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Title:
Wind Turbines – Part 25-6: Communications for monitoring and control of wind power plants – Logical node classes and data classes for condition monitoring

(Titre) :

Introductory note
This document has been developed by PT 25-6 of TC88.
It is understood that the work has been be performed on the basis of TC88 PT25 close co-operation and co-ordination with TC57 WG10 and WG18.

WIND TURBINES

Part 25-6:

Communications for monitoring and control of wind power plants – Logical node classes and data classes for condition monitoring

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

WIND TURBINES –

Part 25-6:
Communications for monitoring and control of wind power plants – Logical node classes and data classes for condition monitoring

FOREWORD

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IEC 61400-25 consists of the following parts, under the general title *Communications for monitoring and control of wind power plants*:

Part 25-1: Overall description on principles and models[1]

Part 25-2: Information models[1]

Part 25-3: Information Exchange Models[1]

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[1] To be published

Part 25-4: Specific communication service mappings (SCSM)[1]

Part 25-5: Conformance testing[1]

Part 25-6: Logical node classes and data classes for condition monitoring[1]

International Standard IEC 61400-25-6 has been prepared by subcommittee 25-6: Logical node classes and data classes for condition monitoring, of IEC technical committee 88:

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

FDIS	Report on voting
XX/XX/FDIS	XX/XX/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.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date[2)] indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,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

2) The National Committees are requested to note that for this publication the maintenance result date is ….

INTRODUCTION

IEC 61400-25 defines information models and information exchange models for monitoring and control of wind power plants. The modelling approach (for information models and information exchange models) of IEC 61400-25-2 and IEC 61400-25-4 uses abstract definitions of classes and services such that the specifications are independent of specific communication protocol stacks, implementations, and operating systems. The mapping of these abstract definitions to specific communication profiles is defined in IEC 61400-25-4.

Part 6 defines the specific information models and information exchange models to be used by condition monitoring systems.

Note 1: The functions for condition monitoring, e.g., a specific analysis method for analysing the vibration sampled values are outside the scope of this part of the standard series. The standard series IEC 61400-25 deals with information and information exchange only.

The definitions in parts IEC 61400-25-1 to IEC 61400-25-5 apply also for this part 6 of the standard series.

Condition monitoring relies mainly on the following kinds of information and the corresponding information exchange models:

1. waveform records (samples) of a specific time interval to be exchanged in real-time or by files for analysis (e.g. acceleration, position detection, stress detection)
2. status information and measurements (synchronized with the waveform records) representing the Turbine Operation Conditions (TOC) of the same interval as for the waveform records; mainly to be used for the correct interpretation of the waveform and correlation. Information representing the TOC may also be used for many other purposes independent of waveform records.
3. results of waveform record analysis and analysis of TOC information (resulting, e.g., in analogue values, statistical values, historical (statistical) values, counters, status information, warnings and alarms)

The information consumed and generated by condition monitoring functions could be located in different physical devices. Some information may be located in the turbine controller device (TCD) while other information may be located in an extra condition monitoring device (CMD). Various actors may request to exchange data located in the TCD or CMD. A SCADA device may want to receive data from the TCD or CMD; a CMD may want to receive data from TCD and vice versa. The information exchange between any two devices requires the use of information exchange services defined in IEC 61400-25-3/4 or defined/selected in this part 6. A summary of the above is depicted in Figure 1.

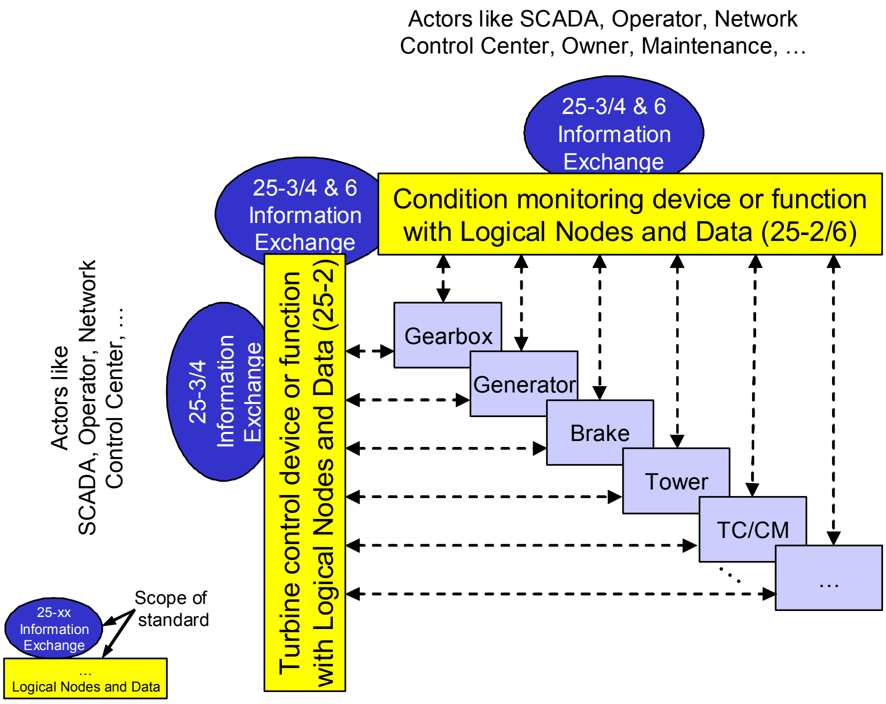


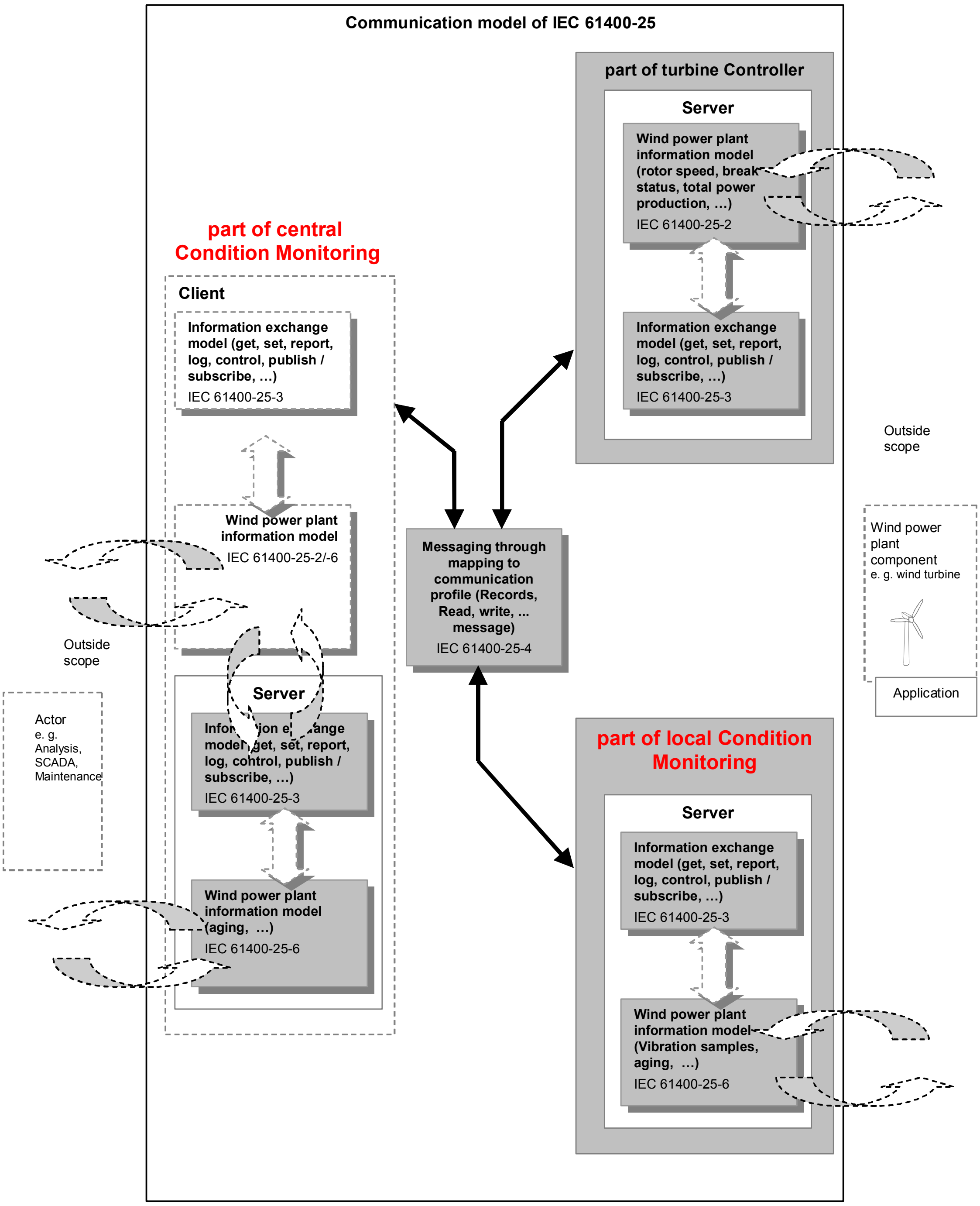
Figure 1 – The two major information and information exchange models

The use case of having the CM functions located in the TCD is a special use case. That use case does not require information exchange services for the information exchange between the CM functions and TC functions. The case of having separate devices is the more comprehensive use case. This is used as the basic topology in this part of the standard. The special case of both functions in one device could be derived from the most general use case.

It may also be required to build a hierarchical model of TC and CM devices/functions. The last but one box in the figure indicates that case. A simple CMD (providing measured values and status information and very basic monitoring capabilities) may be located close to the turbine. A second CMD may be located in the wind park control room. This CMD may retrieve information from the underlying CMD or TCD and may further process and analyse the measured values and status information.

Note 2: The location of devices and functions (more centralized or decentralized topology) is outside the scope of this standard.

Figure 2 depicts the basic concept of the information and information exchange models.



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2 **Figure 2 – Conceptual information and information exchange model of IEC 61400-25-6**

WIND TURBINES –

Part 25-6: Communications for monitoring and control of wind power plants – Logical node classes and data classes for condition monitoring

1 Scope

This standard defines the information models related to condition monitoring for wind power plants and the information exchange of data values related to these models.

The information models mainly comprise:

1. waveform records of measured samples of a specific time interval to be exchanged in real-time or by files for analysis, e.g., vibrations, voltages and currents etc. for acceleration, position detection, stress detection)
2. status information and measurements (synchronized with the waveform records) representing the Turbine Operation Conditions (TOC) of the same interval as for the waveform records; mainly to be used for the correct interpretation of the waveform and correlation. Information representing the TOC may also be used for many other purposes independent of waveform records. This information may be found in IEC 61400-25-2.
3. results of waveform record analysis and analysis of TOC information (resulting, e.g., in analogue values, statistical values, historical (statistical) values, counters, status information, warnings and alarms)
4. fatigue counters (e.g., of aging and derived warnings and alarms, or particle counting in the gearbox oil)

The information models are usually contained in a condition monitoring device (CMD). Other parts of the information models may be contained in a turbine controller device (TCD) or other components (e.g., devices providing meteorological information). All information models are related. In most cases they need to be time synchronized for proper analysis (to a certain extend – not defined by this standard). However the synchronization method is outside the scope of this standard. The information models defined in IEC 61400-25-2 are used when applicable.

Note 1: Information defined in IEC 61400-25-2, e.g., VibGbx (Measured gearbox vibration of gearbox) may be implemented in the TCD to be used by the turbine control. The vibration measurement may be communicated from the TCD to the CMD. Under certain circumstances the TCD may not be able to provide the measurements to the CMD or the CMD needs a much higher sample rate for the required analysis. In this case a separate sensor which meets the higher requirements may have to be installed and connected to the CMD.

The information exchange between CMD and TCD as well as between the CMD and any other actor (e.g., SCADA systems) is specified in this standard. The information exchange comprises mainly:

1. exchange of records of sampled values of waveform signals in real-time or by a file
2. exchange of RMS, statistical, and historical (statistical) data
3. event driven reporting and logging of results of analysis functions and any event derived from measurement and status changes
4. get and set data values
5. control devices
6. retrieval of the self-description of the information models
7. file transfer

The information exchange models defined in IEC 61400-25-3 and the mappings to communication protocols defined in IEC 61400-25-4 are used when applicable.

Note 2: The basic definitions provided in IEC 61400-25 parts 1 to 5 are required to fully understand this part IEC 61400-25-6.

Note 3: The components of a wind power system to be condition monitored are outside the scope of this standard. The definitions of this standard are intended to be common and usable for any kind of applications in the domain of condition monitoring. The requirements on sensors to be used for condition monitoring (e.g., sampling rate, direction of measurement, position where to install the sensors) are outside the scope of this standard.

Note 4: The specification of any requirements (other than information models and information exchange models) and certification of condition monitoring systems is outside the scope of this standard.

Note 5: Editor's notes have been added as background information and open issues. They will be removed later.

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 61400-25-1:2006, Communications for monitoring and control of wind power plants – Overall description on principles and models[3]

IEC 61400-25-2:2006, *Communications for monitoring and control of wind power plants -- Information Exchange Model*[2]

IEC 61400-25-3:2006, *Communications for monitoring and control of wind power plants -- Information Models*[2]

IEC 61400-25-4, *Communications for monitoring and control of wind power plants -- Mapping to communication profile*[2]

IEC 61850-7-1:2003, *Communication networks and systems in substations – Part 7-1: Basic communication structure for substations and feeder equipment – Principles and models*

IEC 61850-7-2:2003, *Communication networks and systems in substations – Part 7-2: Basic communication structure for substations and feeder equipment – Abstract communication service interface (ACSI)*

IEC 61850-7-3:2003, *Communication networks and systems in substations – Part 7-3: Basic communication structure for substations and feeder equipment – Common data classes*

IEC 61850-7-3 Amendment 1, *Communication networks and systems in substations – Part 7-3: Basic communication structure for substations and feeder equipment – Common data classes* [2]

IEC 61850-7-4:2003, *Communication networks and systems in substations – Part 7-4: Basic communication structure for substations and feeder equipment – Compatible logical node classes and data classes*

IEC 61850-7-4 Amendment 1, *Communication networks and systems in substations – Part 7-4: Basic communication structure for substations and feeder equipment – Compatible logical node classes and data classes* [2]

IEC 61850-9-2:2004, *Communication networks and systems in substations – Part 9-2: Specific Communication Service Mapping (SCSM) – Sampled values over ISO/IEC 8802-3*[2]

IEC 60255-24:2001, *Electrical relays – Part 24: Common format for transient data exchange (COMTRADE) for power systems*

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[3] To be published

5 Modelling approach, use cases and actors (informative)

5.1 Introduction

The intention of this clause is to provide the context for the information models and information exchange models for condition monitoring and to provide the common modelling approach. Many WPP specific information models and most information exchange models defined in IEC 61400-25-2, IEC 61400-25-3 and IEC 61400-25-4 can be used for condition monitoring and are referenced in this part 6 of the standard (instead of repeating them here again). Condition monitoring specific information models and information exchange models are defined in this part 6.

The use cases and actors introduced in this clause (to explain the context for this part of the standard) rely on the basic information models provided for condition monitoring. These basic models are explained step by step. A high level view point is depicted in Figure 3.

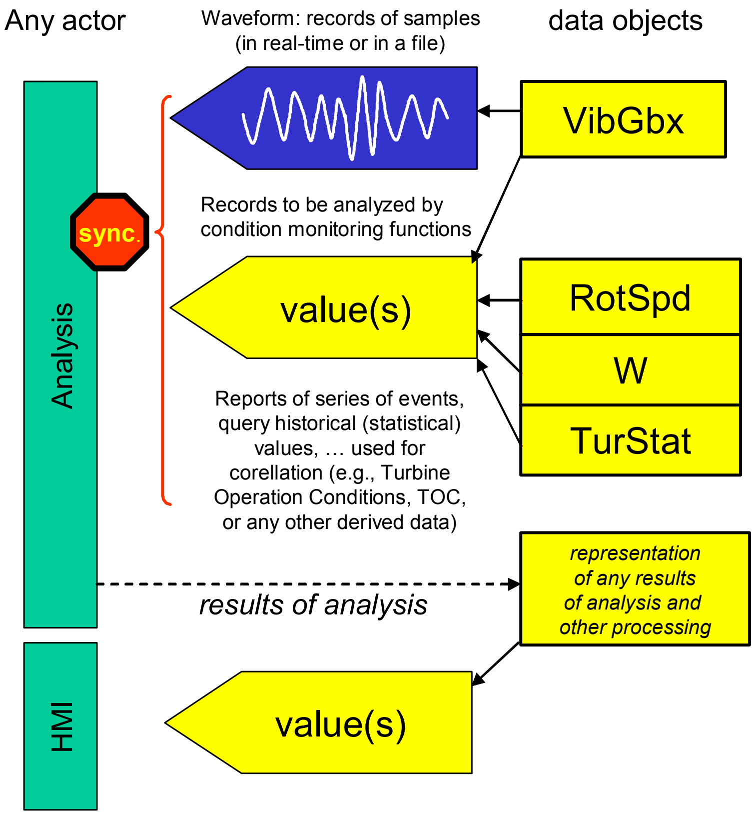

Figure 3 – The two major information and information exchange models

The yellow square boxes represent the information models (in this case they represent basic Data objects, e.g., the waveform samples of the gearbox vibration) or any other measurement or status information (e.g., Rotor Speed, Active Power), and derived data (as result of an analysis or any other processing). The blue and yellow arrows represent the information exchange (in a very abstract way). The information being exchanged is received and further processed by actors like analysis programs, any other processing or display function. One of the crucial requirements is the synchronization of these records of samples and the Turbine Operation Conditions (TOC) data. The dashed line indicates that actors (processing units) could process the received data values and provide new data (to be located in the device that does the analysis or processing).

Note 1 The location of the Data is not relevant for this introduction. The descriptions in this clause are intended to give an overview only, to develop the context, and present basic requirements. Details are intentionally not shown.

There are three different kinds of Data objects:

a) Data objects for the special purpose of analyzing sampled values, i.e., waveform records (this is shown in the upper half of Figure 3). The samples of the signals may be sent in real time (if required for immediate analysis) or as a record in a file (for post mortem analysis). The streams of samples may come from different sources (from TCD or CMD). In most cases, all samples need to be (time) synchronized to allow correct correlation analysis. Based on the analysis results there may be derived status information, e.g., reaching a specific threshold value, e.g., vibration warning or alarm limit reached.

b) Data objects for the general purpose of exchanging any status information and measurement representing, e.g., the TOC are shown in the lower half of Figure 3). The values from these data objects may be exchanged with different exchange methods due to the required functionality, performance and timeliness. The Data values may be provided by TCD or CMD.

c) Data representing the results of the analysis based on data according to a) and b).

The values of any data are exchanged according to the requirements for the specific kind of information model and application requirement.

Data objects may directly represent values provided by sensors. The sensors itself are outside the scope of this standard. The interesting aspects are the representation of the generated and consumed information. A simple sensor may just provide a measured value (raw data). Another sensor may allow configuring its behaviour by setting some configuration data objects. While a complex sensor may provide the raw data and some processed values (doing their own analysis). Or the sensor may provide the processed value only. The raw data may not be communicated at all.

Various aspects of sensors are modelled in this standard:

- Logical nodes for instrument transformers and sensors LN group T (clause 6)
- Logical nodes for supervision and monitoring LN group S (clause 7)

Logical Nodes are the containers that contain the data objects representing the raw or processed (analysed) data or the configuration or description information of a sensor.

Note 2 Standardization of sensors is not required in this standard. The crucial aspects are the information models and information exchange models. The information models of a sensor may be implemented in any Intelligent Electronic device (IED). This may be a personal computer, an embedded controller or the sensor device itself. Any IED that represents the information model and provides the information exchange with the information models conforms to this standard.

Note 3 Sensors usually have one of the many field bus communications. This standard does not require a specific field bus. It is sufficient that the information exchanged over the corresponding field buses are modelled according to the information models of this standard. The information exchange defined in this standard is realized on a higher level than the field bus. A data concentrator IED may communicate with several sensors (collecting raw process data values over one or several field buses). The concentrator IED models the data according to the information models of this standard. This IED may provide the information exchange according to this standard to a higher level device.

5.2 Information models

5.2.1 Introduction

The information model relies on the client-server model. The server is the entity that holds the information models and that provides information exchange to a higher level. A client may retrieve information from a server by just issuing GetDataValue requests. The server may also send cyclically some data values or it may do so on the occurrences of events (e.g., limit violation). All information exchange models defined in IEC 61400-25-3 and additional ones defined in IEC 61850-7-2 and IEC 61850-7-4 (recording) may be applied to communicate with a server. The intention of the following clauses is to provide a brief summary of the information models defined in this standard and made available through a server.

Editor’s note: The following list has been copied from the New work item proposal (88/223/NP). The list needs to be updated and extended.

5.2.2 Information representing sensor data

– Oscillations, Vibrations (may be used for waveforms)
– Particle concentration oil
– Force/Torque

– Material condition (fatigue, wear, stiffness, corrosion, ...)

5.2.3 Information representing Turbine Operation Conditions (TOC)

– Temperatures (Contact measurements and Thermographs)
– Pressure (absolute/differential)
– Electrical Measurements (U, I, P, Q,...)
– Rotational speed (Rotor, Generator)
– Rotor position (Rotor angle)
– Wind speed and -direction

5.2.4 Information representing analysis results

– Any specific result
– General/specific warnings
– General/specific alarms

5.3 Basic information and information exchange models for condition monitoring

The requirements with regard to basic information models (e.g., waveforms of vibration value) and derived information models (e.g., statistical, historical (statistical) data) for condition monitoring provided to a wide range of actors are depicted in Figure 4. Additional information is defined (e.g., Aging data) representing calculated data based on the depicted and other data.

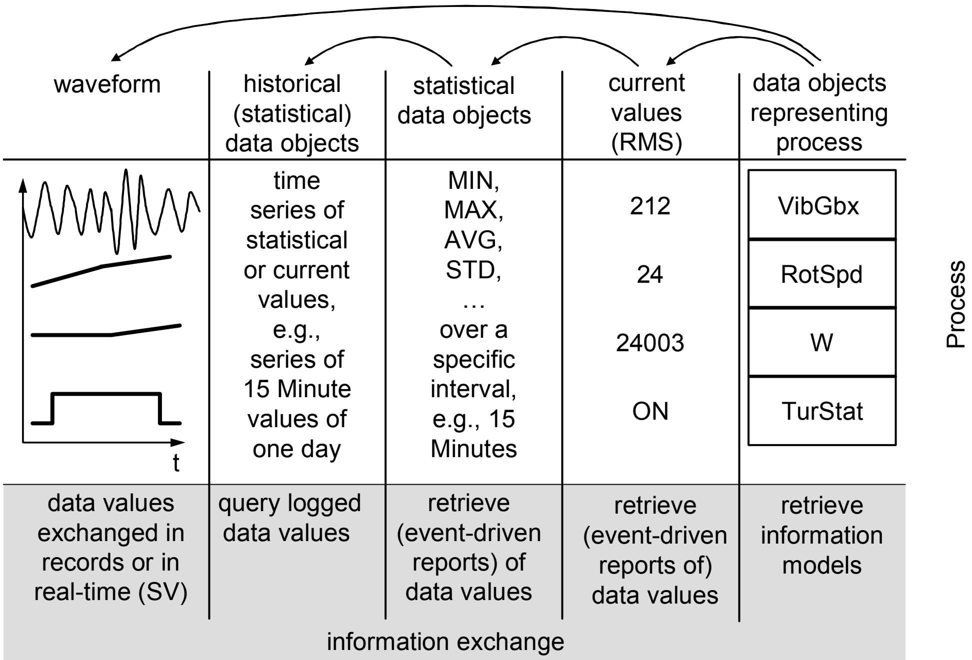

Figure 4 – Basic and derived information models and information exchange

Examples of data objects contained in logical nodes are shown on the right (the logical nodes are not depicted). These data objects may be located in the TCD and/or CMD.

Note 1 The location of the logical nodes (in the TCD or CMD) is quite important for the implementation. For this part of the standard it is irrelevant in most cases; it is especially mentioned if the location is relevant, e.g., as shown in Figure 6. All data objects are defined as being part of a server.

The second column from the right shows the current values (as they are at the current time). These values represent the root mean square (RMS) values. These RMS values could be exchanged by various exchange methods like GetDataValues, report any change of the values or send the values cyclically or issued by an event (e.g., value reaches limit or changes to a certain amount compared to the last value sent).

Annex D
(informative)

Monitoring with Common Data Class MV (Measured Value)

D.1 General

The key issue with regard to the support of information exchange for monitoring functions is the common data class (CDC) Measured Values (MV) as defined in IEC 61850-7-3.

This Annex is intended to introduce the basic concept of the CDC MV.

D.2 The monitoring function of the CDC MV

The CDC MV has several attributes that provide a wide a wide range of functions for the monitoring of any kind of measured (calculated) process values.

D.2.1 The range monitoring function of the CDC MV

Figure C-1 depicts the basic functions of the CDC MV with regard to range monitoring. An analogue value could be in several ranges (normal, high, high-high or max). The ranges are configurable through the attribute “RangeConfig”. Any time when the value crosses a limit (canges the range) causes an event (trigger). These events can be used to issue a message (report) being sent to an IEC 61400-25 client using the report control blocks as defined in IEC 61400-25-3 (IEC 61850-7-2). The reporting model provides a mechanism to exchange any change of the value between any ranges. Additionally the range changes could be logged locally in the server and retrieved later.

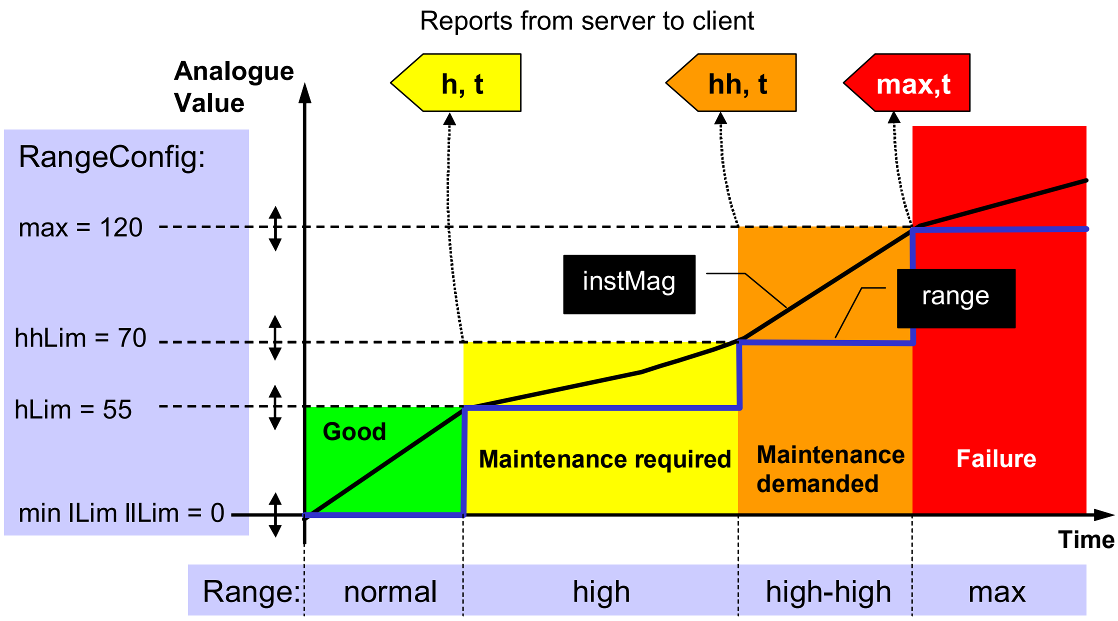

Figure C-1 – Range monitoring function of CDC MV

The interpretation of the range as *Good* for *normal*, *Maintenance required* for *high*, *Maintenance demanded* for *high-high*, and *Failure* for *max* has to be defined by an application.

The complete CDC MV is shown in the following table.

MV class					
Attribute Name	**Attribute Type**	**FC**	**TrgOp (event)**	**Value/Value Range**	**M/O/C**
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
			measured attributes		
instMag	AnalogueValue	MX		Instantaneous value (RMS)	O
mag	AnalogueValue	MX	dchg	Filtered value	M
range	ENUMERATED	MX	dchg	normal|high|low|high-high|low-low|…	O
q	Quality	MX	qchg		M
t	TimeStamp	MX			M
			substitution		
subEna	BOOLEAN	SV			PICS_SUBST
subMag	AnalogueValue	SV			PICS_SUBST
subQ	Quality	SV			PICS_SUBST
subID	VISIBLE STRING64	SV			PICS_SUBST
			configuration, description and extension		
units	Unit	CF		see Annex A	O
db	INT32U	CF		Dead band configuration (0 … 100 000)	O
zeroDb	INT32U	CF		0 … 100 000	O
sVC	ScaledValueConfig	CF			AC_SCAV
rangeC	RangeConfig	CF		Range configuration	GC_CON
smpRate	INT32U	CF			O
d	VISIBLE STRING255	DC		Text	O
dU	UNICODE STRING255	DC			O
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M
dataNs	VISIBLE STRING255	EX			AC_DLN_M

D.2.2 The dead band monitoring function of the CDC MV

Figure C-2 depicts the basic functions of the CDC MV with regard to dead-band monitoring. Dead band monitoring is a means to reduce (filter) the number of values to be reported from a server to a client.

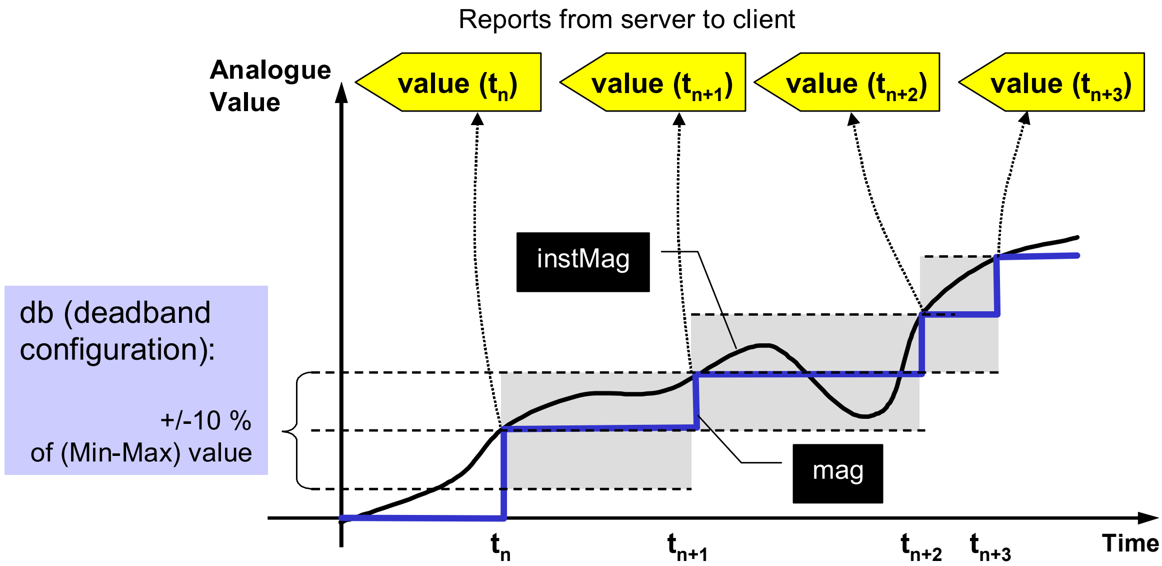

Figure C-2 – Dead-band monitoring function of CDC MV

The dead banded value at time t_n is sent to the client. A value change of +/- 10 per cent of the value (Min – Max) issues another event to send the new value for time t_{n+1} etc.

The server may monitor the value for range changes and dead bands. The reports indicate the reason for inclusion (value change).

These values are RMS values (root mean square). In addition it is possible to calculate Mean values, MAX, MIN, etc. These statistical values can be archived in the server device. See IEC 61400-25-2 for statistical and historical statistical values.