Improve fault location close to the TSO-DSO interface

Based on IEC 62559-2 edition 1
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1. Description of the use case

1.1. Name of use case

Use case identification		
ID	***Area(s)/Domain(s)/Zone(s)***	***Name of use case***
	Distribution Management, Users, Distribution System, Real-Time Operation, Transmission System, Energy systems	Improve fault location close to the TSO-DSO interface

1.2. Version management

Version management				
Version No.	***Date***	***Name of author(s)***	***Changes***	***Approval status***
1	2018-07-20	Francisco Reis & Gonçalo Glória [R&D Nester]		Approved Version

1.3. Scope and objectives of use case

Scope and objectives of use case	
Scope	Location of faults at distribution network lines, connected to the interface with the transmission network, by taking advantage of value-added information collected by TSO's protection devices.
Objective(s)	Increase the information exchanged between the TSO-DSO about fault events. Possibility to make history of records of contingencies in TSO-DSO interface Improve the accuracy of fault location at distribution lines through enhanced levels of real-time information exchange between TSO and DSO. Reduce the needed time to locate a fault by DSO's operational teams and, ultimately, minimize downtime of electricity distribution lines, at the border with the transmission network, in case of a fault.
Related business case(s)	

1.4. Narrative of Use Case

Narrative of use case
Short description
This Use-Case aims at improving the location of faults at distribution lines, close to the interface with the transmission network. Concretely, the focus is on distribution lines, owned and operated by the DSO, that are directly connected to transmission bays, owned and operated by the TSO. In such cases, by having access to information available at the TSO side, collected in transmission bays connecting distribution lines, the DSO will be able to improve the location accuracy of faults on its own distribution lines. This requires additional information to be exchanged in real-time and close real-time between both system operators. The real-time exchange of data from the TSO to the DSO for fault location purposes is the motivation of this use-case with the ultimate goal of optimizing operations on the DSO side. In close real-time timeframe, the SUC suggests the exchange of a report that is automatically generated with

information collected by the protection equipment of the TSO substations like oscillographies for example.
Complete description
The use-case tackles the possibility of improving the location of faults at the DSO level through better cooperation with the TSO. It is applicable when the TSO-DSO physical interface has a particular configuration with the TSO owning transmission bays connecting (on one end) distribution lines, as represented in the following figure. *Figure 1 - TSO-DSO physical interface for use-case application.* While typical protection system configuration may include a distance protection at both ends of distribution lines, connected, at one end, to a distribution bay and, at the other end, to a transmission bay, not always the information collected is exchanged between TSO and DSO as each of the distance protection is owned independently by each of the system operators. The access to redundancy of measurements collected by distance protection devices at both ends of distribution lines is a DSO need in order to improve fault location accuracy. By improving fault location accuracy the DSO will be able to optimize its operations, locating faults faster and more accurately in the field and, consequently, reducing downtimes of distribution lines at the interface with the transmission network. In this use-case after a fault occurrence in a distribution line, located at the TSO-DSO interface, the TSO exchanges in real-time, through an existing TSO-DSO communication link, fault location data with the DSO. Data exchange, acquired by TSO distance protection devices, includes fault location (impedance). In a close to real time timeframe, the TSO will exchange with the DSO a report with additional information about the fault event including the fault type and oscillographies details as well, for example. The exchange of the report will be made through a data exchange platform.

1.5. Key performance indicators (KPI)

Key performance indicators			
ID	***Name***	***Description***	***Reference to mentioned use case objectives***
1	Nº of Oscillographies	Assesses the number of oscillographies transmitted from the TSO to DSO.	Increase the information exchanged between the TSO-DSO about fault events. Possibility to make history of records of contingencies in TSO-DSO interface
2	Nº of Reports	Assesses the number of reports that are exchanged between TSO and DSO	Increase the information exchanged between the TSO-DSO about fault events. Possibility to make history of records of contingencies in TSO-DSO interface
3	Fault location accuracy (Ohm or km)	Assesses fault location accuracy. Fault location accuracy (ohm) is given by the difference between the real location at which the fault occurs (impedance, R+jX) and the fault location information (R+jX) provided by protection devices.	Improve the accuracy of fault location at distribution lines through enhanced levels of real-time information exchange between TSO and DSO.

4	Distribution line downtime (minutes)	Assesses the average downtime (minutes) of distribution lines at the interface with the transmission network. It's only suitable to determine the gains in this KPI if the downtime when there is no fault in the line is calculated.	Reduce the needed time to locate a fault by DSO's operational teams and, ultimately, minimize downtime of electricity distribution lines, at the border with the transmission network, in case of a fault.

1.6. Use case conditions

Use case conditions	
Assumptions	
1	The physical interface between transmission and distribution networks is at the line bay level, in which the DSO owns the distribution line and the TSO owns the transmission bay connecting (at one end) the distribution line.
2	TSO has a software to automatically do the fault analysis and protection behaviour report.
Prerequisites	
1	TSO has installed distance protection devices at transmission bays located at the TSO-DSO interface.
2	TSO records information on fault detection and location at distribution lines located at the TSO-DSO interface.
3	A communication link for real-time data exchange between TSO and DSO is in place.

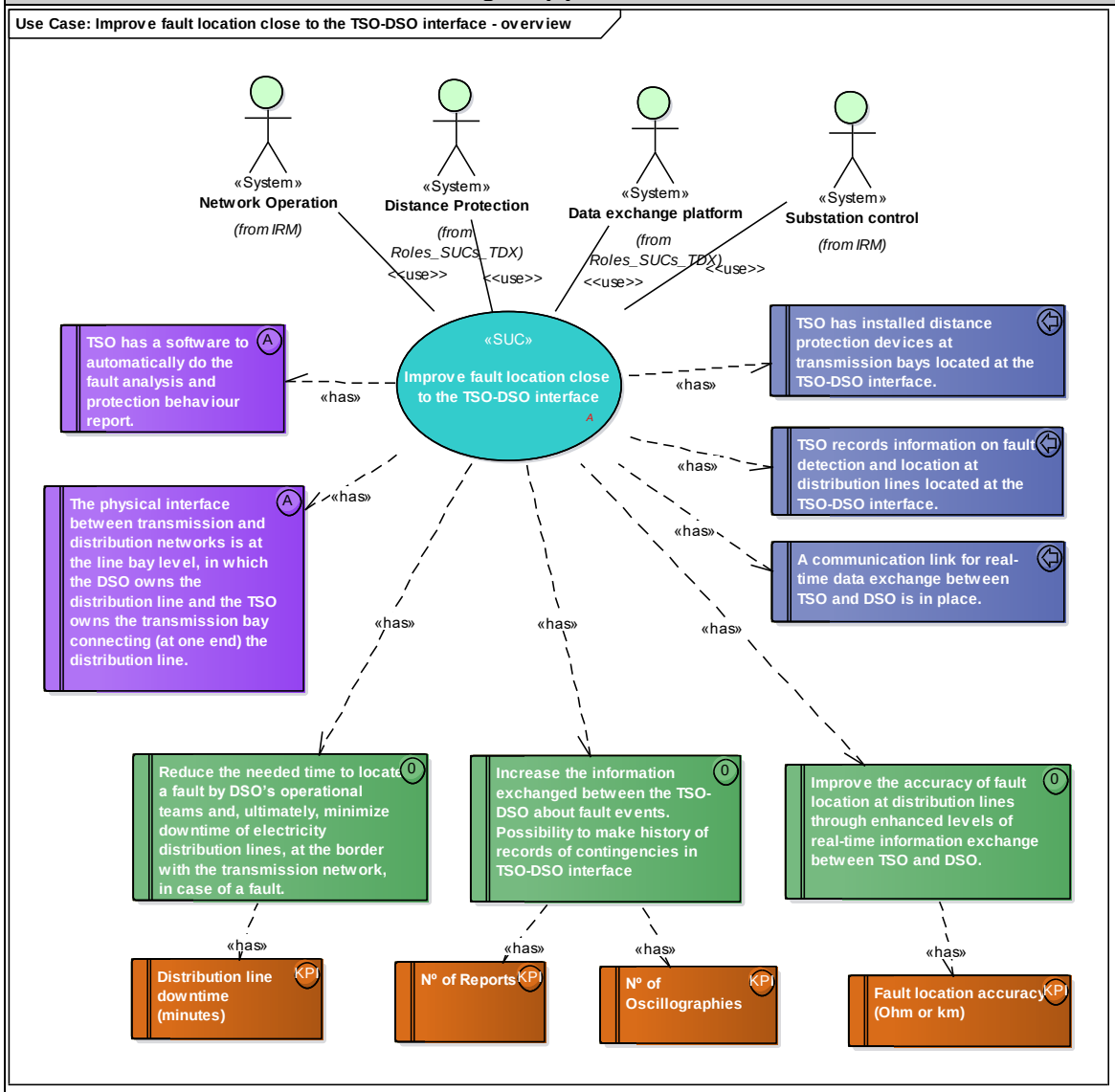
1.7. Further information to the use case for classification/mapping

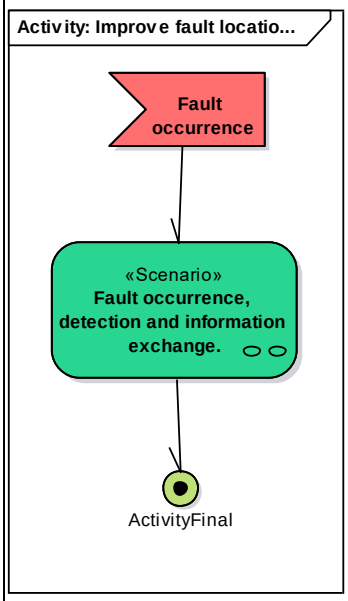
Classification information
Relation to other use cases
<<BUC>> Improve system real-time supervision and control through better coordination (TSO and DSO) <<BUC>> Improve fault location close to the TSO-DSO interface <<SUC>> Information exchange using a collaborative platform
Level of depth
Prioritisation
High
Generic, regional or national relation
Generic use-case with application in different national contexts
Nature of the use case
SUC
Further keywords for classification
TSO-DSO coordination, Data exchange, Fault location

1.8. General remarks

2. Diagrams of use case

Diagram(s) of use case





3. Technical details

3.1. Actors

Actors			
Grouping (e.g. domains, zones)		***Group description***	
Actor name	***Actor type***	***Actor description***	***Further information specific to this use case***
Transmission System Operator	Business	According to the Article 2.4 of the Electricity Directive 2009/72/EC (Directive): "a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity". Moreover, the TSO is responsible for connection of all grid users at the transmission level and connection of the DSOs within the TSO control area. Source : EU Commission Task Force for Smart Grids, EG3	
Network Operation	System	The Network Operation function includes business activity directly involved with monitoring and operating the power grid as a whole system. • The phrase 'directly involved' indicates that the covered activities are limited to a hands-on focus on keeping the power grid running successfully, and more indirect influences on grid operation, such as energy markets, will be covered by other business functions. • The phrase 'as a whole system' indicates that local activity, such as operating a generating plant or substation, is excluded, and here the concern is a system perspective, such as is typical in transmission or distribution control centres.	
Data exchange platform	System	Platform used by several entities to exchange information for different proposes. The 3 type of data (Real-time; scheduled and structural data) can be exchanged in this platform. The operational/control data are not included in real-time type. The exchange of information related with the markets are included in the scheduled data. Data-agnostic ICT infrastructure that enables secured and reliable information exchange for different purposes and within different time scales.	
Substation control	System	The End Device Control (EDC) business function include the ability to control the end device in regards to meet new configuration setting, operation (e.g. enabling demand response) or other system services control by network operation. This role is a specialization of the EDC for a substation.	
Distance Protection	System	Device to detect and locate faults in electricity transmission or distribution lines, generally owned by the TSO or the DSO.	

		The Distance Protection can be seen in the IRM as an "End Device Event" and/or an "End Device Reading". According the IRM: End Device Event: "The End Device Event business object is information provided by the end device based on the end device configuration and represents the occurrence of an event that has been under monitoring. Meter tampering, grounding error are example of end device event". End Device Reading: "The End Device Reading business object represent that data that has been acquired by the end device. A meter reading that provide the cumulative kWh value recorded by a meter device from previous reading, or meter reading on hourly resolution for a period are example on end device reading. A fault reading from a remote fault recorder is also example of end device reading".	

3.2. References

4. Step by step analysis of use case

4.1. Overview of scenarios

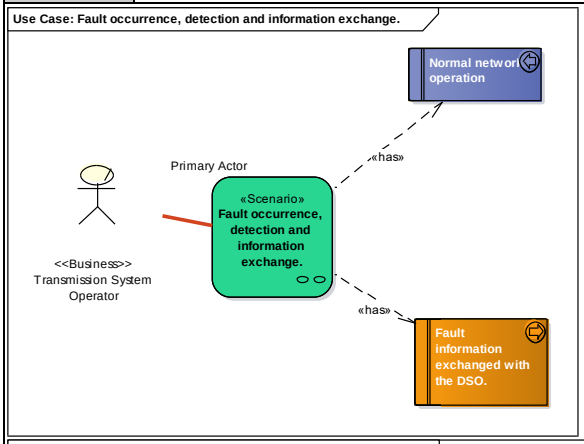
Scenario conditions						
No.	***Scenario name***	***Scenario description***	***Primary actor***	***Triggering event***	***Pre-condition***	***Post-condition***
1	Fault occurrence, detection and information exchange.	A fault occurs in a distribution line at the TSO-DSO interface. The TSO detects and locates the fault. The corresponding information is exchanged with the DSO.	Transmission System Operator	Fault occurrence	Normal network operation	Fault information exchanged with the DSO.

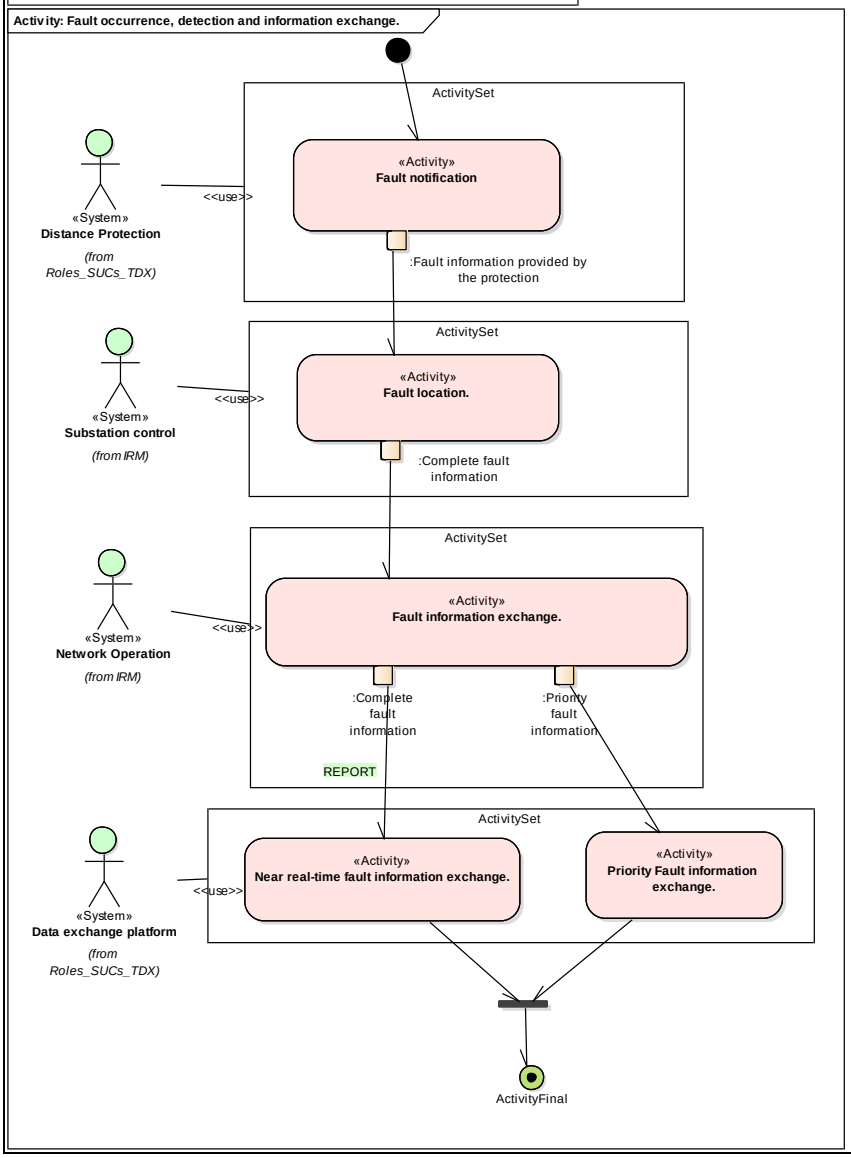
4.2. Steps - Scenarios

4.2.1. Fault occurrence, detection and information exchange.

Scenario step by step analysis

Scenario	
Scenario name	Fault occurrence, detection and information exchange.





Step No	Event	Name of process/activity	Description of process/activity	Service	Information producer (actor)	Information receiver (actor)	Information exchanged (IDs)	Requirement, R-IDs
1.1		Fault notification	Fault occurs in a distribution line and a notification is created. For substations equipped with communication protocol IEC 61850 the gathering happens on event instantaneously. The others that are not equipped with IEC 61850 equipment, the server needs to do pulling every 5 minutes to get the information of all the protections. In some systems, like the one in Slovenia, after the alarm information, the protection department establishes a remote connection to the local SCADA in the substation and checks or downloads the oscillographies and other relevant information.		Distance Protection	Substation control	Info1-Fault information provided by the protection	
1.2		Fault location	Fault in a distribution line is located and respective fault information created.		Substation control	Network Operation	Info2-Complete fault information	
1.3		Fault information exchange	Fault information collected at a	REPORT	Network Operation	Data exchange platform	Info2-Complete fault	

			TSO-DSO communication level. The complete fault information should be transmitted to DSO in close to real time timeframe using a data exchange platform. The priority fault information (impedance to fault) is transmitted on-event to the DSO. If the substation uses IEC-61850, faster information can be transmitted to help the DSO system. In this case faster communication links between TSO and DSO can be used. As example, the ICCP can be used.				information, Info3-Priority fault information	
1.4		Near real-time fault information exchange	Fault data exchanged with the DSO in near real-time. This information should be exchanged after a pre-analysis via a data exchange platform.		Data exchange platform			
1.5		Priority Fault information exchange	If possible (IEC 61850 based substations), the information of the default should be transmitted to		Data exchange platform			

			the DSO with a priority level. In the Portuguese demonstrator, this information will be exchanged via ICCP communication link. However, other protocols can be used.					

5. Information exchanged

Information exchanged			
Information exchanged, ID	***Name of information***	***Description of information exchanged***	***Requirement, R-IDs***
Info1	Fault information provided by the protection	This information is provided by the distance protection. Faulty network element ID Time (Day, Hour, Second, Millisecond) Network fault (Fault notification)	
Info2	Complete fault information	This information is provided by the substation control or by the Network operation system. Faulty network element ID Time (Day, Hour, Second, Millisecond) Network fault (fault notification) Oscillographies Fault Type Impedance to fault	
Info3	Priority fault information	This information should be transmitted as priority information using a fast communication link between TSO and DSO such as the ICCP. Type of information: Priority information Faulty network element ID Time (Day, Hour, Second, Millisecond) Impedance to fault	

6. Requirements (optional)

7. Common terms and definitions

8. Custom information (optional)