Working Group Description

Title

"Big Data & Analytics for Transmission Systems"

Period of Time

48 months (2023, 2024, 2025 & 2026)

Working Group Officers

Rafael Segundo[1] (Chair), Yanli Liu[2], Emilio Barocio[3] (Co-Chairs), Petr Korba[1] (Secretary)

Pillars Leaders

Mario Arrieta-Paternina[4] (P1L), Jochen Cremer[5] (P2L) and Hector Chavez[6] (P3L)

Contribution to the existing activities

The subcommittee on Big Data & Analytics (BDA) for Power Systems brings together leaders from different disciplines and domains and meet them regularly through a wide range of communication channels to define new challenges and opportunities arising by the emerging big data in modern energy grids.

As result of these collective efforts, the Subcommittee continuously promotes different type of activities through their Working Groups (WG) and Task Forces (TF). Some examples include the organization of panel sessions on IEEE PES major conferences or the successful series of Big Data tutorials from the TF on Big Data Webinar Series, providing a space for interaction between junior and renowned researchers. Moreover, the Subcommittee enables the international collaboration through their other active groups such as the TF on Application of Cloud Computing in Power Systems and the WG on Data-driven Modelling, Monitoring and Control in Power Distribution Networks.

The success and the continuous grow on the interest from the international community on the activities supported by this Subcommittee, call for extending and enlargement of existing groups, like the case of the TF on Application of Big Data Analytics on Transmission System Dynamic Security Assessment. This unique group was stablished to tackle challenges at the extra high voltage level, recognizing the lack of this research direction within the Subcommittee and its significant relevance to accomplish a smooth transition towards zero emission electrical networks. After 3 years of activities, the TF has brought together a solid group of members who seek to investigate in more detail specific issues or pillars that are of interest to the international community. The proposed structure of the new group, more than a simple extension of the activities performed as a TF, envisage to have a broader impact on the power system community, giving new guidelines in the handling and managing of the transmission systems data. An example of this, is the support and membership of the former chair of the TF on enabling paradigms for high-performance computing in wide area monitoring protective and control systems. A group that recently concluded activities and whose work reflected on a Technical Report, has been considered in the preparation of the activities presented here.

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To meet these challenges, the WG has summarised its work in three fundamental pillars:

P1 Application of big data & analytics for advanced metering infrastructure
P2 Integration of data-driven solutions to low inertia power systems
P3 Real-time lab demonstrations and open access databases

Technical Needs

Energy transitions worldwide are pushing towards more sustainable societies demanding the maximization of carbon-free power plants integration and minimization of nuclear and fossil-based power generation. Such is the case in Europe, where up to 75% of the total demand is envisaged to be cover by renewable energy production by 2040 or the long-term strategy of the United States, which aims for a Net-Zero power system by 2050.

These aggressive measures to fulfil the demand mostly using clean energy sources involve technical and economic challenges such as dependency on cross border exchange, the reinforcement of the existing transmission capacity and the need of flexibility by means of creating new interconnections with border countries. These, however, will result in a more vulnerable transmission system, which needs to operate closer to their boundary conditions and hence is becoming more difficult to operate in real time. Furthermore, power systems are evolving towards low-inertia power systems (LIPS) and consequently, utilities require higher degree of observability to improve the decision making and situational awareness. Advanced Metering Infrastructure (AMI) with fast sensing infrastructure based on syncrophasor technology, provide the necessary visibility that utilities need. However, new challenges related to the information itself are arising as result of the growing amount of data and the inability to profit from it.

Under this context, this group has been shaped to provide innovative solutions in the scope of three main pillars defined before and summarized next. In the first pillar **P1**, the developing of tools for innovative applications on syncrophasor measurements for modal analysis, data handling, storage, compression, visualization, filtering, bad data detection, missing value replacement and clustering will be investigated. Moreover, in the second pillar **P2**, the data driven solutions for low-inertia power systems can help the assessment of the restrictions and at the same time to determine its stability boundaries. Finally, **P3** is an innovative pillar, where international labs with advanced measurement technology capabilities will be interconnected through PMU data exchange, with the main goal of creating an open database of frequency measurements from the participating members.

Finally, the WG has developed communication and dissemination plans to guarantee the technical and public coverage of the group results through different communication channels. We aim to cover a wide spectrum of target audience with a series of activities and outreach documents and additional materials that will be made publicly available.

Mission and Scope

- Achieve transfer of knowledge between different scientific communities to solve challenging power system problems and bridge the gap between these communities.
- Provide new guidelines in the handling and managing of transmission systems data.
- Create courses and trainings for industry and academia
- Provide a global open access database of PMU measurements
- Built an interconnection of laboratories for testing of algorithms
- Contribute with high quality reports and standards for handling data in transmission systems.

End-Products [D] and Activities [A]

General [Lead by WG Officers]

- [A1] Overall WG in person meetings during the PES GM 2023-2026.
- [A2] Additional virtual meetings (3 per calendar year in winter, spring and autumn).
- [A3] Organization of international workshops during the lifetime of the WG.
- [A4] Panel sessions on major IEEE PES conferences.
- [D1] One report of activities per calendar year.
- [D2] Educational material for courses and tutorials resulting from the different pillars.
- [D3] Development of web based platform for accessing data.

P1. Application of BDA for AMI [Lead by P1L]

- [A1.1] Four virtual meetings per calendar year.
- [A1.2] Yearly review and consolidation of the state-of-the-art on BDA for AMI applications.
- [A1.3] Yearly review of overall P1 goals and implementation of remedial actions if required.
- [A1.4] Developing of tutorials, teaching material and training courses for industry and academia.
- [A1.5] Crossover meetings with the WG for exchange with other pillars.
- [D1.1] At least two peer reviewed publications with contributions from all P1 members.
- [D1.2] Development of one online application of BDA for AMI.
- [D1.3] Contribution to WG yearly reports.

P2. Integration of data-driven solutions for low Inertia power systems [Lead by P2L]

- [A2.1] Three virtual meetings per calendar year
- [A2.2] One in-person meeting per year around a major IEEE PES conference (e.g., GM)
- [A2.3] Reporting and regular update of the state-of-the-art in data-drive solutions for LIPS.
- [A2.4] Development of an international partner network
- [A2.5] Crossover meetings with the WG for exchange with other pillars
- [D2.1] Design of test network (and datasets) for low-inertia power systems to verify (and study) data-driven solution to stability
- [D2.2] Report on data-driven solutions for stability on low-inertia power systems
- [D2.3] Tutorial on data-driven solutions
- [D2.4] Development of integration plan towards trials (with other pillars)

P3. Real-time lab demonstrations and open access databases [P3L]

- [A3.1] Two virtual meetings per calendar year.
- [A3.2] Interconnection with new labs and promotion within the international community.
- [A3.3] Crossover meetings with the WG for exchange with other pillars.
- [D3.1] Collection of open-source database (OSD) of Synchrophasor measurements.
- [D3.2] Contribution to WG yearly reports.

WG Supporting Members

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Alfredo Vaccaro	University of Sannio	Italy
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