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Irrigation techniques — Remote monitoring and control for irrigation —

Part 3: **Interoperability**

Techniques d'irrigation — Surveillance et commande à distance pour l'irrigation —

Partie 3: Interoperability

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Foreword

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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).

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This document was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry,* Subcommittee SC 18, *Irrigation and drainage equipment and systems.*

A list of all parts in the ISO 21622 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The purpose of this standard is to allow interoperability between the different elements of an irrigation system that exist side by side in the same installation. The introduction of the standard in irrigation control systems will lead to improvements in irrigation programming practice and establish a clear separation between decision making and decision implementation.

This standard establishes changes in the architecture of current commercial systems basically at the software level.

The interaction between the language and the changes in the system architecture proposed by this standard provides interoperability between Management Information Systems (MIS) applications and Remote Monitoring and Control Systems (RMCS) for irrigation, guaranteeing their independence and the exchange of standardized information.

Using the interfaces defined in the Clause 5 "Interoperability II: exchange of data from irrigation entities", the interoperability among MIS applications and control subsystems is reached. Additionally, the use of the new level in the architecture, named coordination, provides a mechanism to integrate heterogeneous irrigation products and to manage the data access permissions to different irrigation entities.

Irrigation techniques — Remote monitoring and control for irrigation systems — Part 3: Interoperability

1 Scope

This standard establishes guidelines for interoperability among systems developed for management and/or control of irrigation facilities. The standard can be applied under any technological platform and in any type of irrigation system, regardless of the water management scheme.

This standard does not define hardware or software requirements for any of the systems to which it applies. It only concerns externally visible interfaces and places no restriction on the underlying implementations. The standard has been designed to avoid interference with proprietary solutions subjected to intellectual property. From the point of view of the data exchange, and to guarantee interoperability based on the previous premises, the standard defines three communication interfaces (interface with management, interface with events and interface with subsystems) and the architecture to which these interfaces apply. Three levels of architecture are required to accommodate these interfaces:

— The Management Level, where any MIS complying with the standard will be located. Out of all available data exchange methods, each MIS will only implement those required to execute its functionalities.

— The Higher Control Level: coordination. At this level will be performed the integration among RMCS to make available the data required by any MIS located at the Management Level, following the message broker pattern. A software element, called coordination broker, will ensure this integration and will allow the use of different technologies in its interfaces.

— The Lower Control Level: RMCS. These can also be referred to as irrigation subsystems. Each subsystem must implement the data exchange methods required to perform the duties of the irrigation entity(s) under its control.

A manufacturer can adopt this standard in all the described levels or specifically in one of them, implementing the corresponding defined interfaces. Three examples follow:

— Manufacturer “A” offers a product identified as subsystem and located at the Lower Control Level without including a MIS. The product can comply with the standard requirements without offering a complete system (Subsystem plus MIS), implementing the subsystem interface. Its data will be available to any consumer with permissions that implements the defined interface.

— Manufacturer “B” offers a product identified as MIS and located at the Management Level without a subsystem. This product can comply with the standard requirements without offering a complete system (MIS plus Subsystem), implementing the management interface and exclusively the exchange methods required to perform its functionalities.

— Manufacturer “C” offers a complete solution, including MIS and subsystem. The manufacturer can decide which part of the system will comply with the standard: only the MIS, only the subsystem or both.

A coordination broker can be developed as a product by any of these manufacturers or by an independent developer using the standard specifications for this kind of software.

This standard allows for, but is not limited to, use by water management schemes (e.g., user community, irrigation district, water authority) where irrigation subsystems owned or controlled by the farmer may be controlled or monitored by the MIS of the irrigation scheme. In such situations, the coordination broker shall implement the functionalities necessary to manage permissions such that the water management scheme and the farmer will comply with local water laws, contractual agreements, and cultural norms.

2 Normative reference

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 8601:2000, *Data elements and interchange formats. Information interchange — Representation of dates and times*

ISO 19111: 2009, *Geographic information — Spatial referencing by coordinates*

ISO 9646, *Conformance Testing Methodology and Framework*

IEC 902, *Industrial process measurement and control terms and definitions*

3 Terms and definitions

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
action
application of a method to exchange data leading to accomplish typical irrigation duties

3.2
coordination broker
for irrigation purposes, a message broker responsible for the mapping of irrigation entities, for the collection and consolidation of their data, and for the management of the procedural elements executed by them. It must comply with the management, subsystems and events interfaces

3.3
interface with events
functional connection that enables the exchange of information about events (according to IEC 62682 definition) between the coordination broker and the subsystems

3.4
interface with management
functional connection that enables the exchange of information between MIS applications and the coordination broker

3.5
interface with subsystems
functional connection that enables the exchange of information between the coordination broker and the subsystems

3.6
message broker pattern
architectural software pattern for message validation, transformation, and routing. A message broker is a software product designed as an intermediary to facilitate interactions between third-party applications. The message broker can also be called interface engine or integration broker

3.7
method
mechanisms established for the exchange of data between interoperable systems

3.8
MIS application
computer program aimed at administrative and/or Operational decision-making in the irrigation entities. A MIS will be tool acquired for an organization (like a User Community or an Irrigator) to execute one or more of the following specific functions:

— administrative control;

— accounting control;

— maintenance;

— behavior modeling;

— operational management; and

— any other purpose aiming at improving decision-making.

The above list is descriptive and not limitative.

3.9
optional conditioned parameter
an optional parameter may require one or more optional conditioned parameters

3.10
optional conditioning parameter
an optional conditioning parameter will be supported by at least one required conditioned parameter and may be supported by one or more optional conditioned parameters

3.11
optional parameter
a parameter that is not required but can be activated for an action without requiring the support of additional parameters

3.12
parameter
basic information contained by an action in the interfaces

3.13
procedural element
a specific application of a recipe in an irrigation entity

3.14
procedural model
a representation of the reality used to describe the different parts (procedural elements) of the process to be performed by the elements included in the physical model

3.15
property
required attribute to define an irrigation entity. Note the difference between a parameter, which characterizes an action, and a property, which characterizes an entity

3.16
required parameter
a parameter that must be included when an action is set up

3.17
required conditioned parameter
an optional conditioning parameter requires one or more required conditioned parameters

3.18
physical model
a representation of the reality used to describe the relations, dependences and hierarchy among the physical assets designed to perform a process. The model is divided in seven levels, being the three upper levels focused on administrative purposes and the four lower levels in the process to be performed

3.19
standard history
recorded set of values of a property covering a daily time interval and recorded according to a predefined frequency

3.20
subsystem
denomination received by a RMCS in terms of interoperability

4 Interoperability I: system architecture

4.1 Levels and components of an interoperable architecture

The levels and components are presented in Figure 1 — Levels and components of an interoperable architecture.

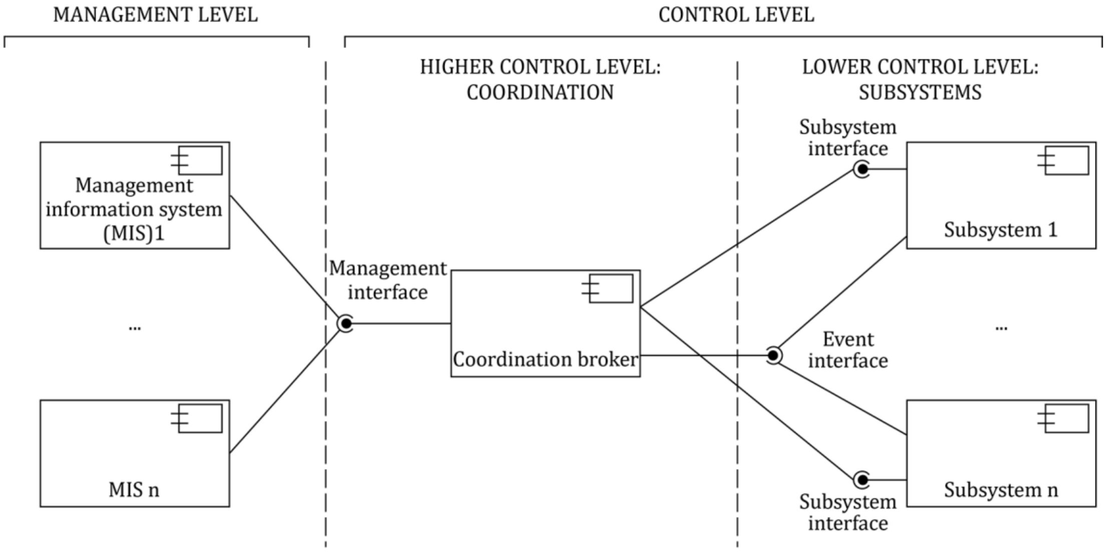

Figure 1 — Levels and components of an interoperable architecture

These architecture levels can be used by Irrigators or User Communities. Both will use the architecture defined in this standard to integrate those management tools and subsystems involved in the management and control of his/its own property irrigation entities. The resulting architecture will be privative for its owner (Irrigator or User Community), limiting the exchange of data to his/her/its subsystems and management tools.

However, it will be possible to enable other permissions to facilitate the exchange of data with third parties, always with the prior authorization of the data owner.

4.1.1 Control level

The control level comprises:

— the coordination broker; and

— one or more subsystems.

The interface with subsystems is established between these two components.

4.1.1.1 Subsystem

The control of an irrigation entity, understood as the acquisition and continuous monitoring of process variables, execution of Operations, changes of set points and emergency stops, among others, is always performed at the subsystem level.

4.1.1.2 Coordination broker

The coordination broker performs the following basic functions:

— Mapping irrigation entities and their association to the subsystems controlling them;

— Establishing an abstraction layer so that MIS applications do not require information on the subsystems responsible for each irrigation entity;

— Collecting and consolidating properties, histories, events and procedural elements inherent to irrigation entities; and

— Coordinating subsystems, providing them with the information they may require, regardless of its origin.

— Managing access permissions among the different components integrated in the interoperable architecture. Managing the available methods for any component integrated in the interoperable architecture.

4.1.2 Management level

This level comprises all computer applications necessary for the efficient Operation of the hydraulic infrastructure, as well as the processes required for the optimum use of water and energy. MIS applications will retrieve the data they require from the control level.

The management interface is stablished between the management level and the upper control level.

4.2 Interface specifications

All data exchanged between the architecture levels defined will comply with the specifications included in this standard. The same applies to the actions.

The specifications in this standard are not tied to any specific implementation, and only establish the foundations and minimum criteria required to guarantee an effective interoperability performance. Application of this standard will require a specific communications protocol at the choice of the manufacturer or developer and adapted to its particular needs. The communication protocol will comply with the implementation documents (informative annexes to this part of the standard). The exchange through all the defined interfaces must be ensured by the application of the security criteria established in the implementation informative - annexes.

4.2.1 Common methods to Management and Subsystem Interfaces

The following methods are defined, which are common to both interfaces. Unless otherwise stated, all defined parameters are required and will be separated by commas.

4.2.1.1 Write a property of an entity (method WRITE)

Table 1 — Input parameters of the method WRITE

Input			
Name	**Type**	**Description**	**Specification**
ActionID	string	ID of the action.	Contains a character string that identifies the action. Generated and known by the element executing the method.
EntityID	string	ID of the entity where the user wishes to execute the action.	Contains a character string that corresponds to a irrigation entity. This is a unique ID within the system.
PropertyName	PropertyName	Name of the property on which the action will be executed.	Contains one of the possible names from the list of entity properties.

Input			
Name	**Type**	**Description**	**Specification**
Value	string	Value of the property to be written.	Contains a character string with the fields corresponding to the value of the property to be written, separated by commas. Only used for non read-only properties.

Table 2 — Output parameters of the method WRITE

Output			
Name	**Type**	**Description**	**Specification**
ActionID	string	ID of the action.	Same parameter included in action input.
Response	string	Response obtained.	Contains two fields separated by commas: Value1, Value2 Where: Value1: closed list of integer numbers identifying the response. Possible values: 0, 1, 2, 3, 4 and 5. Value2: closed list with explanatory texts corresponding to each Value1: If Value1=0, "Action successfully executed". Generated at recipient. If Value1=1, "Execution error". Generated at recipient. If Value1=2, "Lexical error". Generated at recipient. If Value1=3, "Not supported". Generated at recipient. If Value1=4, "Communication error". Generated by coordination when communication with reception subsystem is not obtained. If Value1=5, "Coordination error". Generated by coordination when there is a failure in the application. Value2 might be extended using a hyphen with as many explanatory texts as errors can be discriminated by a subsystem or a coordination broker.

Properties admitting method WRITE are specified for each entity type. The Response will have Value1=3 when executed on a read-only property (Table 26 – Application of the actions on the properties).

4.2.1.2 Read a property of an entity (method READ)

For the reading of the properties, it will be the decision of the subsystem if it returns data stored in the database of its control application or if it forces communication with its remote controller(s) or terminal(s).

Table 3 — Input parameters of the method READ

Input			
Name	**Type**	**Description**	**Specification**
ActionID	string	ID of the action.	Contains a character string that identifies the action. Generated and known by the element executing the method.
EntityID	string	ID of the entity where the user wishes to execute the action.	Contains a character string that corresponds to a irrigation entity. It is a unique ID within the system.
PropertyName	Property Name	Name of the property on which the action will be executed.	Contains one of the possible names from the list of properties of the entity.

Table 4 — Output parameters of the method READ

Output			
Name	**Type**	**Description**	**Specification**
ActionID	string	ID of the action.	Same element included in action input.
Response	string	Response obtained.	Contains two fields separated by commas: Value1, Value2 Where: Value1: closed list of integer numbers identifying the response. Possible values: 0, 1, 2, 3, 4 and 5. Value2: closed list with explanatory texts corresponding to each Value1: If Value1=0, “Action successfully executed”. Generated at recipient. If Value1=1, “Execution error”. Generated at recipient. If Value1=2, “Lexical error”. Generated at recipient. If Value1=3, “Not supported”. Generated at recipient. If Value1=4, “Communication error”. Generated by coordination when communication with reception subsystem is not obtained. If Value1=5, “Coordination error”. Generated by coordination when there is a failure in the application. If Value1=6, “Unavailable”. Generated at recipient for a request about a supported but not in use property. Value2 might be extended using a hyphen with as many explanatory texts as errors can be discriminated by a subsystem or a coordination broker.
Value	string	The value corresponding to the property requested.	Contains a string of fields separated by commas with the value corresponding to the property requested, respecting its format.

Output			
Name	**Type**	**Description**	**Specification**
TimeStamp	string	Date/time when the read value was generated.	Date when the value was generated at source, using coordinated universal time (UTC) ISO 8601 format YYYYMMDDhhmmss±hhmm.

4.2.1.3 Read the standard history of a property (method READSTANDARDHIST)

The preparation of the standard history will be performed at the control level. The values included in the standard history will represent the ones registered during a natural day, stablishing three different number of daily values samples: 24 (hourly sample), 48 (half hourly sample) or 96 (quarter hourly sample). The Response will have Value1=2 in requests for the current day.

Table 5 — Input parameters of the method READSTANDARDHIST

Input			
Name	**Type**	**Description**	**Specification**
ActionID	string	ID of the action.	Contains a character string that identifies the action. Generated and known by the element executing the method.
EntityID	string	ID of the entity where the user wishes to execute the action.	Contains a character string that corresponds to a irrigation entity. It is a unique ID within the system.
PropertyName	PropertyName	Name of the property on which the action will be executed.	Contains one of the possible names from the list of properties of the entity.
Date	string	Date for which execution of the action is requested.	Date of the historic values in coordinated universal time (UTC) ISO 8601 format YYYYYYYYMMDDhhmmss±hhmm.
NumHist	integer	Number of samples that will be contained in the daily standard history requested.	The number of samples per day will have one of the following values: 24, 48 or 96. The default value is 24.
Statistics	string	Name of the statistical variable for which the standard history will be generated.	Type of statistical variable for the calculation of the standard history. It contains one of the following listed values: — last — average — minimum — maximum The default value is last.