reference 2 in Reference Document [2].