

Alarm handling in IEC 61850

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Communication for monitoring and control"*



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*Image: Vattenfall Surveillance center,
Esbjerg Denmark*




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Vattenfall - one of Europe's largest utilities

- 100% owned by the Swedish state

 **6.9 Million**
Electricity Customers

 **1.9 Million**
Heat Customers

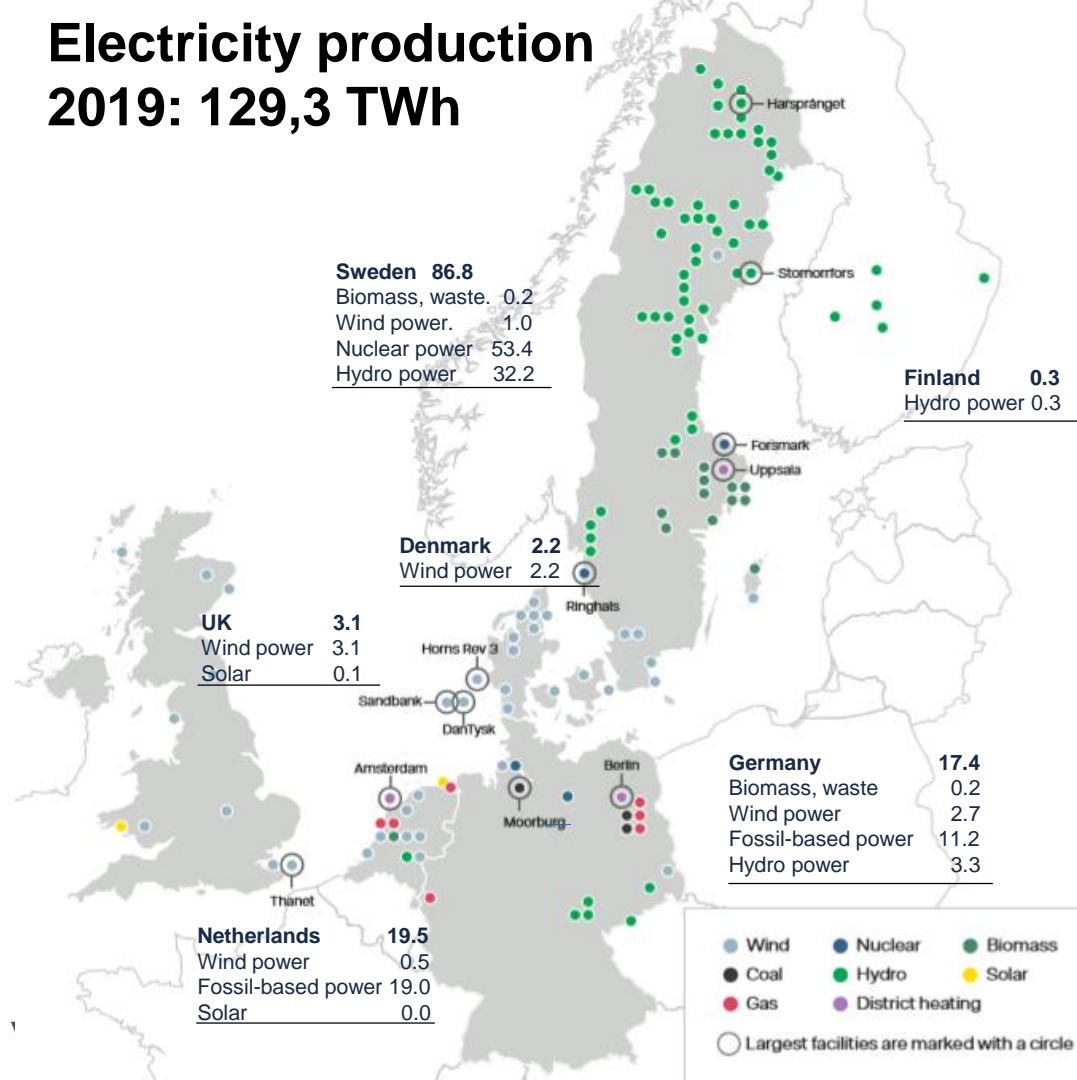
 **3.3 Million**
Electricity Network Customers

 **2.5 Million**
Gas Customers

 **19,814**
Employees

- 58% Sweden electricity production
- No. 1 Heat supplier in Europe,
- No. 2 Offshore Wind worldwide
- No. 3 Electricity sales in Europe
- No. 4 Electricity gener. in Europe

Electricity production 2019: 129,3 TWh



What is an alarm



3.4 Alarm

Deviation, or abnormal condition of an equipment function, usually audibly and/or visibly indicated to an operator or a machine, requiring a timely response.
(source: IEC 62682)



Popular understanding is that it is an event that needs a timely response

3.2 Acknowledgement

The action by which an operator (or machine) confirms recognition of an alarm indication.

(but not quite so simple)



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Why is alarm handling important



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Source: Southam, T., "Alarm Management Presentation - An Introduction," PTP-Global, 2013

Why is alarm handling important



Accident investigations have identified that: inadequate alarm system performance contributed to a significant number of industrial accidents...

- Three Mile Island - 1979
- Piper Alpha - 1988
- Milford Haven Refinery - 1994
- Buncefield Oil Storage - 2005

Today, hardware and software advances has made it possible to alarm most devices at minimal cost

- Large increase in the quantity of alarms

“The alarm system in the control room is so poorly designed that it contributes little in analysis of a causality. Perhaps we can discuss this sometime, preferably before the system, as it is, causes severe problems.”



Edward Frederick
Senior Reactor Operator

Memo 11 months prior to the TMI core melt.



The control room at Three Mile Island

Alarm handling in substations

Alarm in IEC 61850 is the output of an internal (local) trigger

LosSig | SPS | Alarm situation: No signal received

	TmpAlm	SPS	Thermal alarm
Alm1		SPS	Generic single alarm
Wrn1		SPS	Generic single warning
Ind1		SPS	Generic single indication

Alarm handling is (propriety) in the SCADA

PresAlm | SPS | Insulation gas pressure alarm

Limited functionality compared to industrial alarm management standards like ISA 18.2 or IEC 62682

ThdAVal	ASG	ThdA alarm setting – value entered in %
ThdATmms	ING	ThdA alarm time delay in ms

LN: Safety alarm function Name: ISAF

LN: Alarm handling Name: CALH



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Alarm handling in wind

Manly from wind park controller to control and surveillance centers

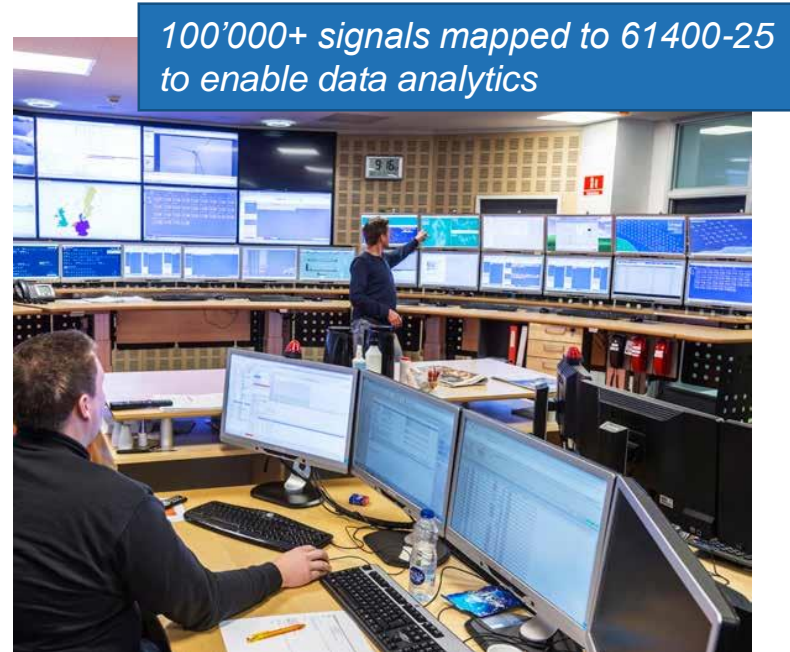
- Each wind farm comes with [it's own] supplier surveillance tool
- 11 vendor "level 2" SCADA systems
- Central alarm system
- Multiple actors (park site office, central surveillance, vendor/OEM surveillance centre, maintenance centre)

"We want to be able to control all the turbines and do it in a similar manner"

*Jan Jørgensen manager Vattenfall's Surveillance Centre,
<http://www.offshorewind.biz/2016/11/04>*



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Vattenfall's Surveillance Centre in Esbjerg, Denmark monitors and operates all turbines

Alarm handling in 61850-90-18

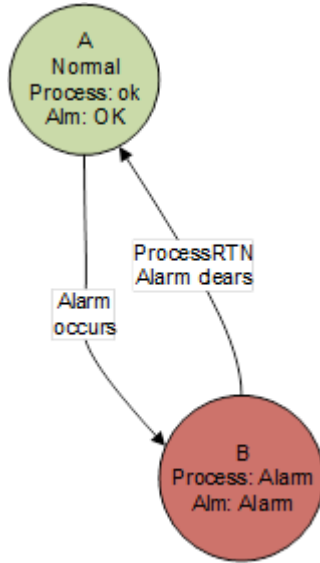


Figure 4 – Event only state machine for alarms without latch and without acknowledgement

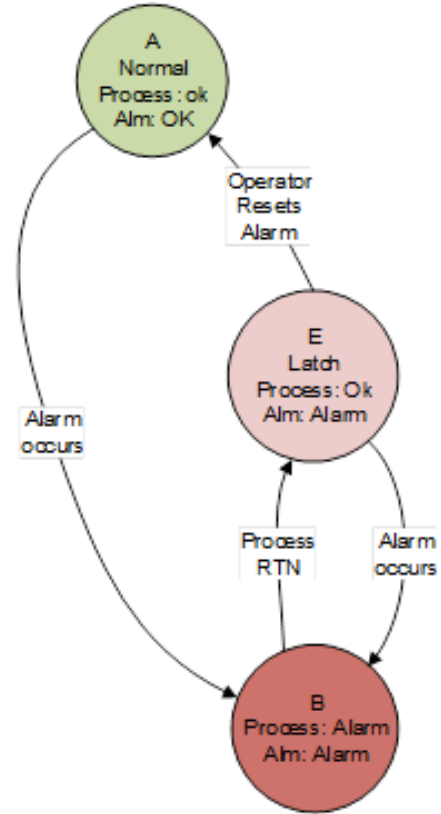
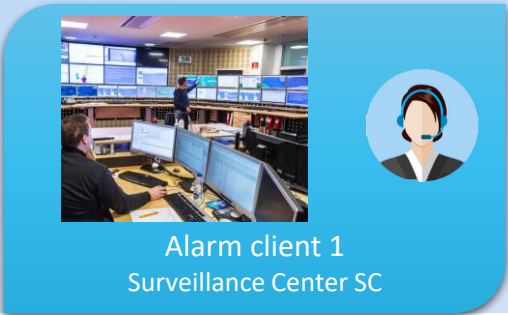
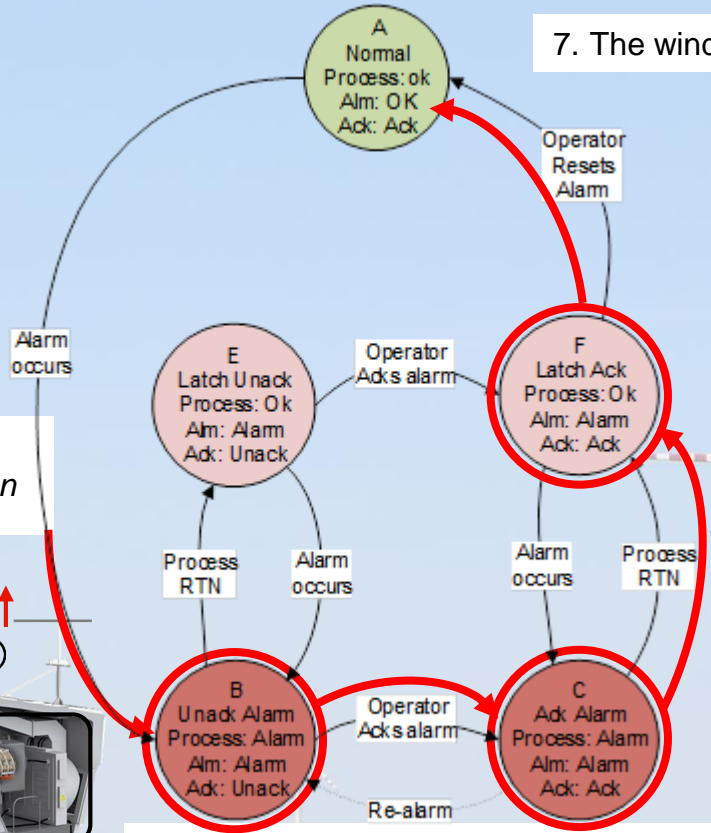
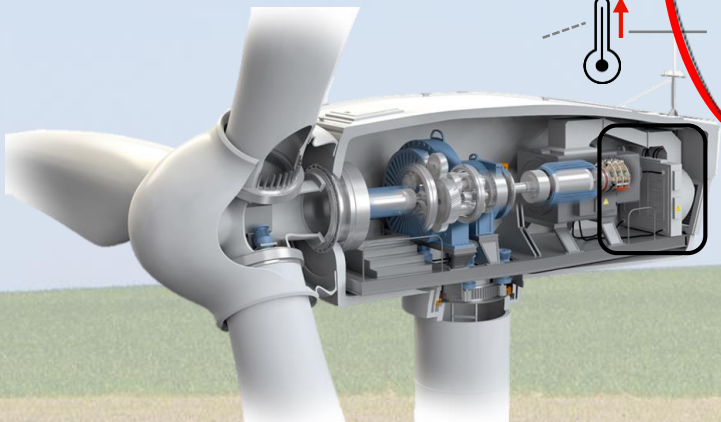


Figure 5 – State machine for latched alarms and no acknowledgement

Wind use case



1. An error is activated from a wind turbine: *"Cabinet for power distribution section temperature too high"*



2. The operator at the Surveillance Center activates an acknowledgement on the HMI to inform all possible monitoring clients, that will take care of the fault

7. The wind turbine starts production automatically

6. Technician sends a reset error command to release the error latch, documented the incident in the reporting system and informs the surveillance center

5. The technician inspected the issue and replaced affected spare parts.

4. Before the technician arrives, wind calms, temperature decreases to normal, *but* alarm is still active *(and alarm is latched)*

3. Activates a technician to inspect turbine and fix problem



Figure – State machine for alarms with acknowledgement and latch

Alarm handling in 61850-90-18

Alarm added as a data object which to any Logical Node

The alarm data object is of common data type ALM and configured to use one of four state machines

Also support for IEC 62684 shelving (e.g. for broken sensor), suppressing (e.g. based on operating conditions or plant states) or setting out of service (e.g. during maintenance)

Table 7 – Attributes of ALM (simplified)

cdcid = ALM, UML class name = ALM					
Attribute name	Attribute type	FC	TrgOp	(Value/Value range) Description	PresCond
DataAttribute for status					
stVal	AlarmStateKind	ST	dchg	The value of the alarm.	M
q	Quality	ST	qchg	Quality of the value in 'stVal'.	M
t	Timestamp	ST		Timestamp of the last change or update event of 'stVal' or the last change of value in 'q'.	M
seqId	INT32U	ST	dchg	Sequence identifier of an alarm instance.	O
origin	Originator	ST		Information related to the originator	M
ctlNum	INT8U	ST		The control sequence number of the last control service.	M
DataAttribute for setting					
reAlmSetTm	Timestamp	SP	dchg	The value of the re-alarm time setting, if the time is set with a time stamp.	AtLeastOne (1)
reAlmSetCal	CalendarTime	SP	dchg	The value of the re-alarm time setting, if the time is set with a calendar time.	AtLeastOne (1)
DataAttribute for configuration, description and extension					
almModel	AlarmModelKind	CF	dchg	Specifies the alarm handling model that corresponds to state machine of alarm.	M
almPrio	INT16U	CF	dchg	(range=[1...1000]) The priority of the alarm.	M
almArea	Unicode255	DC		The area in which the alarm is located.	M
almMsg	VisString255	CF	dchg	Informative message for the alarm.	O
almMsgU	Unicode255	CF	dchg	Informative message for the alarm using unicode characters.	O
almAction	Unicode255	CF	dchg	Proposal for the action to be undertaken.	O
onDITmms	INT32U	CF	dchg	(default=0) On-delay for activation of alarm.	O
datSetRef	P_ObjectReference	CF	dchg	(default=0) Reference to the dataset that contains the data that have an influence on this alarm.	O
Parameters for control services					
ctlVal	AlarmCtlValueKind			Service parameter that determines the alarm control activity. Controllable values are determined by the alarm handling model.	

Counting alarms...

Counting state changes and duration in state

- How often and for how long has a turbine been stopped due to an alarm?

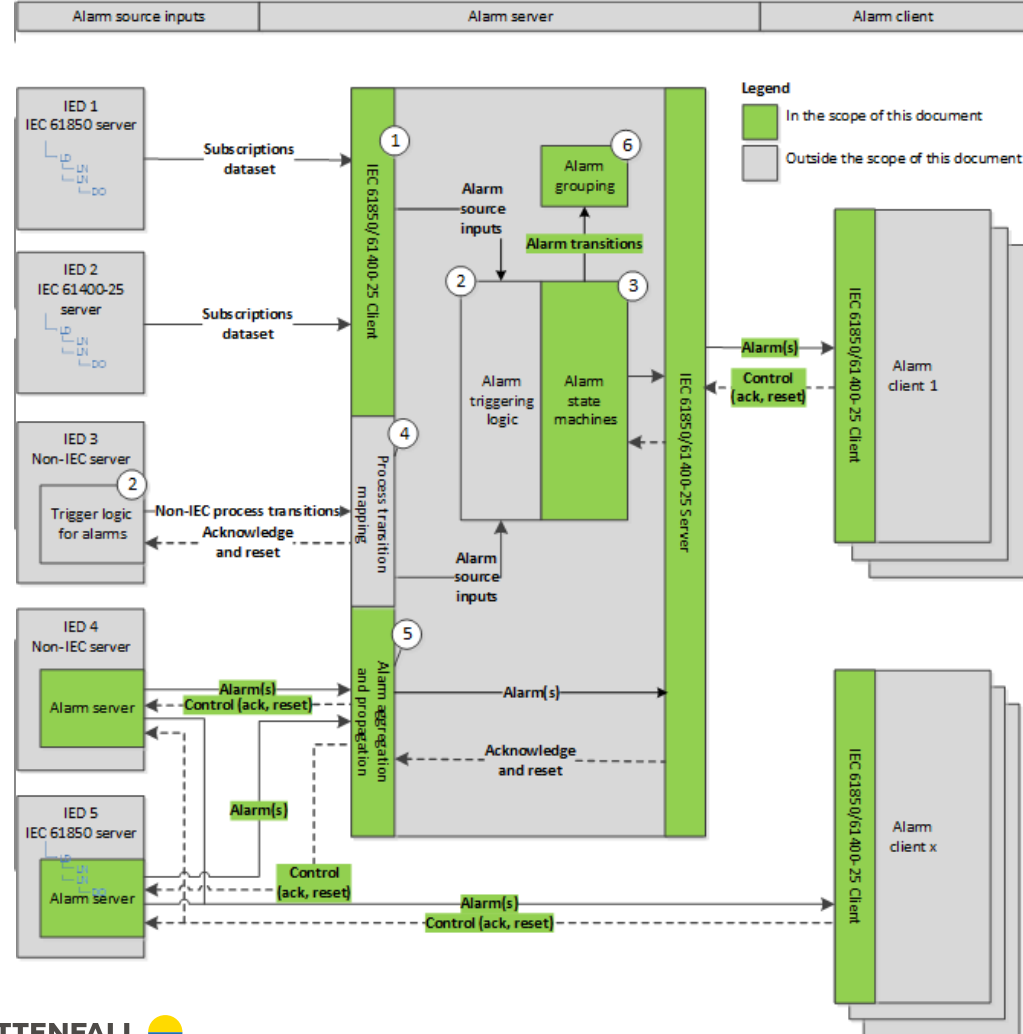
More specifically:

- How often has the status value or alarm switched into each of its states
- How long has the status value or alarm been in each of its (enumerated) states

- Proposal for 61850-90-18:
 - Data objects with common data class CNT for total counter
 - Statistical Logical Nodes for subtotal counter and historical data

Alarm handling in 61850-90-18

Alarm will normally be triggered by an IEC 61850 signal (Event reported, GOOSE or polled) with a client including an alarm handler performing the state-machine





For IEC use only

57/2157/DC

2019-10-18

INTERNATIONAL ELECTROTECHNICAL COMMISSION

Technical Committee 57: Power systems management and associated information exchange

**IEC TR 61850-90-18, Communication networks and systems for power utility automation – Part 90-18:
Alarm handling in IEC 61850 based systems**

Plan to circulate proposal in IEC National Committees in February 2021

Thank you for your attention