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

Part 6: Virtual terminal

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

Partie 6: Terminal virtuel

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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.

ISO 11783-6 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 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 9: Tractor ECU*

Part 1, *General standard for mobile data communication*, Part 8, *Power train messages*, Part 10, *Task controller and management information system data interchange*, Part 11, *Data dictionary*, Part 12, *Diagnostics* and Part 13, *File server* are under preparation.

Introduction

Parts 1 to 11 of ISO 11783 specify a communications system for agricultural equipment based on the CAN 2.0 B [1] protocol. SAE J 1939 [2] 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 J 1939 specifications to be used by agricultural and forestry equipment with minimal changes. The specifications for virtual terminals given in this part of ISO 11783 are based on DIN 9684-4 [3]. 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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Germany

Attention is drawn to the possibility that some of the elements of this part of ISO 11783 may be the subject of patent rights other than that those identified above. ISO shall not be held responsible for identifying any or all such patent rights.

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

Part 6: Virtual terminal

1 Scope

This part of ISO 11783 specifies a serial data network for control and communications on forestry or agricultural tractors, mounted, semi-mounted, towed or self propelled implements. Its purpose is to standardize the method and format of transfer of data between sensor, actuators, control elements, information storage and display units whether mounted or part of the tractor, or any implements. This part of ISO 11783 describes a universal virtual terminal that can be used by both tractors and implements.

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

ISO 11783-3:1998, *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 11783-7, *Tractors and machinery for agriculture and forestry — Serial control and communications data network — Part 7: Implement messages application layer*

3 Terms, definitions and abbreviated terms

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

3.1
auxiliary input device
autonomous electronic control unit (ECU) providing auxiliary controls for common use that may also be being physically located on the virtual terminal (VT)

1) Under preparation.

3.2
object pool
collection of objects that completely define the operator interface for an implement or a single working set

NOTE The complete VT definition will be made up of one or more object pools — one for each working set.

AID attribute ID

4 Technical requirements

4.1 Overview

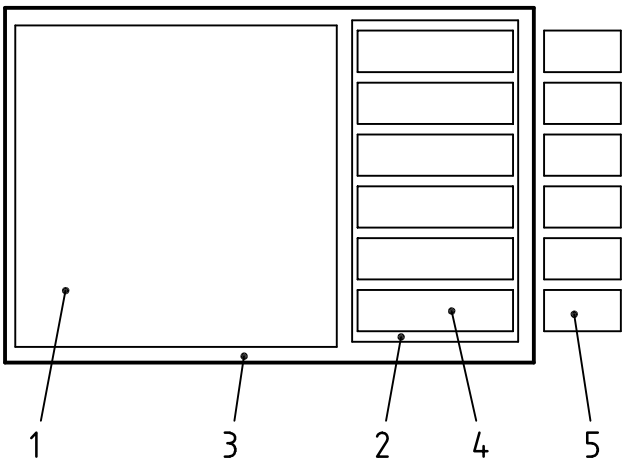
A virtual terminal (VT) is an electronic control unit (ECU), consisting of a graphical display and input functions, connected to an ISO 11783 network that provides the capability for an ECU, an implement or a group of implements to interact with an operator. The VT provides the capability to display information and to retrieve data from an operator. An ECU, an implement or a group of implements represented by a working set master acquires storage for objects within the VT and on demand displays this stored information to an operator. In this part of ISO 11783, the term *working set* will be used for an ECU, an implement or a group of implements either represented by a single ECU or a group of ECUs acting as a working set. Working sets on the network can also acquire the use of input and control keys of the VT to allow the operator to send signals back to the working set.

This part of ISO 11783 describes a VT with the detail and clarity required for VTs built by different manufacturers to be interchangeable with any implement working set that uses its services. The interface protocol of this part of ISO 11783 also reduces the run-time ISO 11783 communication bus traffic as much as possible. For these reasons, the requirements of this part of ISO 11783 are organized in an object-oriented manner with specific attributes and behaviour of each object clearly and fully defined. The required behaviour of the VT given certain situations is also detailed.

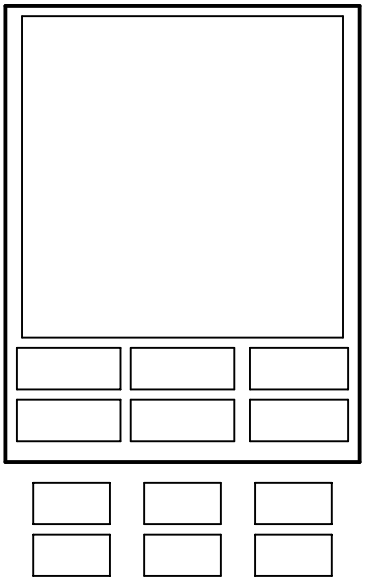
In general, the functions, not the design, of the user interface of the VT are defined in order to avoid restrictions on possible designs. However, certain limitations must be imposed in order to meet the goal of interchangeability between various manufacturers. Specifications regarding physical layout, components, processing power and the number of physical elements comprising a VT have been omitted in order to avoid restricting manufacturer's designs.

The VT shall have a pixel-addressable (graphical) display. Information from connected working sets is shown to the operator on the graphical display. This information is shown in display areas that are defined by data masks, alarm masks and soft key masks. The data for these masks is contained in object definitions that are loaded into a VT either from a working set via the ISO 11783 CAN bus, from a data card, or by some other means. When the information defined by a mask is required on the display, the mask can be made visible by a single Change Active Mask message from the working set, and therefore does not require significant additional network traffic.

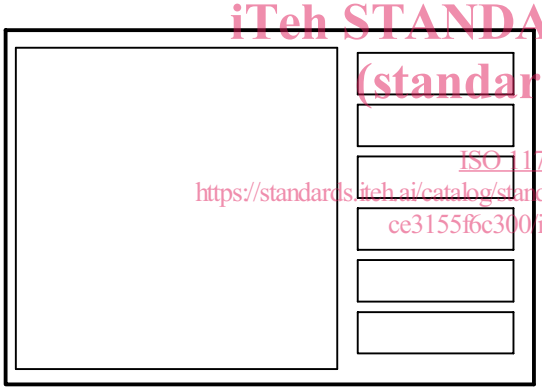
The physical size, resolution, orientation and methods of implementing the graphical display are at the discretion of the designer of the VT. Figure 1 shows examples of some possible VT designs and orientations.



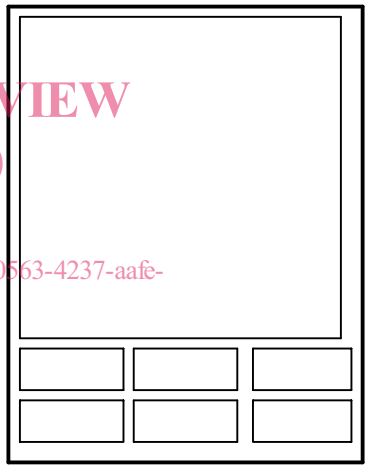
a) Landscape orientation



b) Portrait orientation



c) Touch screen — Landscape orientation



d) Touch screen — Portrait orientation

Key

1 data mask area
2 soft key mask area
3 physical screen
4 soft key designator
5 physical soft key

Figure 1 — Virtual terminal — Examples

4.2 Operator input and control

The VT shall provide the operator with means for control and input. There are five means associated with a VT that can be used for the input of data, selection of display data, and the control of connected working sets.

a) **Soft**

is a means, most likely keys on the VT, using software-changeable designators (labels). “Soft keys” have their identity changed depending on which soft key mask is visible. The VT shall make the association between a soft key and its designator clearly evident to the operator. There is no requirement on the number of physical soft keys. The number of soft key designators supported by the VT shall be between 6 and 64 inclusive per soft key mask. The VT shall provide a means for the operator to navigate and select all defined soft key designators. For example, if there are four physical keys but the VT design supports 16 soft key designators, some type of scrolling or paging would be required to allow the operator to navigate to, and select from, any of the 16 soft key designators using the four physical keys.

b) **Navigation**

is a means of selecting an input field within the active data or alarm mask. “Navigation keys” do not send key activation information to the working set and are proprietary to the VT.

c) **Editing**

is a means of entering/editing information in an input field. “Editing keys” do not send key activation information to the working set and are proprietary to the VT. A means shall be provided for entering any number or character sequence that is valid for the input field. A means shall also be provided for ESC from or ENTER information into a data field. The ENTER means shall be provided to indicate to ECUs the completion of data entry and the ESC means shall be provided to indicate that the data entry was aborted. The VT shall send a response message to an ECU for either an operator-activated ESC means or an ESC command received from an ECU.

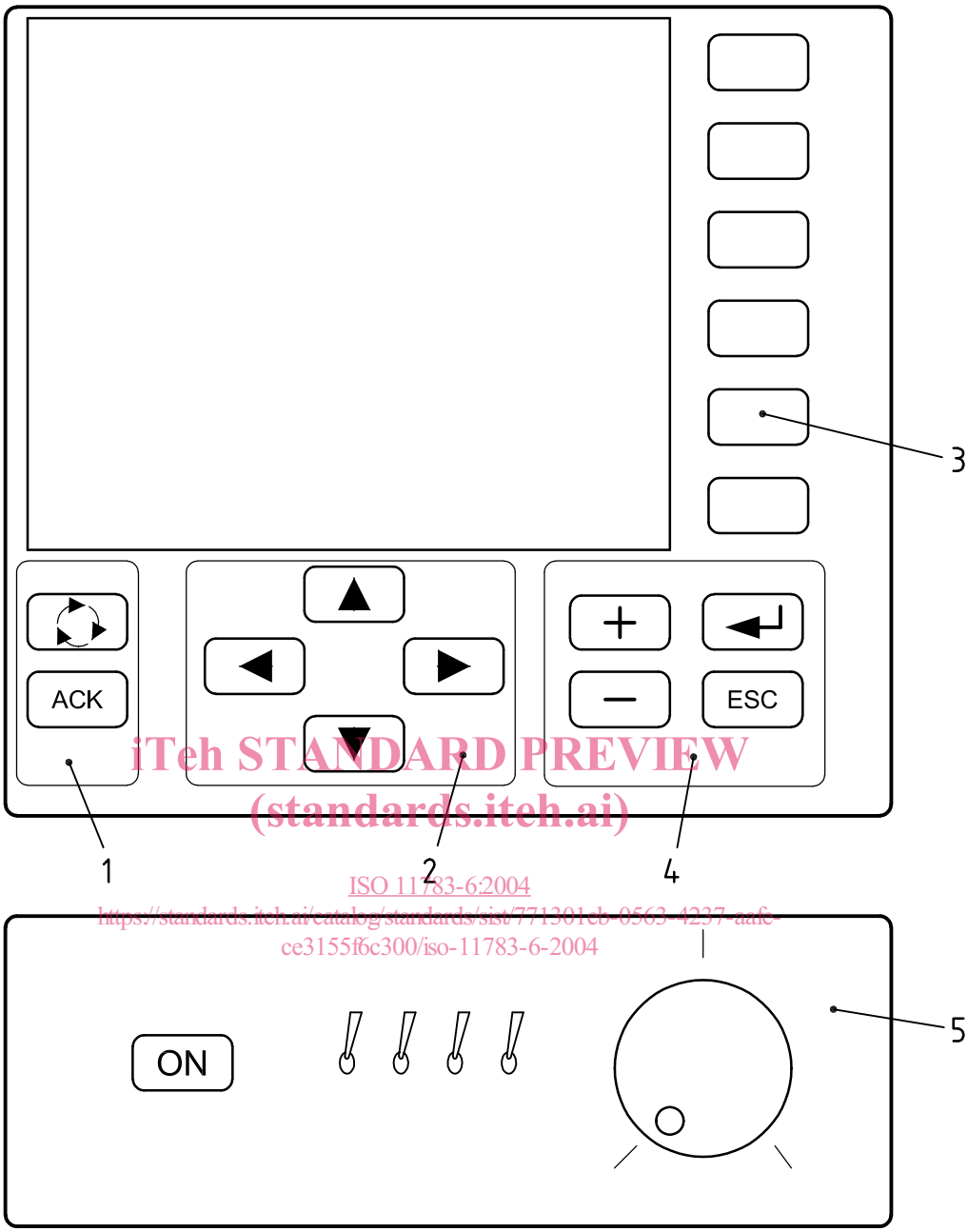
d) **Control**

is a means of selecting between working sets whenever a data mask is visible and for acknowledging alarms. Both means are required. Since more than one working set can use the services of the VT, the VT shall provide a means for the operator of selecting between connected working sets. The working set selection means shall be indicated by three circular arrows or a similar graphic. Only the ACK means sends key activation information to the working set.

e) **Auxiliary input**

is a means for assigning auxiliary inputs to auxiliary functions. See Annex J.

See Figure 2.



Key

1 control
2 navigation
3 soft
4 editing
5 auxiliary input

Figure 2 — Operator input and control means

4.3 Acoustic alarm

The VT shall provide an acoustic alarm. The alarm may be a simple on/off type buzzer or an acoustic device capable of variable frequency and audio level.

4.4 Coordinate system

Positions and sizes in this part of ISO 11783 are always given in physical pixels unless otherwise stated. A two-dimensional coordinate plane (x, y) is used, where x is the number of units wide (x increases from left to right) and y is the number of units high (y increases from top to bottom). The coordinates are signed values. The origin (0, 0) is located at the top left-hand corner of the data mask area.

4.5 Display areas

4.5.1 Data mask area

The VT shall reserve an area of the display for displaying data and alarm masks. This area is called the data mask area (see Figure 1). Recognizing that the physical orientation of the VT display could be different, depending on the manufacturer of the VT, a square data mask aspect ratio is chosen to ensure correct display in either landscape or portrait orientation. The minimum data mask area shall be 200 pixels × 200 pixels. This requirement does not limit the physical resolution or size of the display device, only the useable data mask area. Higher resolution mask areas are permitted, but the square aspect ratio shall be strictly enforced. Examples of data mask areas that would meet this requirement are

— 200 × 200,

— 240 × 240,

— 320 × 320, and

— 480 × 480.

Any other square dimensions would be acceptable.

It is suggested that unused areas of the physical display be used for proprietary information such as vehicle data, VT statistics or other data.

4.5.2 Soft key mask area and soft key designators

The VT shall reserve an area of the display for soft key labels, separate from the data mask area. This area is called the soft key mask area (see Figure 1). Each soft key shall have a reserved display area, called a soft key designator, for displaying a label (see Figure 1). The minimum size of the designator field is 60 pixels wide × 32 pixels high regardless of screen orientation. The soft key designators may contain text, graphics or both. The soft key mask area may be adjacent to, or physically separate from, the data mask area, but shall not be part of the data mask area. If a soft key is continually pressed after another mask has been activated, the VT should not send a Key Activation message for the new mask. It should send the Release Key message for the pushed soft key for the previous mask.

4.6 Behaviour

4.6.1 Object pools

4.6.1.1 General

The operator interface definition for a device or one or more implements represented by either a single ECU or a working set consists of a set of objects (hereafter referred to as the working set's *object pool*). These objects are defined in detail in the following clauses. Each object contains all necessary attributes and child

object references for processing the object to completion. The working set assigns a unique object ID to each object in its object pool so that each object is uniquely addressable. Object IDs shall be unique within a single working set's object pool but may not be between different working sets.

The object pool is transferred to the VT at initialization by using the transport protocol described in ISO 11783-3, and the extended transport protocol specified in Annex K. The procedure is described in more detail in Annex C. The VT is intended to be capable of storing the object pools in a modifiable memory area. The size and number of object pools is limited only by the VT's available memory and software design, but only one object pool per working set exists. All objects shall be fully described before they are made active in a mask on the display.

4.6.1.2 "NULL" object ID

Object ID $FFFF_{16}$ (65535_{10}) is reserved for use as the "NULL" object ID.

4.6.1.3 Processing objects

Objects listed in parent objects may also list child objects, thereby creating a tree hierarchy in the object pool. Objects are always processed in the order listed in the parent object in a "depth-first" manner. In other words, if a reference is made to an object that references other objects, the child references are processed to completion before returning to the parent to continue processing.

4.6.2 Working sets

The object pool supplied by a working set is associated with all members of that working set. This allows object information from one ECU or all the ECUs that make up a working set to be collectively presented as a common object pool. One ISO 11783-5 NAME shall be designated as the working set master for each working set. As coordinator of the communications of a working set, the working set master shall secure the use of the VT and provide the object pool definition of all working set members. It shall also send working set messages that provide the NAMEs of the members of said working set to the VT. This identifies the members of the working set and hence those ECUs which can provide data to the fields in the working set's masks. Appropriate messages for defining a working set are given in ISO 11783-7.

Once members of the working set have been identified to the VT, any member of the working set has the ability to provide data for output objects and to change attributes in the object pool during run-time. The VT shall be able to accept the change attribute type commands from any member of a working set.

The working set master shall provide the initial object pool definition. Any data input by the operator into input field objects is always transmitted to the working set master.

4.6.3 Language, formats and measurement units selection

The VT shall send the standard language, format and measurement units messages defined in ISO 11783-7. The working set object identifies the languages that the working set supports. The VT shall provide a method for the operator to view the list of supported languages and to select an item from the list. If no language has been entered by the operator (as would be the case in a factory-new VT), the VT shall attempt to query the default language from the tractor ECU. Once the operator has set the language, the VT's language message always takes priority over the tractor ECU's language.

The VT shall also provide a method for the operator to select formats (Time, Date, etc.) and measurement units. The VT shall report selected language, formats and measurement units at power up and any time there is a change. These messages allow the working set to modify its object pool to the operator-selected language — by updating string fields — and to the selected units — by changing offsets and scales. If the working set does not support the specified language, formats or units, it should use a proprietary method to select an appropriate setting.

The VT shall store the standard setups in non-volatile storage and restore the values during initialization.

4.6.4 Initialization

Upon power-up, a specific sequence of events shall occur in order to ensure proper initialization of the VT and working sets, as follows.

a) **VT Initialization**

1) The VT shall complete the address claim procedure in accordance with ISO 11783-5 and shall also send an address claim request to the global destination address (255).

2) The VT shall begin transmission of the VT status message.

3) If language selection has not been entered by an operator, the VT shall attempt to request the default language setting from the tractor ECU.

4) The VT shall allow working sets to initialize and to load their object pools.

5) The VT shall complete the auxiliary input initialization defined in Annex J.

b) **Working set initialization**

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

2) The working set master shall wait until the VT begins transmission of the VT status message.

3) The working set master shall identify itself and its members to the VT using messages given in ISO 11783-7.

4) The working set master shall begin transmitting the working set maintenance message.

5) The working set master shall request the language and format messages from the VT (see ISO 11783-7).

6) The working set master may query the VT as necessary to determine its capabilities. Based on the VT's responses, the working set master shall adjust its object pool for scaling, available fonts, supported colours, etc.

7) The working set master may query the VT to determine if its object pool already exists in non-volatile memory.

8) Object pool transfer shall commence and be completed. This can be done either by asking for the object pool to be transferred from non-volatile memory (see Annex E) or by using transport protocol (see ISO 11783-3), extended transport protocol (see Annex K) and the messages given in Annex C.

4.6.5 Working set object and active masks

In the initial object pool definition, each working set master shall provide one, and only one, working set object in order to define a descriptor, active mask and supported languages for the working set. The descriptor may be graphical, text or both but shall fit inside the area defined by the VT for a soft key designator. The descriptor may be used by the VT any time the working set needs to be represented to the operator.

EXAMPLE Communication alarms, auxiliary control setup.

When a working set is "active", it has exclusive ownership of the VT display. The VT shall provide some means to allow the operator to select working set that is to be active. Only one working set is active at any given time. The working set cannot force any of its masks to be visible when another working set is active and it cannot force its working set object to be active. Whenever a working set becomes active, the VT shall

a) display the new working set's current active mask and associated soft key mask, and

b) send the VT status message to the global address (255) to inform working sets of the change.

The working set can select different data masks or activate alarm masks by changing the active mask attribute of the working set object with a Change Active Mask command. The working set can change the active mask even if the working set is not the active working set. This allows the appropriate mask to be displayed when the working set becomes active. When a working set is deactivated, its active mask is hidden, but still remains as the active mask for that working set.

4.6.6 Connection Management

The VT transmits the VT Status message once per second. ECUs use the message to ensure the VT is present and to determine the current status of the VT. If an ECU does not receive this message for at least 3 s it assumes a possible uncontrolled shutdown of the VT. When this happens the working set shall enter a safe state. The safe state is defined as the state in which all functions dependant on the VT operator interface are put into a known state that will not put the operator or machine at risk. The working set shall not leave the safe state until power to the working set is cycled.

Each working set master sends the Working Set Maintenance message once per second. The VT uses this message to ensure that each working set is still present. If the VT does not receive this message for at least 3 s it assumes a possible uncontrolled shutdown of the working set master. When this happens the VT shall delete the working set's object pool to free the memory for other uses. If the working set has control of the VT, the display is cleared and the VT automatically gives control to another connected working set and sends the VT Status message to the global address. If there is an active alarm for the failed working set the VT deselects the alarm mask automatically.

When a working set's object pool has been deleted and the VT receives a Working Set Maintenance message from the missing working set, it should NACK the message (ISO 11783-3). The NACK message is sent to the working set's source address. When a working set has been disconnected and reconnected to the VT, the working set may attempt to reload its object pool.

4.6.7 Updating the operator interface

4.6.7.1 Changing attributes and values

Attributes of objects can be changed during operation by working set masters and working set members using the defined Change Attribute messages. Changeable attributes in each object are assigned an attribute ID (AID). The Change Attribute message allows any attribute with an AID to be changed. In addition, attributes are sometimes grouped together into a single "change" command for efficiency purposes.

Even when the associated data mask is not visible, the working set may continue to change the attributes (including value) so that when the mask is made active and visible, the necessary output data is current and ready to display.

4.6.7.2 Changing, adding and deleting objects

Objects can be completely redefined at run-time and new objects can be added by initiating a transport protocol session to send one or more objects to the VT. When the VT receives an object with an existing object ID, the existing object is replaced (the VT can determine the owner from the source address of the message). Resizing objects is permitted but may cause the VT to run out of memory. See Annex C.

The entire object pool can be deleted by the working set using a Delete Object Pool message.

4.6.8 Special objects

4.6.8.1 Container objects

A container object is a special object used to

a) logically group objects in order to identify and reuse the container, or

b) to hide and show objects.