INTERNATIONAL STANDARD

ISO 17532

First edition
2007-08-01

Stationary equipment for agriculture — Data communications network for livestock farming

Matériel fixe pour l'agriculture — Réseau de communication de données pour fermes d'élevage

Reference number
ISO 17532:2007(E)

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Published in Switzerland

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 17532 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 19, *Agricultural electronics*.

Stationary equipment for agriculture — Data communications network for livestock farming

1 Scope

This International Standard specifies a protocol for the automatic and interactive communication and control of computer systems used in livestock production. It supports communication within the livestock production as well as across the Internet.

While it defines the basic protocol for data exchange, it uses generic data structures so that the protocol is extendable regarding future requirements.

The protocol is applicable only to simple and/or clearly defined entities.

This International Standard deals with the networking of those services used for livestock production which are provided by the devices in systems. It is not applicable to communication within subsystems.

The syntax of the transported data is based on the ADIS and ADED standards as defined in ISO 11787 and ISO 11788; alternatively, XML/ADED can be used as described in this International Standard. Like the ADIS standard specified in ISO 11787, it is implicit that the syntax is not intended for real-time data interchange.

2 Normative references

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

ISO 3166-1, *Codes for the representation of names of countries and their subdivisions — Part 1: Country codes*

ISO 4217, *Codes for the representation of currencies and funds*

ISO 11787, *Machinery for agriculture and forestry — Data interchange between management computer and process computers — Data interchange syntax*

ISO 11788-1, *Electronic data interchange between information systems in agriculture — Agricultural data element dictionary — Part 1: General description*

IEC 60204-1, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11787 and ISO 11788-1, and the following, apply.

3.1
bluetooth
industry standard for the wireless cross-linking of devices with small range

3.2
device
any machine or component which is connected to computer systems used for livestock production

3.3
MAC address
hardware address that uniquely identifies each node of a network

NOTE MAC is an acronym for media access control.

3.4
system
data processing or control component at the computer systems used for livestock production

3.5
subsystem
division of a system, which itself has the characteristics of a data communication system

3.6
network
interconnection of three or more communicating components which exchange data via a network

3.7
network management
execution of a set of functions required for controlling, planning, allocating, deploying, coordinating and monitoring the resources of a network

3.8
datagram
fundamental unit of information carriage in all modern computer networks

NOTE It consists of a header, which contains the information needed to get the datagram from the source to the destination, and a data area, which contains the data content (messages).

3.9
location
agricultural business and the various subsystems (shed, compartment, bay, place) of a farm

3.10
location address
sequence of sub-addresses separated by dots

NOTE The sequence begins with the farm number (15 N). The farm number starts with the numeric ISO Country Code (ISO 3166/3 N) and is immediately followed by a unique national farm ID (12 N).

3.11
server
program in a device which provides a socket with which a client can link up to exchange ISO 17532 messages and services

3.12
client
program in a device that is used to contact and obtain data from a server program on another or the same device

NOTE An ISO 17532 client is designed to work with ISO 17532 server programs only.

3.13
parameter group
group of related parameters which can be used to configure machine configurations for ISO 17532 communication

3.14
parameter class
contains one or more parameter groups which are classified by a special function or task

3.15
parameter identifier
item type for machine configuration

3.16
DD entity
data element definition from the data dictionary (DD)

3.17
DD entity number
number used to identify a data entity in a data dictionary (DD)

3.18
DD item
data details of the data elements from the data dictionary (DD)

3.19
code set
fixed set of states with defined contents

3.20
multicast
delivery of information to multiple destinations simultaneously, using the most efficient strategy to deliver the message over each link of the network

NOTE Delivery is performed only once and copies are created only when the links to the destinations split. “Multicast” is used to refer to an IP multicast, which is a protocol for efficiently sending to multiple receivers at IP networks at the same time.

3.21
multicast address
address of a multicast connection

3.22
transmission control protocol
TCP
connection-oriented, reliable delivery byte-stream transport layer communication protocol

3.23
user datagram protocol
UDP
minimal message-oriented transport layer protocol

3.24
Internet protocol
IP
data-oriented protocol used by source and destination hosts for communication data across a packet-switched Internetwork

3.25
virtual private network
VPN
private communication network used within a company or by different companies or organizations communicating over the Internet

NOTE Secure VPN use cryptographic tunnelling protocols to provide the necessary confidentiality, sender authentication and message integrity to achieve the privacy intended.

3.26
unity
comparison figure with which the values of defined items are expressed

3.27
handle number
unique number used to identify a transaction or a named query

3.28
device ID
unique device number constructed by the MAC address ID

3.29
port
network port
interface for communicating with a computer program over a network

NOTE Network ports are numbered. UDP and TCP will attach a port number to the data sent, which is used by the receiving network component to determine to which application on the device data should be sent.

3.30
session
period of communication activity

NOTE Reliable, interactive transfer of data between two devices in ISO 17532 communication is called a “session”.

3.31
transaction
one interaction between client and server

3.32
session end line
termination
end of a session

4 Abbreviated terms

ADIS agriculture data interchange syntax

ADED agriculture data element dictionary

AN alphanumeric

C conditional

DA data authentication

DD data dictionary

DHCP dynamic host configuration protocol

DNS domain name server

DF data line of faulty data + error item + impact item

DN definition line type of status normal (N)

EDI electronic data interchange

FTP file transfer protocol

IAONA international automation open networking alliance

IEEE institute of electrical and electronic engineers

IETF Internet engineering task force

IP Internet protocol

K key data element

LAN local area network

M mandatory

MCC multicast communication

N numeric

NLF network livestock farming

O optional

PIG industrial Ethernet planning and installation guide

PO processing instruction open

PP processing instruction pending

PPP point-to-point protocol

PR processing instruction result line

RJ45 registered jack type 45

SBC session-based communication

SN sequence number

TCP transmission control protocol

TN termination line with status normal (N)

UDP user datagram protocol

URI uniform resource identifier

URL uniform resource locator

UTC universal time (also known as Greenwich mean time)

VA value line for authentication

VE value line error handling information

VF value line faulty data + error code + impact code

VN value line type and status

VPN virtual private network

WLAN wireless local area network

XML extensible markup language

ZN end session

NOTE For descriptions of line type and status character abbreviations, see Figure 8.

5 General

Networks of computer systems are necessary in livestock farming for controlling various processes (e.g. feeding and climate), environmental balance (field yard balance), and comprehensive environmental and animal protection, as well as for economic reasons.

In order to use services over a networked infrastructure, information must be transported. For this, the way in which the information is to be communicated between the communication partners needs to be known in advance. The purpose of this International Standard is to provide a protocol that serves this need.

IP is used as the basis for ISO 17532 communication and TCP streams are used to ensure reliable communication. For management and short messages, UDP datagrams are multicasted.

For the notation of the description of the ADIS syntax, see ISO 11787.

As the physical layer for the IP, the Ethernet as defined in IEEE 802.3x is the most commonly used today, and this International Standard is designed to support it. IP packets can be transported using wired or wireless communication.

This International Standard defines the requirements for the physical connections and the data communication in a network used for livestock production. The requirements apply for the devices connected directly to this network.

6 Technical requirements and recommendations

6.1 Basic requirements

Fast data communication between the components shall be guaranteed by the devices involved.

If real-time communication is needed, logical separated network segments shall be configured for communication in real time within the important segment.

A structured cabling or wireless connection shall be provided.

6.2 Connectors

The use of RJ45 connectors is recommended. Depending on the environmental conditions (light or heavy duty), the connections shall comply with protection classes IP 20 or IP 67 in accordance with IEC 60529.

6.3 Cables

The devices of the manufacturers shall be star, bus or ring-shaped connections. A four-wire cable is sufficient for the data connection.

For the wiring of the stable net, cable types corresponding to the IAONA recommendations (PIG, release 4.0, 2003) should be used. The transmission speed is determined as a minimum of 10 MB/s for copper wire connections. For the wiring within the barn area, safety class system IP 67 (heavy duty) should be used. In less susceptible environments (stable office), IP 20 (light duty) is sufficient. As basic requirements for the physical layer, the recommendations of the IAONA shall at least be met.

6.4 Transport protocol

Both TCP/IP and UDP are used — TCP/IP for reliable connections, UDP for multicast addressing communication. Components (WLAN, Bluetooth devices) that can be connected to the farm network via TCP/IP and UDP, and which conform to corresponding IEEE standards, are supported. Figure 1 shows this architecture graphically.

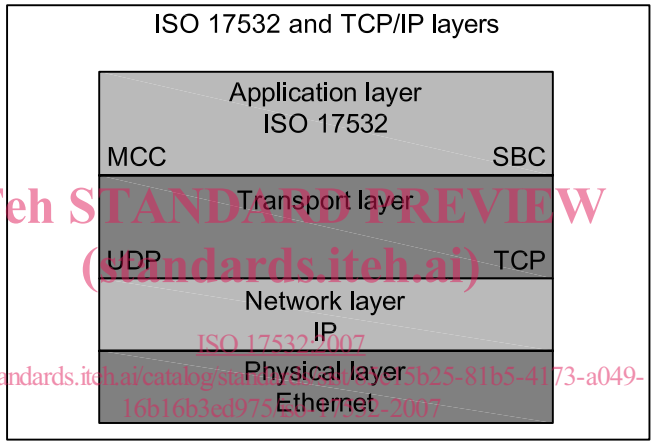


Figure 1 — ISO 17532 and TCP/IP layers

7 Network livestock farming communication

7.1 Farm use

There are no limitations on ISO 17532 communication within livestock production, i.e. within one physical network. A local network can be connected via the Internet using VPN technology, whereby the network can be extended beyond the borders of one farm (physical network).

7.2 Internet use

The coupling of devices using multicast communication over the Internet is not supported. The data exchange between farm devices and Internet partners shall be organized by special services.

NOTE In Internet connections, only TCP connections are supported in ISO 17532 communication. TCP packets can be transported using a variety of physical layer protocols, e.g. PPP (modem use) or Ethernet.

7.3 Multicast communication

The multicast address 224.111.234.123 and port numbers 2434 for ADIS/ADED and 2435 for XML/ADED should be used in local networks. If other multicast addresses are used, they must be configured manually in all the devices.

Due to limitations in the transport of UDP multicast datagrams via the underlying physical layer (e.g. Ethernet), the data area of a datagram must not exceed 1 024 B. The sender of a datagram with ADIS lines also needs to ensure that the datagram length of the transformed XML data does not exceed the length of 1 024 B. Each UDP multicast datagram starts with 8 B for a header containing information about the ISO 17532 MCC communication. Bit 0 of the first byte is set when the datagram is transferred by the transformer to the other MCC address. If bit 1 is set, there is no need to transform the datagram. To keep this sort of message small, no header lines are sent in the datagram. In multicast communication, no header data with information on the data dictionary used, etc. can be sent, so the recipients of the data must be able to react flexibly to the data structure.

In UDP datagrams, a value line (ADIS and XML/ADED) is preceded by a definition line referring to the same entity.

NOTE 1 Management functions and the distribution of simple messages can be easily conducted using UDP as multicast messages without knowing the network address of every single device.

NOTE 2 UDP communication does not acknowledge receipt of UDP packets and is not absolutely secure.

NOTE 3 Owing to the nature of multicast, every device connected to an ISO 17532 network receives the messages sent to the commonly agreed multicast address. It is then the responsibility of the administrator to check bus load and time behaviour.

7.4 TCP connections

7.4.1 General

TCP connections shall be used when it is necessary to ensure that no information is lost or mixed up. The initiating device is called the “client” and the answering device, which was listening for a connection, is called the “server”. Therefore, TCP connections are always point-to-point connections (by default, the communication partners use port number 2434). If, on one computer, several SBC services are offered by several programs, it is necessary during publish/subscribe to arrange for alternative ports. This is the purpose of specifying the port number (item number 901044) in the entities service request (990110) and service inquiry reply (990109).

For transforming data streams between XML/ADED and ADIS/ADED, conversion software is needed.

NOTE When implementing software that handles TCP connections or network connections in general, it is necessary to consider using a timeout to close a connection when the communication partner does not send any messages or no longer responds. However, it has to be kept in mind that a request to search certain data can cause a database system to require quite some time. So timeouts have to be selected carefully. For very long-lasting orders, asynchronous transactions are a means of carrying out the order without the need of setting very long timeouts.

7.4.2 Session

Each session is divided into separate transactions and is always carried out using a TCP connection between two devices (point-to-point communication).

A session starts with information on the authentication of the client. If the authentication stage is left out by the client, the session starts with the header line. Authentication and header lines are encapsulated in one transaction each. Whether a login is necessary depends on the demands of the devices. It can be negotiated during publication of the services in the boot-up stage of a device. The header line supplies basic information on how the following data in this session has to be interpreted in terms of the DD version that was used to compile the data of the session.

A session consists of 1..*n* transactions and ends with a Session End line. Generally, the client sends a Session End line to the server to make sure the server takes note that the TCP connection is closing. Otherwise, there could be a lock-up of the used server TCP port for several minutes (depending on the operating system) before the same TCP port can be used again.

Within a transaction, a variety of functions can be carried out:

— authentication;

— header lines;

— sending or receiving data;

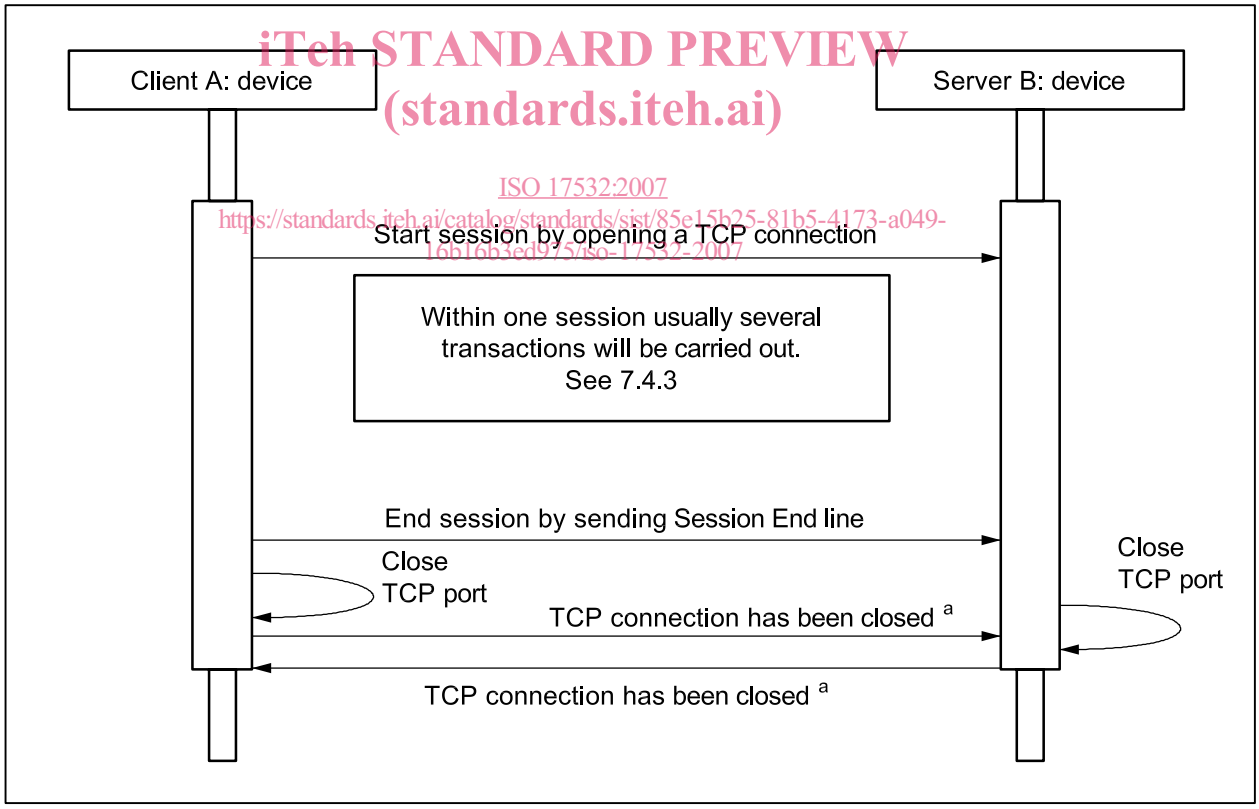
— issuing a search request;

— executing a named query;

— executing a processing instruction.

See Annex A for a detailed list and description of these functions.

Figure 2 shows the flow of the described session.



[a] Both these messages are part of the operating system's implementation of the TCP stack.

Figure 2 — Session

7.4.3 Transaction

Each transaction is separate from the next. Figure 3 shows that device A (client) starts the transaction and device B (server) processes the sent data and sends back either results, error information, comments or nothing.

The client is shown as initiating a transaction by sending the starting line of one of the functions specified in 7.4.2.

a) Sending a Definition Line starts the function “sending data”.

b) Search Request starts with either a Search or a Request Line.

c) Posting a Named Query is started by sending a Query Line.

d) Processing instructions are started by a Processing Instruction line.

e) Login (Authentication) and Header are handled alike.

f) Header lines are formulated as special transactions.

It is not possible to use this feature by means of multicast messages.

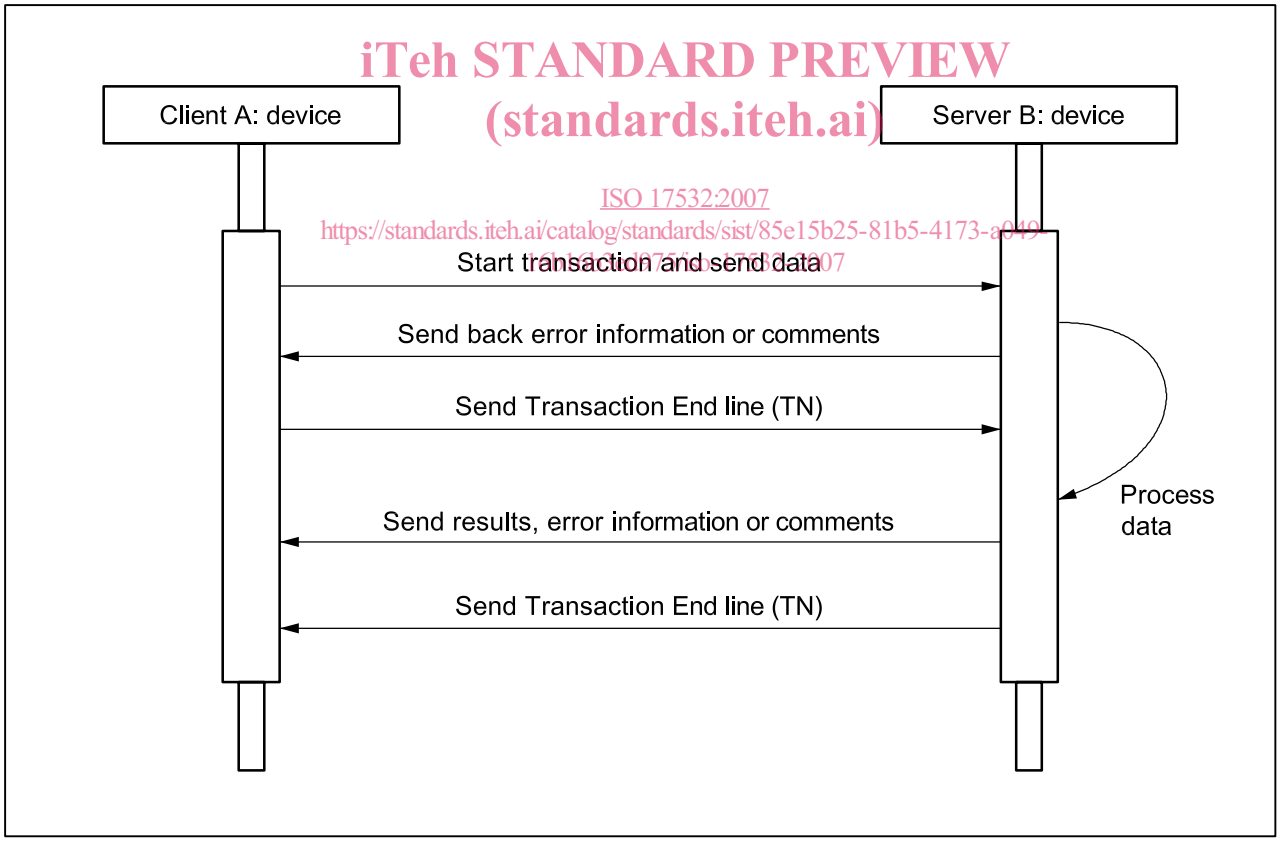


Figure 3 — General handling of transactions

In contrast with the start of a transaction, the end is always marked with the same line, the Transaction End line. Because the client initiates a transaction, it is up to the client to send the Transaction End line after issuing all necessary information. The receiver may have to process the transaction. The receiving end (server) then needs to interact with the client by sending back the requested information or, possibly, any error codes, comments or the like. After processing the transaction that was sent by the client and sending back any information (requested or not), the server then sends back the Transaction End line.

Before starting a new transaction, the client (initiator of the connection to the receiving end) has to wait for the handshake, i.e. the reception of a Transaction End line from the server.

If a transaction cannot be handled correctly for any important reason by one of the communication partners, the session can be cancelled by one of the partners by sending a Session End line. The current transaction is then cancelled, too. After cancelling a session, the TCP connection must be shut down immediately. A TCP connection may not be shut down generally without issuing a Session End line due to technical details of the IP. In certain circumstances it is not possible to open a connection to the same port for a certain time after irregularly ending a TCP connection.

On the one hand, the transaction partners can generally decide whether they want to react to the incorrect transaction end with a rollback or by sending more data. On the other hand, a regular Transaction End indicates that the services within the transaction have definitely been carried out correctly. An exception, of course, is the asynchronous transactions because they are carried out while the initial transaction, session and TCP connection are shut down. Asynchronous transactions (see 7.4.4) are identified by a handle number for future reference.

7.4.4 Asynchronous transactions

Asynchronous transactions are special in the sense that they are carried out while there is no communication connection open between the requesting and the executing end of the interaction of two devices. Immediately in the login, but also in the query or processing instruction, the client can issue a URI to which the server should transfer asynchronous results. If this URI is not given, a TCP connection is created from the server to the default port of the client as a reverse channel as soon as the server wants to send back the asynchronous results.

To refer to the issued function, the asynchronous result carries the same, unique handle number.

The operator finds out whether the data needs to be sent, e.g. as an e-mail by parsing the URI. Within the URI “e-mail” is one of the predefined URI schemes that also gives information about the access mechanism (how to send an e-mail).

NOTE RFC 2396 gives details on URI and URI schemes.

The new ADIS status characters presented in 7.11.3 inform the client that data will be sent back asynchronously. Figure 4 shows in detail how asynchronous transactions are handled.