NIA Project Annual Progress Report Document

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Date of Submission

Jul 2024

Project Reference Number

NIA2_NGESO004

Project Progress

Project Title

Trial on Implementation of Wide Area Monitoring and Control System (WAMCS)

Project Reference Number

NIA2_NGESO004

Funding Licensee(s)

NG ESO - National Grid ESO

Project Start Date

September 2023

Project Duration

1 year and 0 months

Nominated Project Contact(s)

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Scope

This project will explore the implementation of the WAMCS communication/execution hardware by running a non-operational trial. A WAMCS prototype would be established on the GB electricity transmission network. It would be physically trialled by using the existing communication infrastructure. This non-operational demo trial will not instruct active power response so the trial would not affect the real-time system operation.

The WAMCS will be installed in the ENCC. Communication links will be established between the WAMCS and the PMUs/market participants so that the WAMCS can receive the PMU measurement data and send control instructions to the market participants. We will also develop the security and communication requirements for implementing the WAMCS in the GB system.

Communication latency is critical to the version of WAMCS as it affects how quickly the control action can be initiated. This project will measure the communication latencies at different stages in the WAMCS. This learning would be valuable to various WAMCS applications, such as network split prevention protection, oscillation control, etc. Moreover, the response of the WAMCS to different system events will be investigated.

This will be the first time such a WAMCS has been installed on the GB network, and the project will also provide valuable knowledge on how to fit the WAMCS in the CNI environment, which has yet to be explored previously. The project will consist of 5 main work packages:

- WP1 – Design
- WP2 – MCS Development
- WP3 – MCS Deployment
- WP4 - Demonstration
- WP5 – Reporting and Knowledge Sharing

Objectives

The objectives of the project are to:

- Establish the connectivity between the TOs' PMUs and the ESO PDCs to understand PMU accuracy and communications performance requirements for wide area monitoring and real time data acquisition.
- Install the WAMCS consisting of RA, CS and LC in the ENCC CNI environment and establish communication links to market participants via LD.
- To monitor the performance of the WAMCS system and understand solution latency on current infrastructure.
- To validate the response from WAMCS for different system events.
- To ascertain the technical aspects for potential response providers to connect to a wide area control system.
- Training for internal/external stakeholders.

Success Criteria

The following will be considered when assessing whether the project is successful:

- The WAMCS prototype is established, which receives PMU data from SPEN PDC to ESO PDC.
- The WAMCS logic correctly identifies the system event and sends a response instruction to the market participants.
- A project report is delivered on time, which details:
  - Architecture and design of the WAMCS, and communication requirements to obtained TO PMU data and send instructions to market participants.
  - The costs of implementing the WAMCS and the associated communication links.
  - The performance of the WAMCS, in terms of latency, correct coordination and discrimination with different level of PMU data quality and communication quality.

Performance Compared to the Original Project Aims, Objectives and Success Criteria

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Project Overview

This project aims to explore the implementation of the Wide Area Monitoring and Control System (WAMCS) communication/execution hardware through a non-operational trial. The WAMCS prototype will be physically tested using the existing communication infrastructure. The system consists of communication links between Phasor Measurement Units (PMUs) installed by the Transmission Owner (TO) and the Monitoring and Control System (MCS) installed in the ESO. The MCS will identify frequency events based on PMU data and estimate the real power balance required, communicating this to various service providers. However, this project will only conduct a non-operational demonstration without any actual power changes.

Upon deployment, the scheme will undergo functional testing and latency assessment of the wide area control commands, aiming to meet the NG ESO target of 0.5 seconds from measurement to control command.

Project Plan and Work Packages

The project is divided into five work packages (WPs):

WP1 – Design

Objectives and Achievements:

Statement of Work (SoW): Completed and agreed upon by all partners.

Access Requirements: Documented and addressed, allowing for remote project execution with local support.

Hardware and Software: All necessary components ordered and received.

Training: Three days of training provided by GE Digital to the ESO project team.

The design phase established a modified, centralized version of the regional frequency control scheme developed under the EFCC project. The deployment at NG ESO's LD3 Data Centre includes multiple PhasorControllers (PhCs), issuing commands to remote

sites via a secure IPsec tunnel. The design work was successfully completed, setting the foundation for future WAMCS activities within NG ESO.

WP2 – MCS Development

Objectives and Achievements:

PhC Development: Developed functionality allowing PhC connection to the NG ESO IPsec tunnel.

EFC Logic Development: Modified logic for the Local Device and Central Supervisor, enabling the EFC demonstration.

MCS Trial Run: Prepared and executed trial runs within GE offices, producing a draft report on outcomes.

Latency Monitoring: Developed a solution for monitoring the latency of asynchronous connections.

The EFC logic development, connection requirements, and latency measurement protocols were successfully established. All items in this work package have been completed.

WP3 – MCS Deployment

Objectives and Achievements:

Data Forwarding: Changed PMU data transmission from aggregated to forward streaming to minimize latency.

Deployment: Installed MCS equipment at various sites and conducted basic testing.

Data Collection and Archiving: Enabled GE to receive and archive trial data from SPEN and NG ESO devices.

Local Device Deployment: Deployed redundant Local Devices at GE offices.

The project successfully deployed local devices and the MCS system at the Data Centre. Communication links between PMUs and the Phasor Data Concentrator (PDC) were updated for forward streaming, laying the groundwork for the upcoming demonstration.

WP4 – Demonstration

Objectives and Achievements:

Non-operational Demonstration: Started testing the MCS system with emulated PMU data, generating various scenario datasets.

Communication Link: Currently establishing the link between SPEN PDC and ESO PDC.

The non-operational demonstration began in Q2 of 2024-25 and will continue into Q3, after which the MCS system will be decommissioned.

WP5 – Reporting and Knowledge Share

Objectives and Achievements:

Outcome Reporting: Key outcomes will be documented, and sanitized datasets provided.

Deployment Reports: Brief reports on deployment and decommissioning will be prepared to inform future MCS projects.

These reports are expected to be delivered in Q3 of 2024-25.

Conclusion and Next Steps

To date, the project has successfully completed the design and development phases, with the MCS system installed and tested at key locations. The team is finalizing the communication link setup between SPEN and ESO PDCs, after which the non-operational demonstration will proceed. The upcoming steps include completing the demonstration, decommissioning the system, and delivering comprehensive reports and datasets to inform future deployments.

This project has made significant progress in implementing a WAMCS prototype, paving the way for future advancements in wide area monitoring and control within the NG ESO IT environment.

Required Modifications to the Planned Approach During the Course of the Project

Due to IT security risks, the monitoring and control system (MCS) system has been installed in a Data Centre environment, rather than the Critical National Infrastructure (CNI) environment. The latency of communication between selected PMUs in Scotland to ESO Phasor Data Concentrator (PDC) will be measured separately and the latency from the emulator to the Local Device will be evaluated separately and then will be added. This method still provides the complete latency details.

Lessons Learnt for Future Projects

1. The centralized WAMCS approach has been developed and this method could be used when the EFC tool is required for the production in future.
2. The Local Device (LD) design and the components required have been researched and this learning could be used for the future stages.
3. The learning on firewall and port requirements for the forward streaming methods will be used for future implementation of this solution.
4. Learnings around requirements for deploying the MCS system in the CNI environment have been gained and could be used for future deployment in production.
5. The project setup was challenging due to the time required for the contract negotiation, in particular topics such as gaining security clearance to work in the CNI environment and delays with multi-party contracting. These learnings are beneficial for the future projects.

Note: The following sections are only required for those projects which have been completed since 1st April 2013, or since the previous Project Progress information was reported.

The Outcomes of the Project

The project has so far delivered:

1. The design requirements of the WAMC system, for the Enhanced Frequency Control (EFC), have been completed.
2. The installation of MCS systems (RA, LC, CS, LD and Emulator) was completed. This provided learnings on the required software requirements and the requirements to install in the system for future operational purpose.
3. The communication link between PMU to PDC, for the forward streaming of PMU data rather than aggregated stream has been established. This provided learnings on firewall requirements, port allocation requirements to the future projects.
4. The project team also completed trainings on PDC design and WAMC applications and this will build the ESO's further capabilities on WAMC system applications

Data Access

Details on how network or consumption data arising in the course of NIA funded projects can be requested by interested parties, and the terms on which such data will be made available by National Grid can be found in our publicly available "Data sharing policy related to NIC/NIA projects" and www.nationalgrideso.com/innovation.

National Grid Electricity System Operator already publishes much of the data arising from our NIC/NIA projects at www.smarternetworks.org. You may wish to check this website before making an application under this policy, in case the data which you are seeking has already been published.

Foreground IPR

The following is expected to be generated:
Statement of Work document that includes the EFC Design for WAMCS implementation