INTERNATIONAL STANDARD

IEC 60870-6-503

Second edition
2002-04

Telecontrol equipment and systems –

Part 6-503: Telecontrol protocols compatible with ISO standards and ITU-T recommendations – TASE.2 Services and protocol

Matériels et systèmes de téléconduite –

Partie 6-503: Protocoles de téléconduite compatibles avec les normes ISO et les recommandations de l'UIT-T – Services et protocole TASE.2

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TELECONTROL EQUIPMENT AND SYSTEMS –

Part 6-503: Telecontrol protocols compatible with ISO standards and ITU-T recommendations – TASE.2 Services and protocol

FOREWORD

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International Standard IEC 60870-6-503 has been prepared by IEC technical committee 57: Power system control and associated communications.

This second edition cancels and replaces the first edition published in 1997 and constitutes a technical revision.

The text of this standard is based on the following documents:

FDIS	Report on voting
57/574/FDIS	57/582/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

Annexes A and B form an integral part of this standard.

The committee has decided that the contents of this publication will remain unchanged until 2004. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

INTRODUCTION

The Telecontrol Application Service Element (TASE.2) protocol (also known as Inter-Control Centre Communications Protocol, ICCP) allows for data exchange over Wide Area Networks (WANs) between a utility control centre and other control centres, other utilities, power pools, regional control centres, and Non-Utility Generators. Data exchange information consists of real-time and historical power system monitoring and control data, including measured values, scheduling data, energy accounting data, and operator messages. This data exchange occurs between one control centre's Supervisory Control And Data Acquisition/Energy Management System/Distribution Management System (SCADA/EMS/DMS) host and another centre's host, often through one or more intervening communications processors.

This part of IEC 60870 defines a mechanism for exchanging time-critical data between control centres. In addition, it provides support for device control, general messaging and control of programs at a remote control centre. It defines a standardized method of using the ISO 9506 Manufacturing Message Specification (MMS) services to implement the exchange of data. The definition of TASE.2 consists of three documents. This part of IEC 60870 defines the TASE.2 application modelling and service definitions. IEC 60870-6-702 defines the application profile for use with TASE.2. IEC 60870-6-802 defines a set of standardized object definitions to be supported.

The TASE.2 describes real control centres with respect to their external visible data and behaviour using an object oriented approach. The objects are abstract in nature and may be used in a wide variety of applications. The use of TASE.2 goes far beyond the application in the control centre to control centre communications. This standard must be understood as a tool box for any application domain with comparable requirements. i.e. the TASE.2 may be applied in areas like substation automation, power plants, factory automation, chemical plants, or others which have comparable requirements. It provides a generic solution for advanced Information and Communication Technology.

The TASE.2 version number for this standard is 2001-08. See 8.2.3 for more details.

TELECONTROL EQUIPMENT AND SYSTEMS –

Part 6-503: Telecontrol protocols compatible with ISO standards and ITU-T recommendations – TASE.2 Services and protocol

1 Scope

This part of IEC 60870 specifies a method of exchanging time-critical control centre data through wide-area and local-area networks using a full ISO compliant protocol stack. It contains provisions for supporting both centralized and distributed architectures. This standard includes the exchange of real-time data indications, control operations, time-series data, scheduling and accounting information, remote program control and event notification.

Though the primary objective of TASE.2 is to provide control centre (telecontrol) data exchange, its use is not restricted to control centre data exchange. It may be applied in any other domain having comparable requirements. Examples of such domains are power plants, factory automation, process control automation, and others.

This standard does not specify individual implementations or products, nor does it constrain the implementation of entities and interfaces within a computer system. This standard specifies the externally visible functionality of implementations together with conformance requirements for such functionalities.

1.1 Control centre

The model of a control centre includes four primary classes of host processors: SCADA/EMS, Demand Side Management (DSM)/ Load Management, Distributed Applications, and Display Processors. The SCADA/EMS host is the primary processor, utilizing analogue and digital monitoring data collected at power plants, Non-Utility Generators, and transmission and distribution substations via Data Acquisition Units (DAUs) and Remote Terminal Units (RTUs). The control centre typically contains redundant SCADA/EMS/DMS hosts in a "hot standby" configuration. The DSM/Load Management host(s) are used by either an operator or EMS application to initiate load management activities. The Distributed Application host(s) perform miscellaneous analysis, scheduling, or forecasting functions. Display Processors allow for local operator and dispatcher display and control. Typically, the control centre will contain one or more Local Area Networks (LANs) to connect these various hosts. The control centre will also access several WANs, often through intermediate communications processors. These WAN connections may include the company-wide area network for communications with the corporate host and a distinct real-time SCADA network. Each control centre will also have one or more TASE.2 instances to handle data exchange with remote control centres.

Other classes of host processors like archive systems, engineering stations, or quality control systems (e.g. for data recording according to ISO 9000) may also be included. The application of the TASE.2 control centre model is in principle unlimited. This model provides a common and abstract definition applicable for any real systems which have comparable requirements.

1.2 Architecture

The TASE.2 protocol relies on the use of MMS services (and hence the underlying MMS protocol) to implement the control centre data exchange. Figure 1 shows the relationship of TASE.2, the MMS provider, and the rest of the protocol stack. In most cases, the values of objects being transferred are translated from/to the local machine representation automatically by the local MMS provider. Some TASE.2 objects require a common syntax (representation) and meaning (interpretation) by both communicating TASE.2 systems. This common representation and interpretation constitutes a form of protocol. The control centre applications are not part of this standard. It is assumed that these applications request TASE.2 operations and supply control centre data and functions to the TASE.2 implementation as needed. The specific interface between TASE.2 and the control centre applications is a local issue and not part of this standard.

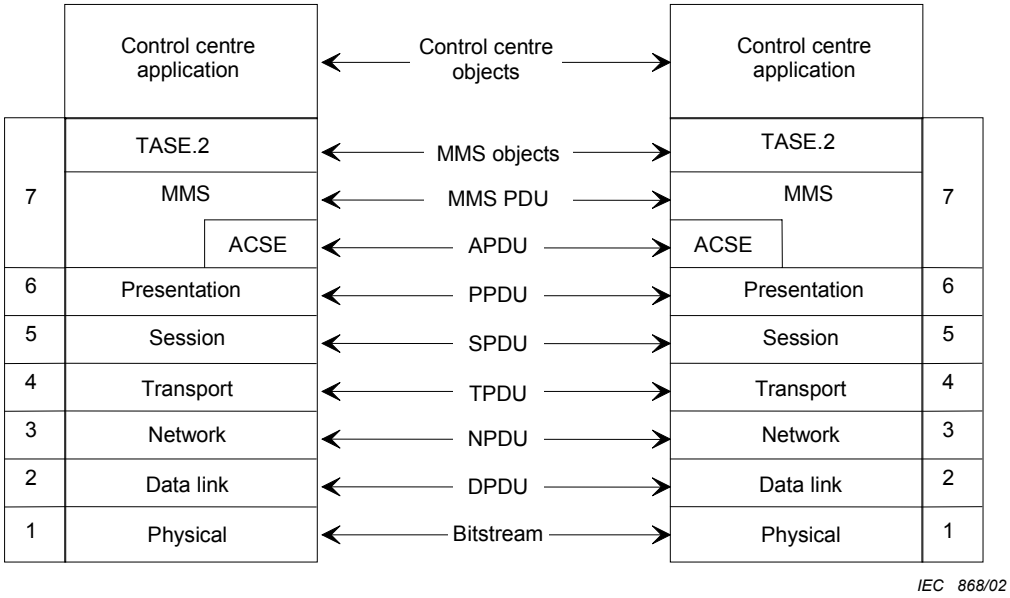

Figure 1 – Protocol relationships

The protocol architecture for TASE.2 requires the use of ISO protocols in layers 5-7 of the OSI reference model. The Transport Profiles (layers 1-4) may use virtually any standard or de-facto standard (including TCP/IP) connection-mode transport layer and connectionless-mode network layer services over any type of transmission media.

1.3 Network Model

The TASE.2 Data Exchange network may be either a private or public packet-switched or mesh network connecting communications processors which provide adequate routing functionality to allow for redundant paths and reliable service.

Figure 2 shows a typical network topology using a router-based Wide Area Network (WAN). The WAN provides routing and reliable service between control centres (which may include internal networks and routing capabilities).

The mesh network shown in figure 3 demonstrates the concept of redundant paths for a mesh network. Each control centre maintains its own series of direct circuits, and also provides a mechanism for routing between those direct circuits. Control Centre C provides an alternate routing path for network traffic going from Control Centre A to B. This network configuration requires key control centres to provide significant routing capabilities.

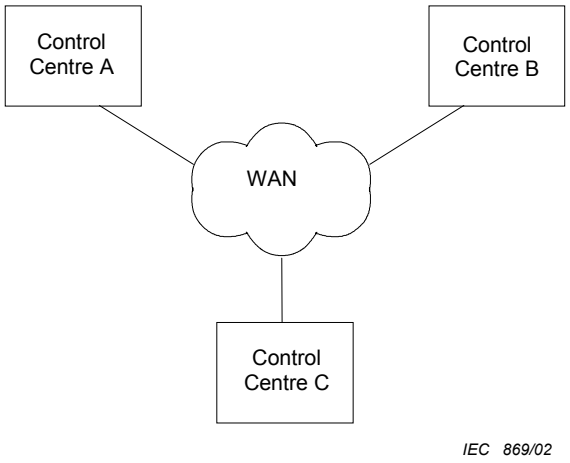

Figure 2 – Router-based WAN

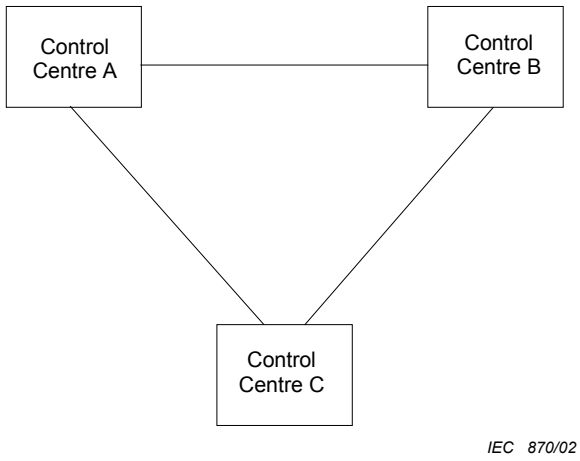

Figure 3 – Mesh network

1.4 Relation between TASE.2 and MMS

The TASE.2 resides on top of MMS. It describes a standardized application of MMS using the MMS services and protocol. TASE.2 enhances the functionality of MMS by specifying structured data mapped to MMS objects and assigning specific semantics to it. As an example of pure MMS services, MMS allows reading data from a remote system. The data will be responded without any specific condition. If these data are read depending on very specific conditions (e.g. on change only) then TASE.2 provides appropriate services which are not provided by MMS.

Though the specific requirements agreed upon within IEC TC 57 have led to the definition of TASE.2 there are several other application domains (outside the control centres) with less, very limited or mixed requirements which may use the TASE.2 services. These other areas are outside the scope of this standard but the use of TASE.2 goes far beyond the specific scope of this standard.

TASE.2 provides an independent and scaleable set of services to allow efficient implementations optimized for the respective requirements of a control centre. It does this by defining several conformance building blocks. MMS offers also a scaleability of its services specifying MMS Conformance Building Blocks (CBBs). A simple TASE.2 implementation requires only a simple MMS implementation.

TASE.2 and MMS provide their services to their respective users. MMS provides its services to TASE.2 and TASE.2 provides its services to the control centre application. MMS is an independent standard that can provide its services also to users other than TASE.2 – it may serve directly to specific control centre applications and to any other application. This means that the use of MMS is not restricted to TASE.2.

For requirements outside the scope of this standard or for future requirements, for example journaling of data, downloading and uploading of mass data like programs, additional MMS models and services, i.e. Journaling and Domain Loading respective can be applied by an real system in addition to TASE.2. This is possible because the additional application of MMS objects and services is independent of the use of TASE.2 and the use of MMS by TASE.2.

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.

IEC 60870-6-702:1998, *Telecontrol equipment and systems – Part 6-702: Telecontrol protocols compatible with ISO standards and ITU-T recommendations – Functional profile for providing the TASE.2 application service in end systems*

IEC 60870-6-802:2002, *Telecontrol equipment and systems – Part 6-802: Telecontrol protocols compatible with ISO standards and ITU-T recommendations – TASE.2 Object models*

ISO/IEC 8073, *Information technology – Open Systems Interconnection – Protocol for providing the connection-mode transport service*

ISO/IEC 8208:2000, *Information technology – Data communications – X.25 Packet Layer Protocol for Data Terminal Equipment*

ISO/IEC 8473, *Information technology – Protocol for providing the connectionless-mode network service*

ISO/IEC 8802-3:2001, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

ISO 9506-1:2000, *Industrial automation systems – Manufacturing Message Specification – Part 1: Service definition*

ISO 9506-2:2000, *Industrial automation systems – Manufacturing Message Specification – Part 2: Protocol specification*

ISO/IEC 9542, *Information processing systems – Telecommunications and information exchange between systems – End system to Intermediate system routing exchange protocol for use in conjunction with the Protocol for providing the connectionless-mode network service (ISO 8473)*

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ISO/IEC 10589:1992, *Information technology – Telecommunications and information exchange between systems – Intermediate system to intermediate system intra-domain-routing exchange protocol for use in conjunction with the protocol for providing the connectionless-mode network Service (ISO 8473)*

ISO/IEC ISP 10608-1:1992, *Information technology – International Standardized Profile TAnnnn – Connection-mode Transport Service over Connectionless-mode Network Service – Part 1: General overview and subnetwork-independant requirements*

ISO/IEC ISP 10608-2:1992, *Information technology – International Standardized Profile TAnnnn – Connection-mode Transport Service over Connectionless-mode Network Service – Part 2: TA51 profile including subnetwork-dependent requirements for CSMA/CD Local Area Networks (LANs)*

ISO/IEC ISP 10608-5:1992, *Information technology – International Standardized Profile TAnnnn – Connection-mode Transport Service over Connectionless-mode Network Service – Part 5: TA1111/TA1121 profiles including subnetwork-dependent requirements for X.25 packet-switched data networks using virtual calls*

ISO/IEC ISP 10613-1:1994, *Information technology – International Standardized Profile RA – Relaying the Connectionless-mode Network Service – Part 1: Subnetwork-independent requirements*

ISO/IEC ISP 10613-2:1994, *Information technology – International Standardized Profile RA – Relaying the Connectionless-mode Network Service – Part 2: LAN Subnetwork-dependent, media-independent requirements*

ISO/IEC ISP 10613-3:1994, *Information technology – International Standardized Profile RA – Relaying the Connectionless-mode Network Service – Part 3: CSMA/CD LAN subnetwork-dependent,media-dependent requirements*

ISO/IEC ISP 10613-5:1994, *Information technology – International Standardized Profile RA – Relaying the Connectionless-mode Network Service – Part 5: Definition of profile RA51.51, relaying the Connectionless-mode Network Service between CSMA/CD LAN subnetworks*

ISO/IEC ISP 10613-7:1994, *Information technology – International Standardized Profile RA – Relaying the Connectionless-mode Network Service – Part 7: PSDN subnetwork-dependent, media-dependent requirements for virtual calls over a permanent access*

ISO/IEC ISP 10613-8:1994, *Information technology – International Standardized Profile RA – Relaying the Connectionless-mode Network Service – Part 8: Definition of profile RA51.1111, relaying the Connectionless-mode Network Service between CSMA/CD LAN subnetworks and PSDNs using virtual calls over a PSTN leased line permanent access*

ISO/IEC ISP 10613-9:1994, *Information technology – International Standardized Profile RA – Relaying the Connectionless-mode Network Service – Part 9: Definition of profile RA51.1121, relaying the Connectionless-mode Network Service between CSMA/CD LAN subnetworks and PSDNs using virtual calls over a digital data circuit/CSDN leased line permanent access*

ISO 8649, *Information processing systems – Open Systems Interconnection – Service definition for the Association Control Service Element*

3 Definitions

For the purposes of this part of IEC 60870, the following definitions apply. Much of the terminology used with this standard is derived directly from ISO 9506-1 and ISO 9506-2 (MMS). Refer to those standards for further definitions.

3.1
action
activity performed by the TASE.2 server under some defined circumstances

3.2
accounting information
set of information which describes an account for a utility. See IEC 60870-6-802 for more details

3.3
bilateral agreement
agreement between two control centres which includes the data elements to be accessed and the means to access them

3.4
bilateral table
computer representation of the bilateral agreement. The representation used is a local matter

3.5
client
communicating entity which makes use of the VCC for the lifetime of an association via one or more TASE.2 service requests

3.6
data set
data set represents a grouping of data values for singular operations by a TASE.2 user. Data sets allow for convenience in access by the TASE.2 user

3.7
data value
A data value represents some alphanumeric quantity that is part of the Virtual Control Centre (VCC) which is visible to a TASE.2 user. Data values exist as part of the implementation of the control centre and represent either real entities within the utility such as current, or derived values calculated in the control centre

3.8
instance
implementation of TASE.2 executed in either the client or the server role

3.9
interchange schedule
set of information that specifies how energy is transferred from one system to another. See IEC 60870-6-802 for more details

3.10
object
instance of a TASE.2 object model

3.11
object model
definition of an abstract representation that is used for real data, devices, operator stations, programs, event conditions, and event enrollments

3.12
operation
activity which shall be performed by the TASE.2 server at the request of the TASE.2 client

3.13
server
communicating entity which behaves as a VCC over the lifetime of an association

3.14
service
activity which is either a TASE.2 action or operation

3.15
tagged
the term is derived from the practice of putting a physical tag on a device as it is turned off for servicing or locked out from network access as a safety measure. The TASE.2 term is used to signal such a condition to the TASE.2 user

3.16
time series
set of values of a given element that is taken at different times as specified by a single time interval. A time series is implemented through the transfer set mechanism as defined within this specification

3.17
transfer account
set of information that associates interchange scheduling information with either hourly or profile data. See IEC 60870-6-802 for more details

3.18
transfer conditions
events or circumstances under which a TASE.2 server reports the values of a data set, values in a time series, or all transfer account information

3.19
transfer set
object used to control data exchange by associating data values with transmission parameters such as time intervals, for example there are four types of Transfer Sets: Data Set Transfer Sets, Time Series Transfer Sets, Transfer Account Transfer Sets, and Information Message Transfer Sets. A Data Set Transfer Set contains one or more data values which are each mapped to unique physical elements. A Time Series Transfer Set contains one or more data values which are all mapped to the same physical element, but represent its values at different times specified by a single time interval. A Transfer Account Transfer Set contains all of the values of all of the Transfer Accounts. An Information Message is used to manage the exchange of arbitrary binary or text messages or files

3.20
user
implementation of TASE.2 executed in either the client or the server role

3.21
virtual control centre (VCC)
abstract representation of a real control centre which describes a set of behaviour with regards to communication and data management functionality and limitations

4 Abbreviations

BCD	Binary Coded Decimal
CBB	Conformance Building Block
DMS	Distribution Management System
DSM	Demand Side Management
EMS	Energy Management System
ICC	Inter-Control Centre
MMS	Manufacturing Message Specification
QOS	Quality of Service
RBE	Report By Exception
SCADA	Supervisory Control And Data Acquisition
TAL	Time Allowed to Live
TASE.2	Telecontrol Application Service Element 2, also known as Inter-Control Centre Communications Protocol (ICCP)
TLE	Time Limit for Execution
TOD	Time Of Day
UCA	Utility Communications Architecture
VCC	Virtual Control Centre
VMD	Virtual Manufacturing Device

5 TASE.2 Model

The purpose of the TASE.2 model description is to provide a clear understanding of the TASE.2 protocol and its context within the utility control centre environment. This model identifies the basic components, object models and the operation of the protocol. This clause describes both an informal and formal model. In the informal model, different data types are described within the context of the utility control centre environment. In the formal model, the object models together with their specific operations and actions are described in detail. Clause 6 explains the mapping of the formal object models onto the MMS object models. Clause 7 explains the mapping of the operations and actions onto MMS services. Clause 8 summarizes specialized objects used internally by TASE.2.

5.1 Informal TASE.2 Model Description

The model of a control centre includes several different classes of applications, some or all of which may be present, such as SCADA/EMS, DSM/Load Management, Distributed Applications, and Man/Machine Interface. In interactions with other computing elements, a control centre may act as a client, server, or both. As a server, a control centre appears as a singular entity to the clients. The actual implementation may contain several processes and several host processors that are reflected in that logical entity. As a server, a control centre may interact with a number of clients. Control centres which exchange data do so within the rules and restrictions defined in a Bilateral Agreement. Typically, Bilateral Agreements restrict the client's view on a control centre to a subset of data that exists in the server.

TASE.2 is modelled as one or more processes operating as a logical entity which perform certain communications that allow the control centres to acquire or change data, and control devices. This specification defines the services and protocol for performing the communications between these processes. It also uses object models to define the data types and devices on which the TASE.2 services perform. TASE.2 is defined in terms of the client-server model of ISO 9506 (MMS).

The TASE.2 specification defines a number of operations and actions. TASE.2 operations are associated with a TASE.2 client. TASE.2 actions are associated with a TASE.2 server. There are two TASE.2 services that are considered to be both an operation and an action because either a TASE.2 client or a TASE.2 server may invoke them. These services are Conclude and Abort.

Each TASE.2 operation begins with a local TASE.2 instance, acting as a TASE.2 client, invoking a MMS service. This invocation causes the local MMS provider to make use of the MMS protocol to communicate with the remote MMS server associated with the TASE.2 server. The remote MMS server may deliver indications to the remote TASE.2 server, which in turn responds appropriately, invoking one or more MMS responses and/or services as defined in this standard.

A TASE.2 action begins with a local TASE.2 instance, acting as a TASE.2 server, invoking an MMS unconfirmed service. This invocation causes the local MMS provider to make use of the MMS protocol to communicate with the remote MMS client associated with the TASE.2 client. There are no corresponding MMS communications back from the client associated with this invocation. However, in some circumstances such as the acknowledgement of critical data, TASE.2 defines operations necessary for the client to perform when receiving an MMS indication from an unconfirmed MMS service. Thus, TASE.2 defines algorithms for both the client and server for each TASE.2 operation and action, respectively, in terms of:

– the relevant access control mechanisms;
– the mapping between TASE.2 objects and MMS objects;
– the MMS services and indications used;
– the relationship to real control centre functions.

The TASE.2 instances shall have the ability to interface with the local applications to store and retrieve current data, send/deliver operator messages, perform device control and access remote programs as agreed upon between the participating control centres. The specific mechanism for providing this functionality is outside the scope of this standard, and is a local implementation issue.

Figure 4 shows the logical relationships of TASE.2 to the control centre applications. The local TASE.2 instance uses the services of the local MMS provider to communicate with the remote TASE.2 instance. It should be noted that the actual relationships, structure, location, connectivity and interfaces between TASE.2 and the rest of the control centre is local to the control centre and outside the scope of this standard.

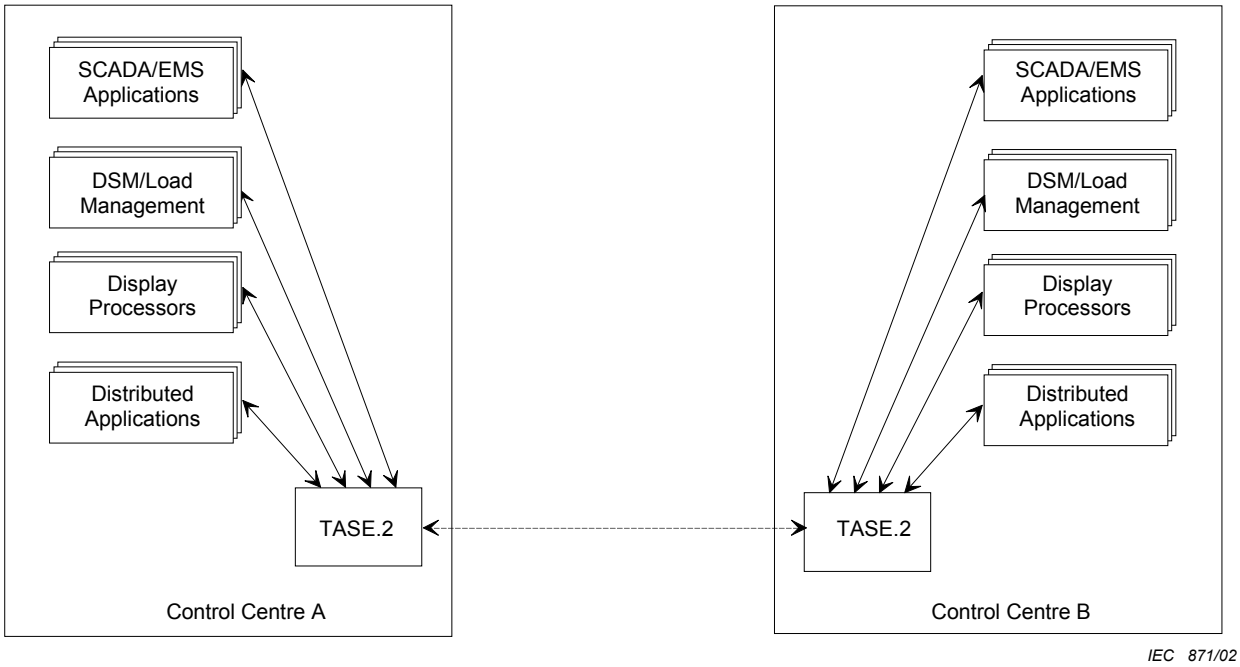

Figure 4 – Informal TASE.2 Model

5.1.1 Associations

TASE.2 association is based on the MMS model of an association. Associations occur between two TASE.2 instances. They are typically long running in that an association is established when two instances start, and remain in place as long as the instances are running and the underlying communications connections are maintained. TASE.2 instances are expected to remain running until an exception condition occurs (for example, an error, operator restart for reconfiguration, or maintenance downtime).

TASE.2 associations include an attribute for network Quality of Service (QOS). The QOS attribute includes such aspects as throughput, residual error rate, priority, transit delay, and protection. Different values for QOS for TASE.2 associations are either defined within this standard in a different clause or by another standard. They are not defined by the control centres or implementations.

The QOS attribute of an association is used within the Network layer Quality of Service parameter. When QOS is used, it is implemented by establishing at least one association between the two TASE.2 instances for each QOS value required. The TASE.2 client shall use an association which is appropriate to the QOS of the operation to be performed. The level of QOS for a TASE.2 association is determined by prior agreement between the control centres. Refer to IEC 60870-6-702 for more details regarding the mapping to the Network layer Quality of Service parameter.

Three TASE.2 operations are defined for use in managing associations: Associate, Conclude, and Abort. The Associate operation is used by a TASE.2 client (initiator) to establish an association with a TASE.2 server. The Conclude operation is used to terminate an association between two TASE.2 instances. Either TASE.2 client or server may terminate the association. The Abort operation is also used by either a TASE.2 client or server to terminate an association when there are failures in the underlying communications mechanisms. See 5.2.2 and 7.1.1 for more details. There are no TASE.2 actions for associations.