



## USE CASE 14 – CONTROLLED ISLANDING

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### Use Case Title

Centralized application separates grid into islands to prevent blackout

### Use Case Summary

Controlled islanding is a method that can significantly improve the handling of electric power system disturbance and reduce their effect on sensitive customers. It requires information at the system level of the system configuration and the steady state of the system. A CIM model of the system is required for the definition of the points of separation of an island from the rest of the system. Generation and load information needs to be continuously provided in order to determine the need for load or generation shedding to establish a balance following the islanding.

When a wide area system disturbance is detected and a decision for some preventive actions are made, the controlled islanding system will make a decision to reduce loads and increase or reduce generation in an area of the system followed by commands to trip breakers of transmission lines in order to form an island isolated from the rest of the system with a load-generation balance.

This system can be applied at different levels of the system depending on the availability of power plants or distributed energy resources.

The controlled islanding system will also need to be modeled both in CIM and in IEC 61850 (no such model exists today).

This use case follows from the wide area protection definition through the analysis of the different possible modes of operation. The objective is to stress the 61850/CIM interface to discover aspects of the “seams” which exist between these two standards or to identify missing objects in both standards.

The CIM and 61850 must both be used at least at both ends of the process for this use case to be of practical use.

### Use Case Detailed Narrative

The experience from the August 2003 blackout showed that operation of some distance relays during the initial phases of the wide area disturbance resulted in the formation of islands that

were able to reach a stable balance between load and generation thus limiting the effects of the disturbance and avoiding blackout in the area. Considering the large number of generators that tripped during the disturbance, it becomes clear that there are better ways to control the system in case of a wide area disturbance and keep in service as many generators as possible.

Another factor that needs to be considered is the current practice to disconnect from the grid any non-utility generators in case of a system disturbance – in some cases based on direct commands from the utility protection and control systems, in other based on local detection of the disturbance using frequency and voltage relays.

The increasing use of wind turbines and other different distributed energy resources (DER) is another development that needs to be taken into account.

The difference between controlled islanding and the conventional remedial action schemes is that it does not monitor the state of specific transmission lines and generating facilities, but looks at the system topology and the loads and generation in areas of the system. In some cases this concept can be implemented at the transmission system level, while in other it can be done locally at the substation level, all the way down to a distribution feeder.

The system needs to continuously monitor the load-generation balance in a designated area and when it receives a signal from the upper level will send a command to trip the required breakers to form one or more islands.

The system needs to determine based on the known topology and the state of different transmission lines and power transformers what are the points where switching may be required in order to form a balanced island. It continuously runs optimization procedures in order to select the size of the island and the isolation points.

In case of detection of events that may lead to a wide area disturbance, the system sends signal for the formation of the islands to the pre-selected locations in the system. These signals are of two types:

- To create a balance between the load and generation before the isolation from the system
- To isolate the island from the system

This is required to ensure that there will be no loss of generation in case that the created island has an unbalance between load and generation that may result in dynamic instability within it.

The system requires bi-directional communications between multiple substations and power plants in the electric power system and the system data acquisition and control level.

The operation of the controlled islanding system is based on the continuous monitoring of the state of the system and its individual components. This includes information related to either generation or load in different parts of the system, all the way down to the distribution feeders in substation that are part of the system.

The topological model of the system, including each substation, is required at the system level in order to determine the load-generation balance, as well as the state of the different transmission lines and transformers for determination of the islanding strategy.

The global system topology is updated every time when a change of state of a switching device is indicated from the available at the system level signals or reports.

The configuration of the system is limited to the settings of the starting functions.

The operation of the controlled islanding system can be described in the following steps:

1. Definition of starting functions
2. Configuration of the system based on topology and settings
3. Continuous monitoring of state of system elements (transmission lines and power transformers), loads and generators
4. Optimized selection of areas with load-generation balance
5. Selection of breakers to trip in case of emergency
6. Definition of actions to achieve true balance in case of emergency in selected areas
7. Check for operation of disturbance detection elements
8. Sending of commands to balance load-generation in a selected area (if emergency condition is detected)
9. Sending of commands to trip breakers to form islands (if emergency condition is detected)
10. Back to step 3

Each of the above steps imposes specific requirements for the harmonization between IEC 61850 and CIM.

**1. Running dynamic stability studies for different system topologies and determining conditions that can detect the initial phase of a potential system disturbance. Determining starting criteria at the system level and at the execution levels based on the studies.**

Requires a complete system topology model, including also the generators and loads. The existing CIM models should support this.

Requires also definition of functional elements for the starting functions. Some existing IEC 61850 logical nodes can be re-used and some new will need to be created. Harmonization between CIM and IEC 61850 will be required.

**2. Selecting criteria to detect a system disturbance**

The functional elements defined in 1 above will be configured.

**3. Continuous monitoring of state of system elements (transmission lines and power transformers), loads and generators**

Harmonization of the measurements and status monitoring functional elements between CIM and IEC 61850 is required.

**4. Optimized selection of areas with load-generation balance**

No harmonization required

**5. Selection of breakers to trip in case of emergency**

No harmonization required

**6. Definition of actions to achieve true balance in case of emergency in selected areas**

No changes required.

**7. Check for operation of disturbance detection elements**

No changes required.

**8. Sending of commands to balance load-generation in a selected area (if emergency condition is detected)**

The CIM model needs to be harmonized to be able to send commands for load-generation balance

**9. Sending of commands to trip breakers to form islands (if emergency condition is detected)**

The CIM model needs to be harmonized to be able to control the breakers at the island formation points

**Harmonization Tasks**

Based on the analysis of the above use case, the following harmonization tasks have been identified:

- Development of controlled islanding starting functions object models for CIM and IEC 61850
- Load and generation models required in IEC 61850
- Harmonization of measurements and status monitoring/control models

## Business Rules and Assumptions

### ACTORS

<i>Actor Name</i>	<i>Actor Type (person, device, system etc.)</i>	<i>Actor Description</i>
Controlled Islanding System	System	Detects potential system disturbance and issues commands for controlled islanding
Load monitor	Device	Monitors the load of a system area
Generator monitor	Device	Monitors the output of a generator
Load-shedding device	Device	Sheds load to balance the load-generation within an area before islanding
Breaker control device	Device	Trips the breaker in order to form an island
System Element monitor	Device	Monitors the state of transmission line or power transformer
CIM Model Server	System	
IED database	Device database	Contains the settings for each setting group for each device in the controlled islanding system
System Operator	Person	Performs system islanding studies and operation.

### STEP BY STEP ANALYSIS OF EACH SCENARIO

#### Scenario Description

Primary Scenario: Successful test

<i>Triggering Event</i>	<i>Primary Actor</i>	<i>Pre-Condition</i>	<i>Post-Condition</i>
<i>(Identify the name of the event that start the scenario)</i>	<i>(Identify the actor whose point-of-view is primarily used to describe the steps)</i>	<i>(Identify any pre-conditions or actor states necessary for the scenario to start)</i>	<i>(Identify the post-conditions or significant results required to consider the scenario complete)</i>
System is capable of segmented into balanced islands.	Controlled Islanding System	System model.	Balanced islands are created in the network

### Steps for this scenario

<b>Step #</b>	<b>Actor</b>	<b>Description of the Step</b>	<b>Additional Notes</b>
#	<i>What actor, either primary or secondary is responsible for the activity in this step?</i>	<i>Describe the actions that take place in this step including the information to be exchanged. The step should be described in active, present tense.</i>	<i>Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column..</i>
1	System Operator	System Operator performs islanding analysis using system topology model and potential system conditions.	Use system CIM model
2	System Operator	System Operator creates system configuration to support islanding	Use Cases 5 & 13 are similar to this step
3	Controlled Islanding System	Controlled Islanding System monitors in parallel with other operational systems the state of the power network	Continuous monitoring of system and updating of contingent islanding operations
3.1	Controlled Islanding System	Controlled Islanding System selects areas with balanced load and generation	
3.2	Controlled Islanding System	Controlled Islanding System determines breakers which should be tripped in event of emergency to create balanced island areas	
3.3	Controlled Islanding System	Controlled Islanding System determines additional system operations that will need to be performed to balance island areas	
4	Controlled Islanding System	Controlled Islanding System detects emergency condition amenable to islanding	
5	Controlled Islanding System	Controlled Islanding System transmits current contingent islanding operations to field devices	
5.1	Controlled Islanding System	Controlled Islanding System transmits commands to balance load and generation.	Distributed Generation, Load Shedding, etc.
5.2	Controlled Islanding System	Controlled Islanding System transmits commands to trip breakers and create balanced islands	

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# REQUIREMENTS

## Functional Requirements

<i>Functional Requirements</i>	<i>Associated Scenario # (if applicable)</i>	<i>Associated Step # (if applicable)</i>

## Non-functional Requirements

<i>Non-Functional Requirements</i>	<i>Associated Scenario # (if applicable)</i>	<i>Associated Step # (if applicable)</i>