CIGRE Study Committee C4

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

WG [1]N° C4.64	**Name of Convenor:** Chun Fang (CANADA) **E-mail address**: cfang@hydro.mb.ca
Strategic Directions #[2]: 1, 2, 4	**Sustainable Development Goal #[3]:7, 9, 13**
The WG applies to distribution networks: ☒ Yes / ☐ No	
Potential Benefit of WG work #[4] : 1, 2, 4, 5	
Title of the Group: Application of Real-Time Digital Simulation in Power Systems	

Scope, deliverables and proposed time schedule of the WG:

Background:

Real-time digital simulation has been around for more than twenty-five years and has become a standard tool to perform hardware-in-the-loop testing for complex control and protection schemes associated with HVDC and FACTS. Many utilities have invested to create a real-time simulation centre, quite often with hardware replicas, to test in-house developed control systems, remedial action schemes as well as to confirm settings for complex protection schemes such as those associated with series compensated lines. These specialized tests can help to de-risk and shorten commissioning tests, verify functional specifications and provide a platform for training field staff.

Many emerging technologies can benefit from real-time testing such as inverter-based resources, energy storage, and microgrids. The impact of wide-area events, such as geomagnetic disturbances, could be simulated in real time and hardware and protection impacts evaluated. Emerging control and protection such as travelling wave relays, digital substation devices interoperability and cybersecurity risk to power systems can be evaluated prior to field trials. In Australia, real time simulation is being used to assist in making operating decisions given the high penetration of level of inverter-based resources.

The objective of this working group is to summarize and review the main applications of real-time digital simulation and highlight lessons learned. Emerging applications and their benefits will also be highlighted. Techniques used to create network model equivalents will be documented including the creation of dynamic equivalents for simulating low frequency oscillation modes.

This working group will provide valuable insight that will assist utilities and others in making a business decision on when to invest in the technology.

Scope:

1. Survey existing real-time simulation facilities regarding location, objectives, hardware replicas and size of real time simulator fleet. Analyse the survey responses in order to:
   - Develop a method of sizing a real time simulator fleet considering the discussion below on the use of power system equivalents.
   - Propose practical study cases for real-time simulation for power system studies for performance evaluation.
   - Summarize best practices for operating and maintaining a real-time simulation facility.
   - Summarize and review typical applications of real-time digital simulation. Include lessons learned, benefits, limitations and model validation from these case studies.

2. Discuss and compare methods used to determine the size and complexity of ac network models and equivalents for real-time digital simulation, including creation of dynamic and frequency dependent equivalents. Survey the current practices for populating dynamic models for real-time simulation applications. Identify power system topologies that can benefit from real-time simulation. Provide case studies, considerations and benefits of real-time simulation in power system operations. Include methods used to setup and adjust power flow conditions. Develop example cases using different methods being proposed by CIGRE B4.74.

3. Summarize and review cross-platform model continuity considerations and model validations between off-line and real-time simulators.

4. Summarize the latest emerging application areas considering, for example, inverter-based resources, protection, remedial action schemes, geomagnetic disturbances and the benefits to the power system in the context of real time simulation. If available, detailed case studies will be described.

5. Present considerations needed to make an investment decision when creating a new real-time simulation facility. Investigate criteria used to determine system simulation benefits from real-time simulation as compared to offline simulation tools. Present investment considerations in a real-time simulator justified compared to high-performance off-line EMT simulation tools for applications beyond hardware in the loop.

Liaison from SC B4 will be sought.

Deliverables:

☒ Technical Brochure and Executive Summary in Electra
☐ Electra Report
☐ Future Connections
☐ CSE
☒ Tutorial
☒ Webinar

Time Schedule: start: August 2021 **Final Report**: August 2023

Approval by Technical Council Chairman:

Date: March 28th, 2021

Notes: [1] Working Group (WG) or Joint WG (JWG), [2] See attached Table 1, [3] See attached Table 2 and CIGRE reference Paper: Sustainability – at the heart of CIGRE's work. [4] See attached Table 3

Table 1: Strategic directions of the Technical Council

1	The electrical power system of the future reinforcing the End-to-End nature of CIGRE: respond to speed of changes in the industry by preparing and disseminating state-of-the-art technological advances
2	Making the best use of the existing systems
3	Focus on the environment and sustainability (in case the WG shows a direct contribution to at least one SDG)
4	Preparation of material readable for non-technical audience

Table 2: Environmental requirements and sustainable development goals

	CIGRE selected the 7 SDGs that are the most relevant to CIGRE. In case the WG work refers to other SDGs or do not address any specific SDG, it will be quoted 0.
0	Other SDGs or not applied
7	**SDG 7: Affordable and clean energy** Increase share of renewable energy; e.g. expand infrastructure for supplying sustainable energy services; ensure universal access to affordable, reliable, and modern energy services; energy efficiency; facilitate access to clean energy research and technology
9	**SDG 9: Industry, innovation and infrastructure** Facilitate sustainable infrastructure development; facilitate technological and technical support
11	**SDG 11: Sustainable cities and communities** Increase attention on sustainable and resilient buildings utilizing local (raw) materials, power for electric vehicles, strengthening long-line transmission and distribution systems to import necessary power to cities, developing micro-grids to reinforce the sustainable nature of cities; protect and safeguard the world's cultural and natural heritage; reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and waste management
12	**SDG 12: Responsible consumption and production** E.g. Promote public procurement practices that are sustainable; address reducing use of SF6 and promote alternatives, encourage companies to adopt sustainable practices and to integrate sustainability information into their reporting cycle, address inefficient fossil-fuel subsidies that encourage wasteful consumption
13	**SDG 13: Climate action** E.g. Increase share of renewable or other CO_2-free energy; energy efficiency; expand infrastructure for supplying sustainable energy; strengthen resilience and adaptive capacity to climate-related hazards and natural disasters; integrate climate change measures into national policies, strategies and planning; improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning
14	**SDG 14: Life below water** E.g. Effects of offshore windfarms; effects of submarine cables on sea-life
15	**SDG 15: Life on land** E.g. Attention for vegetation management; bird collisions; integration of substations and lines into the landscape

Table 3: Potential benefit of work

1	Commercial, business, social and economic benefits for industry or the community can be identified as a direct result of this work
2	Existing or future high interest in the work from a wide range of stakeholders
3	Work is likely to contribute to new or revised industry standards or with other long term interest for the Electric Power Industry
4	State-of-the-art or innovative solutions or new technical directions
5	Guide or survey related to existing techniques; or an update on past work or previous Technical Brochures
6	Work likely to contribute to improved safety.