
**Road vehicles — Video communication
interface for cameras (VCIC) —**

**Part 4:
Implementation of communication
requirements**

*Véhicules routiers — Interface de communication vidéo pour caméras
(ICVC) —*

Partie 4: Mise en oeuvre d'exigences de communication



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Contents

	Page
Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms, definitions, symbols, and abbreviated terms	3
3.1 Terms and definitions	3
3.2 Abbreviated terms	3
4 Conventions	4
5 Overview	4
5.1 General	4
5.2 Document overview and structure	4
5.3 Open Systems Interconnection (OSI) model	5
5.4 Document reference according to OSI model	5
6 Physical layer	6
7 Data link layer	7
7.1 General	7
7.2 Configuration	7
8 Network layer	7
8.1 General	7
8.2 Audio Video Transport Protocol (AVTP)	7
8.3 IPv6	8
8.4 IPv4	10
8.5 Address allocation process	11
9 Transport layer	11
9.1 General	11
9.2 User Datagram Protocol (UDP)	12
9.3 Transmission Control Protocol (TCP)	12

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

ISO 17215 consists of the following parts, under the general title *Road Vehicles — Video communication interface for cameras (VCIC)*:

- *Part 1: General information and use case definition*
- *Part 2: Service discovery and control*
- *Part 3: Camera message dictionary*
- *Part 4: Implementation of communication requirements*

Introduction

Driver assistance systems are more and more common in road vehicles. From the beginning, cameras were part of this trend. Analogue cameras were used in the beginning, because of lower complexity of the first systems. With increasing demand for more advanced functionality, digital image processing has been introduced. So-called one box design cameras (combining a digital image sensor and a processing unit) appeared in the vehicles.

Currently, the market demands such systems with multiple functions. Even different viewing directions are in use. It seems to be common sense that 6 up to 12 cameras in a single vehicle will be seen in the next future. Out of this and the limitation in size, power consumption, etc. it will lead to designs where the cameras are separated from the processing unit. Therefore, a high performance digital interface between camera and processing unit is necessary.

This International Standard has been established in order to define the use cases, the communication protocol, and the physical layer requirements of a video communication interface for cameras, which covers the needs of driver assistance applications.

The video communication interface for cameras

- incorporates the needs of the whole life cycle of an automotive grade digital camera,
- utilizes existing standards to define a long-term stable state-of-art video communication interface for cameras usable for operating and diagnosis purpose,
- can be easily adapted to new physical data link layers including wired and wireless connections by using existing adaption layers, and
- is compatible with AUTOSAR.

This part of ISO 17215 is related to the general information and use case definition. This is a general overview International Standard which is not related to the OSI model.

To achieve this, it is based on the Open Systems Interconnection (OSI) basic reference model specified in ISO/IEC 7498-1 and ISO/IEC 10731, which structures communication systems into seven layers. When mapped on this model, the protocol, and physical layer requirements specified by this International Standard, in accordance with [Table 1](#) are broken into:

- application (layer 7), specified in ISO 17215-3;
- presentation layer (layer 6), specified in ISO 17215-2;
- session layer (layer 5), specified in ISO 17215-2;
- transport protocol (layer 4), specified in ISO 17215-4, ISO 13400-2;
- network layer (layer 3), specified in ISO 17215-4, ISO 13400-2;
- data link layer (layer 2), specified in ISO 17215-4, ISO 13400-3;
- physical layer (layer 1), specified in ISO 17215-4, ISO 13400-3.

Table 1 — Specifications applicable to the OSI layers

Applicability	OSI 7 layers	Video communication interface for cameras		Camera diagnostics
Seven layers according to ISO 7498-1 and ISO/IEC 10731	Application (layer 7)	ISO 17215-3		
	Presentation (layer 6)	ISO 17215-2		
	Session (layer 5)	ISO 17215-2		
	Transport (layer 4)	ISO 17215-4	Other future interface standards	ISO 13400-2
	Network (layer 3)			
	Data link (layer 2)	ISO 17215-4		
	Physical (layer 1)			

ISO 17215-1 has been established in order to define the use cases for vehicle communication systems implemented on a video communication interface for cameras; it is an overall International Standard not related to the OSI model.

ISO 17215-3 covers the application layer implementation of the video communication interface for cameras; it includes the API.

ISO 17215-2 covers the session and presentation layer implementation of the video communication interface for cameras.

ISO 17215-4 is the common International Standard for the OSI layers 1 to 4 for the video communication interface for cameras. It complements ISO 13400-2 and ISO 13400-3 and adds the requirement for video transmission over Ethernet.

ISO 17215-2 and ISO 17215-3 (OSI layer 5 to 7) services have been defined to be independent of the ISO 17215-4 (OSI layer 1 to 4) implementation. Therefore, ISO 17215-4 could be replaced by other future communication standards.

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Road vehicles — Video communication interface for cameras (VCIC) —

Part 4: Implementation of communication requirements

1 Scope

This part of ISO 17215 specifies the communication requirements for video camera interfaces. It is concerned mainly with layers 1 through 4 of the ISO/OSI basic reference model. These layers are the physical layer, the link layer, the network layer, and the transport layer. [Figure 1](#) presents the communication protocols specified in this part of ISO 17215 in relation to the ISO/OSI layers as well as the content of the other parts of ISO 17215.

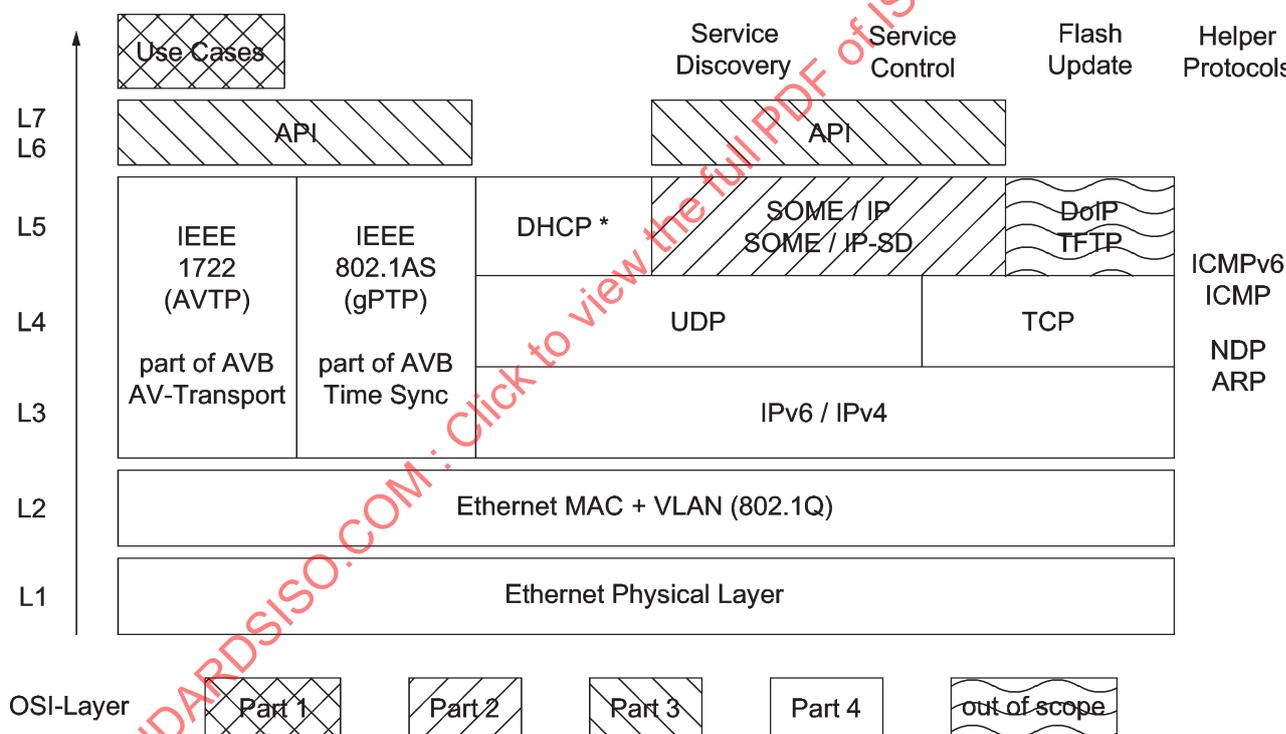


Figure 1 — Overview of ISO 17215

The general terminology defined in ISO 17215-1 is also used in this part of ISO 17215.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7498-1, *Information processing systems — Open systems interconnection — Basic reference model*

ISO/IEC 10731, *Information technology — Open Systems Interconnection — Basic Reference Model — Conventions for the definition of OSI services*

ISO 17215-4:2014(E)

ISO 17215 (all parts), *Road vehicles — Video communication interface for cameras (VCIC)*

IEEE 802.3-2012, *Standard for Ethernet*

IEEE 802.1Q, *IEEE Standard for Local and Metropolitan Area Networks — Media Access Control (MAC) Bridges and Virtual Bridged Local Area Networks*

IEEE 802.1AS, *Timing and Synchronization for Time-Sensitive Applications in Bridged Local Area Networks*

IEEE 1722, *Layer 2 Transport Protocol for Time-Sensitive Applications in a Bridged Local Area Network*
IETF RFC 826, *Ethernet Address Resolution Protocol: Or Converting Network Protocol Addresses to 48-bit Ethernet Address for Transmission on Ethernet Hardware*

IETF RFC 768, *User Datagram Protocol*

IETF RFC 791, *Internet Protocol*

IETF RFC 792, *Internet Control Message Protocol*

IETF RFC 793, *Transmission Control Protocol*

IETF RFC 896, *Congestion Control in IP/TCP Internetworks*

IETF RFC 1122, *Requirements for Internet Hosts — Communication Layers*

IETF RFC 1323, *TCP Extensions for High Performance*

IETF RFC 1624, *Computation of the Internet Checksum via Incremental Update*

IETF RFC 1878, *Variable Length Subnet Table For IPv4*

IETF RFC 1981, *Path MTU Discovery for IP version 6*

IETF RFC 2018, *TCP Selective Acknowledgment Options*

IETF RFC 2131, *Dynamic Host Configuration Protocol*

IETF RFC 2132, *DHCP Options and BOOTP Vendor Extensions*

IETF RFC 2460, *Internet Protocol, Version 6 (IPv6) Specification*

IETF RFC 2464, *Transmission of IPv6 Packets over Ethernet Networks*

IETF RFC 2988, *Computing TCP's Retransmission Timer*

IETF RFC 3122, *Extensions to IPv6 Neighbor Discovery for Inverse Discovery Specification*

IETF RFC 3203, *DHCP reconfigure extension*

IETF RFC 3315, *Dynamic Host Configuration Protocol for IPv6 (DHCPv6)*

IETF RFC 3390, *Increasing TCP's Initial Window*

IETF RFC 3484, *Default Address Selection for Internet Protocol version 6 (IPv6)*

IETF RFC 3782, *The NewReno Modification to TCP's Fast Recovery Algorithm*

IETF RFC 4286, *Multicast routing discovery*

IETF RFC 4291, *IP Version 6 Addressing Architecture*

IETF RFC 4294, *IPv6 Node Requirements*

IETF RFC 4443, *Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6 (IPv6) Specification*

IETF RFC 4861, *Neighbor Discovery for IP version 6 (IPv6)*

IETF RFC 4862, *IPv6 Stateless Address Autoconfiguration*

IETF RFC 4884, *Extended ICMP to Support Multi-Part Messages*

IETF RFC 5095, *Deprecation of Type 0 Routing Headers in IPv6*

IETF RFC 5220, *Problem Statement for Default Address Selection in Multi-Prefix Environments: Operational Issues of RFC 3484 Default Rules*

IETF RFC 5405, *Unicast UDP Usage Guidelines for Application Designers*

IETF RFC 5482, *TCP User Timeout Option*

IETF RFC 5681, *TCP Congestion Control*

IETF RFC 5722, *Handling of Overlapping IPv6 Fragments*

IETF RFC 5871, *IANA Allocation Guidelines for the IPv6 Routing Header*

IETF RFC 1042, *Standard for the transmission of IP datagrams over IEEE 802 networks*

NOTE The keywords *shall*, *should*, etc. as defined in IETF RFC 2119 are used in this part of ISO 17215 to indicate requirement levels. Capitalization of those keywords is not required.

If an RFC referenced by this part of ISO 17215 has been updated by one or several RFCs, the update is fully applicable for the purpose of implementing this part of ISO 17215. This presumes the additional document describes an implementation which is compatible with implementation described by document referred to herein.

If one or more errata for an RFC referenced by this part of ISO 17215 have been published, all of these errata documents are fully applicable for the purpose of implementing this part of ISO 17215.

It is assumed that future implementations of this part of ISO 17215 will use the most recent versions of the referenced RFCs but maintain backward compatibility to existing implementations.

3 Terms, definitions, symbols, and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17215-1 apply.

3.2 Abbreviated terms

Term	Description
API	Application Programming Interface
ARP	Address Resolution Protocol
AVB	Audio Video Broadcast
AVTP	Audio Video Transport Protocol
DHCP	Dynamic Host Configuration Protocol
DoIP	Diagnosis over IP
EMC	Electromagnetic Compatibility
gPTP	Generalized Precision Time Protocol

ICMP	Internet Control Message Protocol
LLC	Logical Link Control
MAC	Media Access Control
MII	Media Independent Interface
NDP	Neighbour Discovery Protocol
OSI	Open Systems Interconnection
PDU	Protocol Data Unit
PHY	Physical Layer
POE	Power over Ethernet
TCP	Transmission Control Protocol
TFTP	Trivial File Transfer Protocol
UDP	User Datagram Protocol
VLAN	Virtual Local Area Network

4 Conventions

This International Standard is based on the conventions specified in the OSI service conventions (ISO/IEC^o10731) as they apply for physical layer, protocol, network and transport protocol, and diagnostic services.

5 Overview

5.1 General

This International Standard has been established in order to implement a standardized Video Communication Interface for Cameras in vehicles.

The focus of this International Standard is using existing protocols.

[Figure 1](#) specifies the relation to the other parts of this International Standard.

[Figure 2](#) specifies the relation of this International Standard to existing protocols.

5.2 Document overview and structure

This International Standard consists of a set of four sub-documents, which provide all references and requirements to support the implementation of a Video Communication Interface for Cameras according to the standard at hand.

- ISO 17215-1 provides an overview of the document set and structure along with the use case definitions and a common set of resources (definitions, references) for use by all subsequent parts.
- ISO 17215-2 specifies the discovery and control of services provided by a VCIC camera.
- ISO 17215-3 specifies the standardized camera messages and data types used by a VCIC camera (OSI Layer 7).

- ISO 17215-4 specifies standardized low-level communication requirements for the implementation of physical-, data link-, network-, and transport layer (OSI Layers 1 to 4).

5.3 Open Systems Interconnection (OSI) model

This International Standard is based on the Open Systems Interconnection (OSI) Basic Reference Model as specified in ISO/IEC 7498 which structures communication systems into seven layers.

All parts of this International Standard are guided by the OSI service conventions as specified in ISO/IEC 10731 to the extent that they are applicable to diagnostic services. These conventions define the interaction between the service user and the service provider through service primitives.

The aim of this subclause is to give an overview of the OSI model and show how it has been used as a guideline for this part of ISO 17215. It also shows how the OSI service conventions have been applied to this International Standard.

The OSI model structures data communication into seven layers called (top down) application layer (layer 7), presentation layer, session layer, transport layer, network layer, data link layer, and physical layer (layer 1). A subset of these layers is used in this International Standard.

The purpose of each layer is to provide services to the layer above. The active parts of each layer, implemented in software, hardware, or any combination of software and hardware, are called *entities*. In the OSI model, communication takes place between entities of the same layer in different nodes. Such communicating entities of the same layer are called peer entities.

The services provided by one layer are available at the Service Access Point (SAP) of that layer. The layer above can use them by exchanging data parameters.

This International Standard distinguishes between the services provided by a layer to the layer above it and the protocol used by the layer to send a message between the peer entities of that layer. The reason for this distinction is to make the services, especially the application layer services and the transport layer services, reusable for other types of networks other than the video communication interface for cameras. In this way, the protocol is hidden from the service user and it is possible to change the protocol if demanded by special system requirements.

5.4 Document reference according to OSI model

[Figure 2](#) illustrates the document references.

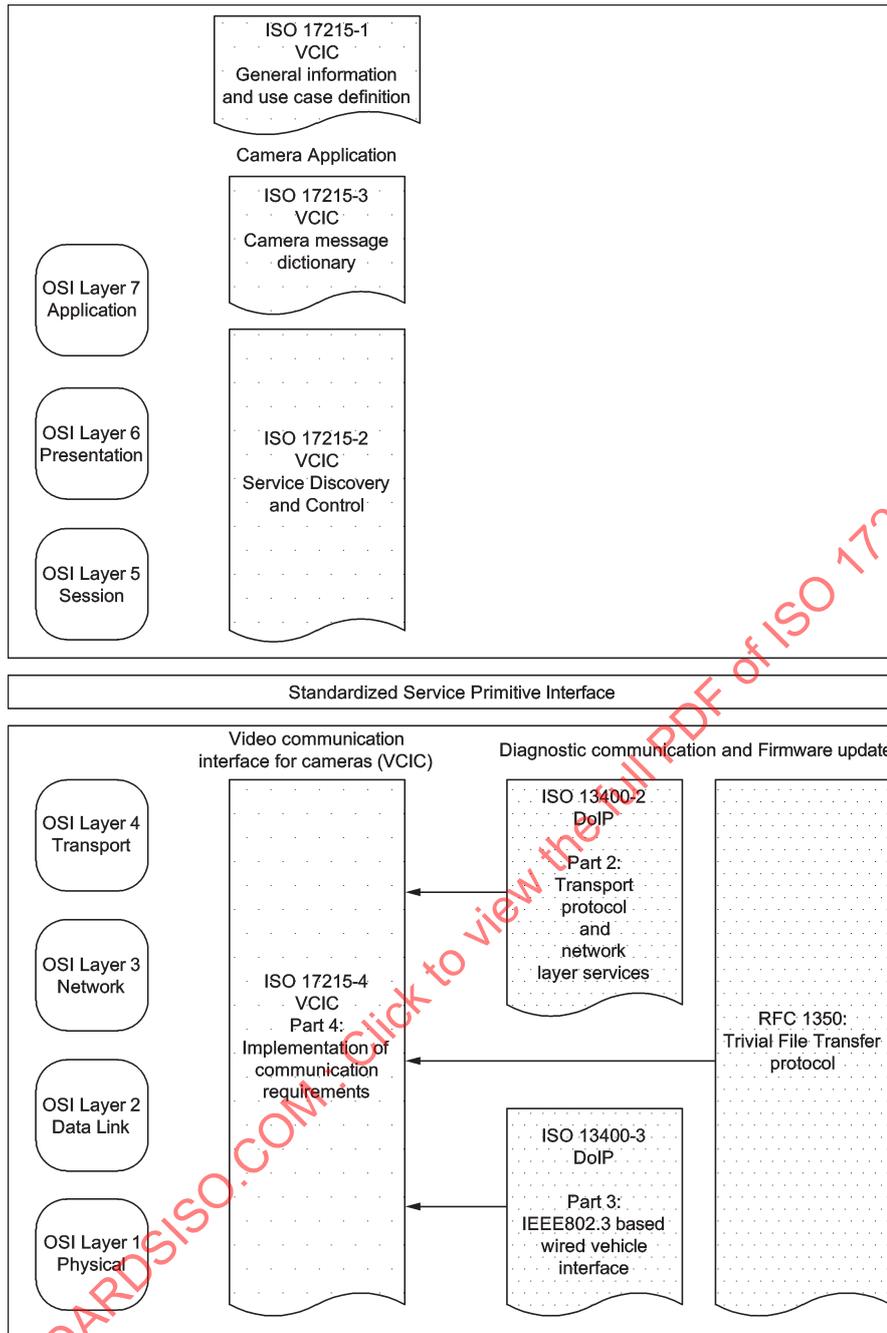


Figure 2 — Video communication interface for cameras document reference according to OSI model

6 Physical layer

The physical layer is the lowest layer in the OSI model. It is concerned with the hardware required to transmit raw bits through the link. This includes the specification of frequency spectrum, voltage levels, error correction mechanisms, link topology, and others. In the automotive environment, special emphasis is placed on the electromagnetic compatibility between different components. The BroadReach Technology (www.opensig.org) can be used as a reference implementation of the physical layer.

- The PHY layer shall provide a bandwidth of 100 Mbit/s or more.
- The PHY layer shall use full-duplex operation.

- The PHY layer shall fulfil automotive grade EMC requirements (CISPR 25, ISO 10605, ISO 11451).
- The PHY layer shall provide a standard media independent interface as defined in IEEE 802.3.
- The PHY layer can provide power-over-ethernet (IEEE 802.3af/at).
- The link start-up time shall be lower than 100 ms.

7 Data link layer

7.1 General

The data link layer is one level above the physical layer. The PDU on this layer is called a frame. The data link layer has two sub layers, known as the media access control layer and the logical link control layer.

- The data link layer shall be implemented according to IEEE 802.3.
- The data link layer shall provide support for the IEEE 802.1AS protocol according to IEEE 802.3 (2012).
- The MAC and PHY layers shall interact according to IEEE 802.3.
- The LLC layer shall support the mechanisms of IEEE 802.1Q.
- The LLC layer shall support the usage of multiple VLANs.
- The LLC layer shall support the usage of priorities within the VLAN tags.

7.2 Configuration

- The camera shall support the configuration of at least three VLANs with different VLAN-IDs.
- The camera shall support the configuration of a VLAN-ID for the video stream and the protocol used for this purpose (i.e. AVTP/IEEE 1722).
- The camera shall support the configuration of a VLAN-ID for IP-based protocols.
- The camera shall support the configuration of priorities inside the VLAN tag based on IEEE 802.1Q. The priority configuration shall at least support a fixed default priority per VLAN-ID and also a fixed priority per communication protocol used inside a VLAN. The priority of the protocol shall always overwrite the VLAN's default priority.

8 Network layer

8.1 General

The network layer is the third layer in the OSI model. It provides the means to transport data between two nodes over multiple hops. The protocol specified in this part of ISO 17215 is based on the internet protocol standard known as IPv6. Although the mandatory features of this part of ISO 17215 are based on IPv6 only, IPv4 can be used for applications in network scenarios where backward compatibility with IPv4 is required. IP-based communication is used for service discovery and control (see ISO 17215-2) while the actual video data are transmitted using AVTP.

8.2 Audio Video Transport Protocol (AVTP)

AVTP specifies methods to transport audio/video data and timing information with low latency so that audio/video content sent by a talker can be reproduced on listeners. Again, in the automotive environment, the network topologies are semi-static, so the stream reservation can be anticipated in

the design phase without the need for a dynamic protocol. The results can be stored as configuration data to enable faster startup times.

- AVTP shall be implemented according to IEEE 1722-2011. AVTP makes use of other standards for clock synchronization and quality of service.
- The generalized precision time protocol shall be supported according to IEEE 802.1AS.
- If necessary, stream reservation and traffic shaping parameters for cameras shall be set with the corresponding methods defined in IEEE 802.1Qat (SRP) and IEEE 802.1Qav (FQTSS).
- If the camera supports IEEE 802.1Qat (SRP), it shall be possible to reserve the full link bandwidth minus 10 Mbit/s for AVTP data.
- If the camera does not support IEEE 802.1Qat (SRP) and IEEE 802.1Qav (FQTSS), it shall be compatible with full AVB implementations.
- The Unique ID used for the AVTP Stream ID shall be set to the last octet of the camera's IP address.

8.3 IPv6

The following requirements for the usage of IPv6 apply.

- The IPv6 standard IETF RFC 2460 shall be supported.
- The IPv6 node requirements outlined in IETF RFC 4294 shall be fulfilled.
- Deprecation of type 0 routing headers in IPv6 IETF RFC 5095 shall be respected.
- The routing header allocation guidelines IETF RFC 5871 shall be followed.
- MTU path discovery shall be performed according to IETF RFC 1981.
- Overlapping IP fragments shall be discarded according to IETF RFC 5722.
- Multicast routing discovery shall be performed according to IETF RFC 4286.
- IPv6 multicast listener discovery shall be performed according to IETF RFC 3810.
- IPv6 packet transmission over ethernet shall be performed according to IETF RFC 2464.
- IPv6 does not need to support packet fragmentation.

8.3.1 NDP

All hosts use IPv6 stateless address auto-configuration for generating addresses for their interfaces. All interfaces have a link-local address. To ensure unique addresses and to support global addresses, the Neighbour Discovery Protocol (NDP) is used.

- Neighbour discovery shall be performed according to IETF RFC 4861.
- Inverse neighbour discovery shall be performed according to IETF RFC 3122.

8.3.2 ICMPv6

The Internet Control Message Protocol (ICMP) is part of the internet protocol suite and is used to send error messages, e.g. to indicate that a requested service is not available or that a host could not be reached. Consequently, ICMP is a mandatory part of an IP stack implementation and is located on the network layer according to the OSI layered architecture model. When using IPv6, the corresponding ICMPv6 shall be used.

- ICMPv6 shall be implemented according to IETF RFC 4443.

- Extended ICMP shall be implemented according to IETF RFC 4884.

Table 2 — Mandatory ICMPv6 message types

ICMPv6 message ID	ICMP message name	Reference
1	Destination Unreachable	IETF RFC 4443
2	Packet Too Big	IETF RFC 4443
3	Time Exceeded	IETF RFC 4443
4	Parameter Problem	IETF RFC 4443
128	Echo Request	IETF RFC 4443
129	Echo Reply	IETF RFC 4443
133	Router Solicitation	IETF RFC 4861
134	Router Advertisement	IETF RFC 4861
135	Neighbour Solicitation	IETF RFC 4861
136	Neighbour Advertisement	IETF RFC 4861
137	Redirect Message	IETF RFC 4861
141	Inverse Neighbour Discovery Solicitation Message	IETF RFC 3122
142	Inverse Neighbour Discovery Advertisement Message	IETF RFC 3122
151	Multicast Router Advertisement	IETF RFC 4286
152	Multicast Router Solicitation	IETF RFC 4286
153	Multicast Router Termination	IETF RFC 4286

8.3.3 Address configuration

This subclause specifies how a device retrieves a valid IP address to communicate over the IP-based network. Note that an IPv6 host usually has multiple IP addresses assigned to any one physical network interface.

- IPv6 default address selection shall be performed according to IETF RFC 3484.
- IPv6 default address selection in multi-prefix environments shall be performed according to IETF RFC 5220.

8.3.3.1 Auto-configuration

This subclause specifies auto configuration requirements.

- IPv6 addresses shall conform to the rules laid out in IETF RFC 4291.
- Auto-configuration of link-local IPv6 addresses shall be performed according to IETF RFC 4862.

8.3.3.2 DHCPv6

The Dynamic Host Configuration Protocol for IPv6 (DHCPv6) is a client-server networking protocol used to allocate IPv6 addresses in a local network. In an automotive environment, the network topology is semi-static, so some modifications can be applied to enable fast initialization in the regular use case. However, scenarios like repairs, upgrades, and diagnosis might still require reassignment of addresses.

- DHCPv6 shall be implemented according to IETF RFC 3315.
 - Cameras shall implement the DHCPv6 client functionality.

- ECUs shall implement the DHCPv6 server functionality.
- If a DHCPv6 server is present in a network, a connected devices supporting IPv6 shall acquire an IPv6 address from same server.
- The DHCP Reconfigure option shall be supported, even without DHCP Authentication.

8.4 IPv4

IPv4 can be used as an alternative solution when IPv6 support is not available.

- IPv4 shall be implemented according to IETF RFC 791.
- The transmission of IPv4 over Ethernet shall be implemented according to IETF RFC 1042.
- Classless subnets shall be supported based on IETF RFC 1878.
- IGMP shall be implemented according to IETF RFC 3376.
- IPv4 does not need to support packet fragmentation.

8.4.1 ARP

The Address Resolution Protocol (ARP) is used to map network layer (IPv4) addresses to link layer (MAC) addresses:

- The ARP shall be implemented according to IETF RFC 826.

8.4.2 ICMP

The Internet Control Message Protocol (ICMP) is part of the internet protocol suite and is used to send error messages, e.g. to indicate that a requested service is not available or that a host could not be reached. Consequently, ICMP is a mandatory part of an IP stack implementation and is located on the network layer according to the OSI layered architecture model.

- ICMP shall be implemented according to IETF RFC 792.
- The camera shall answer to unicast ICMP echo request messages.
- The camera shall answer to broadcast ICMP Echo Request message if the destination address equals the local subnet broadcast address and the source address is inside the local subnet.
- The camera shall implement ICMP type 3 with at least code 2 (protocol unreachable) and 3 (port unreachable).

Table 3 — Mandatory ICMP message types

Type	ICMP message name	Reference
0	Echo Request	IETF RFC 792
3	Destination Unreachable (at least code 2 and 3)	IETF RFC 792
8	Echo	IETF RFC 792

Since ARP is a separate protocol (as opposed to NDP for IPv6), the list in [Table 3](#) is relatively short.

8.4.3 DHCP

DHCP is used to assign IPv4 addresses in a local network. In the context of this part of ISO 17214, ECUs play the role of DHCP servers and cameras play the role of DHCP clients.

- DHCP shall be implemented according to IETF RFC 2131.