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Tractors and machinery for agriculture and forestry — Serial control and communications data network —

Part 10: Task controller and management information system data interchange

Tracteurs et matériels agricoles et forestiers — Réseaux de commande et de communication de données en série —

Partie 10: Contrôleur de tâches et échange de données des systèmes d'information de gestion

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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.

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 11783-10 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 19, *Agricultural electronics*.

ISO 11783 consists of the following parts, under the general title *Tractors and machinery for agriculture and forestry — Serial control and communications data network*:

— *Part 1: General standard for mobile data communication*

— *Part 2: Physical layer*

— *Part 3: Data link layer*

— *Part 4: Network layer*

— *Part 5: Network management*

— *Part 6: Virtual terminal*

— *Part 7: Implement messages application layer*

— *Part 8: Power train messages*

— *Part 9: Tractor ECU*

— *Part 10: Task controller and management information system data interchange*

— *Part 11: Mobile data element dictionary*

— *Part 12: Diagnostics services*

— *Part 13: File server*

— *Part 14: Sequence control*

Introduction

ISO 11783 specifies a communications system for agricultural equipment based on the CAN 2.0 B[2] protocol. SAE J1939[3] documents, on which parts of ISO 11783 are based, were developed jointly for use in truck and bus applications and for construction and agriculture applications. Joint documents were completed to allow electronic units that meet the truck and bus SAE J1939[3] specifications to be used by agricultural and forestry equipment with minimal changes.

General information on ISO 11783 is to be found in ISO 11783-1. The purpose of ISO 11783 is to provide an open, interconnected system for on-board electronic systems. It is intended to enable electronic control units (ECUs) to communicate with each other, providing a standardized system.

The International Organization for Standardization (ISO) draws attention to the fact that it is claimed that compliance with this part of ISO 11783 may involve the use of a patent concerning the controller area network (CAN) protocol referred to throughout the document.

ISO takes no position concerning the evidence, validity and scope of this patent.

The holder of this patent has assured ISO that he is willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with ISO. Information may be obtained from:

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Tractors and machinery for agriculture and forestry — Serial control and communications data network —

Part 10: Task controller and management information system data interchange

1 Scope

ISO 11783 as a whole specifies a serial data network for control and communications on forestry or agricultural tractors and mounted, semi-mounted, towed or self-propelled implements. Its purpose is to standardize the method and format of transfer of data between sensors, actuators, control elements and information storage and display units, whether mounted on, or part of, the tractor or implement. This part of ISO 11783 describes the task-controller applications layer, which defines the requirements and services needed for communicating between the task controller and electronic control units. The data format to communicate with the farm-management computer, the calculations required for control and the message format sent to the control function are defined in this part of ISO 11783.

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 11783-1, *Tractors and machinery for agriculture and forestry — Serial control and communications data network — Part 1: General standard for mobile data communication*

ISO 11783-3, *Tractors and machinery for agriculture and forestry — Serial control and communications data network — Part 3: Data link layer*

ISO 11783-5, *Tractors and machinery for agriculture and forestry — Serial control and communications data network — Part 5: Network management*

ISO 11783-6, *Tractors and machinery for agriculture and forestry — Serial control and communications data network — Part 6: Virtual terminal*

ISO 11783-7, *Tractors and machinery for agriculture and forestry — Serial control and communications data network — Part 7: Implement messages application layer*

ISO 11783-11, *Tractors and machinery for agriculture and forestry — Serial control and communications data network — Part 11: Mobile data element dictionary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11783-1 apply.

4 Abbreviations

For the purposes of this document, the abbreviations given in ISO 11783-1 apply.

5 General description

5.1 Task management

There are two main purposes of task management in the mobile implement control system.

The first is the management of the farm resources, including tractors, implements, sensor systems, workers and the products used. It is possible for the farmer to plan and evaluate the use of the resources. He is then able to automatically control the use of his inventory of products and can keep track of the status and conditions of his machinery. Resource designators are globally transferred as coding data and are part of the data transfer file as detailed in Clause 7.

The second purpose is the management of the farm activities carried out in the fields. These activities are described by tasks to distinguish all the work that is planned or has been done by the farmer or by a contractor for one customer in one partfield.

The data transfer is possible in two directions. The planned tasks are sent to the task controller on the MICS (mobile implement control system) and the results of the work are sent back to the FMIS (farm-management information system). Tasks can be generated both on the FMIS and on the MICS.

Task management has the following workflow:

a) Planning field tasks and maintaining coding data using the software of an FMIS computer operated by the farmers or contractors, as detailed in 5.2.

b) Converting the task data into XML format.

c) Assigning the task data produced by the planning software to the data required for the implements or sensor systems to be used to complete the planned tasks. This step is optional.

d) Transferring the task data from the FMIS system to the task controller of the MICS, as detailed in 5.4.

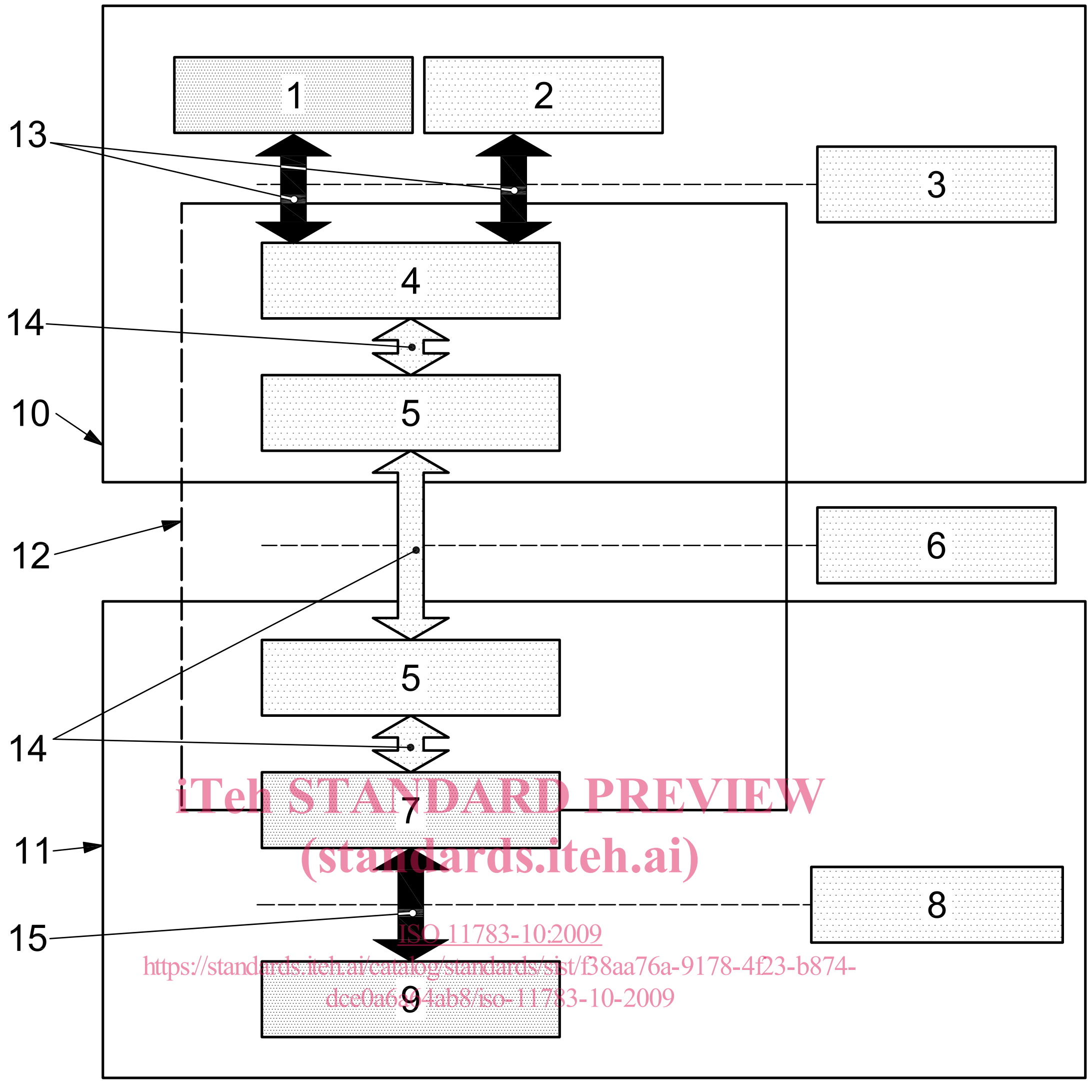
e) The task controller uses the task data to transmit process data messages to the ECUs on the implement.

f) The task controller collects data according to the DataLogTriggers specified in the task data.

g) Transferring the collected data to the FMIS. Collected data can be in the XML format or in a proprietary format. When a proprietary format is used, this step involves converting the proprietary format into the XML format.

h) Reading the XML files and converting into the FMIS format for storage and evaluation of the data.

Figure 1 illustrates the interfaces between the software on the FMIS computer and the ECUs mounted on an ISO 11783-configured implement.



Key

1 management information system
2 implement configuration data
3 XML format
4 task-controller configuration program
5 task-controller interface driver
6 task-controller data carrier
7 ISO 11783 task controller
8 ISO 11783 network
9 ISO 11783 control function
10 farm-management information system (FMIS)
11 mobile implement control system (MICS)
12 not standardized
13 standardized data transfer with data transfer file
14 standardized or proprietary data format
15 standardized data transfer within the ISO 11783 network

Figure 1 — Task management entities and interfaces

5.2 Task management on FMIS computer

Task management is defined as a part of an FMIS, responsible for planning and evaluation of field work. Tasks specify what, where, how, by whom and when work is planned to be carried out.

The amount of data transferred between the FMIS and the MICS is dictated by the administrative requirements of a farming enterprise. For the recording of field activities only, the task management can be used to file the data in a working journal. For this purpose, only the coding data need be transferred from FMIS to MICS, and the tasks are created on the MICS by selection of the involved resources. In this case, only the data transfer file from MICS to FMIS contains tasks. In enterprises where tasks are planned on the FMIS, these will be included, together with the coding data, in the data transfer file from FMIS to MICS. These planned tasks can range from mere planned allocations of resources to geographical information for site-specific field operations.

5.3 Preselection and assignment of working sets

Any device in the mobile system can only be identified uniquely by its working-set master's NAME. At the FMIS, the preselection of devices depends on the planned task. It can be necessary to assign a type of device or function, a specific device or even the device of a particular manufacturer. The DeviceAllocation XML elements may include planned assignments about the working sets to be used. This information ranges between specific and indistinct.

The XML attribute WorkingSetMasterNAMEValue contains the eight-byte NAME of a control function as it is defined in ISO 11783-5. Not all parts of a NAME need be specified and only certain elements of a NAME need to be defined to determine a device on the mobile network. Those parts of WorkingSetMasterNAMEValue containing information to be used on the mobile system to select a proper device are masked by a bitset structure stored in the XML attribute, WorkingSetMasterNAMEMask. All different combinations of elements of the NAME structure can be marked as valid for device selection (logical AND). On the FMIS, these masks could be coded as symbols. Once the preselection information is set in a task on the FMIS, it is not overwritten on the mobile system, because the working set that is used during task processing on the mobile system is stored as XML attribute DeviceIdRef.

5.4 Task-controller interface driver

After generating the interface files, the task-controller driver of the manufacturer of the task controller is activated on the farm computer. This driver is responsible for the data transfer to the task controller, which is part of the MICS using its proprietary data format or the ISO 11783-10 XML format and data carrier, such as any type of memory card or radio link. The translation of the data from the data transfer files in messages on the ISO 11783 network, as well as the kind of transfer between the mobile system and the FMIS, is not subject to a standardized procedure. To make implement-specific set point data, this driver can add and use device description data supplied by the manufacturers.

5.5 Task-controller user interface

A task controller can provide a means for the user to interact with the task controller. User interaction can be through a VT (virtual terminal) or other interface. Operator interfaces can range from very simple to elaborate, depending on the designer’s intent. For example, a simple task controller that only supports single tasks that run automatically might not require any user interaction. More advanced task controllers can offer additional operator interface capabilities, such as

— select a task from a list,

— start/stop/resume a task,

— modify a task,

— create a task, and

— add new coding data.

Through the user interface, an operator can react to special circumstances or events in order to execute tasks in a reasonable way. The operator can also be informed about the status and results of the tasks and their components. For example, the operator could print a work confirmation for a farmer.

6 Task-controller requirements

6.1 Task selection and execution

The task controller can provide a mechanism for the selection and shall provide a mechanism for the execution of a task contained in the data transfer file. Selection of an individual task can be done either by the operator through an operator interface or automatically by the task controller. The means of task selection is not specified by this part of ISO 11783. The task-controller designer is free to decide how task selection is implemented. The method provided for starting and stopping a task is not subject to standardization. This functionality is also to be determined by the task-controller designer.

On a MICS, a task shall always be selected. If no task was selected by the user, then the task controller shall prompt the operator for a task selection or select a task automatically.

The status of a task is defined in Table 1.

Table 1 — Task status

Initial	Task is prepared at FMIS but not yet processed on MICS.
Running	Task is currently being processed on MICS. Only one task can be active per task controller at the same time.
Paused	Task was previously running, is not currently running, and is not yet completed.
Completed[a]	Task is finished. This state can only be set by the operator and cannot be set automatically by the MICS.
[a] The *completed* task state is optional. Some task controllers may not support this state.	

6.2 Logging of time and position

There can be a need to assign some optional information, such as date, time and GPS position data, to events that occur during task processing. This could be an event reflecting the interconnection of XML elements, such as the allocation of GPS position-related comments and/or flags or the assignment or exchange of a worker, for example. Other events are based on logging of received process data variable values from task-related working sets, which shall be supplied with information of date, time and position.

The XML elements AllocationStamp and Time enable the allocation of local time and date values to several XML elements where needed. These XML elements can be of the type planned or effective, for specifying whether an event was planned or accomplished. Additionally, at a task level within the Time XML element only, more detailed time types, such as preparation time, ineffective time, repair time or clearing time, are defined. All time and date values shall be local time and date values inside this XML element.

Optionally, the AllocationStamp and Time XML elements can include a position XML element that contains GPS-related information. To be able to allocate multiple process data values, the Time XML element can include several DataLogValue XML elements. The number of these DataLogValues stored inside the task shall be limited to totals or single instance values. For large amounts of DataLogValues, the use of the TimeLog XML element and binary log file is defined.

All process data-related logging data can be stored in a binary format as a separate file. The reference to the binary file is to be set by XML element TimeLog. More TimeLog XML elements can exist per task, referring to external files with unique names inside the name space of the set of tasks belonging to the data transfer file. The uniqueness of file name prefixes shall be guaranteed by the task controller. Each TimeLog file definition results in two separate files — one to contain the binary data and the other to contain the XML coded header structure of the binary data set. The header structure defines the maximum data per binary record and enables the correct interpretation of the binary data. The filename extension of the binary file shall be ".bin"; the filename extension of the XML header structure file shall be ".xml".

6.3 Logging parameters from parameter groups

In addition to the ProcessDataVariable values, the values or parameters from other parameter groups can be logged by a task controller. The XML elements DataLogTrigger and DataLogValue contain attributes to specify from which parameter group a value is to be logged. These attributes are optional. When these attributes are specified, the DataLogDDI attribute in DataLogTrigger or DataLogValue shall be set to the ParameterGroupNumberValue (DDI = $0xDFFE_{16}$). Each parameter group may contain multiple values, and therefore both a parameter group number and a start and stop bit to obtain a single value from the data field of the CAN data frame shall be specified when the task controller logs data from parameter groups other than the ProcessDataVariable. The size of the value is at a maximum 32 bits, and is stored as the DataLogValue attribute in the XML element DataLogValue.

When the task controller logs data from parameter groups, a reference to a DeviceElement is required. If this log data originates from parameter groups other than the ProcessDataVariable, a device with a control function NAME with a filled-in WorkingSetMasterNAME XML attribute and a DeviceElement referring to this device shall be defined. These device and DeviceElement XML elements may be generated by the task controller or can be supplied by the FMIS.

6.4 Connection management

Upon power-up, a specific sequence of events shall occur, in order to ensure proper initialization of the task controller and working sets, as described in 6.4.1 and 6.4.2 and depicted in Figure 2.

6.4.1 Task-controller initialization

The task controller shall complete the following initialization.

a) The task controller shall complete the address claim procedure in accordance with ISO 11783-5 and shall also send a request for an address claimed to the global destination address (255).

b) The task controller shall wait for 6 s after completing the address claim procedure.

c) The task controller shall begin transmission of the task-controller status message.

d) The task controller shall allow working sets to initialize and to load their device description objects.

6.4.2 Working-set initialization with the task controller

The working set shall complete the following initialization.

a) The working set shall complete the address claim procedure in accordance with ISO 11783-5.

b) The working-set master shall wait for 6 s after completing the address claim procedure.

c) The working-set master shall wait until the task controller begins transmission of the task-controller status message.

d) The working-set master shall identify itself and its members to the task controller, using the working-set master and working-set member messages given in ISO 11783-7.

   The working-set master may send these messages for other purposes (e.g. virtual terminal initialization).

e) The working-set master shall begin transmission of the working-set task message.

f) The working-set master may query the task controller, as necessary, to determine its capabilities.

g) The working-set master may request the language and format messages from a virtual terminal.

h) The working-set master shall query the task controller to determine if its device description object pool already exists.

i) The working-set master shall either

   1) activate the existing device description at the task controller, or

   2) commence and complete a transfer of the device description object pool to the task controller and activate the device description at the task controller, accomplished using the messages defined in Annex B and either the transport protocol (see ISO 11783-3) or extended transport protocol (see ISO 11783-6), depending on the size of the object pool.

6.5 Connection management

The task controller shall transmit a cyclic task controller status message at an interval of 2 s. The task controller also sends a task controller status message immediately whenever the task status changes or the value in any of the other task controller status message bytes changes, although at least 200 ms shall elapse between task controller status messages (the maximum transmit rate for task controller status message is 5 Hz). This message includes an indication of the current task status and is sent to the destination-specific global address (GA). If the working-set master does not receive this message for at least 6 s, it assumes a possible uncontrolled shutdown of the task controller and stops sending the working set task message. The working set may re-establish connection to the task controller by restarting the initialization procedure.

All working-set masters that maintain a connection with a task controller shall indicate their presence by transmitting to the task controller a cyclic working-set task message at an interval of 2 s. The working-set master shall wait at least 6 s after finishing the address claim procedure before transmitting the working-set task message. This timeout enables the task controller to detect a restart of a working set. If the task controller does not receive this message for at least 6 s, it assumes a possible uncontrolled shutdown of the working set.

The task controller status message and the working-set task message are defined in Annex B.

When a working set is restarted, or starts and connects to the task controller during an active task, the task controller shall accept the upload and activation of the working sets device descriptor and issue the measurement commands applicable to this working set.

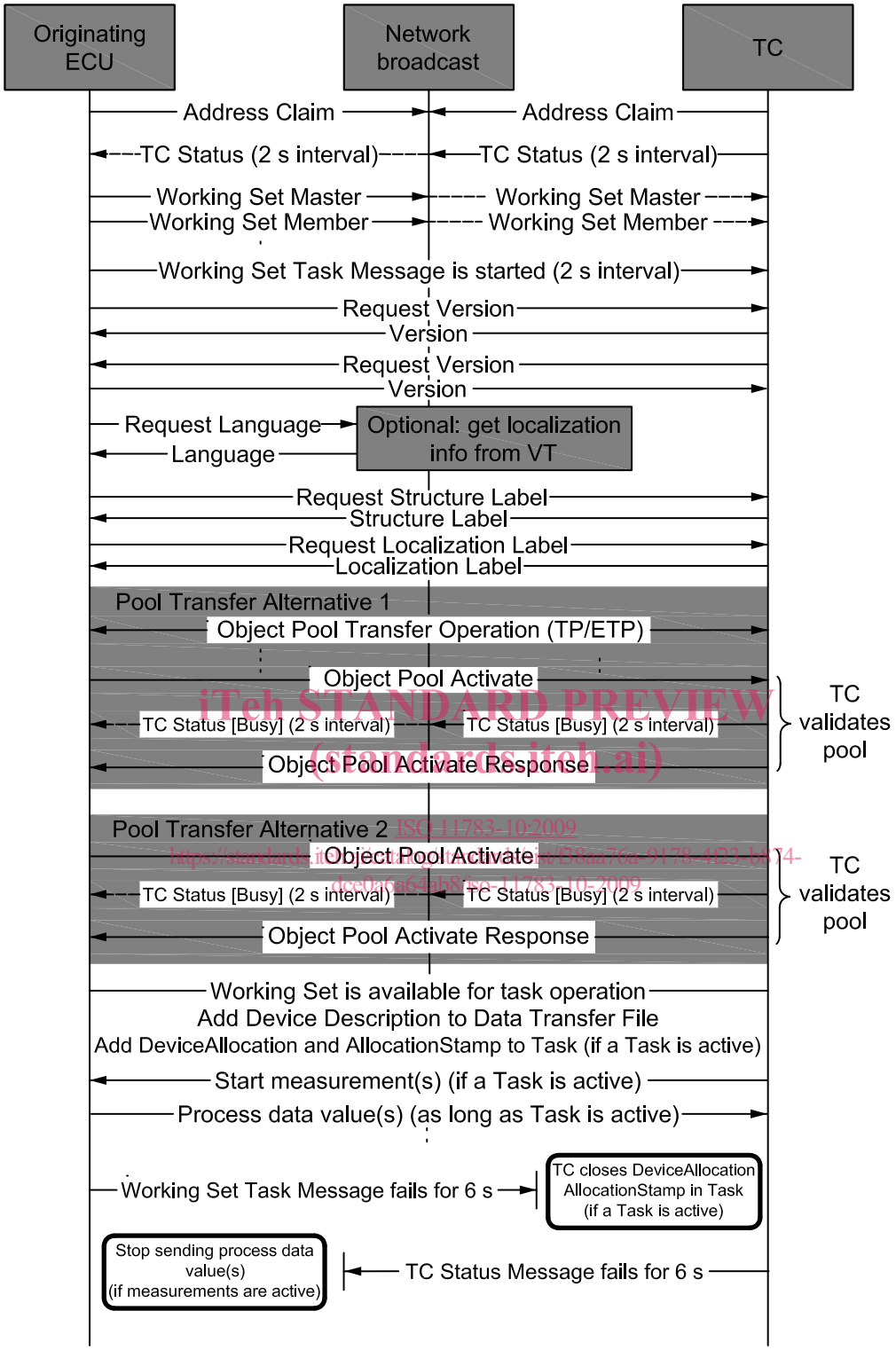


Figure 2 — Initialization and shutdown of connections

6.6 Data exchange on the network

The task controller converts data from the data transfer file into process data messages to control the devices. These process data messages contain commands and values sent to the participating working-set control functions. The task controller performs calculations to schedule the process data messages to be transmitted to the required addresses on the ISO 11783 network. An example of these calculations are site-specific applications such as when the task controller looks up the position of an element of the working set in the application grid, combines it with the operation delays of this working set, and sends the relevant data to this working set. In the opposite direction, the task controller processes the process data messages sent by the participating working-set members and converts these process data variables to task data, in order to return these to the data transfer file.

All task-controller-specific data exchange on the ISO 11783 network is based on process data messages.

The task controller can generate process data messages containing process data variables that are not specified in a task data file. The process data messages control operation and data logging of the participating working-set control functions. The task controller shall only send or request process data variables that are supported by the working-set control functions. Examples of this type of control are the use of sensor systems and the use of recorded spatial operation of working set control functions to control working set control functions.

6.6.1 Site-specific application

Site-specific applications require the task controller to schedule sending of process data messages according to the actual location. For matching of the actual location with ProcessDataVariable XML element definitions, the geometry for site-specific process data has to be specified in the task data. The geometry definition is either a gridcell or a polygon, and shall be labelled with a unique identification. Gridcells and polygons refer to a TreatmentZone to which the site-specific process data variable values are related. When the relevant DeviceElement enters a new TreatmentZone, the new set point values associated with that TreatmentZone are sent over the ISO 11783 network to the appropriate working-set master.

Of the geometry definitions, gridcells have constant length and width dimensions. The gridcell location is relative to the origin of the grid to which a gridcell belongs. The structure and identification of gridcells are specified in the XML elements Grid and Gridcell. Polygons can be used to define irregularly shaped TreatmentZones. The XML elements Polygon, Linestring and Point are used to define this type of TreatmentZone. Figure 3 presents a comparison of both types of TreatmentZone definition and Figure 4 the grid definition in more detail.