CIGRE Study Committee C4

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

WG [1]N° C4.61	**Name of Convenor:** Jinliang He (CHINA) **E-mail address**: hejl@tsinghua.edu.cn
Strategic Directions #[2]: 1, 2, 4	**Sustainable Development Goal #[3]: 9, 13**

The WG applies to distribution networks: ☒ Yes / ☐ No

Potential Benefit of WG work #[4] : 1, 3, 4, 5, 6

Title of the Group: Lightning transient sensing, monitoring and application in electric power systems

Scope, deliverables and proposed time schedule of the WG:

Background:

Lightning fault locations along the transmission line are distributed randomly in the power system. The related electromagnetic transient characteristics are complex and are of great significance to realize the location of lightning faults and the identification of fault types for power system's lightning protection design, operation, and maintenance. This advantage can be observed by the application of protection units or lightning location system (LLS) in the last decade. However, with the rapid development of HVDC transmission lines and the accelerated integration of renewable energy, the architecture of modern power networks is becoming even more complex. The protection units are normally installed in the substation and capture the transient current signal with lower sampling frequency. Grid operators thus locate the lighting strike point within a few spans by calculating the flashover location. Indirect measurement of electromagnetic field and time difference of arrival (TDOA) method are adopted to retrieve the lightning location in the traditional LLS measurement. In these conditions, the fault type cannot be identified accurately, the transient characteristics along the transmission lines and substations cannot be obtained, and the fault location accuracy needs to be further improved. Moreover, distribution networks contain many more branches and feeders where the protection unit and LLS are difficult to be used for lightning fault location.

In recent years, coupled with fast transition to smarter grids, great progress in sensor technology, device manufacturing and sensor’s communication networking technology has been achieved in the broadband-frequency voltage and current sensing and monitoring. Low cost, high-precision voltage and current sensors and their monitoring systems have been widely applied to the transmission lines, distribution lines and substations. Key fingerprint information of lightning fault such as the amplitude, frequency and waveform of the transient voltage and current can be provided by the accurate distributed measurement. Moreover, key parameters such as travelling wave velocity, frequency variation, attenuation, dispersion and distortion in the transient process can also be indicated. The distributed acquisition of massive data provides an important technical method for lightning fault location, transient voltage evaluation and fault identification (back-flashover, shielding failure and coupling induced lightning strike, or other kind of faults, such as pollution flashover) of power transmission and distribution systems, as well as the practical data support for the protection design of lightning electromagnetic transients in substations. Since large amount of sensors can be installed even until redundancy is reached, if they are combined with the machine learning algorithm, the fault and non-fault data collected by sensor networks can be deeply mined, by which the exact fault location can be determined and diagnosis error can be significantly reduced.

The objective of this working group therefore is to summarize the state of lightning transient sensing and monitoring in power systems, including the advanced voltage and current sensor technology, the distributed sensor network and communication technology, and the application of such sensor network to the lightning location, fault identification and intrusion transient analysis. This working group will provide strong support for the realization of smart grid or intelligent grid.

Scope:

1. Summarize the development states of the advanced lightning transient voltage and current sensors in power system, including the coupling capacitive voltage sensor, voltage sensor based on piezoelectric effect and electro-optic effect etc, and current sensor based on low-cost Rogowski coil, magnetoresistive effect and magneto-optic effect etc.

2. Summarize the state-of-art on sensor miniaturization technology, calibration, sensing time synchronization, wireless communication system, and low power-consumption supply technology. Discuss the principles of building a low-cost distributed sensor network for the purposes of lightning transient voltage and current monitoring.

3. Analyse lightning transient voltage and current in HVAC transmission lines and substations, HVDC transmission lines and convertor stations, and distributed networks using big data mining technology and discuss the characteristics and fingerprint information of the lightning transient along the path from the transmission lines to substations.

4. Discuss the application of distributed sensing and monitoring network to the lightning fault location, fault-type identification and the intrusion of the transient. In addition, analyse the potential application of such technology for the lightning protection design and evaluation in HVAC, HVDC transmission and distribution networks.

Liaison from SC B5 will be invited as to consider possible contributions from work being done by WG B5.52 (Analysis and Comparison of Fault Location Systems in AC Power Networks) and B5.55 (Application of Travelling Wave Technology for Protection and Automation).

Deliverables:

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

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

Approval by Technical Council Chairman: Marcio Szechtman

Date: January 16th, 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.