European Research Infrastructure supporting Smart Grid Systems Technology Development, Validation and Roll Out

TRANSNATIONAL ACCESS
USER PROJECT FACT SHEET

USER PROJECT

Acronym	WMPOMS
Title	Wide area monitoring of power oscillations and determination of mode shapes using PMU signals
ERIGrid Reference	04.002-2018
TA Call No.	4th

HOST RESEARCH INFRASTRUCTURE

Name	National Smart Grid Laboratory (NSGL)		
Country	Norway		
Start date	06/01/2019	Nº of Access days	14
End date	30/01/2019	Nº of Stay days	25

USER GROUP

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1. USER PROJECT SUMMARY (objectives, set-up, methodology, approach, motivation)

1.1   Objectives

The objective of the research is to
1. Separate out the closely spaced modes of oscillation in real-time.
2. Quickly and accurately inform the control operator about the appearance/disappearance of new modes and the variations in the ongoing tracked modes.

1.2   Test Set-up(s)

Testing of WMPOMS need PMU signal. Therefore the test set-up broadly consists two parts i.e. "PMU signal generation/access" and "Real-time testing of WMPOMS" as shown in Fig. 1. The real-time PMU signal can be made available in two ways either by simulating the offline power system in Opal-RT or having an access from the power company. These ways can be treated as two subparts of part I of the test plan as shown in Fig. 1.
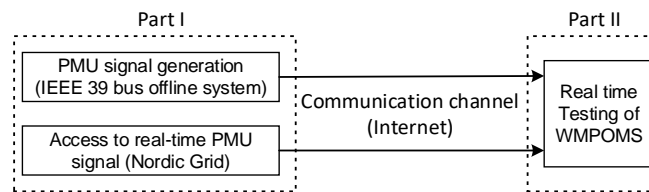

Fig. 1.   Broad test plan

The complete block diagram for the part II of the test plan i.e. real-time testing of WMPOMS is shown in Fig. 2. The physical lab set up and working on it is shown in Fig. 3.
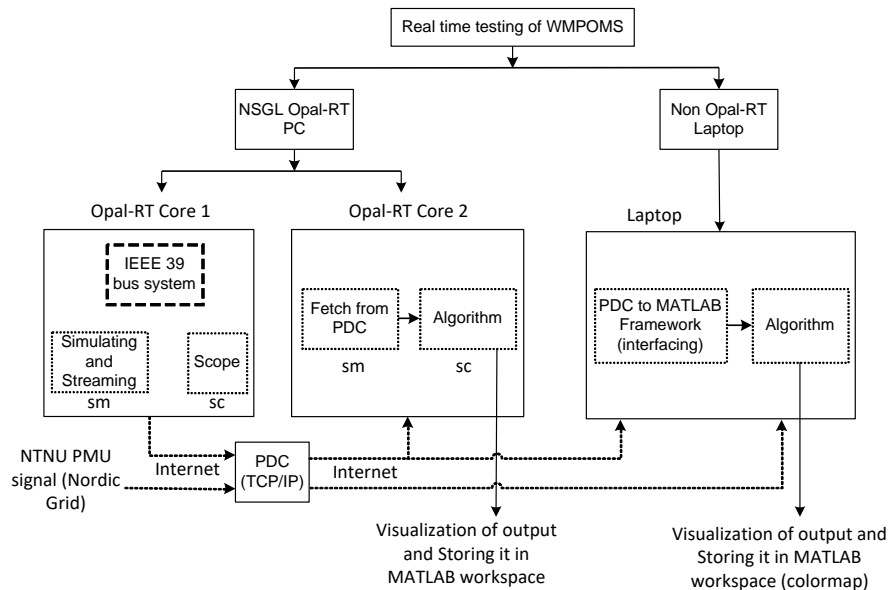

Fig. 2.   Flow chart for real-time testing of WMPOMS

1.3   Methodology

The methodology shown in Fig. 2 is incorporated on two platforms.

1.3.1.   NSGL Opal-RT PC platform: Part I & II

This platform has served for both parts of the test plan. However, in part I, this platform has only served for its first subpart i.e. PMU signal generation. Under this subpart, IEEE 39 bus system is simulated in ePHASORsim in core 1 of Opal-RT while the network data is provided in PSS/E file

format. ==The voltage magnitude signal from the bus-39 is collected and sent to PDC.== Execution of part II on this platform is done in core 2 of Opal-RT. In this part II of the test plan, the RT-Lab is configured with PDC to fetch the signal from PDC to RT-Lab via internet. Now, the fetched signal is given to console subsystem, where the WMPOMS algorithm is executed in real-time.

1.3.2. Non Opal-RT Laptop platform: Part II

In this platform, a non-Opal RT laptop is used to fetch the signal stream to MATLAB in real-time. The most important tool in this platform is Synchro-measurement Application Development Framework (SADF) [1]. SADF is a Matlab coding based library which enables receiving of TCP, UDP, or TCP/UDP synchro-measurement data. The function "SADF_setting" allows to configure the PMU/PDC connection settings. The function "SADF_run" allows to embed the WAMPAC algorithm in it which may require the understanding of the function "demo_WAMS" first.

Fig. 3.   Physical laboratory test-setup and working on it

1.4   Approach

The main approach involved is shown in Fig. 2. The components involved in the approach are shown in Table. 1.

Implementation details	Equipments	Communication involved	Monitoring aspects
MATLAB version 2015 or above	6 GB RAM, 3.2 GHz speed, Window 7 or above (64 bit)	Purchased code to fetch the streamed out signal to RT-Lab	Monitoring of dominant power oscillation frequency in real-time.
PSS/E	Opal-RT (ePHASORSIM)	SADF library to fetch the signal to MATLAB	
RT-Lab	Matlab 2013 and above		

Table 1. Components involved in the approach

1.5   Research Motivation

The researchers have incorporated mode decomposition technique before applying spectral tools for well spectral estimation [2], [3]. The authors in [4], have proposed a mode decomposition technique T-EMD, to aid the performance of traditional FFT spectrum in mode estimation. Similarly, the authors in [5] uses EMD to have the trend identification and de-noising of measured power system oscillations. It is stated that the use of nonstationary techniques are more suitable than moving-average approaches in analyzing rapid variations in nonstationary phenomenon characterized by short-lived irregularly occurring events.

2. MAIN ACHIEVEMENTS (results, conclusions, lessons learned)

2.1. Results

The main achievement was to establish the interfacing between the RT-Lab and MATLAB with the PDC. The video result for online monitoring is shown at the link in Ref. [10] for IEEE 39 bus system simulated in Opal-RT. The snapshot of the video is also shown in the Fig. 4.
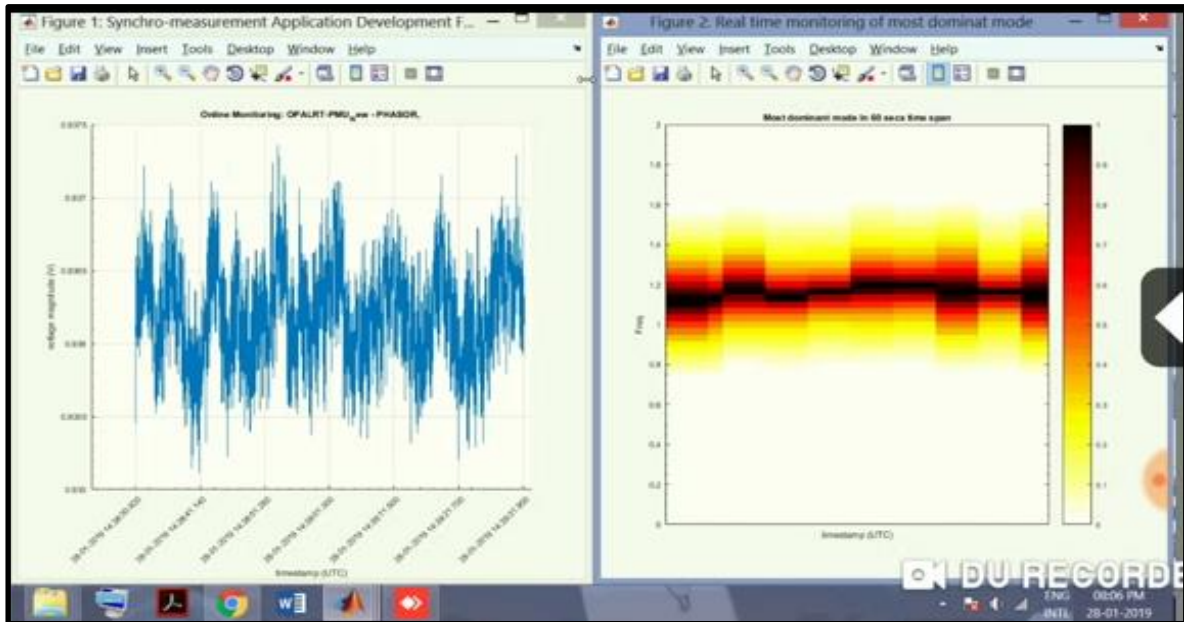

Fig. 4.   Real-time monitoring of Opal-RT PMU signal (IEEE-39 bus system)

2.2. Conclusions

- WMPOMS is effective and accurate in monitoring of real-time power oscillations.
- Further improvement is needed in WMPOMS algorithm to increase its speed of processing the PMU signal, particularly by re-writing the code to achieve fastness.

3. PLANNED DISSEMINATION OF RESULTS (journals, conferences, others)

Results will be shown in the form of conference and will be best tried to publish in journal as well with the collaboration of user group members, including the project manager and his team mates.

4. PLANNED DISSEMINATION OF RESULTS THROUGH ERIGRID CHANNELS
Contact erigrid-ta@list.ait.ac.at to organise promotion of your results

By the report and by Conference/Journal publication

References

[1]   M. Naglic, M. Popov, M. A. M. M. van der Meijden, and V. Terzija, "Synchro-Measurement Application Development Framework: An IEEE Standard C37.118.2-2011 Supported MATLAB Library," *IEEE Transactions on Instrumentation and Measurement*, vol. 67, no. 8, pp. 1804–1814, Aug. 2018.

[2]   D. J. Trudnowski, "Estimating electromechanical mode shape from synchrophasor measurements," *IEEE Transactions on Power Systems*, vol. 23, no. 3, pp. 1188–1195, 2008.

[3]   D. Yang, Y. Li, C. Rehtanz, and D. Yang, "A hybrid method and its applications to analyse the low frequency oscillations in the interconnected power system," *IET Generation, Transmission & Distribution*, vol. 7, no. 8, pp. 874–884, 2013.

[4]   A. Prince, N. Senroy, and R. Balasubramanian, "Targeted approach to apply masking signal-based empirical mode decomposition for mode identification from dynamic power system wide area measurement signal data," *IET Generation, Transmission & Distribution*, vol. 5, no. 10, pp. 1025–1032, 2011.

[5]   A. R. Messina, V. Vittal, G. T. Heydt, and T. J. Browne, "Nonstationary approaches to trend identification and denoising of measured power system oscillations," *IEEE Transactions on Power Systems*, vol. 24, no. 4, pp. 1798–1807, 2009.