IEEE PES General Meeting 2016

Report:

Task Force on Benchmark Models for Stability Controls

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Task Force on Benchmark Systems for Stability Controls

- Main objective: to set up benchmark systems for researchers on small-signal stability to be able to compare results and evaluate the effectiveness of new proposals.

- Benchmarks: each chosen benchmark system has a unique feature which makes it challenging to design damping controllers for it.

- Validation: all results were validated in at least two different software platforms and the results exhibit very close matches.

- Link: http://ewh.ieee.org/soc/pes/psdpc/PSDP_benchmark_systems.htm

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Systems

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- Simplified 14-Generator Australian Power System
- NETS-NYPS 68 Bus System

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Benchmark Systems for Small-Signal Stability Analysis and Control

The objective of this website is to maintain a database with a set of benchmark models that could be used by the research community on small signal stability analysis and control to compare small-signal stability analysis methods and algorithms, as well as to compare different power system stabilizer (PSS) tuning procedures. These benchmarks highlight a number of practical aspects and issues that should be observed while proposing a new tuning procedure for the PSSs (or a new type of power oscillation damper (POD) to enhance the poor damping of the electromechanical oscillations exhibited in each system without adversely impacting other oscillatory modes and other aspects of the system transient response.

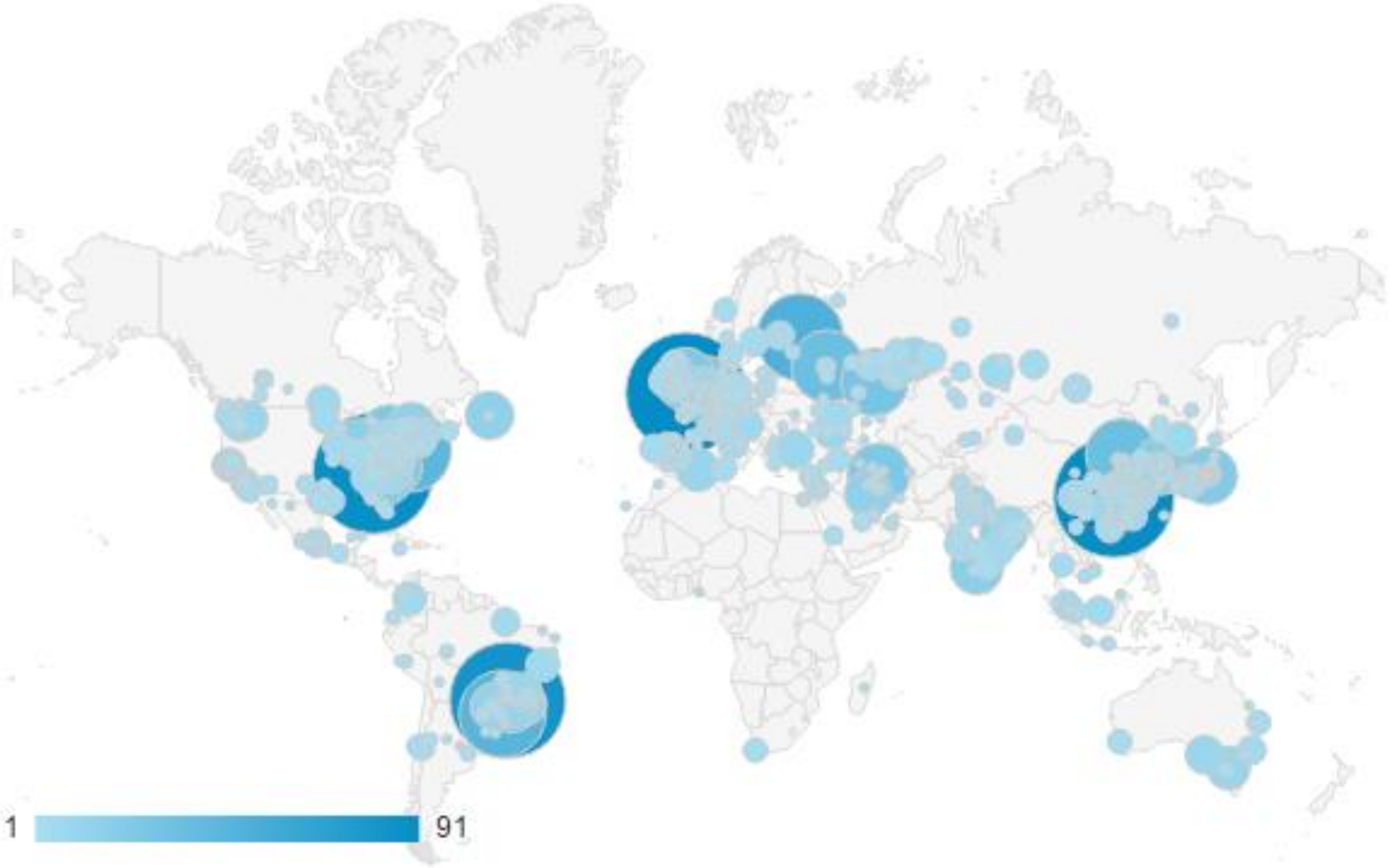
Brief description of the main feature of each benchmark system:

System	Feature
Three-Machine Infinte-Bus System	Simultaneous damping of intra-plant, local (inter- plant) and inter-area modes
Brazilian 7 Bus Equivalent Model	Poor controllability due to zeros in the vicinity of the critical electromechanical mode
Two Area Four Generator Model	Simultaneous damping of local and inter-area modes in a system with a highly symmetrical structure
IEEE 39 Bus System	Coordination of multiple stabilizers to damp electromechanical modes within a control area
Simplified 14-Generator Australian Power System	Simultaneous damping of local and inter-area modes of a longitudinal system considering multiple operating conditions
NETS-NYPS 68 Bus System	Coordination of multiple stabilizers to damp multiple local and inter-area modes operating conditions

Report of the IEEE PES Task Force on Benchmark Systems for Stability Controls

This web site was produced as part of the work carried out by the IEEE PES Task Force on Benchmark Systems for Stability Controls. The reports and implementations contained in it were developed by the contributors to this Task Force, but they are not peer-reviewed documents. The authors are not committed to provide any support to potential users (although they can be contacted and do so on a voluntary basis). Any citation of the reports distributed by this web site should mention them as working papers.
The interested user and/or reader can find a consistent documentation of the benchmark systems in the Technical Report of the mentioned Task Force, which is available for download at the PES Resource Center. The download is free for PES members, but charges apply for non-members (even those who are IEEE members).
The link for downloading this Technical Report (PES-TR18 Benchmark Systems for Small-Signal Stability Analysis and Control (2015) - PDF) is given below:

http://resourcecenter.ieee-pes.org/pes/product/technical-reports/PESTR18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Task Force on Benchmark Systems for Stability Controls

- Technical Report: TR-18 – Benchmark Systems for Small-Signal Stability Analysis and Control (resourcecenter.ieee-pes.org/pes/product/technical-reports/PESTR18)

- Transactions Paper: Benchmark Models for the Analysis and Control of Small-Signal Oscillatory Dynamics in Power Systems (ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=7463478&tag=1)

- Future work: this effort will be continued by the Working Group on Dynamic Security Assessment of the PSDP Committee.

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Benchmark Systems for Small-Signal Stability Analysis and Control

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Benchmark Systems for Stability Controls Task Force

Benchmark Models for the Analysis and Control of Small-Signal Oscillatory Dynamics in Power Systems

IEEE Task Force on Benchmark Systems for Stability Controls

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***Abstract*—This paper summarizes a set of six benchmark systems for the analysis and control of electromechanical oscillations in power systems, recommended by the IEEE Task Force on Benchmark Systems for Stability Controls of the Power System Dynamic Performance Committee. The benchmark systems were chosen for their tutorial value and particular characteristics leading to control the system design problems relevant to the research community. For each benchmark, the modeling guidelines are provided, along with eigenvalues and time-domain results produced with at least two simulation softwares, and one possible control approach is provided for each system as well. Researchers and practicing engineers are encouraged to use these benchmark systems when assessing new oscillation damping control strategies.**

***Index Terms*—Benchmark system, damping controller, electromechanical oscillations, power system stabilizer, small-signal stability.**

I. Introduction

A major root cause of large-scale power system blackouts is poorly-damped or unstable electromechanical oscillations which are inherent to interconnected power systems. Therefore, reliable planning and operation of power systems to ensure satisfactory damping performance is of considerable practical interest. Indeed, due to a number of factors including the increasing size, dynamic complexity and utilization of power systems provision of adequate damping remains an important research challenge [1]–[3]. In this context, the paper summarizes the set of six carefully chosen benchmark power system models as recommended by the IEEE Task Force (TF) on Benchmark Systems for Stability Controls established by the Power System Stability Controls Subcommittee of the Power System Dynamic Performance Committee [4]. A 'benchmark system' comprises a model of the power system together with a set of conventional power system stabilizers (PSSs) whose parameters are soundly tuned in accordance with one of several techniques that are widely applied in practice. Thus, these benchmark systems provide a basis for assessing the damping performance of novel damping controls and/or tuning methodologies to the research community.

Installing PSSs to increase the damping component of the electrical torque of a synchronous generator through the modulation of its excitation voltage, has been the industry practice for many decades to improve the small-signal stability of interconnected power systems [5]. Many variants of the phase compensation designs of the 1970s have been proposed to minimize possible adverse dynamic effects of this controller at non-electromechanical frequencies [3], [6]. The advances in robust control theory over the years have also led to a number of alternative PSSs, all acting through the automatic voltage regulator (AVR) and exciter of the synchronous machines [2]. Controllers with structures other than the lead-lag phase compensation and/or applied to FACTS devices have been termed power oscillation dampers (PODs) [7].

Many methods to tune the parameters of conventional PSSs and PODs have been proposed and continue to appear in the literature. The performance of the new controller is usually verified by digital simulations and compared to that of a conventional PSS using a test system built mainly to highlight the advantages of the new controller. In such cases there is a tendency to over-emphasize the benefits of the new controller in comparison with well applied conventional solutions. Thus, there is a clear need for a set of benchmark systems with soundly tuned conventional PSSs to provide a common basis for fairly evaluating the performance of novel damping controllers and/or PSS tuning methods in comparison with conventional approaches.

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Color versions of one or more of the figures in this paper are available online at http://ieeexplore.ieee.org.
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Thank you.

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