EMS-WAMS Integration Project - OFGEM justification paper	
Name of Scheme/Programme	EMS-WAMS Integration
Primary Investment Driver	Asset Health
Scheme reference/ mechanism or category	SPNLT2061 Non-Lead Asset – Protection, Control, Telecoms and Metering
Output references/type	NLRT2SP2061
Cost	£ 0.8m
Delivery Year	RIIO ET2
Reporting Table	C0.7Non-load Master / C2.2a Scheme Summary
Outputs included in RIIO T1 Business Plan	Yes

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1 Introduction

Constant monitoring and control of the SPT Network is essential in the operation of the electrical power network. It is essential to allow the design, connection, control, operation and fault response to enable network management and ensure that there is a secure and reliable electrical supply to all customers, and is provided to control room engineers via the Energy Management Systems (EMS).

EMS provides a snapshot view of the system to control centre engineers. EMS and associated applications are based on the static parameters of the network such as magnitude of voltage, current and power every 1-3 seconds. In recent years with the changes in the energy landscape, introduction of more intermittent generation and reduction of system strength our network is now more prone to variable system dynamics.

Additional system monitoring is carried out with dedicated devices within substations to accurately monitor system dynamics. This capability was enhanced during the NIC-funded Visualisation of Real-Time System Dynamics Using Enhanced Monitoring (VISOR) project in RIIO-T1. The project established a Wide-Area Monitoring System (WAMS), which realised the following benefits:

- enhanced understanding of true system dynamics in real-time through measurement of magnitude and angle of network parameters
- reducing uncertainty to improve real-time situational awareness;
- increasing accuracy of system modelling and safety limit calculations that govern power system capacity margins and overall operation;
- increasing power system resilience by extending the ability to detect high-impact, low-probability events that can cause plant damage and blackouts;
- Compliance with the new STC requirement to provide real-time dynamic data to National Grid ESO.

WAMS data is used extensively by system analysts to conduct post-event analysis, but is not available in real-time to control room engineers at the moment.

The incorporation of WAMS measurements, analytics and alarms within the EMS display at the control centre can improve our engineers' understanding and visibility of system dynamics and help prevent low-probability but high-impact events such as system wide blackouts. This justification paper supports the intention for SPT to invest £0.8m during the RIIO-T2 period to integrate WAMS with the EMS.

2 Background Information

WAMS measurements, analytics and alarms can be valuable to the control centre and planning engineers in a number of system scenarios, but it is important that any WAMS information presented to a control centre engineer is relevant and comprehensible – displayed clearly and concisely, without extraneous detail. This can be achieved through integrating WAMS information into the conventional EMS displays and tools that the engineers are more familiar with in their daily activities.

The WAMS-EMS Demonstration System (WEDS) "Sandbox" environment was created under the VISOR project to facilitate this. WEDS incorporates a mirror of the SPEN EMS and a PhasorPoint WAMS server, both receiving live data – its purpose being to enable exploration, experimentation,

and familiarisation with WAMS-EMS integration without disturbing the operational EMS. It currently operates on live WAMS and EMS data, in an isolated network.

Although WEDS has proven an important tool, it could be augmented by additional functionality to run various scenarios (for example, based on historical data) and advanced analysis techniques. It would also benefit from increased accessibility from both EMS users and the analysts who work with existing system monitoring data.

3 Optioneering

The following is a summary of the options considered for this project.

	Option	Status	Reason for rejection
1	**Do nothing**: Maintain the separate EMS and WAMS systems	Rejected	Rejected on the basis that there are significant benefits to the system visibility that WAMS provides being available to EMS users.
2	**Integrate by moving the system to dedicated RTS WAMS servers**	Proposed	This is proposed. It provides accessibility to different user groups, and allows for them to use targeted data and analyse it with different criteria.
3	**Integrate by moving the system to the RTS network**	Rejected	Rejected on the basis that this reduces the accessibility, flexibility or capabilities of WAMS to corporate, system performance and analyst users.
4	**Integrate by linking the existing WAMs to the RTS network**	Rejected	Rejected on the basis that this does not meet the security, availability and accessibility requirements for operators and data sharing with the system operator

4 Detailed analysis

Options 2 to 4 propose the integration of WAMS into the EMS. Option 2 allows for the most widespread use of the system across the business, while ensuring the security and availability of the data.

4.1 Dynamic assessment

A number of advantages are gained from the display of the dynamic WAMS data on the EMS, without further analysis being applied:

- Verification of measurements: WAMS provides accurate power system measurements which are independent of the EMS's own sources. This can compensate for, or highlight, any problems with the EMS source data.
- Visibility of power system behaviour: WAMS data refreshes quicker and is better time-synchronised than EMS sources. During system disturbances, this allows for quicker identification of oscillatory behaviour which requires a control response, which may otherwise be mistaken for normal system variations.
- Monitoring of imbalance: The WAMS use of three-phase measurements highlights negative and zero sequence components/imbalance which can damage the connected assets including those of customers.
- Voltage angle characterisation: As WAMS provides phasor measurements, it measures the voltage angle difference across an area, which can highlight system stress. Unnoticed, such conditions lead to network insecurity and block system restoration.

- Perform system integrity related actions to avoid cascading faults and system wide blackout: The WAMS-EMS integrated system will allow control centre engineers at TO and the ESO to address rapid changes in the network through assessment of rate of change of angle and frequency. This provides them the critical time to react and take actions to avoid cascading faults leading to a system wide blackout.
- Enhanced Islanding, re synchronisation and black start support: WAMS data can independently detect islands. Integration with the EMS helps the control room engineer to bring islanded areas closer together to improve the chances of successful re-synchronisation, and also aid in the identification of potential re-synchronisation corridors.

Provision of the WAMS data to the EMS has the advantages of improving the visibility of the network to the control room engineer, allowing them to identify system issues in real-time beyond what would have been possible with only the EMS system.

4.2 Advanced analysis

In addition to improving the general situational awareness of the control engineers, WAMS also facilities advanced analysis that can provide them with the information to manage the network during critical system scenarios. This is in combination with the EMS's network topology data, control capability and own system analysis functionality. This improved analysis includes:

- Oscillatory stability status: WAMS allows system analysts to identify and investigate oscillations on the network. With integration, a simplified alert/alarm status can be provided to the EMS operator to advise them in real-time to undertake appropriate actions when required, for example to deal with a known oscillation condition on an interconnector.
- Improved grid State Estimation: WAMS data, inclusive of angles, can be filtered down to be comparable to the EMS source data and fed into the EMS State Estimator. By providing this more accurate data, the stability assessments and contingency analyses which it carries out are more reliable.
- Angle-based grid management: The combination of WAMS data with EMS sensitivity analysis allows the prediction of the post-contingency behaviour of the system, thereby giving the control room engineer a concise picture of how close the system is to operational limits.
- Grid strength estimation: WAMS data was successfully used on the RIIO-T1 MIGRATE innovation project to give a more accurate measurement of system strength than the traditional calculation method, which is more appropriate for a system with higher penetration of wind-farms, HVDC links, etc. This can highlight high risk conditions to control room engineers.
- Disturbance detection and characterisation: Investigations of disturbances using the EMS system can be complicated by the volume of events that are generated, insufficient time-synchronisation to create a meaningful timeline, or the lack of coverage. WAMS automatically categorises and locates events with high timing accuracy, supplementing the EMS capability.

The combination of the WAMS and EMS data crates a powerful set of analysis tools which enables the control room engineers to better avoid system disturbances, react to those which occur, and perform post-event analysis.

4.3 Architecture

The proposed option 2 is to deploy a new highly-available pair of WAMS servers in the RTS network, serving three purposes in particular:

- Provision of WAMS measurements to the live EMS including State Estimator and operator situational awareness displays.
- Hosting of WAMS analytics, alarms and displays that are configured and change-controlled specifically for the Control Room.
- A highly-available communication end-point inside the SPEN RTS network, for sharing of WAMS data with the National Grid ESO.

The new RTS WAMS receives its data direct from the IEEE C37.188.2 Proxy, rather than from a PDC further downstream. This minimises the potential points of failure, configuration to be managed (since no Proxy configuration is required when PMUs are added) and latency.

The proposed architecture retains the WEDS, and augments it with a Dynamic Dispatcher Training Simulator, which allows simulated scenario analysis.

4.4 Security

The physical security risk is based on the location of the servers.

Use of a proxy allows the use of a single TCP connection initiated by the new WAMS servers, which is more convenient for the implementation of cybersecurity measures.

4.5 Innovation

The integration uses the outcomes of the RIIO-T1 VISOR innovation project to deliver further benefits from the project, widening and normalising the use of this innovative system.

5 Conclusion

In coordination with the proposed EMS replacement (SPNLT2049), it is proposed to integrate WAMS and so give improved visibility and advanced analysis tools to the control room engineers. This will provide crucial support for them to anticipate and react to system stress and instability.

- Costs: £ 0.8 m
- Timing of investment: 2026
- Declared outputs: N/A

6 Future Pathways – Net Zero

We have reviewed this project against the criteria set out within the business plan guidance and have assessed that it does not prevent achievement of our Net Zero plans or lead to stranded assets.

7 Outputs included in RIIO T1 Plans

N/A