1 Description of the use case

1.1 Name of use case

Use case identification		
ID	System configuration(s)	Name of use case
JRA1-EICT-UC	JRA1-EICT-TRANS	Electrical + ICT benchmark reference setup for transmission system
JRA1-EICT-UC	JRA1-EICT-DIST	Electrical + ICT benchmark reference setup for distribution system

1.2 Version Management

ID	Date	Author(s)	Changes	Approval Status
1.0	20.4.2021	Petra Raussi	-	Draft
1.1	02.11.2021	Gunter Arnold	Edit. comments	
1.2	08.11.2021	Vetrivel	Finalize document	

1.3 Scope and objective of use case

Scope	Interfacing/coupling of ICT and power system can span three categories: real-time, non-real-time, and hardware-based. On theoretical level all categories are included in the use case, but the practical implementation is conducted for real-time coupling.
Objective(s)	O1: Optimise power system operation w.r.t voltage regulation O2: Highlight effects of communication phenomena, e.g., latency caused by communication network.
Belongs to use case group (if applicable)	Functional Scenario 6 Digitalization and other FSs and TCs with high level integration of ICT.

1.4 Narrative of use case

Short description
This use case develops a reference setup to serve as a benchmark for scenarios with high level of interaction between power systems and ICT infrastructure. The benchmark forms a basis for the implementation of the test cases in ERIGrid 2.0 project, especially those aligned with the Functional Scenario 6 on digitalization. Three main areas of interest when it comes to integration of ICT and power systems are highlighted: automated grid operation and distributed coordination, substation automation and protection, and cybersecurity. Both WAN and communication infrastructure within a substation are relevant and the applications in focus are state estimation and voltage control. The benchmark is split into three different interfacing/coupling options: real-time, non-real-time, and hardware based. In the benchmark reference case, the implementation is focused on real-time coupling.
Complete description
The purpose of this document is to give an extensive view on the development of the reference setup to be used as benchmark for the scenarios with high levels of interaction between the electrical power system and Information and Communication Technologies (ICT). This benchmark is especially aligned with the Functional Scenario 6 (FS6) on digitalisation and accounts also for other Functional Scenarios when ICT infrastructure or communications are integral part of the system description, use case or test case. Based on the Functional Scenario 6 three different aspects on defining a combination of power system and ICT infrastructure are considered, including automated grid operation and distributed coordination, substation automation and protection and cybersecurity. Hence, this benchmark is derived based on the applications described in the Functional Scenarios. Both Wide Area Network (WAN) and communication infrastructure within a substation are highly relevant. The highlighted applications include state estimation, novel autonomous functions such as protection concepts, fault location and service restoration, and verification and validation of interoperability and performance of systems and equipment. The relevant cybersecurity applications are vulnerability analysis, intrusion detection and impact analysis. Therefore, for this benchmark, it is considered to focus on voltage control applications. Broadly speaking, the above-mentioned applications span three categories of coupling/interfacing: real-time, non-real-time, and hardware based. However, the particular co-simulation example of this benchmark shall focus on the real-time case and provide simulation models and results of the same. Nevertheless, the non-RT and hardware cases will be documented as a part of the benchmark in the deliverable, giving an overview of the possibilities and tool chains to implement them. It is expected that these cases will be developed more in depth the following work in ERIGrid 2.0. This benchmark takes into account not only the Functional Scenario 6, but also associated Test Cases (TC) including: • TC21 on performance characterization of new equipment and communication technologies • TC22 on resilience assessment of ICT infrastructure • TC23 on interoperability testing • TC24 on impact analysis in terms of cybersecurity The reference setup for the simulation of TCs of this nature requires the following basic components:

- Power System simulator
- Communication simulator/emulator
- Service or function for which the communication of power system information is required at a particular physical location
- Tools that allow information connectivity between the power system simulator and the communication simulator.
- Tools that allow information connectivity between the communication simulator and the service/function.

1.5 Optimality criteria

ID	Name	Description	Reference to mentioned use case objectives
C1	Electrical power network stability	Constraints applicable for the electrical power network are met.	O1
C2	Communication network stability	Constraints applicable for the communication network are met.	O2

1.6 Use case conditions

Assumptions
Electrical power network is connected to external grid that guarantees supply in cases where demand is not met by local generation from DERs. The communication network emulates the topology of a digital substation, in addition to the wide area network between the substation and control centre. This guarantees the transfer and access of data through an ideal emulated communication network.
Prerequisites
The applications used in the co-simulation have an operational time long enough that the communication channel disturbances can have significant impact on the operation. This is due to the fact that in real-world conditions, using communication networks over long geographical distances induces a certain amount of communication latencies.

1.7 General remarks

2 Graphical representation(s) of use case

Provide UML use case diagram.