

Constellation

Project Progress Report – January to December 2025



Constellation Partners



GE VERNOVA



UNIVERSITY OF STRATHCLYDE
PNDC

SIEMENS



Contents

1.	Executive summary.....	3
1.1	Project background.....	3
1.1.1	Situation.....	3
1.1.2	Complication.....	3
1.1.3	Solution.....	4
1.2	Project progress.....	5
1.3	Risks and issues.....	7
2.	Project Manager’s report.....	8
2.1	Workstream 1 – Software & Cyber Security Requirements, Design and Development.....	9
2.2	Workstream 2 – Functional Requirements, Design, Development and Hardware Specification.....	11
2.3	Workstream 3 – Trials & Analysis.....	14
2.4	Workstream 4 – Open Innovation Competition (OIC).....	25
2.5	Workstream 5 – Academic Insight & Future Governance.....	29
2.6	Workstream 6 – Learnings & Dissemination.....	29
3.	Business case update.....	35
4.	Progress against plan.....	37
4.1	Detailed progress in the reporting period.....	38
4.2	Identification and management of issues.....	38
4.3	Key achievements and notable events in the reporting period are shown below:.....	40
4.4	Look-ahead to next reporting period.....	40
5.	Progress against budget.....	40
6.	Project bank account.....	40
7.	Project Deliverables.....	41
8.	Data access details.....	42
9.	Learning outcomes.....	42
10.	Intellectual Property Rights (IPR).....	43
11.	Risk management.....	45
12.	Accuracy assurance statement.....	52
13.	Material change information.....	52
14.	Other information.....	52

1. Executive summary

1.1 Project background

1.1.1 Situation

The energy industry is at the heart of the UK's journey to Net Zero as more consumers shift their behaviour and increase their reliance on electricity. Our traditional role of keeping the lights on is evolving to also ensuring consumers can effectively heat their homes and charge their electric vehicles to travel. It is therefore essential to increase the whole electricity system's resilience. UK Power Networks is keenly aware that we must do this cost effectively to ensure the impact on energy bills is kept to a minimum.

To facilitate Net Zero at the lowest cost to consumers, Distribution Network Operators (DNOs):

- Have developed sophisticated and powerful central capabilities, such as Advanced Distribution Management Systems (ADMS) and Active Network Management (ANM); and
- Will employ smart services such as flexibility to allow quick and efficient connection of more Low Carbon Technologies (LCTs) to the distribution network.

1.1.2 Complication

Network resilience: The existing central network management systems deliver significant benefits in terms of the ability to actively control large volumes of demand and generation on the network. However, these systems have limited resilience, specifically in their ability to continue to operate optimally when communication links are unavailable.

Previously the loss of Distributed Generation (DG) was of little consequence to the operation of the distribution network, as it did not provide services in significant volumes to the distribution network. However, as we increase our reliance on Distributed Energy Resources (DER) to provide smart services, the loss of a high proportion of generation at the distribution level could lead to an increase in disconnection events and potentially blackouts. More specifically, UK Power Networks estimates that 2.9GVA¹ of smart services in GB will be at risk of being impacted by loss of communication with central systems or by unnecessary interruption of DERs by 2050.

Network capacity: The expected increase in DER required to achieve Net Zero will require a significant amount of network capacity to be available in specific areas. One of our first steps is to ensure that we fully utilise the existing network capacity, where it makes sense to do so from a whole systems perspective. However, DNOs' existing protection systems can limit the available capacity in some instances. Protection is designed to protect the network from faults, but in specific cases it limits the amount of DG that can be connected. Load blinding is the latest solution which allows the protection to use a pre-calculated power factor to differentiate between network faults and generation/load. This solution is limited by a single static setting which is unsuitable for the changing power flows of the future network. By 2050, this will result in parts of the GB network having an estimated 1.4GVA¹ of inaccessible spare capacity to connect more DER and support our transition to Net Zero due to static protection settings.

Digitalisation: Existing protection, control and communication functionality within substations are supplied by dedicated hardware, which require lengthy installation, commissioning and maintenance processes. The current products can also be difficult to integrate and have limited flexibility to adapt their functionality. The Energy Data Taskforce recommend maximising the value of smart digital solutions, rather than solely relying on the mass deployment of equipment. As such, there is a growing need for single hardware containers hosting a number of flexible and easy to implement virtual (software) solutions.

¹ https://www.ofgem.gov.uk/system/files/docs/2020/11/Constellation_nic_2020_fsp_-_public_27.11.2020_0.pdf

1.1.3 Solution

Technology is evolving at a rapid pace and UK Power Networks recognises the opportunities this presents to enhance our resilience and facilitate Net Zero at the lowest cost for consumers. In order to overcome these complications, we will leverage the latest advances in 5G communication and software engineering to enhance our local substations; making them more intelligent, digital and interoperable enabling them to have a secure, scalable communications between them.

Constellation² achieves this through a flexible and future proofed system for local intelligence working in partnership with the existing central systems. There are two distinct Methods:

- Method 1: Local Active Network Management – Local network optimisation at the substation level to provide resilience to DER operation against loss of communication with the central systems.
 - Whenever the central systems are unable to communicate with our local network assets, the local intelligence will take over optimisation for that specific provider, substation or area. This will enable the network to be operated more optimally, controlling the area locally, compared to curtailing the provider.

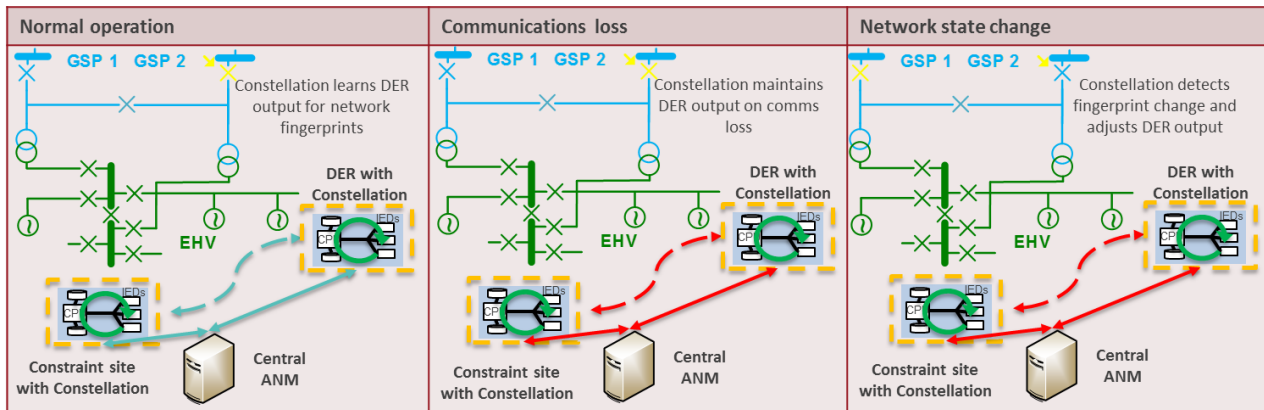


Figure 1-1: Local ANM (Method 1) summary diagram

- Method 2: Wide Area and Adaptive Protection:
 - Provide resilience to DG operation against instability events triggering the conventional generator protection. Constellation will develop sophisticated protection algorithms to identify when the DER should disconnect if events have caused islanded operation. This will rely on low latency communications via 5G slicing.

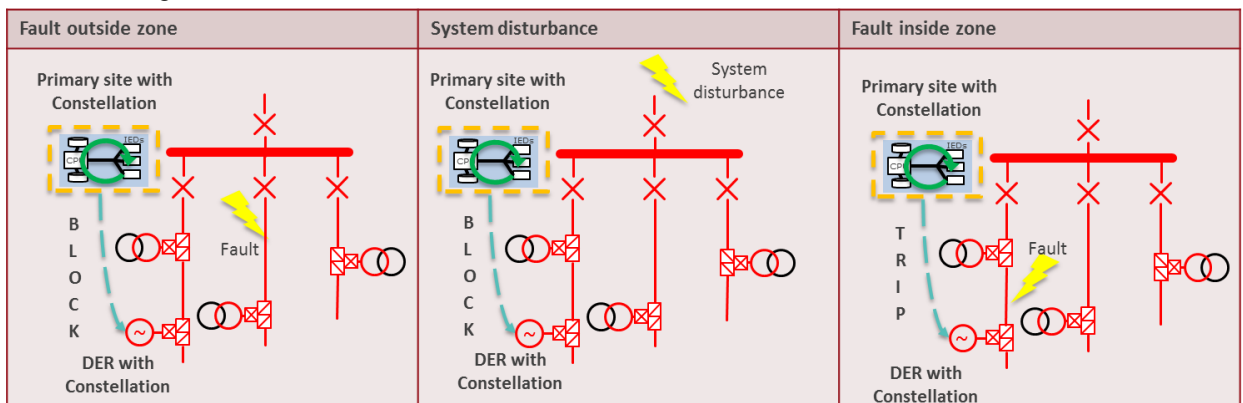
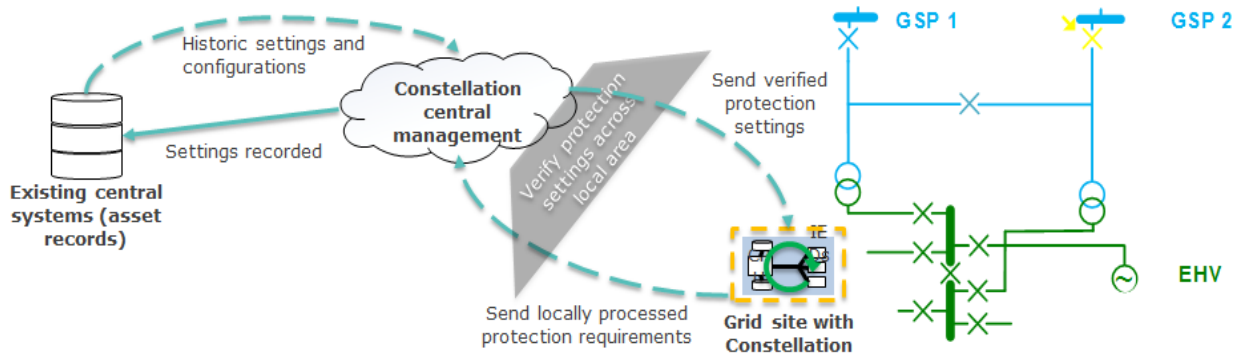


Figure 1-2: Wide area protection (Method 2) summary diagram

² [UK Power Networks Innovation - Constellation](#)

- o Dynamically assessed protection settings and enhanced wide area control to enable more capacity for DER to connect. Constellation will develop the ability to provide real time protection settings from the substation to dynamically validate and modify them. This will allow the load blinding to adapt to the power flows on the network and correctly discriminate between genuine faults and generation / load.



Constellation is one of UK Power Networks’ flagship innovation projects, which will be delivered between May 2021 and September 2026 in partnership with ABB, GE, Siemens, Power Network Demonstration Centre (PNDC) and Vodafone and was awarded funding in 2020 by Ofgem as part of the Network Innovation Competition (NIC) funding mechanism.

If proven successful, UK Power Networks estimates that by 2030 the solutions trialled as part of Constellation could save customers in GB £132m. The project Methods will also enable carbon savings³ of 1.9m tCO₂ and will release an additional 1.98GVA of network capacity by 2030 in GB.

1.2 Project progress

This Project Progress Report (PPR) is the ninth PPR for the Constellation Network Innovation Competition (NIC) project, covering the period between January and December 2025. This document fulfils the reporting requirements of Sections 8.11 – 8.15 of v3.0 of the NIC Governance Document⁴. This document aims to provide project stakeholders with information on the activities and lessons learnt from the Constellation project.

In this PPR, the general project progress is presented first, and then followed by Workstream detail of the progress – starting with Workstream 1 and finishing with Workstream 6. To date, good progress has been made and the project is on schedule for delivery in line with the non-materially changed delivery plan in April 2024. Over this period, the project has successfully:

- Concluded the PNDC testing of the Constellation Solutions and Site Acceptance Testing (SAT)s on the network trial areas;
- Successfully awarded three Open Innovation Competition winners and concluded the offsite testing of those solutions;
- Successfully completed two academic research pieces targeting key areas of interest to the project and published findings on the project microsite;
- Successfully issued project Deliverables 5 and 6;

³ https://www.ofgem.gov.uk/system/files/docs/2020/11/Constellation_nic_2020_fsp_-_public_27.11.2020_0.pdf

⁴ https://www.ofgem.gov.uk/system/files/docs/2017/07/electricity_network_innovation_competition_governance_document_version_3.0.pdf

- Presented three scientific papers at CIRED Geneva 2025 and submitted one additional scientific paper and two abstracts for 2026;
- Continued engagement with DER owners and operators in the trial areas; and
- Successfully appointed a new Workstream 1 Lead;

In this reporting period (January to December 2025), the project has successfully accomplished the following highlights in each of the designated Workstreams:

- **Workstream 1** (on track): is responsible for the specification, design, and development of the software architecture, system integration, and cyber security aspects across all Constellation elements. During this reporting period, integration testing between the central Azure servers and the Thanet area has been finalised, with GE Vernova now receiving PMU data from the Thanet area. Virtual machines for the OIC ABB CogniEN platform were installed and commissioned at both Maidstone and Thanet grid sites, enabling full data collection and fault-prediction functionality. Additional work included GE Vernova firmware upgrades, Maidstone area Internet Protocol (IP) reconfiguration, CyberArk implementation to enhance privileged-access security, and network-switch integration at both sites. Workstream 1 remains on track, providing the digital foundation and cyber secure architecture necessary to support Constellation's transition toward business as usual (BaU).
- **Workstream 2** (on track): is responsible for the specification, design, and development of the functionality (performance) of all Constellation elements and the equipment to be trialled. This workstream manages the on-site installation and commissioning activities. The main highlights of this reporting period are the installation and configuration of all devices within the Constellation cubicles across all sites in the Thanet area, along with the successful completion of the Site Acceptance Testing (SAT) of the Constellation infrastructure (Cubical and IEDs), WAP, and CogniEN. Good progress was also made on the remaining project methods. However, some issues are currently being experienced and closely monitored as they impact the overall performance of the project Solutions.
- **Workstream 3** (on track): is responsible for the design and management of the Constellation trials, which incorporate off-network trials hosted at PNDC and network trials hosted on the UK Power Networks' distribution network. During this reporting period, the off-network trials have been completed covering Maidstone and Thanet test scenarios for all solutions, i.e. Wide Area Protection (WAP), Local Area Network Management (LANM) and Adaptive Protection System (APS)/ Central Management System (CMS). Furthermore, all the specified virtualisation platform testing and security evaluation have also been completed at PNDC, thus facilitating a confident transition into Passive Network Trials. Passive trials have commenced in both Maidstone and Thanet areas, following significant effort in setting up and configuring project equipment and software on site. Further work is pending, in particular the investigation of the performance of 5G communication and that of the server Parallel Redundancy Protocol (PRP) cards.
- **Workstream 4** (on track): is responsible for running the Open Innovation Competition (OIC), which involves incubating and testing additional solutions for deployment on the Constellation platform. Following the launch of the Open Innovation Competition, three applicants have been selected for OIC trials. The successful solutions are fault assessment and prediction solution, "CogniEN with IntelliView" by ABB, "Omega Suite (Optisys)" by SMPnet, and "DigiTAPP SW & TC" by Fundamentals. CogniEN has been successfully deployed to site for field trials and the remaining two solutions have completed integration, functional and system testing in the PNDC controlled test environment and are pending SATs for field deployment. The testing at PNDC has helped to demonstrate integration and operation of the solutions in the virtual environment providing confidence for site trial deployment and lessons learnt from the incubation process.
- **Workstream 5** (delivered): focuses on the academic insights and governance aspects of Constellation, exploring the technical, organisational, and regulatory enablers required for future distributed electricity system operation. During this reporting period, both academic research streams "System Reliability and Distributed Control" and "Future Governance in a Net Zero World with Distributed Electricity System Operation" were completed and consolidated into Deliverable D6. The studies provided critical evidence on how hybrid control architectures can

enhance system resilience and how governance frameworks must evolve to ensure accountability, interoperability, and cyber-resilience across multi-vendor environments. The overall academic insights activity focused on key areas of concern and interest of project Constellation and enhanced the overall development of the project to ensure readiness for BaU.

- **Workstream 6** (on track): is responsible for the dissemination of knowledge generated across the Constellation project. During this reporting period, the project team continued to broaden industry engagement and visibility through multiple national and international forums. Constellation was presented at a variety of industry leading events, conferences, and webinars. The project also received notable external recognition by successfully winning “Physical Technology of the Year” at the Energy Awards 2025 and “Innovation of the Year Award” at National Sustainability Awards 2025. The project was also highly commended as “Innovation of the Year” at the UK Green Business Awards 2025. Workstream 6 remains on track, ensuring the project’s insights and achievements are effectively communicated across the sector and contribute to wider industry learning

1.3 Risks and issues

The project continues to apply robust risk management procedures to reduce the probability and impact of risks materialising. Since the bid submission, several risks have been added to the risk register; all risks are shown in Section 11. Some of these risks have the potential to impact the critical path, however suitable mitigations have been implemented and are continuously reviewed. The project team carefully track these risks on a monthly basis and ensure further mitigations are applied where necessary.

To date, three risks have materialised as issues and are actively being managed by UK Power Networks (as described in section 4.2). The latest of those risks has materialised during a previous reporting period which was successfully closed through a non-material change to Deliverables 4, 5, and 7 as well as the overall project end date.

In this reporting period, and as we prepare for the BaU transition of the project and OIC Solutions, a few key risks are being closely monitored and actively managed. One key risk that continues to be closely monitored is the site-to-site 5G communication. The project team has faced multiple packet⁵ loss issues when switching communications from fibre over to 5G. The issue has now been tracked to be taking place over the radio access network (RAN) and work remains ongoing on resolving this. Additionally, the 5G signal has been lost on one of the DER sites and then we are currently investigating the root cause of this issue and resolution plans. UK Power Networks are working closely with Vodafone, Ericsson⁶, and Virgin Media O2⁷. Collaboration also continues with the PNDC to ensure that troubleshooting activities are pre-tested or validated off-network.

Another key risk that is being closely monitored is the business case of the project Solutions and the readiness for BaU transition. It is essential that the Solutions which will successfully transition to BaU are fully de-risked and have a clear business model and value proposition that justifies both post project operation and the roll out to additional sites in other parts of the networks. As highlighted above, we are actively troubleshooting the 5G connectivity issue to ensure the scheme is fully operational and fit for purpose. We are also working closely with GE Vernova to ensure that the technical success of LANM during the PNDC testing phase continues on the network by tweaking it to resolve true challenges faced by the network today. Similarly, we are engaging with key stakeholders both at UK Power Networks and the wider Siemens team to ensure that APS and CMS provide immediate value in the network and that the outcome of the Constellation project is made commercially available for DNOs to utilise once proven to be successful.

Please refer to section 7 of this report for the revised delivery schedule of the project Deliverables.

⁵ A 5G packet is a unit of data that travels through a 5G network to its destination

⁶ Responsible for key parts of the 5G network infrastructure, especially the RAN in this case

⁷ Manage part of the infrastructure used for the DER side which is currently down

2. Project Manager's report

The main highlight of this reporting period is the successful issue of Deliverables 5 and 6. The fifth deliverable of the Constellation project, titled "Learning from the Open Innovation Competition (OIC)", was successfully submitted to Ofgem on 30 July 2025. The deliverable focussed on the overall process of the OIC from identifying focus areas, assessment process, and final selections. It also provides details on the successful candidates and the testing progress of each OIC solution. The sixth deliverable of the Constellation project, titled "Learning from academic insights and the governance required to prepare for the future world of distributed network operation", was successfully submitted to Ofgem on 28 February 2025. The deliverable focussed on collating key learnings and takeaways from the multitude of research activities that have taken place throughout the project. Redacted versions of these reports are made openly available through the dedicated project webpage⁸ in the next reporting period. Lastly, as the passive network trials progress, the PPRs will mainly focus on reporting general challenges and troubleshooting activities. The Constellation infrastructure (Cubicle and IEDs) have already been successfully tested and commissioned on all possible sites, there is one site where it has not been possible due to space constraints. The focus moving forward will be on the Solutions that are hosted on this infrastructure.

Additionally, the project has made good progress during the reporting period, focusing on the following areas:

- Conclusion of project Methods testing at the PNDC;
- Progression of the passive network trials;
- Business Case Revalidation of project Solutions;
- Progression of the OIC;
- Engagement with partners and DER owners and operators; and
- Management of changes in key personnel.

Conclusion of project Methods testing at the PNDC

A major part of this reporting period was the successful conclusion of the off-site testing at the PNDC of all main parts of the project. Key findings from the testing of each project Solution were presented to the relevant stakeholders where further engagement has taken place and any feedback was successfully implemented. A detailed report was collated for each Solution, as well as both virtualisation and cyber security testing results. These reports are currently under review by the relevant stakeholders with approval expected to follow shortly, within the next reporting period. Some key activities that will be actively tested in PNDC's facilities are 5G, PRP, and final parts of the virtualisation testing.

Progression of the passive network trials

During this reporting period, the passive networks trials continued to progress successfully. Both grid sites and four of the five DERs are now in full operation with the Constellation infrastructure (Cubicle and IEDs) have been successfully commissioned and are in passive operation. The virtualised centralised protection aspect of the project has shown promising performance allowing efficient commissioning and protection management. Furthermore, the WAP solution displayed two successful operations which are detailed in Section 2.3.2. On the other hand, some of the other solutions still require further assessment and/or troubleshooting to ensure readiness for the active trail.

Business Case Revalidation of project Solutions

As the final stages of the project are reached, more focus is put on the preparation of the BaU rollout of the project Solutions. Due to the nature of project Constellation, Solutions rely on common infrastructure adding additional complexity to the cost benefit analysis (CBA). During this reporting period, a financial assessment of the costs associated

⁸ <https://innovation.ukpowernetworks.co.uk/projects/constellation/>

with the equipment used for digitising the network was carried out. The assessment focused on grid substations as a starting point to grant a reasonable rule-of-thumb for future roll-outs. Furthermore, each project and OIC solution has been revisited to ensure the business case identified as part of the Full Submission Pro-forma (FSP) remains applicable and that the anticipated CBA stacks up. These works have driven very positive feedback from stakeholders, helping identify potential sites for future rollouts that are likely to take place as part of the current price control period.

Progression of the Open Innovation Competition

This reporting period saw the successful awarding of three innovative solutions as part of the OIC. These solutions provide unique value supporting key challenges faced by DNOs. From voltage optimisation to fault prediction, such solutions are prime examples of how digitising substations creates scalable infrastructure that enables innovation to flourish. The OIC solutions made great progress to date with one already passively operating on site and the rest concluding the PNDC testing in preparation for the imminent start of the network trials. These solutions are showcasing very promising performance that is anticipated to support the business case of the project.

Stakeholder Engagement

Constellation is an ambitious and complex NIC project with UK Power Networks alongside five partners and three OIC candidates delivering different aspects of the project. Therefore, it is essential to have frequent and open communication between UK Power Networks and its diverse range of stakeholders. To support this regular meetings have continued from the previous reporting period both internally within the project team and to wider stakeholders, as well as additional touchpoints of engagement, including:

- Fortnightly one-to-one sessions with each individual partner to discuss progress and highlight any potential challenges or risks;
- Fortnightly sessions with all partners to discuss upcoming priorities and any areas where support is required from another partner. Key focus was given to the testing activities in this reporting period;
- Weekly sessions with successful OIC candidates to expedite progress and flag any potential challenges or risks;
- Executive board meetings to ensure senior and executive representatives from each organisation are informed of current progress and can influence the delivery of Constellation; and
- Continued engagement with DER owners with a focus on agreeing planned outages for site works activities.

Personnel

In this reporting period, various changes in the team are underway and the changeover of some roles has successfully concluded, as seen below:

- Workstream 1: A new Workstream 1 Lead was successfully appointed in March 2025 and has taken over all responsibilities to ensure successful delivery of the Workstream; and
- Workstream 5: A new technical lead at PNDC was successfully appointed during the first quarter of this reported period;

2.1 Workstream 1 – Software & Cyber Security Requirements, Design and Development

Workstream 1 is responsible for the specification, design and development of the software, architecture, integration and cyber security aspects across all Constellation elements. This Workstream is delivered in collaboration with ABB, GE Vernova and Siemens as they will be designing and developing software solutions for Methods 1 and 2. This Workstream is also in collaboration with Vodafone (partner) and RUGGEDCOM (supplier), who will provide the secure site-to-site communication, and the PNDC who will test all Constellation elements.

Progress during this reporting period

Configuration of Constellation Cubicle Components

The configuration of all Constellation cubicle components in the Thanet area has been completed within this reporting period. All devices have been installed, powered up, and configured. All Ethernet cables and fibre optics have been connected according to the network architecture, enabling communication between all devices. Lastly, all servers have been put into operation, running all virtual machines required for the solutions.

Furthermore, all the IP addresses at Maidstone were successfully reconfigured to align with the current requirements of the Constellation project. A firmware upgrade for GE Vernova systems was completed using the VMWare Management Interface, leveraging both Secure Shell (SSH) and web interfaces to upload new Virtual Machine Disk (VMDK) images and replace existing firmware.

Network switch integration activities were undertaken at Thanet and Maidstone sites. Layer 2 switches were configured for onboarding into a real-time Network Monitoring System (NMS). Base configuration for NMS was completed, and Maidstone switches were successfully added. Thanet switches initially required IP reconfiguration and firewall policy updates to enable SSH access. However, engagement with the relevant stakeholders resulted in a requirements to revisit this configuration in preparation for potential BaU deployment once the active trial has commenced.

Lastly, during commissioning of 5G site-to-site communication, continuous packet drops were observed. Investigations are ongoing to identify the root cause of this issue and improve signal quality. Furthermore, issues with the PRP network have been faced during the SAT in the Thanet area, the project team is currently investigating this issue and potential resolutions. Once a solution is identified for any or all of these challenges, the configuration may be required to be updated to enable such resolution.

OIC Incubation Support for Deliverable 5

The OIC concluded in this reporting period and three new innovative solutions have successfully started the incubation process. All three innovative solutions have successfully progressed through design, development and Factory Acceptance Testing (FAT). Due to the varied nature of the selected solutions, the incubation and network trial plans were tailored to ensure an optimal approach is taken when de-risking them. In light of that, virtual machines (VMs) for ABB CogniEN platform have been successfully installed and are operational at both Maidstone and Thanet grid sites. The remaining two solutions are in final stages of the PNDC testing and findings from that will be used in efficiently setting up the VMs necessary to deploy them.

Roll out of CyberArk as part of UK Power Networks' Cyber Resilience Program

A new initiative, CyberArk, was introduced to support the Cyber Resilience Program (CRP). CyberArk is a security software solution designed to protect organisations from cyber threats by managing and securing privileged accounts, credentials, and secrets. It helps ensure that only authorised users have access to critical systems and information. The CRP is using CyberArk to enhance our security by safeguarding privileged accounts and sensitive data. This helps prevent unauthorised access, reduces the risk of cyberattacks, and ensures compliance with regulatory requirements. CyberArk is especially valuable for project Constellation as it will enable key project and OIC partners to have secure remote access as required which facilitates the deployment, troubleshooting and maintenance of their designated Solutions in a more cyber secure method

Outlook for next reporting period

- Resolve any outstanding issue related to architecture and/or configuration;
- Continue architecture validation and benchmarking for BaU;
- Complete CyberArk deployment and finalise network switch integration across sites;
- Deployment of the remaining OIC solutions; and
- Assessment of various design alternatives in preparation for BaU;

2.2 Workstream 2 – Functional Requirements, Design, Development and Hardware Specification

Workstream 2 is responsible for the specification, design, development and agreement of the functionality (performance) of all Constellation elements and the equipment, which will be trialled. The topics covered include:

- Hardware requirements: in line with IEC 61850 and applicable national standards;
- Centralised virtualised digital protection system: This system is virtualised, running on ABB SSC600 virtual machines installed on substation servers. It is responsible for protecting all feeders connected to the busbar and implements Wide Area Protection functionality. To ensure redundancy, this protection system operates with an SSC600 virtual machine on substation server 1 and another SSC600 virtual machine on substation server 2;
- Method 1: deployment of the infrastructure and data required for Local ANM functionality at the trial sites;
- Method 2a (WAP) – Wide Area Protection functionality: islanding prevention and response to voltage and frequency events. The algorithm of this Method is included in centralised virtualised digital protection system; and
- Method 2b (APS) – Adaptive Protection functionality: automatic updating of protection settings via IEC 61850. This also includes a centralised management system that can retrieve and store a wide range of protection settings from remote devices.

Progress during this reporting period

Design of Constellation solutions

In this reporting period, there have been two key updates to the Constellation solutions design:

- The DER network architecture has been updated to include a connection to our Control Centre system and to improve remote access to these sites;
- Four feeders at Thanet Grid were already equipped with Delay Auto Reclose (DAR) functionality in the existing protection system. This functionality has now also been integrated into the Centralised Protection units, which will replace the existing system once the project enters its active operational phase; and
- At Thanet grid, the GOOSE signals published by the centralised protection have been redistributed to allow new bays to be added to the device configuration.

As Constellation is a highly innovative project with inherent complexity in the solutions developed, it is anticipated that the design will continue to be refined and updated as further testing is carried out.

Site design

In preparation for the Constellation trials in Maidstone and Thanet, the electrical and civil work for each individual site needs to be designed. The site design primarily involves producing drawings to support the site works. These drawings include Alternating Current (AC) schematics, Direct Current (DC) schematics, device application diagrams, and general arrangement drawings for each device and panel.

In the previous reporting period, the designs for all DERs in the Thanet area had been completed. Furthermore, the network architecture received several updates related to the DERs and communication between the DERs and the grid site. In this reporting period, the designs required for the second stage (Active operation) have been issued. These relate to adding the second merging unit for the grid feeders in preparation of the active operation of the successful Constellation solutions.

Site Works – Switchgears

Site works on the switchgears encompass all modifications and actions necessary to deploy and put into operation the required Intelligent Electronic Devices (IEDs) for the Constellation project. These activities must adhere to the site designs for each bay. The most important site works tasks are:



Figure 2-1 - New protection devices deployed in Thanet Grid

- Install new IEDs and the auxiliary components: The items classified as auxiliary components are Miniature Circuit Breakers (MCBs), test blocks, terminal blocks, and auxiliary relays. They are important for the connections between the switchgear components and IEDs;
- Wire all electrical connections: Ensure correct wiring between the devices mentioned above and the switchgear components (Current Transformers (CT), Voltage Transformers (VT), Circuit Breakers, Disconnectors), power supply, etc;
- Deploy communication cables: Install fibre optics and/or patch cords to enable IEDs to connect with other devices via the Constellation network;
- Load the latest configuration to the IEDs; and
- Test and validate if the equipment and connections were deployed properly.

It is important to emphasise that conducting the site works requires scheduling outages for the bays under work. This sophisticated coordination activity requires extra care to avoid affecting the existing protection and control systems that remain in operation to avoid impacting the supply of electricity to customers.

Site works – Constellation cubicle

In the last reporting period, it was flagged that siteworks associated with the fourth, and final, DER of Thanet area were unable to commence due to significant spatial limitations on site. The site in question is an 11kV containerised substation that hosts a suite of essential network equipment. The project team conducted multiple workshops to identify the best way forward with this activity. It was concluded that such site type would not be suitable for the Constellation scheme. Whilst it would be possible to fit the cubicle inside the substation using the newly designed compact format, it will not be possible to maintain the required clearances to safely operate the equipment, especially during testing.

That said, one key advancement that has a very strong potential to release more space in such substation would be the use of virtual remote terminal unit (RTU). That would allow the cubicle to be fitted in place of the physical RTU on site which satisfies the required clearances. The project team is continuously monitoring industry developments should a reliable solution become available for further testing either as part of the Constellation project, or beyond.

Site works – Air conditioning

During the SAT and passive operation of both the Thanet and Maidstone grids, it was observed that the room housing the Constellation cubicle became warm due to the operation of switches and servers, despite the presence of fans installed on the cubicle. Therefore, it was decided to install air conditioning in these rooms to regulate the temperature. Figure 2-2 shows the air conditioning installed at one of the sites.



Figure 2-2: Air conditioning installed at grid site.

Standards and internal documentation

In the current reporting period, two Engineering Approval Standards (EAS) have been published:

- EAS 05-2555 - Ruggedcom Switches. This document details all Ruggedcom switches used and approved for the Constellation network; and
- EAS 05-2556 - Meinberg M1000. This document details the time server Meinberg M100 used and approved for the Constellation network.

The following documents are in progress:

- Engineering Commissioning Procedure (ECP) 05-0350 – ABB SSC600 – Digital Centralised Protection System Commissioning Procedure: This document provides guidance on commissioning the ABB SSC600. Document has been submitted for senior verification and approval;
- Engineering Commissioning Procedure (ECP) 05-0351 – Layer 2 Network and Precision Time Synchronisation Protocol Commissioning Procedure: This document provides guidance on commissioning the Layer 2 Network and Precision Time protocol for digital substation applications. Document has been submitted for senior verification and approval; and
- Engineering Design Standard (EDS) 05-3553 – Network Architecture for Digital Substations: This standard outlines the details and characteristics of the network architecture for digital substation applications. The document is pending validation and definition of the 5G router antennas. Additionally, analysis of the performance of the PRP card installed on the servers is ongoing (see Section **Error! Reference source not found.**) and may lead to changes in the network architecture design.

Outlook for next reporting period

The following items are still pending and expected to be completed during the next reporting period:

- Progress update on the 5G network performance in both areas;
- SAT and validation of the virtual Automatic Voltage Control (AVC) method, as well as the new tap changer installed on site;
- Allow remote connection for the remaining two DERs; and

- Update on standards, procedures and approval documents.

2.3 Workstream 3 – Trials & Analysis

Workstream 3 is responsible for designing, running, and evaluating the outcomes of the Constellation trials. The trials aim to ensure de-risking of the Constellation Methods is achieved by advancing their Technology Readiness Level (TRL) and successfully demonstrating their functionality in an operational environment. The trials consist of two complementary phases – off-network trials hosted at the PNDC and live trials on UK Power Networks’ distribution network. The iterative nature of the trials process ensures the translation of specifications associated with the Constellation Methods into a set of refined requirements and network management policies and standards for BaU rollout, as illustrated in Figure 2-3 below.

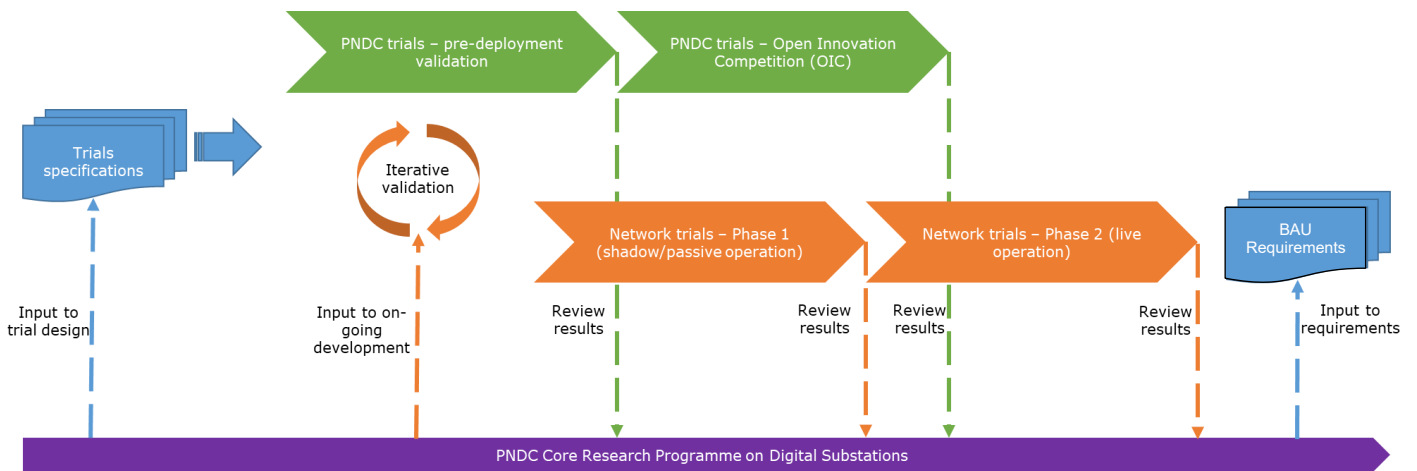


Figure 2-3 – Constellation trials process

2.3.1 Off-Network Trial

During this reporting period, all PNDC (off-network) trials have been completed. Summary of progress is as follows:

- Completion of Local ANM testing for the Thanet area, all other tests were completed in the previous reporting period;
- Troubleshooting APS/CMS testing;
- Issue of all PNDC trials reports for WAP, APS / CMS and LANM;
- Issue of virtualisation platform testing report; and
- Completion of security evaluation tests and issue of test report.

LANM Thanet testing at PNDC

The final part of LANM test, associated with the Thanet trial area, was completed at PNDC during this reporting period following the finalisation of the LANM scheme by GE Vernova and integration with the PNDC test environment. The PNDC LANM test setup is depicted in **Error! Reference source not found.**

Figure Redacted

Figure 2-4 – Thanet LANM test setup at PNDC

Following the successful completion of PNDC SAT, subsequent tests were conducted. The outcomes including set parameters are documented in the corresponding “issue notes” released by GE Vernova. PNDC LANM testing focused on validating the specified functions adhering to the test flow depicted in **Error! Reference source not found.:**

- Transition and timing between LANM modes (i.e. Direct Distributed, isolated) based on known conditions;
- Curtailment and release of DERs based on constraint violation and direction of power flow across constraint points; and

- Distributed Network Protocol 3 (DNP3) override controls of LANM modes.

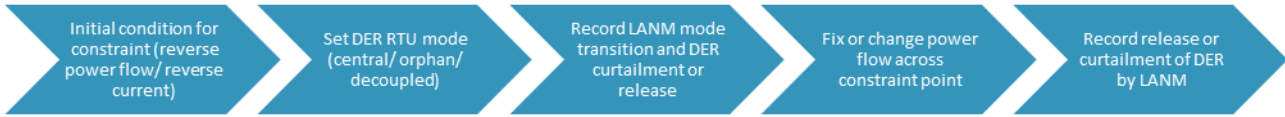


Figure 2-5 – LAN Test Flow

Figure 2-6 illustrates a representative example of the test performed (data obtained from Grafana dashboard on the DE WAMS server). This shows Strasbourg Street generator Remote Terminal Unit (RTU) orphaned and LANM in Direct Distributed mode) being curtailed due to reverse power flow exceeding the constraint point limit.

Figure Redacted

Figure 2-6 – Curtailment of Strasbourg Street generator

In conclusion of the LANM testing at PNDC, the following key observations are made:

- LANM is capable of successfully transitioning between the different operational modes based on the DER RTU and in particular whether the RTU is connected to Central ANM or lost connectivity;
- The LANM scheme was able to maintain a headroom at the constraint point where there is DER available to curtail;
- Negative tests (i.e. forward flow exceeding absolute CP limit) yielded no response from LANM, which is the correct response; and
- Advanced Distribution Management System (ADMS) override tests were conducted successfully.

Lastly, a more recent development of the LANM solution involved replacing the communications between the grid and DER Virtual Phasor Controllers (vPhCs) to IEC 61850 Multimedia Messaging Service (MMS) instead of DNP3 to bring it in line with up to date requirements for digital substation communication. The MMS communication was verified at PNDC over fibre and 5G communications prior to rollout to site.

Troubleshooting APS/CMS testing

An issue was identified during Maidstone SAT regarding communication between the APS virtual machine (SICAM GridEdge) and the second centralised protection unit. A temporary solution adopted at Maidstone grid appeared effective but did not fully resolve the problem. Investigation by the partner supplying this method, Siemens, indicates the PRP card used on the servers may be the root cause. Troubleshoots are ongoing to determine a resolution. Progression on

this matter has been slowed down due to an access issue faced by Siemens to the virtual machine running on site which caused a comms issue between the VM and CMS. More details on this matter can be found on Section 2.3.2.

Security evaluation testing

Testing carried out at PNDC covered Local Area Network (LAN), Wide Area Network (WAN) and remote access layers, systematically encompassing reconnaissance, vulnerability assessment, exploitation and remediation stages to guide deployment at live trials sites. The LAN testing helped to identify potential weaknesses by simulating real-world scenarios, such as privilege escalation and lateral movement concepts. Similarly, WAN testing extended to cloud platforms and Virtual Private Network (VPNs), with a focus on identifying misconfigurations and vulnerabilities in WAN, cloud services, VPNs or other network resources and segments.

The key findings from the security evaluation testing are presented as:

- Access controls: Access to the ESXi host interfaces is granted through Secure Shell (SSH) and Hypertext Transfer Protocol Secure (HTTPS), with proper authentication via password verification. However, the management of ESXi hosts limits SSH access and only allows administrative privileges. Access to other resources is password-protected and granted as required;
- Patches and updates: Software patches and updates are checked automatically, which is essential to ensure that the most recent versions are installed on the systems, but the system is not connected to the internet to get the patches. This applies to the ESXi hosts, VMs and the network devices. Therefore, manual patches and updates carried out at installation have not been updated. A procedure to perform routine offline updates is required;
- MAC address: Changes to the MAC address of network resources have been attempted and were successfully rejected by the scheme. This is a positive outcome as it supports monitoring;
- Port management: Ports are opened on the ESXi hosts and other switches for testing and administrative purposes. However, these ports are not automatically closed, which can pose a security risk;
- Vulnerability: The WhiteBox testing outlined several vulnerabilities with known exploitations, such as denial-of-service attacks. These are related to open ports and services;
- Service status: Most services start and stop manually or when the host is switched on. To improve cyber security, it is recommended that services depending on ports be started and stopped with port usage. This will ensure that non-essential services are not running;
- VPN: The VPN router that connects the Constellation network to the WAN is vulnerable due to the use of outdated firmware and open ports; and
- Deprecated BIOS boot: The BIOS boot option has been deprecated and will be removed in future ESXi host firmware versions. Unified Extensible Firmware Interface (UEFI) is the recommended boot option. The hosts have secured a boot option, which will be enforced via updates.

2.3.2 Live Network Trial

During this reporting period, progress on site revolved around the conclusion/progression with SATs for the various Solutions across the project areas. Key highlights are summarised in this section.

SAT – Maidstone area

In the last reporting period, the SAT for the Maidstone area was completed, with only the validation of the 5G network between the grid site and DER site still pending. This was not tested during the current reporting period, due to the original method that was used to establish connectivity to the DER in the Maidstone area. Additionally, we have been testing the 5G performance between the Thanet grid and a DER, where some issues have been encountered. The

lessons learnt from this validation will support and facilitate the 5G network validation between Maidstone and its DER. Furthermore, the connectivity method to the DER is being reconfigured in line with the latest project development

Finally, during the Thanet SAT, the network architecture for the DERs was updated (as mentioned in Section **Error! Reference source not found.**), adding a connection to our Control Centre system and improving remote access to these sites. This enhancement facilitates the 5G tests and will need to be applied to the Maidstone DER.

SAT – Thanet area

In the previous reporting period, the Thanet area was being prepared to start the SAT. In this reporting period, the SAT for Thanet has been progressed very well in all sites with some activities still ongoing. The following list highlights some of the completed tests to validate the Constellation network, which supports all methods applied in the project:

- Validation of the PRP network (Layer 2): Ensuring seamless failover with zero-time recovery and testing the functionality of the Redbox to connect Single Attached Node (SAN) devices on a PRP network. The PRP network is applied only to the grid sites;
- Time synchronisation checks: Confirming that all merging units, PMUs, virtual machines, and OMICRON devices in the network are synchronised via Precision Time Protocol (PTP), Network Time Protocol (NTP), or Inter-Range Instrumentation Group B (IRIG-B). Using the OMICRON test unit, we also validated the status of the PTP signal provided by the GPS time server clock and verified the performance of the Best Master Clock Algorithm (BMCA) on each device synchronised via PTP;
- Traffic control: Media Access Control (MAC) address filters have been created to control the traffic of Generic Object-Oriented Substation Events (GOOSE) and Sampled Measured Values (SMV) on the switches and Redbox ports, ensuring network stability and reducing data traffic on these ports;
- Validation of Rapid Spanning Tree Protocol (RSTP): Testing the RSTP ring between Layer 2 switches on PRP LAN A and PRP LAN B. RSTP is applied only to the grid sites;
- Remote access configuration: Confirming that all devices from the available Thanet area sites can be remotely accessed;
- Communication tunnel setup: Configuring and validating the communication tunnel between the grid site and DER to enable communication between both sites. The tunnel has been validated over fibre and is currently under test for the 5G network; and
- Testing different 5G antennas to improve performance on the DER under test, and then rolling out this solution to other sites. The 5G signal level is good at the Thanet Grid router (see Figure 2-7). The signal level at the Thanet DER is weak when using internal antennas (see Figure 2-8). As a troubleshoot, we temporarily tested two external antennas (see Figure 2-9), achieving a good signal level similar to that at the grid site. Figure 2-10 shows a photo of the temporary test we conducted, with the external antennas on the left-hand side. The right-hand side of the same figure illustrates an example of how these antennas may be permanently installed if proven to be successful.

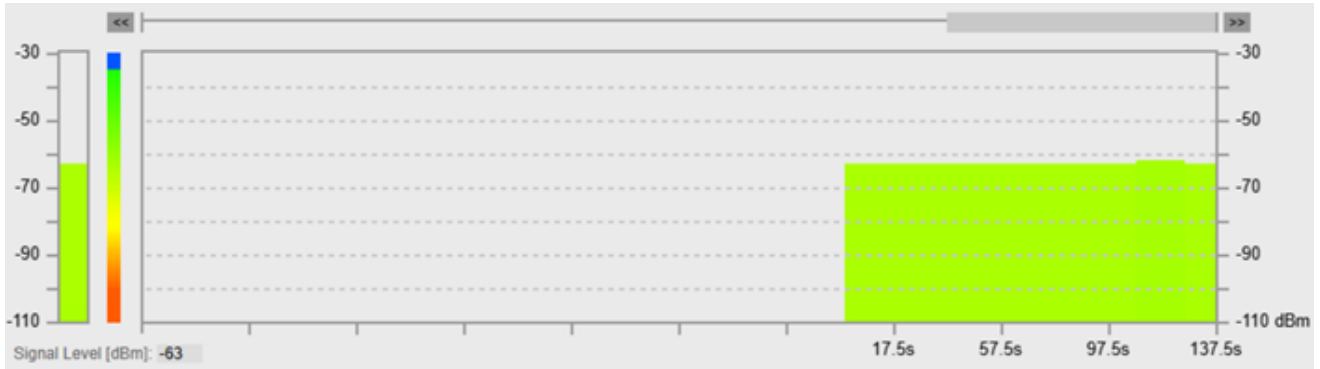


Figure 2-7 – 5G signal strength on the 5G router at Thanet Grid – signal good.

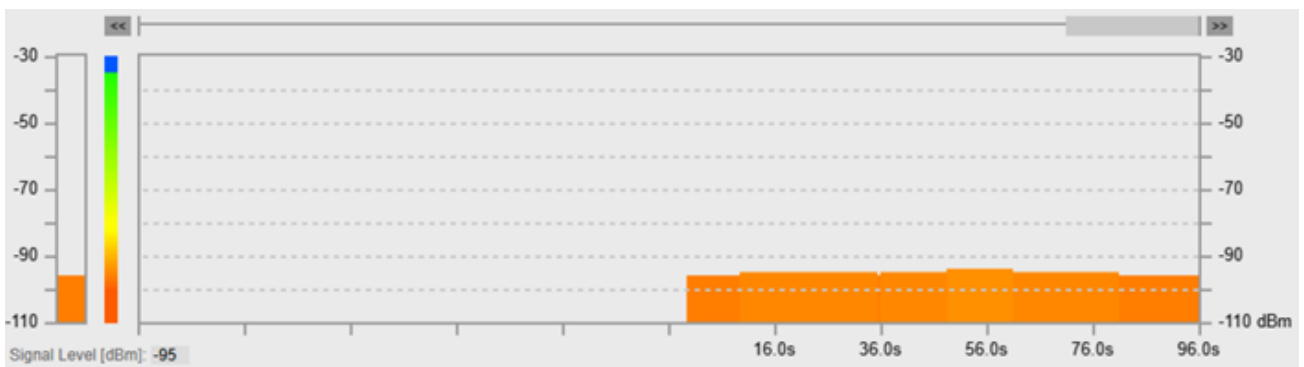


Figure 2-8 – 5G signal strength on the 5G router at the DER using internal antennas – signal weak.

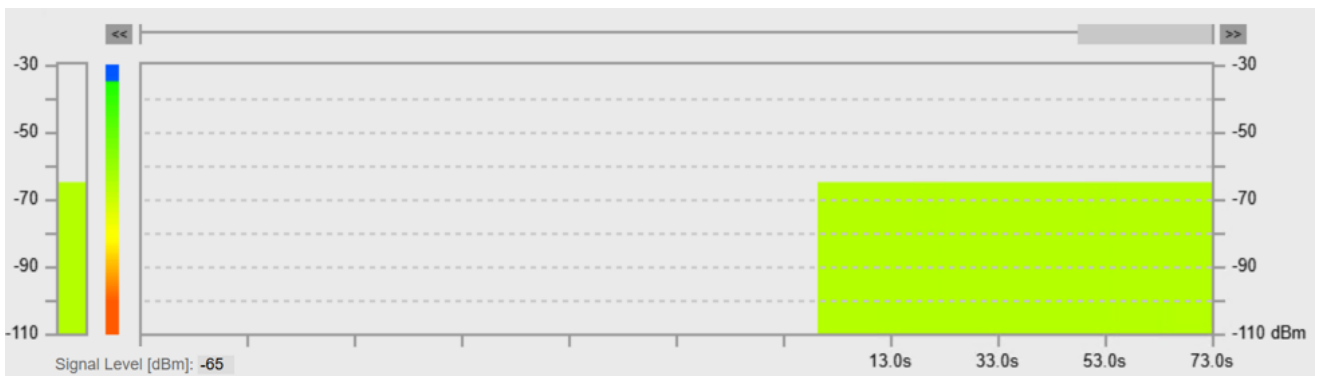


Figure 2-9 – 5G signal strength on the 5G router at the DER using two external antennas - signal good.



Figure 2-10 – The left-hand side shows the temporary test setup with external antennas, while the right-hand side illustrates a potential permanent installation.

The 5G latency in both directions is shown in Figure 2-11 (around 30 minutes of recording). The top diagram displays latency from DER to Thanet Grid, while the second diagram shows latency from Thanet Grid to DER. The 5G latency consistently performs better from Thanet Grid to DER across all measurements: minimum, maximum, and average latency. This aligns with the fact that the 5G signal is weaker at the DER.

Furthermore, analysis of GOOSE packet drops shows that performance from Thanet Grid to DER is significantly better than in the opposite direction. Packet drops from DER to Thanet Grid typically occur every four minutes (even when the external antennas are used), as illustrated in Figure 2-13. In contrast, during a 13-hour period (Figure 2-12), only one packet was dropped from Thanet Grid to DER, and eight packets were received with latency higher than 100 ms (GOOSE messages are published every second). Investigations are ongoing by the relevant project team in relation to the packet drop, especially from DER to Thanet grid.

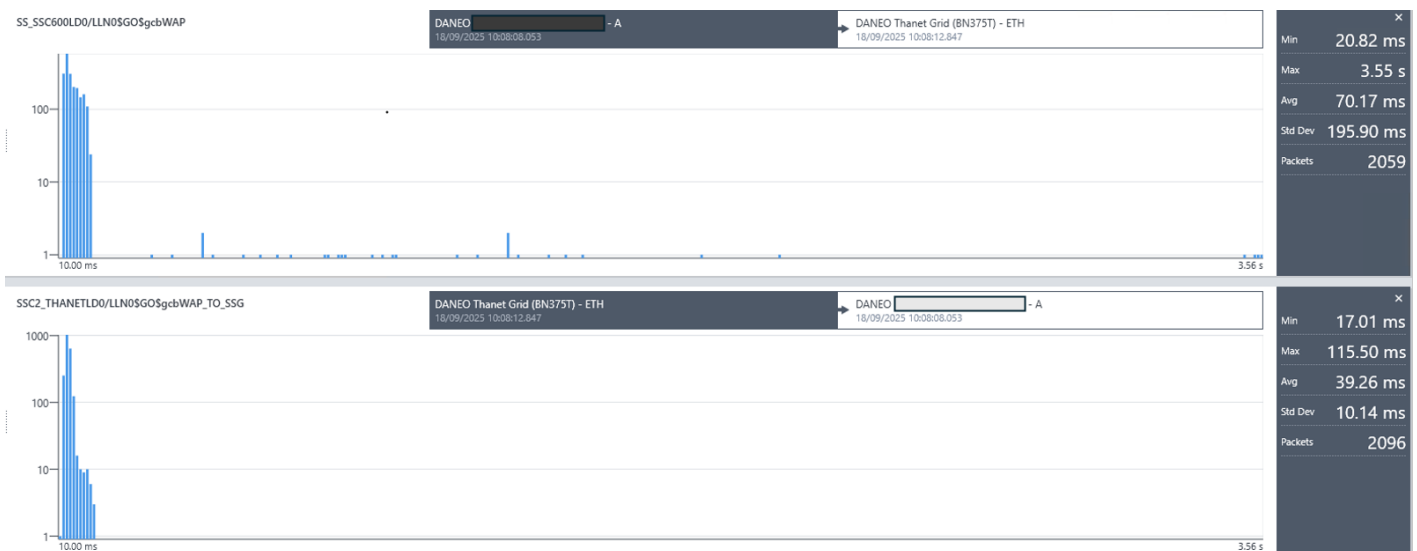


Figure 2-11 – Latency measurement of GOOSE communication between Thanet grid and DER via 5G.

Statistics	
	A
Receive time	10/10/2025 13:29:20.386
Packet count	48431
Status changes seen	6
Status changes missed	0
Retransmissions missed	1
Duplicates seen	0
Time to live expired	False
Time to live expired count	8

Figure 2-12 – GOOSE packet drop measured at DER for a signal from Thanet grid.

Figure Redacted

Figure 2-13 – Verification of GOOSE signal reception from DER at Thanet grid. Packet drops observed approximately every four minutes.

The following list highlights some of the completed tests to validate the centralised virtualised digital protection system and WAP for all sites part of Thanet area:

- GOOSE Simulation: All binary signals sent by the merging units were simulated using a test set, such as an OMICRON CMC 356. The purpose was to confirm how the centralised protection system processes these signals;
- Single Tests: A series of trials were conducted, each operating only one protection function per test. This allowed assessment of the behaviour of the centralised protection unit (time performance, GOOSE outputs, LEDs, disturbance recording and events) for each function in isolation. Results were satisfactory for all protection functions;
- Curve Tests: Sequential tests were performed, varying current or voltage levels and checking the time performance of protection functions under these conditions. Short-circuit phases were also varied during trials. All protection functions operated within the correct time for all scenarios, confirming settings and performance;
- Trip Signals to Merging Units: Necessary tests per bay were executed to validate that trip signals from the centralised protection system were sent only to the correct merging units, avoiding incorrect bay operations. Results were satisfactory for all bays; and
- WAP Validation: Intertrip and Rate of change of Frequency (RoCoF) block signal conditions were simulated at all sites to validate performance when DER protection systems receive these signals and to confirm all conditions under which the grid site transmits them. Tests were performed for all sites (Thanet grid and DERs) in isolation, pending 5G network resolution in order to further validate the remaining sites and communication method.

The following list highlights some of the troubleshooting related to APS:

- The issue reported during Maidstone SAT regarding communication between the APS virtual machine (SICAM GridEdge) and the second centralised protection unit remains unresolved. A solution adopted at Maidstone grid appeared effective but did not fully resolve the problem. Investigation by the partner supplying this method indicates the PRP card used on the servers may be the root cause. Troubleshoots are ongoing to determine a resolution;
- The solution provider and UK Power Networks IT team are working to resolve communication issues between the virtual machine running on the site servers and the Central Management System (CMS); and
- Findings for the PNDC testing concluded that the requirement for a fully adaptive protection management solution may not be as effective in the foreseeable future as it would require a substantial change in the network for it to be considered effective. This in turn created a risk to the deployability of such Solution in BaU. Therefore, the project team is currently investigating the potential use of a virtualised protection management system that is both in line with the Constellation architecture and commercially available to be easily rolled out if proven to be successful. That said, the testing of APS will continue in line with the project scope and the aforementioned will be completed in parallel to maximise the value of these works.

The following list highlights some of the activities related to Local ANM:

- Validation of PMU data arriving at the Phasor Data Concentrator (PDC) running at all sites;
- Validation of PMU data from Thanet grid and one DER arriving at the Azure Server. PMU data from the remaining sites are pending communication to the Control Centre or 5G connectivity to the grid site;
- Validation of PMU data from Thanet grid and one DER arriving at the Phasor Controller (PhC). Data from the remaining sites are pending 5G connectivity to the grid site; and

- On going assessment of the LANM Solution continues between the partner and UK Power Networks team, especially in light of the latest technological and procedural advancement of the network infrastructure which significantly reduced the risk of communication losses. The project team is considering the approach LANM is utilised to maximise the value of this Solution.

Configuration of centralised virtualised digital protection systems, merging units and PMU devices

In the previous reporting period, the configuration of the centralised protection units, merging units, and PMU devices at the Maidstone area was completed, and the Thanet area was updated based on lessons learnt from the Maidstone SAT.

During this reporting period, as mentioned in Section **Error! Reference source not found.**, the configuration of the Thanet Grid centralised protection system was updated to include the DAR function for four feeders. Additionally, the GOOSE signals published by the centralised protection units were redistributed allowing the future configuration of new bays if required.

During passive operation, it was identified that the way the PDCs were configured could lead to a situation where a PDC was unable to receive PMU data from the PMU sender. This issue occurred when PDCs were shut down or rebooted without stopping communication to the PMU. The PMU device can connect to up to four receivers, and when a PDC is rebooted, the PMU does not terminate the communication link. Since the PMU device communicates with a single PDC, after four reboots, the PMU could end up with four active communication links, none of which were operational.

This problem was resolved by configuring a fixed User Datagram Protocol (UDP) listening port on the PDC. As a result, communication between the PDC and PMU device will always be established via the same UDP ports, preventing situations where links are active but non-operational.

For the next reporting period, the configuration of these devices will only be updated if issues are encountered during network trials.

2.3.3 Looking Forward

Challenges and lessons learnt

The following key lessons can be shared from the PNDC testing activities:

- WAP GOOSE messages, with the frequent toggling of the communication supervision, messages seemingly create additional stress on the WAN. It is currently unclear how well this scales up with a large number of DER sites participating in a WAP scheme, each publishing a WAP GOOSE stream and a subsequent response GOOSE message from the grid site. Reducing the maximum retransmission time for WAP GOOSE messages should be considered as an alternative to the toggling logic to reduce the GOOSE traffic across the 5G network. Furthermore, this should be considered together with monitoring of the performance of the 5G RAN and IP core networks to determine sources of packet losses and increases in communication latency.
- Active management of services running virtualised hosts is required. For instance, most services running on the hypervisor are started automatically. Specific service startup policies should be applied, where non-essential services are disabled.
- MTU size impacts stable communication between different elements of the solution. In particular, the tunnel between the grid and DER site requires an MTU of 1500 bytes as opposed to the default 1488 bytes to ensure layer 3 communication is achieved reliably between the two locations, which is necessary for LANM and management traffic.
- An improvement in communication monitoring tools is needed to enable the direct monitoring and diagnosis of the communication networks performance (both LAN and WAN), in particular for C37.118 and DNP3 traffic. Better visualisation of those protocols and associated latencies can help identify issues in communication network performance or configuration in a similar way GOOSE and SMV packet monitoring is deployed in the project using dedicated tools.

The following key lessons can be shared from the early network trials activities:

SAT – Thanet area

The number of bays, and therefore merging units, installed at Thanet Grid is much higher than at Maidstone Grid. As a result, a larger volume of data is transmitted, leading to high bandwidth usage across the network.

The MAC address filtering initially planned for the Thanet area proved insufficient. When all devices were connected to the switches, the network became unstable, and some devices experienced missing communication data.

To resolve this, new filters were deployed on the switches, further restricting the data received by several connected devices. This solution stabilised the network. It is important to note that the issue was caused by certain devices struggling to handle the high data volume - not by the switches themselves.

Passive Operation – Maidstone area

The passive operation stage occurs after site commissioning of the methods and before enabling all devices to operate on UK Power Networks assets. This stage has proven highly valuable, providing several lessons learnt and increasing confidence in the devices and methods applied, as well as verifying the performance, stability, and reliability of the solutions.

Key issues and events during passive operation at Maidstone area:

- **Faulty Antenna on Time Server at DER:** The DER within the Maidstone area suddenly lost time synchronisation protocols. Upon accessing the device, an antenna fault alarm was observed. Investigation steps were carried out following the equipment manual, confirming the issue was with the antenna. Voltage measurements were normal at the time server terminal, surge protector terminals, and all cable terminals connecting to the antenna, which reinforced that the fault was in the antenna itself. After replacing the antenna, the system promptly returned to normal operation, and no further issues occurred with this equipment;
- **Unexpected Behaviour on Centralised Protection Virtual Machines:** Occasional freezes of approximately one second were observed on the centralised protection virtual machines, during which the device was temporarily out of operation. The frequency of this issue is low, occurring a few times per month. The problem remains unresolved but is under analysis and testing by the supplier; and
- **Event on 25th July – Frequency Variation:** An event occurred either at the 132 kV or 400 kV level at Maidstone, causing a significant frequency variation, which was also detected at the DER. Disturbance recordings show that the SSC600 at the DER received a block signal from Maidstone Grid, which would have prevented the operation of the RoCoF protection function. This validates one of the functionalities of the WAP method.

Passive Operation – Thanet area

Key issues and events during passive operation at Thanet area:

- **17th April – Short Circuit on Feeder 2:** A phase B-to-ground short circuit occurred on Feeder 2 to St Peters. The existing protection system operated and opened the circuit breaker. The merging unit and centralised protection system also operated within the same time frame, confirming correct performance during a real fault. Both the merging unit and centralised protection activated the instantaneous phase overcurrent and neutral overcurrent protection functions' and
- **PRP Card Failure on Server 1 at Thanet Grid:** One PRP card on Server 1 at Thanet Grid has gone out of operation. This card is used exclusively by the first centralised protection unit, which became inoperative when the card failed. The protection virtual machine was restored by reconfiguring it to use a standard server port instead of the PRP card, and this server port was then connected to the Redbox. The damaged card will be replaced with a new one.

Substation server and PRP network

In the last reporting period, it was reported that occasionally, when servers were restarted, they could not reconnect to the PRP network due to PRP card failures, requiring a complete system restart. This issue is still under assessment.

In the current reporting period, one PRP card on a Thanet Grid server is no longer operational, even after a full system restart. Additionally, as noted in Section **Error! Reference source not found.**, the APS virtual machine has also experienced communication issues with devices via the PRP network, and investigations indicate the PRP cards installed on the servers may be the cause.

A potential solution to overcome this issue has been identified and approved. Testing is currently undergoing before updating the Constellation architecture. **Trials outlook for next reporting period**

Over the next reporting period, Workstream 3 will focus on the following activities:

- Completion of pending virtualisation platform tests that require manipulation of substation server hardware;
- Setting up and troubleshooting the infrastructure to allow remote access to the remaining DERs in the Thanet area;
- Validation of the 5G performance, especially in terms of packet drop and latency. This includes a test using an alternative external antenna to compare performance and decide on the final solution.
- Completion of SATs in the Thanet area;
- Regression testing at PNDC of solution / configuration as dictated by the outcome of trials; and
- Finalisation of the trials plans and next steps for Maidstone and Thanet areas.

2.4 Workstream 4 – Open Innovation Competition (OIC)

The aim of the OIC is to address any key business needs and provide additional value to our customers through the Constellation project. This will further de-risk the Constellation approach to local intelligence using an open platform and prove the wide range of applications that could be deployed on it, including innovations from third parties who do not have a foothold in the existing substation automation market. Workstream 4 is responsible for the incubation and trial of additional Methods (use-cases) that are delivered by third parties and procured from the market in an open competition format.

In the previous reporting period, the progress in workstream 4 largely consisted of evaluating received submissions and selecting suppliers to participate in the OIC trials. At the end of that reporting period two suppliers had been selected with a third in review pending further clarifications on solution implementation and value for money.

Progress during this reporting period

- Acceptance of the three proposed solution that was under review for the OIC trials;
- Commercial arrangements finalised with all OIC trial participants;
- Accelerated deployment of one solution direct to site trials;
- Supplier FAT reports where applicable and product demonstrations delivered to UK Power Networks;
- Commencement and completion of incubation activities at PNDC for the two applicable solutions;
- Completed test reports from the PNDC trials; and
- Deployment of remaining two solutions for site trials.

A summary of the three selected proposed solutions, use case and key benefits is shared in the table below.

Table 2-1 – OIC Solutions Overview

Vendor Name	Proposed Solution	Focus Area/Use Case	Key Benefits
ABB	CogniEN with IntelliView	Fault level estimation, early fault prediction, substation analytics	Enhances quality of supply and preventive maintenance
SMPnet	Omega Suite (Optisys)	DER coordination, grid optimisation, digital twin capabilities	Tackles a key Distributed Energy Resource Management System (DERMS) challenge which is voltage optimisation and reactive power control
Fundamentals	DigiTAPP SW & TC	Virtualised Automatic Voltage Control (AVC), voltage regulation	Tackles a key operational challenge and demonstrates the value of virtualisation through integrating external assets

Following the successful completion of the ABB solution FAT, it was determined, through SME engagement, that the solution was not required to undergo further “off-network” testing at PNDC. This is because the virtualised SSC600 unit, which is used to extract the necessary data for this solution, has already been deployed and proven on site as part of Constellation Deliverables 3 and 4. The remaining vendor solutions proceeded to PNDC incubation trials on the Constellation test environment.

During the PNDC trials, both SMPnet and Fundamentals solutions successfully demonstrated their core capabilities on the constellation equipment interfaced to the real-time virtual network over a range of test scenarios. A brief summary of each solution is given below.

CogniEN with IntelliView

The solution is based on ABB’s “CogniEN EDGE fleet manager” product, builds on the foundations on substation digitalisation and standardisation including the IEC 61850 communication standard. The solution comprises three main components as follows:

- Anomaly detection and recording using ABB SSC600 centralised protection and control device. This would take receipt of current and voltage measurement data from existing relays or merging units and identify anomalies that may give rise to potential issues and that would otherwise have gone undetected. These are then registered for further analysis in order to assess likelihood of the anomaly developing in to a future network fault;
- Artificial Intelligence (AI) based fault prediction using ABB’s existing “Fleet Management” and “IntelliView” AI Fault prediction modules. These modules are used to form a model which deploys Machine Learning (ML) techniques to process the data and identify patterns within the feature vectors which may indicate when future faults will occur within the power network within a 7-10 days’ horizon. It will also indicate the root cause and approximate location (for applicable fault types) of the future fault; and
- Prediction result presentation. This will be designed to ensure the results of fault prediction are able to be clearly presented to avoid any ambiguity or misunderstanding.

The solution utilises standard protocols ensuring that it is capable of being integrated with UK Power Networks’ existing systems which facilitates BaU deployment if the solution is proven to be successful. Figure 2-14 below showcases the user interface of the CogniEN solution.

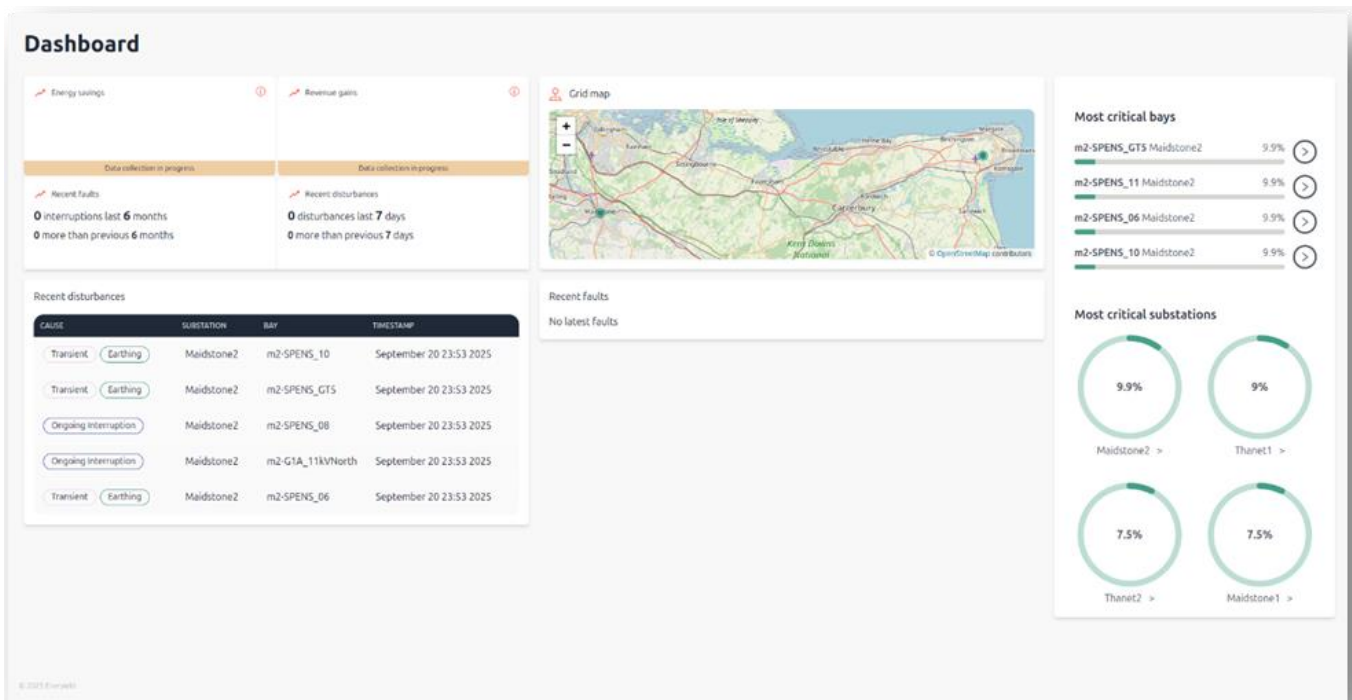


Figure 2-14 – CogniEN EDGE fleet manager User Interface

Omega Suite (Optisys)

The SMPnet Optisys virtual solution tested at PNDC supported the following functionality:

- Wide Area Voltage Optimisation (WAVO);
- Advanced Congestion Management; and
- Digitalisation with Digital Twins.

Working within the constraints of the virtual Thanet test network, the PNDC trial period covered a range of scenarios designed to assess the functionality of SMPnet grid optimisation software Optisys, particularly the WAVO and Advanced Congestion Management capabilities. Early integration testing indicated limitations with the MMS functionality currently available in the Real-Time Simulator Computer Aided Design (RSCAD) simulation environment, where control is only available for switchgear and breaker elements at present. Therefore, the DNP3 protocol was utilised by SMPnet’s Optisys platform for DER communications such as transmitting analogue control setpoints and receiving digital and analogue status signals and transformer tap positions. Additionally, the PMU data streams (C37.118⁹) from the virtual network, representative of the real-world equivalent placement, were processed by the Optisys platform during PNDC trials.

Results from the PNDC testing show that that the Optisys solution responds as expected to the simulated events on the real-time virtual network. For WAVO, Optisys responded to the voltage disturbances within 15 minutes by controlling the active power and power factor setpoints of the DERs within cost of curtailment constraints resulting in voltage levels being controlled back to within limits. Initial deployment concept was to be on the cloud; however, this was changed to be deployed at the UK Power Networks centralised servers due to restrictions envisaged with a cloud deployment linking to the UK Power Networks’ Control Room. This resulted in some rework of the solution implementation by the SMPnet technical delivery team.

⁹ The C37.118 standard defines a method for exchange of synchronized phasor measurement data between power system equipment.

During a workshop in July, it was determined that the preferred deployment option for site trials would be as a central deployment in the UK Power Networks' Control Room, communicating with RTUs via Inter-Control Centre Communications Protocol (ICCP) to a DNP3 master station. This was viewed as the most likely option for BaU roll out and a more scalable approach. SMPnet have been working with the control room team to implement the required ICCP interface prior to site trials.

DigiTAPP SW & TC

The Fundamentals virtual AVC solution relates to the virtualisation and digitalisation of their traditional on-load tap changer relays (SuperTAPP SG) and AVC infrastructure deployments. The solution, incorporates:

- An AVC Virtual Machine (AVC VM) containing the AVC Logical Device (LD);
- A tap changer Intelligent Electronic Device (DigiTAPP IED) containing the tap changer LD; and
- IED configuration tools for configuration and management of the devices.

An instance of the AVC VM was deployed on one of the PNDC grid site servers and communications established with the physical hardware of the DigiTAPP IEDs via GOOSE. The PNDC tested implementation acquired network measurement data for the AVC VM via MMS reports issued from the ABB SSC600 Software (SW), with the latter already configured to collect and process SMV from the simulated Maidstone network model. The physical DigiTAPP interfaces to the Constellation environment at PNDC required updates to the transformer configuration, addition of signal processing logic associated with the drive mechanism and routing of analogue and digital signals to the DigiTAPP IEDs via the RTDS Input/Output cards. Two DigiTAPP IEDs were interfaced, one for each of two parallel 132/33kV transformers, on the simulated Maidstone network.

Results from the PNDC testing show that the AVC responds to a range of simulated voltage disturbances and excursions on the network and initiates control responses from the interfaced DigiTAPP IEDs to change parallel transformer tap positions to keep the 33kV bus voltage within threshold limits and reduce circulating current between the transformers.

Challenges and lessons learnt

- SMPnet Optisys: it was found during integration tests with the Constellation environment at PNDC that RSCAD's (the real-time modelling environment) IEC 61850 MMS implementation is designed primarily for simulating binary control of discrete elements. As a result, MMS write commands targeting analogue parameters such as transformers settings, setpoints for voltage, current or power are not supported or routable within the simulation model. It was decided to switch to DNP3 for control of these parameters.
- The version of Fundamentals AVC software tested at PNDC was not capable of processing SMV, it is understood this will be a future capability, an alternative method to retrieve the required network measurements relied on the AVC SW subscribing to MMS reports from the existing ABB SSC600. This introduced complexity and required additional development work by Fundamentals.
- Fundamentals DigiTAPP IED bandwidth saturation: an issue was encountered during initial integration where the volume of network traffic on the process bus was impacting the connectivity of a required third-party tool, OMICRON's IEDScout, utilised for manual control and resetting lockout conditions, and the DigiTAPP IEDs. This issue was resolved during testing by applying MAC address filtering on the switch connecting the DigiTAPP devices. It is expected that some form of filtering will be required in future deployments to achieve a reliable and low latency connection to the DigiTAPPs for manual control operations.

Outlook for next reporting period

- Stakeholder review and approval of PNDC test reports and completion of any follow up activities;

- Functionality enhancement proposals for OIC solutions and potential integration into its wider systems; and
- Commencement of the network trials for the remaining OIC solutions and preparation for BaU adaptation of successful solutions.

2.5 Workstream 5 – Academic Insight & Future Governance

Workstream 5 is fundamental in ensuring that the Constellation project delivers a future-proof system capable of increasing the electricity system resilience. It is aimed at answering the complex technical, commercial and contractual challenges of distributed network operation. It was carried out through four investigation packages delivered by academic researchers and validated across the project consortium and the PNDC core research programme working group.

Two academic insight activities were completed by the University of Strathclyde covering protection, virtualisation and 5G communications, earlier in the project.

During this reporting period, two additional academic insights have been completed. The focus of these insights was “System Reliability and Distributed Control¹⁰” in collaboration with Imperial College consultants and “Future Governance in a Net Zero World with Distributed Electricity System Operation¹¹” in collaboration with the University of Manchester. This research provided a detailed understanding of how future distributed and decentralised energy systems can operate reliably, securely and efficiently. It explores the evolving relationship between control system design, cyber resilience, and governance frameworks required to underpin future energy system operation aligned with Net Zero objectives.

All findings from the academic insights gathering and learnings from these activities have been published as part of Deliverable 6¹² of the project. Furthermore, all individual research pieces can be found on the project microsite¹³. Therefore, to avoid unnecessary repetition, readers are kindly advised to refer to the sixth project deliverable for full details on this Workstream.

Outlook for next reporting period

- Dissemination of academic findings from Deliverable 6 through industry events and publications; and
- Integration of validated research outcomes into the Constellation BaU transition and Deliverable 7.

2.6 Workstream 6 – Learnings & Dissemination

Workstream 6 is responsible for the dissemination of the knowledge generated from the project. The project has a comprehensive knowledge dissemination plan in place that is outlined in the roadmap in Figure 2-15 below. We have completed the planned dissemination activities in the roadmap so far and have carried out several others in addition. Further details are presented in the section below.

¹⁰ <https://d1oyzg0jo3ox9g.cloudfront.net/app/uploads/2023/10/10.4.7.2-Academic-Insights-System-Reliability-and-Distributed-Control-1.pdf>

¹¹ <https://d1oyzg0jo3ox9g.cloudfront.net/app/uploads/2023/10/10.4.7.4-Academic-Insights-Future-Governance-in-a-Net-Zero-world-with-distributed-electricity-system-operation-Redacted-1.pdf>

¹² Link Placeholder

¹³ <https://innovation.ukpowernetworks.co.uk/projects/constellation>

Constellation

Project Progress Report – January to December 2025



*greyed out activities have been completed

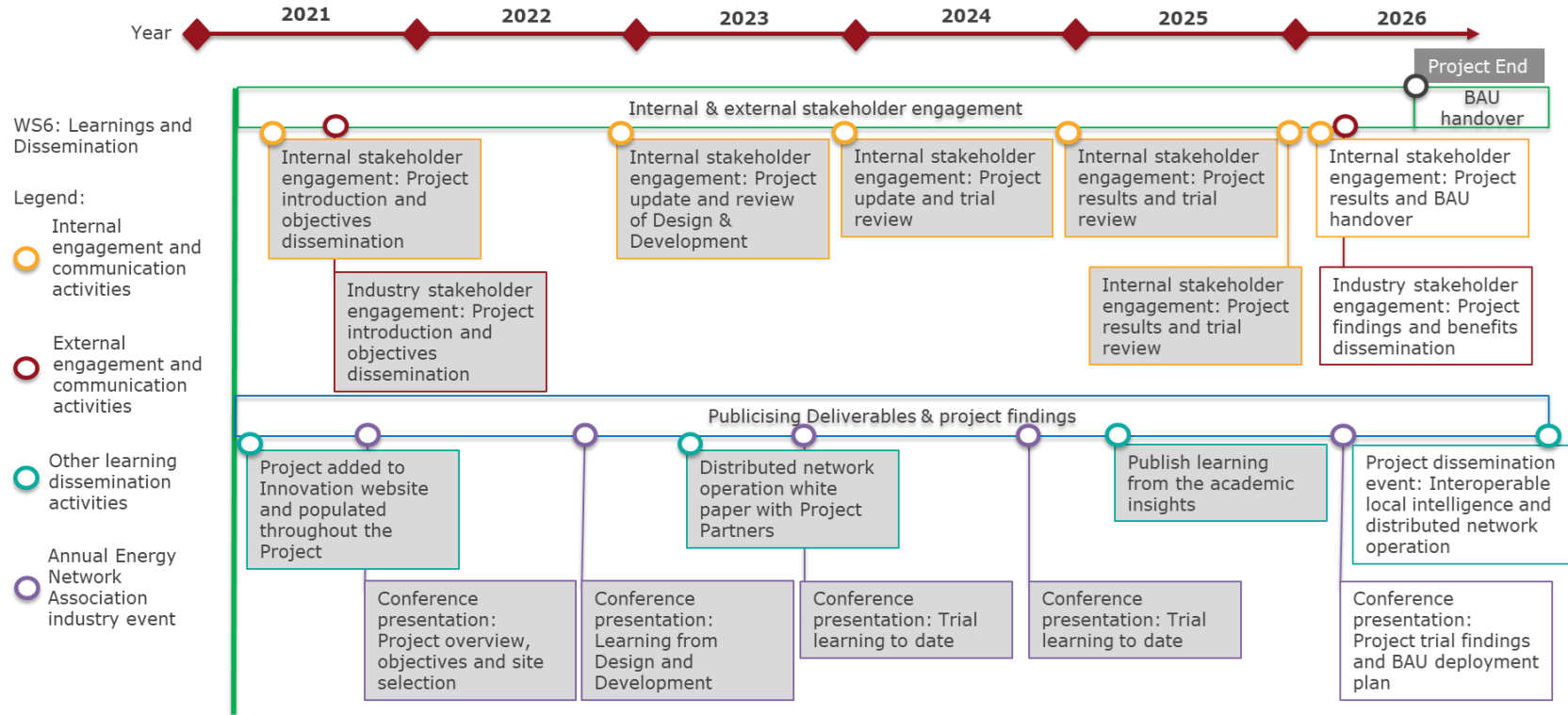


Figure 2-15 - summarising workshop discussions

Progress during this reporting period

The key highlight of this Workstream during this reporting period is the successful shortlisting of Project Constellation in 3 major industry awards:

- “Energy Innovation Award” at the National Sustainability Awards 2025 (Won – Figure 2-16)
- “Physical Technology of the Year” at the Energy Awards 2025 (Won – Figure 2-17); and
- “Innovation of the Year Award” at the UK Green Business Awards 2025 (Highly Commended).



Figure 2-16 Energy Innovation Award at the National Sustainability Awards 2025



Figure 2-17 – Physical Technology of the Year at the Energy Awards 2025

Moreover, the following key activities have been carried out:

Engagement and communication activities

- **DER Engagement:**

Constellation is being trialled in the Maidstone and Thanet network areas; these trial areas were selected for their unique network topologies and diversity of distributed generation types. To effectively model the DER sites and their operating characteristics, it's important to gather as much plant data as possible. Therefore, it's imperative that continue engagement with DER owners in those areas. In this reporting period, the required distribution network outages were communicated and agreed with the DER owners impacted by RTU upgrades and integrations. Site activities related to 5G integration were also coordinated with the required DER owner. Lastly, a general project update was also provided to the DER owners impacted by those works in addition to multiple ad-hoc engagement throughout the period.

- **Technical dissemination:**

The Workstream 3 Lead is a member of the "Power System Relaying and Control Committee (IEEE PSCCC P21 – PSRC 149)" for creating a "Roadmap for Developing New or Updating existing IEEE Standards to Address Issues of Centralised Protection and Control (CPC) Systems", under which one of its core activities is standards related to CPC virtualisation.

Presentations:

- Project progress update and panel discussion at DistribuTech 2025 in Texas, USA (Figure 2-18);
- Presentation and knowledge exchange session at the Net Zero Networks event in London;
- Presentation of two scientific papers at CIRED 2025 in Geneva (**Error! Reference source not found.**);
- Knowledge sharing session with Scottish Power Energy Networks;
- Presentation focused on the voltage optimisation enabled by Constellation at Fundamentals' "Voltage Matters" webinar;
- Project progress update at OMICRON's European Protection Symposium webinar;
- Project progress update and knowledge sharing at ABB's "Expert Days" event in Vaasa, Finland (Figure 2-20); and
- Poster presentation at the Energy Innovation Summit 2025 (Figure 2-21).



Figure 2-18 - DistribuTech 2025 in Texas, USA

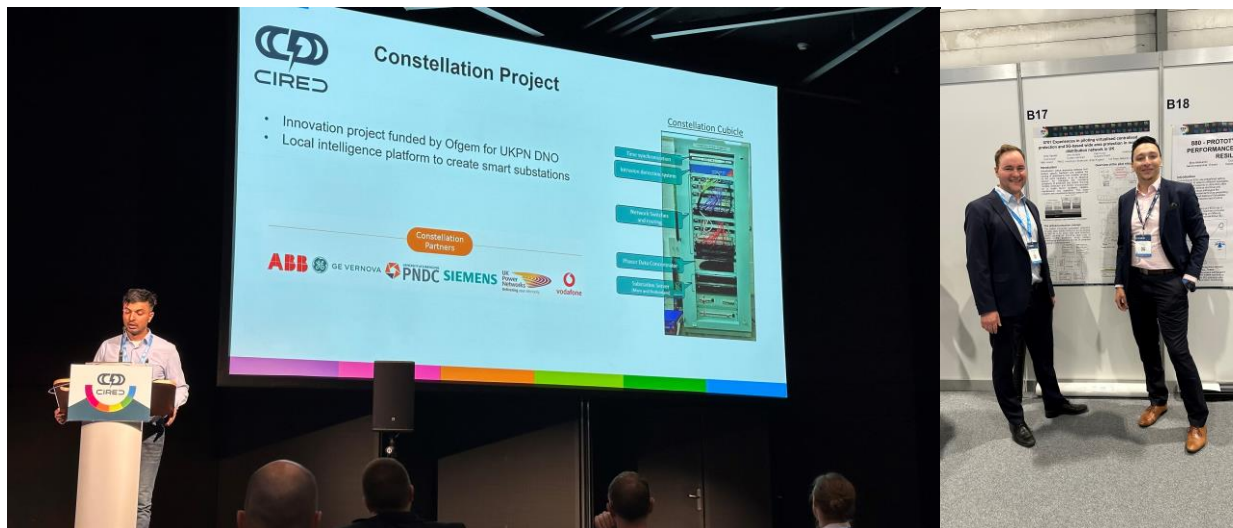


Figure 2-19 - CIRED 2025 in Geneva



Figure 2-20 - ABB's "Expert Days" event in Vaasa, Finland



Figure 2-21 - Energy Innovation Summit 2025

- **Other dissemination activities:**

- Paper abstract accepted at the DPSP 2026 conference in London and a corresponding paper has been submitted on the topic of the deployment of virtualised protection;
- Special session proposal has been submitted to the DPSP 2026 conference on the topic of virtualised protection and 5G enabled Wide Area Protection;
- Press release with owners of the Maidstone area DER to showcase Constellation and its role in releasing additional capacity for additional generation;
- Press release highlighting the success of the Open Innovation Competition and successful candidates; and
- Multiple press releases celebrating the awards received by project Constellation.

Challenges and lessons learnt

The dissemination activities during this reporting period highlighted the continued interest from industry stakeholders in the project activities and outcomes. In particular, suppliers reiterated their great interest in supporting the development and deployment of new solutions to be demonstrated in the Constellation virtualisation platform. Furthermore, discussions with stakeholders and potential end users emphasised the need for standardised approaches to virtualisation platform configurations and testing methods to ensure a robust transition to BaU.

Outlook for next reporting period

Over the next reporting period, regular and further dissemination activities will be carried out including:

- Continued knowledge sharing and project updates on leading industry events and conferences;
- Abstract submissions for CIRED 2026 Workshop; and
- Consideration of a journal paper submission summarising key findings from the project.

3. Business case update

The project team has identified that the hardware and software requirements for hosting the software (virtualisation) solutions in the substations and DER sites, is different to those initially used in the business case. The business case may be impacted due to higher cost equipment than what was in the original bid, however, the project team will continue to evaluate the hardware costs as the procurement process is still ongoing. We are also continuing the work on a strategic investigation into an alternative virtualisation approach which will support the business case.

During this reporting period, a cost assessment activity was conducted on the infrastructure cost of rolling out Constellation to future sites. The activity focused on the equipment required for future site upgrades and did not include the licenses cost of potential Solutions that would form part of the BaU roll out. This approach was driven by the following key reasons:

- Knowing the Constellation infrastructure cost would provide a clear baseline which must be offset by the successful Solutions to ensure a positive business case; and
- Not all project partners have a clear commercial offering of the developed solutions at this stage of the project;

As anticipated, this activity has proven to be challenging as such costs are driven by a variety of interdependent components such as volumes, technology advancements, and design complexity driven by future proofing the infrastructure. Therefore, the next reporting period of the project will put great focus on this area in preparation of BaU roll out of the Constellation project once proven to be successful.

Careful consideration is currently in place for the potential roll out to up to three additional network areas within the current price control period. Whilst this grants a great opportunity to increase the learnings from the project and further strengthen the business case, it also adds immense pressure on the project team to ensure the project readiness for a such step whilst also preparing for the successful conclusion of the project and issuing the final project Deliverable.

As part of the testing and verification of the project, the business case will be re-evaluated, but during this reporting period it remains consistent with the Constellation Full Submission Proforma (FSP) where the calculations and assumptions are described in detail.

Figure 3-1 shows the costs and gross benefits, as well as the net expected benefits of Constellation when rolled out across GB, split between the two different cost and benefit categories. The left side of the graph shows the costs, while the right side shows the benefits.

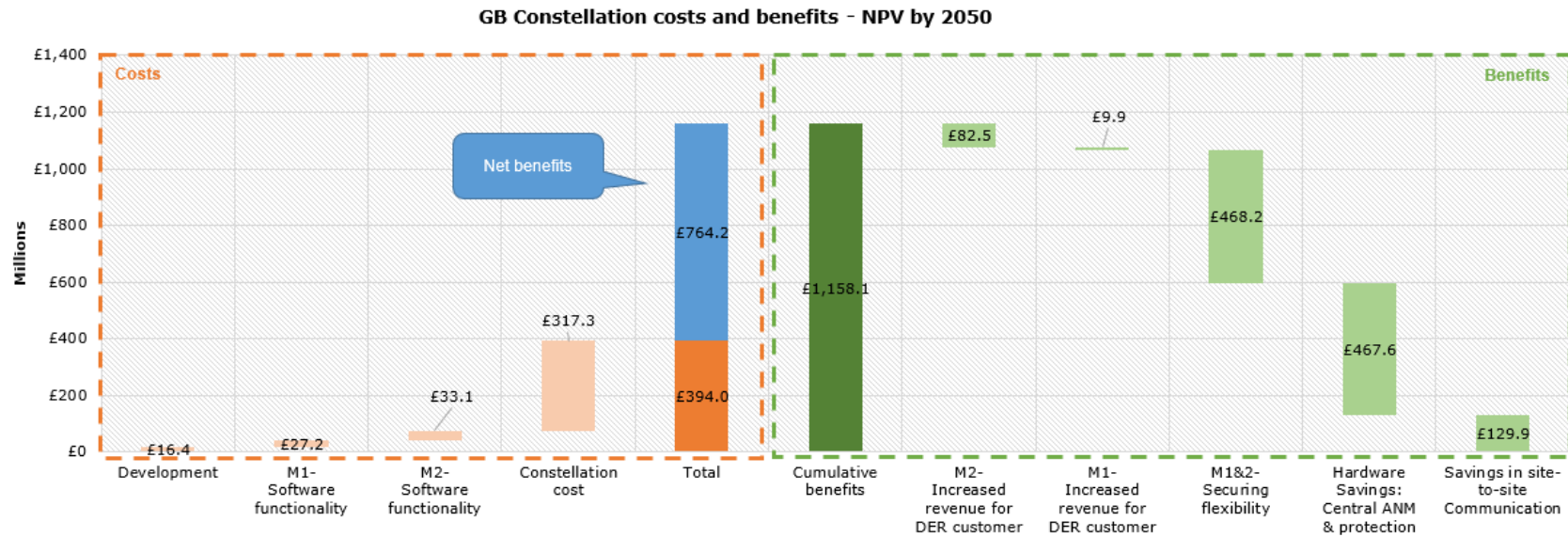


Figure 3-1 Forecasted financial benefits in GB by 2050

Constellation

Project Progress Report – January to December 2025

4. Progress against plan



Figure 4-1 shows the high-level project plan for Constellation. The plan is updated to reflect the non-material change request during the previous reporting period. The project remains on track to achieve the Deliverables by the markers shown below. In the next sections the project team describe the progress of more specific items in the detailed project plan.

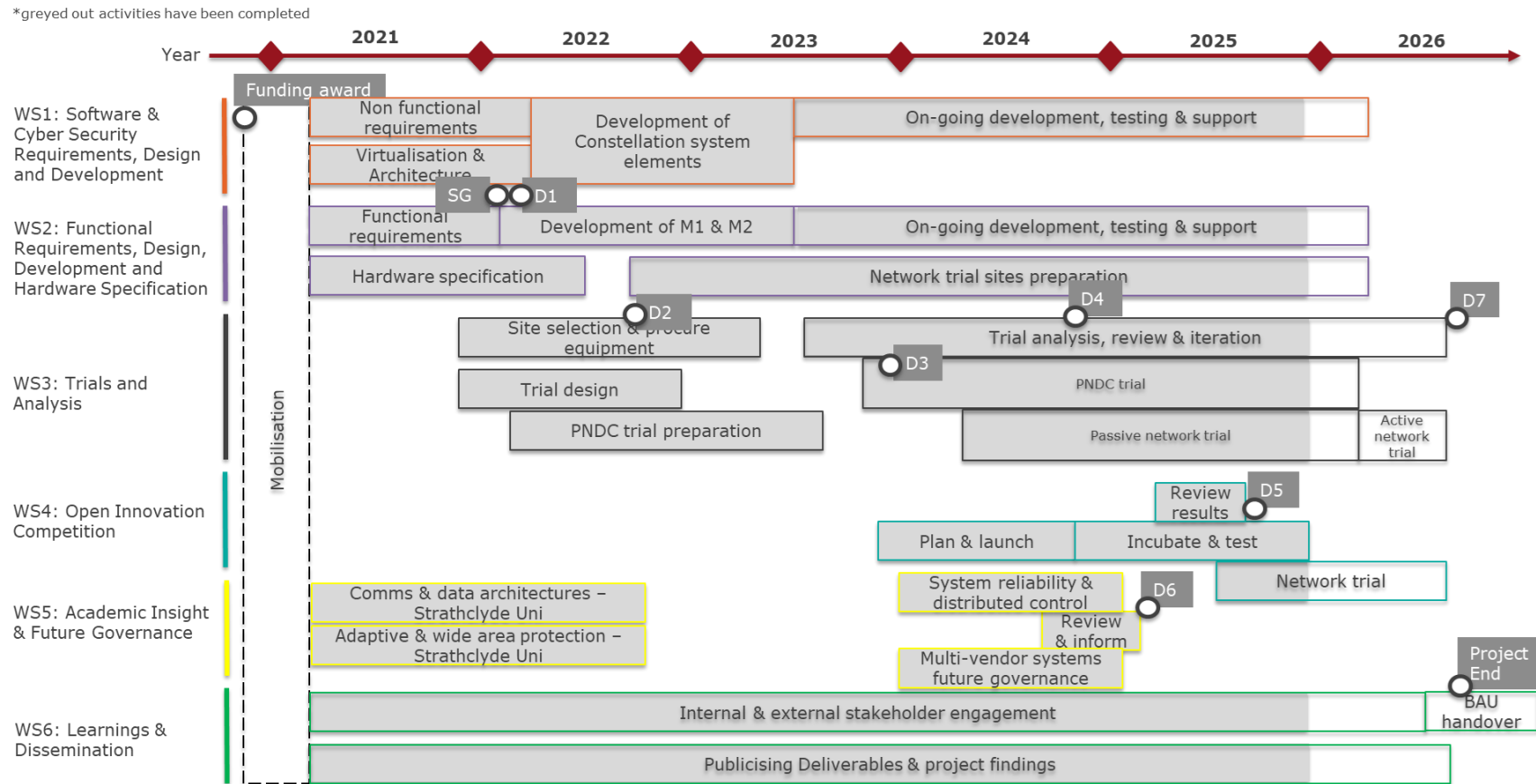


Figure 4-1 - High level plan (shaded elements are completed and partially shaded elements are in progress)

4.1 Detailed progress in the reporting period

In order to monitor project progress against the plan and track any potential risks or issues several regular meetings are held including fortnightly and ad-hoc sessions with the individual partners, bi-weekly sessions with all partners as well as regular risks and issues review sessions with all partners.

Overall, progress to date is behind the high-level project plan submitted in the FSP and was managed through two non-material change requests. Despite this, six out of the seven Deliverables have been successfully completed. As highlighted in the previous reporting period, we are closely monitoring the progress of the Constellation trials. As we approach the final project Deliverable, the key hurdles that must be overcome to achieve a smooth and successful BaU transition of the project are becoming increasingly evident. The project team is extremely confident in the ability to successfully conclude the project and achieving the success criteria of Deliverable 7. However, focus has shifted beyond the proof of concept and is now set on paving the way to successful BaU deployment. We will continue to monitor progression and update Ofgem appropriately through future Project Progress Reports or separately if necessary. Further details are provided in section 4.2.

A summary of tasks that started (or continued) in the reporting period is shared in the table below, together with their status at the end of the period.

Table 4-1 – Summary of project tasks in this reporting period

Task description	Workstream	Status at end of period
Establishing stable site-to-site 5G communication	1	In progress
Configuration and deployment of the Constellation cubicle in Thanet Area	2	In progress
SAT in Thanet area	2	In progress
PNDC off-network trials for Thanet configuration	3	Completed
OIC launch and shortlisting process	4	Completed
OIC incubation of selected suppliers	4	In progress
Delivery of the academic insights research topics	5	Completed
Preparation of Deliverable 6 for submission	-	Completed
Preparation of Deliverable 5 for submission	4	Completed
Carry out recruitment for Workstream 1 Lead	-	Completed
Passive network trial	3	In progress
Constellation project and OIC solutions business case and CBA validation	-	In progress

4.2 Identification and management of issues

The project team recognises the importance of robust risk management methodologies for any project, but more specifically for complex innovation projects. Due to the nature of these projects, it is likely that an issue in one area might impact the overall project activities and so it is important to track any interdependencies. A full list of project risks identified for Constellation is provided in Section 11.

So far in the project, three risks have impacted the project plan. Two of which have materialised into an issue and were managed by the non-material change described in detail in previous reporting periods. The other is currently being closely monitored to minimise its impact.

Project issues:

- **Delay in starting the off-network project trials** – Deliverables 3, 4 and 5 were impacted.
 - **Cause:** A global electronic shortage of specific components impacted the telecommunication industry. Our suppliers informed us that the cause of this electronic shortage is a combination of global factors, including the conflict between Ukraine and Russia;
 - **Solution:** As per our previous Project Progress Reports, we worked closely with our partners to minimise the impact of the issue. Siemens are a partner in the Constellation project, and as such, ensured our order was prioritised due to the strategic importance of Constellation. To resolve the challenge, on April 2023, we

submitted a non-material change request agreeing to submit Deliverable 3 by 22 December 2023, Deliverable 4 by 31 May 2024 and Deliverable 5 by 31 October 2024.

- **Delay in completing the PNDC trial** – Deliverables 4, 5 and 7 were impacted.
 - **Cause:** Due to the innovative nature of the project and the inherited complexity of the developed solutions, the PNDC trials were not able to conclude in line with the provisionally set out plan. As there is a strong dependency between the success of the PNDC trial and the confidence in commencing the network trials. Such delay had an impact on all subsequent project deliverables linked to the trials;
 - **Solution:** We worked closely with our partners to minimise the impact of the issue. The Constellation equipment has been commissioned in one grid site so that final configuration could be run in parallel with the ongoing PNDC testing. This allowed the project team to progress with preparing for the site trial and ensure learnings were captured for upcoming installations in the remaining sites. Once all the PNDC testing has been completed, and onsite configuration has been completed, the project will commence the distribution network trial. To resolve the challenge, we submitted a non-material change request agreeing on April 2024 to submit Deliverable 4 by 29 November 2024, Deliverable 5 by 30 July 2025, Deliverable 7 by 29 September 2026, and pushing the project end date back to 29 September 2026.

- **Delays in provision of data for Local ANM** – Local ANM requires synchrophasor data at key points on the trial network which have high bandwidth requirements:
 - The standard data communication route was not suitable due to bandwidth limitations. As a result, we had to find a secure and efficient way to communicate the phasor measurement data with GE, Vernova which was not anticipated during the project bid;
 - We established this connection for the Maidstone trial area using the operational fibre telecommunication network successfully. Nevertheless, this resulted in a three-month delay in data provision. We will carry out similar work in the Thanet area as well;
 - The PDC, which is responsible for sending the synchrophasor streams to the central server, was faulty and had to be replaced which added complexity to the installation tasks;
 - The link between the central server and the Maidstone substation required new configurations and security measures to be implemented. This further delayed the data collection;
 - There were synchronisation issues identified with the synchrophasor data on-site. To resolve these, we have purchased additional hardware; and
 - To manage this issue, GE Vernova will proceed with developing the non-data dependent aspects of Local ANM first and once the data is available will proceed with the machine learning aspects. We expect no impact on any of the expected learnings from the development and trials.

The list below presents the key risks, which could develop into issues in the next period if they are not mitigated:

- **Establishing stable site-to-site communication** – The project team has faced multiple packet loss issues when switching communications from fibre over to 5G. A similar issue has been faced at an earlier stage of the project which was resolved through updating the Vodafone network configuration allow for the necessary large number of GOOSE message retransmissions. Despite validating that this “fix” is still in place and multiple trouble shooting workshops, it is still not clear what the root causes are of such packet loss. This issue is being managed through weekly triage calls to agree plans and review test results as well as ad-hoc workshops for coordinated troubleshooting.

- **Validation of the project Solutions business cases:**
 - LANM: the latest developments in communication redundancy and hardware enhancement of (RTU) resulted in a significant reduction in communication loss incidents on our network. As a result of that, the effective utilisation of LANM as it was originally intended has been impacted significantly. In order to

maximise the value out of these initiatives, topics such as RTU-bypass and Virtual RTU are being investigated and are likely to be further developed over the coming months of the project.

- APS/CMS: findings from the PNDC testing of APS concluded that the need for automated adaptive protection settings may not be required within the foreseeable future in light of the rate of DERs penetration. This also coincided with delays in commercial availability of the APS solution that would enable BaU transition. Therefore, a more valuable alternative would be a virtual protection system that allows interoperability bidirectional data exchange between a digital platform and the protection IEDs in operation. Such solution would enhance the asset management of protection relays and will ultimately enable users to adjust protection settings remotely as needed. Finalisation of the agreed execution plan of this proposal is currently ongoing; and
- **Readiness for BaU roll out post project completion** – Potentially as a result of the aforementioned challenges, the commencement of the Active Trial continues to be pushed back until the project and OIC Solutions are fully de-risked. The challenge this causes is that the closer the project gets to its currently planned end date, the shorter the available period the project team has to test active operation. Whilst active operation in itself is not crucial to conclude the safety and de-risking of the Solutions, it forms a major part in increasing the confidence levels of the wider business and in paving the way for BaU roll out. The project team currently forecasts the start of the active trial in Q2 of 2026, however, this all remains subject to the successful resolution and agreement on the BaU plans for each project and OIC Solution;

4.3 Key achievements and notable events in the reporting period are shown below:

- Submission of Deliverables 5 and 6 of the project;
- Completion of the PNDC Solutions testing;
- Full deployment of the Constellation cubicles in all project areas (excluding the 11kV DER);
- Completion of the main SATs in the Thanet area and commencement of the Passive Network Trial in the area;
- Awarding successful innovators in the OIC and commencement of the incubation process at the PNDC and on-site; and
- Successful completion and publication of the academic insights research activities; and
- Presentation at various industry events to disseminate learnings.

4.4 Look-ahead to next reporting period

The following major tasks and milestones are planned for the next reporting period:

- Deployment of the remaining OIC solutions in the applicable network areas;
- Completion and approval of the necessary standards and specifications for project Constellation;
- Commencement on the active network trials;
- Business case revalidation and BaU deployment preparation activities; and
- Submission of Deliverable 7 and Project Closedown Report.

5. Progress against budget

This section is provided in the Confidential Appendix A.

6. Project bank account

This section is provided in the Confidential Appendix A.

7. Project Deliverables

This section provides an overview of progress against each of the Deliverables set out in the Project Direction. The information provided below describe progress on the evidence for each Deliverable.

Table 7-1 – Constellation Deliverables

Ref	Project Deliverable	Deadline	Evidence	Progress
1	Details of the system design and architecture for protection and control on a substation with local intelligence	28/02/2022	(WS1 and WS2) Report on the system design of Constellation and the associated architecture for communication, protection and control across Methods 1 and 2	This Deliverable was successfully submitted on time.
2	Description of the trial design and site selection criteria process for Methods 1 and 2	31/08/2022	(WS1 and WS2) Report containing: <ul style="list-style-type: none"> • A description of the trial site selection criteria process for each phase of the network trials; and • Details of the trial requirements for the demonstration of each element of Constellation 	This Deliverable was successfully submitted on time.
3	Initial learning from off-network PNDC trial, and learning from development and virtualisation of Methods 1 and 2	22/12/2023	(WS1, WS2 and WS3) Report containing: <ul style="list-style-type: none"> • Details of the key learning from the design and development of Methods 1 and 2; • Details of learnings from design of 5G slice; and • Testing preparation and early lessons from the off-network testing 	The submission date for this Deliverable has been changed by the non-material change request as part of the previous reporting period. The new date is 22/12/2023. This Deliverable was successfully submitted.
4	Review and insights following site installation and learning from mid trial passive network demonstration	31/05/2024	(WS2 and WS3) Report containing: <ul style="list-style-type: none"> • Key lessons from site installation process at DER sites and primary/grid substations; and • Early learning from the passive network demonstration 	The submission date for this Deliverable has been further impacted by the non-material change request during this reporting period. The new date is 29/11/2024. This Deliverable was successfully submitted.

Ref	Project Deliverable	Deadline	Evidence	Progress
5	Learning from the Open Innovation Competition (OIC)	31/10/2024	(WS3) Report containing key learning on the OIC use case prioritisation, participant selection and incubation process	The submission date for this Deliverable has been further impacted by the non-material change request during this reporting period. The new date is 30/07/2025. This Deliverable was successfully submitted.
6	Learning from academic insights and the governance required to prepare for the future world of distributed network operation	28/02/2025	(WS7) Report containing analysis by the academic partner on the opportunities, risks and barriers to full distributed and interoperable future network operation	This Deliverable was successfully submitted on time.
7	Analysis and presentation of findings from the trials and plan for BaU deployment	30/09/2025	(WS3) Report containing findings from the trials and appraisal of the business case including key learning and plan for BaU deployment	The submission date for this Deliverable has been impacted by the non-material change request during this reporting period. The new date is 29/09/2026.
[Note this is a common Project Deliverable to be included by all Network Licences as drafted below]				
N/A	Comply with knowledge transfer requirements of the Governance Document.	End of project	<ol style="list-style-type: none"> Annual Project Progress Reports which comply with the requirements of the Governance Document. Completed Close Down Report which complies with the requirements of the Governance Document. Evidence of attendance and participation in the Annual Conference as described in the Governance Document. 	<p>Eight PPRs completed. The Close Down Report is N/A at this stage.</p> <p>The end date of the project has been impacted by the non-material change request during this reporting period. The new date is 29/09/2026.</p>

8. Data access details

To view the full Innovation Data Sharing Policy, please visit UK Power Networks' website <https://d1oyzg0jo3ox9g.cloudfront.net/app/uploads/2025/10/UKPN-InnovationDataSharingPolicy-Nov25-v1.pdf>

UK Power Networks recognises that innovation projects may produce network and consumption data, and that this data may be useful to others. This data may be shared with interested parties wherever it is practicable and legally permissible to do so, and it is in the interest of GB electricity customers. In accordance with the Innovation Data Sharing Policy, updated in 2025, UK Power Networks aims to make available all non-personal, non-confidential / non-sensitive data on request, so that interested parties can benefit from this data.

9. Learning outcomes

The project team recognises the importance of “best in class” learning and dissemination. Specific lessons learnt regarding each of the Workstreams are captured in the Workstream PPRs. The materials which are available for dissemination as of yet are Deliverables 1, 2, 3, 4, 5, and 6, as well as a number of industry white papers, which are made publicly available on the UK Power Networks’ Innovation website¹⁴.

The following documents are available to other GB DNOs upon request:

- Summaries of test specifications and trial design;
- Constellation architecture;
- Summary of FATs;
- Summary of SATs;
- Summary results of WAP, LANM and APS off-network testing; and
- Summary results of WAP, LANM and APS UK Power Networks’ distribution network testing.

10. Intellectual Property Rights (IPR)

This section lists any relevant IPR that has been generated or registered during the reporting period along with details of who owns the IPR and any royalties which have resulted, and any relevant IPR that is forecast to be registered in the next reporting period.

Table 10-1 – IPR generated in this reporting period

IPR description	Owner	Type
Deliverable 5 – Learning from the Open Innovation Competition (OIC)	UK Power Networks	Relevant foreground IP
Deliverable 6 – Learning from academic insights and the governance required to prepare for the future world of distributed network operation	UK Power Networks	Relevant foreground IP
Academic Insights – System reliability and distributed control	UK Power Networks, Imperial College	Foreground IP
Academic Insights – Future Governance in a Net Zero world with distributed electricity system operation	UK Power Networks, University of Manchester	Foreground IP
CIREN 2025 paper submitted: “Experiences in Piloting Virtualised Centralised Protection and 5G-Based Wide Area Protection in Real Distribution Network in UK”	ABB and UK Power Networks	Foreground IP
CIREN 2025 paper submitted: “Remote Power Flow Prediction Using PMU Data and ML for Enhanced DER Resilience in Communication Loss Scenarios”	GE Vernova and UK Power Networks	Foreground IP

Table 10-2 – IPR forecast for next reporting period

IPR description	Owner	Type
Off-network testing reports of all Constellation solutions	UK Power Networks and PNDC	Foreground IP

¹⁴ <https://innovation.ukpowernetworks.co.uk/projects/constellation>

Constellation project Virtualisation and Cybersecurity testing detailed reports	UK Power Networks and PNDC	Foreground IP
OIC PNDC incubation report	UK Power Networks and PNDC	Foreground IP
DPSP 2026 paper submitted: "Towards Large-Scale Deployment of Virtualised Protection"	ABB, OMICRON, PNDC, and UK Power Networks	Foreground IP
Lessons learnt papers at CIRED 2026 Workshop	ABB, SMPnet, and UK Power Networks	Foreground IP

11. Risk management

This section lists the risks highlighted in the FSP plus any other risks that have arisen in the reporting period. The project team has described how we are managing the risks we have highlighted and how we are learning from the management of these risks. Risks R1-23 are captured in the FSP. We identified Risks 24-68 since the funding was awarded. The project continues to monitor risks and issues on a fortnightly basis, at a ‘deep-dive’ risk management meeting. At this meeting, risk impacts and mitigation plans are updated as required.

Table 11-1 – Risk register

ID	Risk / Issue	Status	Description	Impact	Risk			Mitigation / Planned Actions	Mitigated			Owner	Last updated	Date Closed
					Prob.	Impact	Score		Prob.	Impact	Score			
R52	Issue	Active	Delay in data gathering reduces time for ML	Possible delays to the project	5	4	20	- Early planning and engagement with relevant experts to ensure data gathering for ML is prioritised - UK Power Networks to transmit DER Site 1 PMU data from Maidstone Grid in lieu of DER set up completion	3	3	9	WS2 Lead	14/11/2025	
R55	Issue	Active	Access to large store of data for ML development	Possible delays to the project	4	5	20	- Carry out FAT without ML at first instance and have separate testing once ML is ready - Early planning for site work to ensure data gathering for ML is prioritised	3	3	9	WS2 Lead	14/11/2025	
R58	Risk	Active	Specification and plan for provision of network data for Adaptive Protection and Local ANM longer than planned	Possible delays to the project	5	5	25	- Siemens provide a data specification for UK Power Networks to approve - UK Power Networks to work closely with GE to ensure data can be collected early - UK Power Networks to transmit DER Site 1 PMU data from Maidstone Grid in lieu of DER set up completion	4	3	12	WS2 Lead	14/11/2025	
R13	Risk	Active	Deployment of equipment and systems is not achievable or is more difficult/takes longer than expected	Project incurs delays or cannot proceed	4	5	20	- Plan integration between systems as part of the design - Prepare key systems to be ready for integration, while detail design is taking place	3	3	9	WS1 Lead	14/11/2025	
R23	Risk	Open	The DER operators in the trial areas do not wish to participate in trials	Trial results are of lower quality and potentially insufficient to inform BAU roll-out	5	4	20	- Engaged with DER operators in the provisional trial areas - Ensured minimal effort and impact on DER operation during trial - Coordinate the necessary outages in line with the business requirements of the DER site owners	2	3	6	Project Manager	14/11/2025	
R26	Risk	Open	Internal expertise is not available to support	The project will not deliver all of the intended outcomes to the expected quality or will be delayed	4	5	20	- Work closely with internal stakeholders to clarify expected input and secure support - Plan the work to align with resourcing needs	3	3	9	Project Manager	14/11/2025	
R43	Risk	Open	5G service needs to be resilient to power failures to be used for protection / SCADA	The project will not deliver all of the intended outcomes and will not be accepted to BAU	4	5	20	- Specify the requirements for protection and control - Design the trial with Vodafone and PNDC to demonstrate the resilience of the 5G service	3	3	9	WS3 Lead	14/11/2025	
R47	Risk	Open	Negative sequence and zero sequence data is not available	Project is delayed and/or requires re-scoping	4	5	20	- Understand the specific network parameters which are required for M1 and M2 - Understand if we can leverage existing ADMS capabilities to provide - Last resort is to manually identify and load the required parameters	3	3	9	WS2 Lead	14/11/2025	

R48	Risk	Open	Integration of equipment and systems (from different Partners) is not achievable due to shortfalls in design	Project incurs delays or cannot proceed	4	5	20	- Collaborative requirements gathering and design process is undertaken to ensure integration elements are understood - Interfaces between systems (and Partners) defined early as part of the requirements development stage	3	3	9	WS1 Lead	14/11/2025
R53	Risk	Active	DER sites available too late for ML	Possible delays to the project	5	4	20	- Ensure key lines at monitored at substation during data gathering phase - UK Power Networks to transmit DER Site 1 PMU data from Maidstone Grid in lieu of DER set up completion	3	3	9	WS2 Lead	14/11/2025
R61	Risk	Open	Additional hardware and software identified as part of the design cannot be accommodated within the project budget	Project overspend requiring additional partner contributions and/or change request for reduction in project scope	4	5	20	- Contingency available to support some of the additional cost - Close collaboration with partners to manage the delivery of the scope within the available budget	2	2	4	Project Manager	14/11/2025
R10	Risk	Active	Unavoidable changes are made to key personnel on the project	Possible delays to the project	4	4	16	- Comprehensive project documentation is maintained to reduce the impact of any staff changes that may occur. - Ensure knowledge sharing is undertaken across the project team to avoid single point of failure	3	3	9	Project Manager	14/11/2025
R34	Risk	Open	Not enough resource to carry out integration	Project is delayed and/or requires re-scoping	4	4	16	- Plan key resource requirements and availability - Understand resource requirements and plan alternative ways of securing the necessary expertise	3	4	12	WS1 Lead	14/11/2025
R39	Risk	Open	Project and BAU not sufficiently coordinated to transition into BAU	Limited outcomes from the trials	4	4	16	- Keep the BAU owners and stakeholders engaged and updated - Ensure the products meet the BAU requirements or there are plans in place to meet the BAU requirements	2	2	4	Project Manager	14/11/2025
R41	Risk	Open	There is no appropriate data management in place to support the increased volumes of data	Project is delayed and may not be accepted into BAU	4	4	16	- Specify the data management requirements early - Agree specific data management plans before the trials with the relevant business stakeholders	2	3	6	WS3 Lead	14/11/2025
R65	Risk	Active	Inflation related increase in labour cost exhausts the project budget	Project is stopped or re-scoped	4	4	16	- Monitor budget continuously and report to Innovation Programme Manager - Discuss inflation with Regulation and Finance	4	1	4	Project Manager	14/11/2025
R2	Risk	Active	Architecture and system build costs are significantly higher than anticipated at FSP costing stage	Project overspend requiring additional partner contributions and/or change request for reduction in project scope	3	5	15	- Contingency built in and a price review stage gate included at the end of detail design. This will allow costs to be re-negotiated after the architecture and design has completed. - Engage provider on fixed priced contract rather than time and materials	2	4	8	Project Manager	14/11/2025
R11	Risk	Active	The specification and procurement of the equipment takes longer than expected	Possible delays to the project	5	3	15	- Ensure timescales on the project are realistic and have built-in contingency for high risk elements - Undertake regular reviews during high risk and critical project activities	3	2	6	Project Manager	14/11/2025
R21	Risk	Active	5G coverage is not available in the trial areas in time for the trials	Project is delayed and/or requires re-scoping	3	5	15	- Contingency budget to account for the installation of small 5G cells in the trial areas - Vodafone to leverage relationship with infrastructure operator (Telefonica) in the trial areas to ensure coverage is delivered in time for the trials	2	2	4	WS2 Lead	14/11/2025

R25	Risk	Active	Activities on the critical path are delayed or stopped	Key milestones and deliverables are delayed	3	5	15	- Frequent progress review sessions in place across all Partners - Frequent coordination sessions in place across all Partners - A robust project plan is developed and it is validated and updated closely	2	3	6	Project Manager	14/11/2025
R27	Risk	Open	Single point of failure in resourcing	Project is delayed and/or requires re-scoping	3	5	15	- Ensure there is clear and structured documentation to enable handovers - Plan the work to align with the resourcing needs	3	4	12	Project Manager	14/11/2025
R31	Risk	Open	Substation PC is not powerful enough to support the virtualised protection and control	The project will not deliver all of the intended outcomes	3	5	15	- Align virtualisation standards with BAU - Align substation design and IP addressing with BAU - Collaborate with Partners to understand hardware requirements for the software they are developing - Conduct rigorous virtualisation platform tests at the PNDC	2	4	8	Project Manager	14/11/2025
R33	Risk	Active	Delays caused by extended procurement processes	Project is delayed and/or requires re-scoping	5	3	15	- Provide Procurement with early visibility of required procurement activities - Plan sufficient time to carry out all procurement activities	3	2	6	Project Manager	14/11/2025
R35	Risk	Open	No suitable expertise for testing and integration	The project will not deliver all of the intended outcomes	3	5	15	- Understand the testing and integration requirements early - Plan how the necessary testing and integration skills are made available in time for the Project	2	4	8	WS1 Lead	14/11/2025
R40	Risk	Open	There is a cyber security breach	Network is rendered open to cyber attack	3	5	15	- Specify robust cyber security requirements - Compliance with cyber security requirements - Develop a suitable cyber security breach response plan	3	3	9	WS1 Lead	14/11/2025
R45	Risk	Open	Conflicting interactions with other systems (DERMS, Distributed Restart, etc)	Project is delayed and/or requires re-scoping	3	5	15	- Constellation elements integration and interactions with other systems are specified early - Key interactions with other systems are planned and tested during the project	3	3	9	Project Manager	14/11/2025
R50	Risk	Open	Poor accuracy of load and generation forecasts required for the modelling	Limited outcomes from the trials	5	3	15	- Agree existing forecasting capabilities and identify impact during the design stage of the project	3	3	9	WS2 Lead	14/11/2025
R3	Risk	Active	Some elements of the technical solution are not achievable to the desired specification within the project timescale and budget	The project will not deliver all of the intended outcomes	3	4	12	- Ensure requirements and solution design is realistic after the detail design stage. - Continuously and quickly adapt to changing requirements, with iteration loops built into the project plan throughout the development. - Regularly progress following UK Power Networks established project control methods	3	3	9	Project Manager	14/11/2025
R4	Risk	Active	Methods do not deliver the anticipated benefits	Lower than anticipated value delivered	3	4	12	- Regularly revise business case to update expected method costs and expected benefits - Identification of new use cases to maximise the value of project methods	3	3	9	Project Manager	14/11/2025
R5	Risk	Open	Project Partner/Supplier performance is not adequate	Outcomes are delayed, with potential overspend. This may also require a change in partner/supplier as an interim step.	3	4	12	- Ensure shared responsibility for deliverables - Incentivise partner/supplier for success - Ensure tendering/onboarding process focuses on critical project elements	2	3	6	Procurement	14/11/2025

R18	Risk	Open	Insufficient availability of quality training data for machine learning to enable solution to be accurate and effective on the network	Accuracy of algorithm decision making is not assured	4	3	12	- Using simulation early, and ramp up level of autonomous operation throughout the duration of the tests as data is built up	3	3	9	WS2 Lead	14/11/2025	
R20	Risk	Open	The selected hardware is not suitable for the time-critical operation of Methods 1 and 2	The project will not deliver all of the intended outcomes	3	4	12	- Equipment was selected based on its ability to perform the required functionality - Sufficient risk budget to ensure equipment scope change can be absorbed	2	3	6	WS2 Lead	14/11/2025	
R29	Risk	Open	Unable to recruit suitable / sufficient resource for the project	Project is delayed and/or requires re-scoping	3	4	12	- Carry out robust recruitment to ensure expertise is on-board - Plan a suitable "plan B" alternative to secure the expertise required	2	3	6	Project Manager	14/11/2025	
R32	Risk	Open	Other connections / build at trial sites impact project	Project is delayed and/or requires re-scoping	3	4	12	- Understand the expected development activities in the trial areas - Coordinate trial preparation with the other on-going activities	2	2	4	Project Manager	14/11/2025	
R38	Risk	Active	Integrating multi-vendor IEC61850 is harder than anticipated	Project is delayed and/or requires re-scoping	3	4	12	- Secure the expertise from the consortium of Partners to ensure the requirements and design are achievable - The Partners revise the design and the products / services if necessary	2	3	6	Project Manager	14/11/2025	
R44	Risk	Open	Not all stakeholders are kept up to date with project results and progress	Project is delayed and may not be accepted into BAU	3	4	12	- Stakeholders are identified and engagement approach is specified - Frequent and clear communication with stakeholders is carried out throughout the project	3	3	9	Project Manager	14/11/2025	
R46	Risk	Open	NG equivalent model for impedances and other network parameters is challenging to obtain	Project is delayed and/or requires re-scoping	3	4	12	- Understand the specific network parameters which are required for M1 and M2 - Plan how these can be provided to the Partners	3	3	9	WS2 Lead	14/11/2025	
R8	Risk	Open	A partner/supplier may withdraw from the project	Partner/supplier must be replaced or project descope	2	5	10	- Ensure all partners/suppliers are engaged and involved throughout the project - Previous engagement with wider industry provides confidence there are a number of potential organisations who can deliver some project aspects	2	4	8	Project Manager	14/11/2025	
R14	Risk	Open	Solution has unintended impact on the network causing failure, underperformance, and/or customer equipment failure	Loss of supply, damage to customers' equipment	2	5	10	- Equipment is fully tested off-network - Sufficient time is included in project plan to resolve any issues fully and re-test - No equipment will be deployed on the network into an active trial before it has successfully passed FAT and SAT	1	5	5	WS3 Lead	14/11/2025	
R15	Risk	Open	Catastrophic failure of equipment causes network damage and/or injury	Network equipment is damaged, injury is caused	2	5	10	- Solution consists of mainly software components and the hardware ones cannot fail explosively (substation PC, routers & switches) - Failure Mode and Effects Analysis is undertaken to ensure such failures are anticipated and designed out	1	4	4	Project Manager	14/11/2025	
R16	Risk	Open	IT security standards are not met	Network is rendered open to cyber attack	2	5	10	- OT integration testing is included in the PNDC trial scope - Ensure full engagement with IT security team throughout the project - Key UK Power Networks security requirements need to be fulfilled before the system is commissioned to our network - Ensure test plan encompasses all relevant IT security tests	2	4	8	WS1 Lead	14/11/2025	
R30	Risk	Open	Someone else develop a product which makes Constellation obsolete	Project is stopped or re-scoped	2	5	10	- Review on-going work in the industry to identify if anyone else has demonstrated key Constellation elements	1	3	3	Project Manager	14/11/2025	

R42	Risk	Open	The Open Innovation Competition products break some of the other project elements	Project is delayed and may not be accepted into BAU	2	5	10	- Ensure sufficient testing at PNDC before adoption into the DNO network - Specify what separation is required for all OIC products to ensure safe operation of other systems	1	2	2	WS4 Lead	14/11/2025	
R51	Risk	Open	Bandwidth and network availability for PMU to central server for data gathering is not sufficient for Local ANM	Limited outcomes from the trials	2	5	10	- Estimate bandwidth and advise on protocol support - Close collaboration during the design stage to ensure design is fit for purpose	2	3	6	WS2 Lead	14/11/2025	
R68	Risk	Active	Delay in the start of the Active network trials	Potential lack of wider business buy in and risk of no successful BaU roll out	5	2	10	- Close engagement with the wider business areas to ensure visibility of the project findings - The addition of relevant use cases and test scenarios within the passive trial to raise confidence - "wait and see" approach to see how the solutions react to actual network faults during the passive trial	3	2	6	Project Manager	14/11/2025	
R19	Risk	Active	Length of trial period is not sufficient to collate all representative data	Trial is insufficiently representative of potential scenarios with which the solution may be required to cope	3	3	9	- Significant time allocated for testing on the network - Off-network testing to simulate various network scenarios	1	3	3	WS3 Lead	14/11/2025	
R67	Risk	Open	5G backup solution packet loss issues in failover scenarios	Additional testing would be required for 5G only sites with possible overall project delay	3	3	9	- Extensive testing to pinpoint the root cause of the issue - Limit the volume of traffic sent over 5G as a temporary mitigation plan	1	3	3	WS1 Lead	14/11/2025	
R36	Risk	Open	Testing scenarios cannot be replicated accurately across the different elements in the project	Limited outcomes from the trials	2	4	8	- Prepare a robust trial plan and specify the testing scenarios	1	3	3	WS3 Lead	14/11/2025	
R56	Issue	Closed	Constellation trials are delayed due to equipment availability among global electronics shortage	Possible delays to the project	5	5	25	- Non-material change to Deliverables 3, 4 and 5 to mitigate the impact of the delay - Continue close collaboration with supplier	3	1	3	WS3 Lead	24/05/2023	24/05/2023
R66	Issue	Closed	Delays in PNDC trial testing and solutions validation	Delay in Deliverable 4 submission	4	4	16	- Biweekly project team workshop to review progress and agree on changes - Non-material change to Deliverables 4, 5 and 7 to mitigate the impact of the delay	2	4	8	Project Manager	14/11/2025	29/11/2024
R9	Risk	Closed	Suitable sites for the demonstration of the solution are not available	Trials cannot proceed	4	5	20	- Undertook early research and identified two potential network areas, of which two are proposed in the bid - Ensure value can be derived from the off-network testing	2	2	4	WS2 Lead	14/11/2021	14/11/2021
R59	Risk	Closed	ABB and Siemens `s software cannot be installed as a VM	Project is delayed and additional scope / cost may be required	4	5	20	- Work with VMWare to ensure VM environment is capable of supporting ABB `s software - Install Siemens software early and do testing to confirm operation	3	3	9	WS1 Lead	18/11/2022	18/11/2022
R12	Risk	Closed	IPR requirements deter some innovation competition entrants	Limited outcomes from innovation competition element	4	4	16	- Ensure early publication and full explanation of IPR requirements to ensure entrant buy-in to project requirements	2	3	6	WS4 Lead	25/11/2024	30/06/2024
R49	Risk	Closed	Use-cases are not defined clearly and in time for the development	Project is delayed and additional scope / cost may be required	4	4	16	-Define the project use-cases early as part of the initial requirements -Clearly communicate scope of each Partner and align it to the plan	2	3	6	Project Manager	16/09/2022	16/09/2022

R60	Risk	Closed	Acquisition of land for the 5G equipment Vodafone is installing	Project is delayed and/or requires re-scoping	4	4	16	- Early engagement with legal team to ensure acquisition is possible within timescales of the project	3	3	9	Project Manager	25/01/2023	25/01/2023
R63	Risk	Closed	Richborough constraint monitoring for Local ANM may be unfeasible. Constraint locations are far from Thanet and there is need for additional monitoring	Project is delayed and/or requires re-scoping	4	4	16	- GE and UK Power Networks working on the Local ANM design to identify solution for adequately managing the Thanet / Richborough area	2	3	6	WS2 Lead	24/05/2023	28/07/2023
R1	Risk	Closed	COVID-19 restrictions continue and impact project activities	Cannot hold face-face meetings slowing design process and de-prioritised site work (non-essential)	3	5	15	- Contingency built in and a price review stage gate included at the end of detail design. This will allow costs to be re-negotiated after the architecture and design has completed. - Engage provider on fixed priced contract rather than time and materials	2	3	6	Project Manager	12/12/2022	12/12/2022
R6	Risk	Closed	Suitable innovation competition entrants cannot be found	Project is delayed and/or requires re-scoping	3	5	15	- Leverage PNDC core research programme contacts - Leverage the R&D connections and experience of all partners - Utilise learnings from the LANM and WAP tenders - Advertise the OIC through external events and activities	3	3	9	Procurement	25/11/2024	30/06/2024
R7	Risk	Closed	Failure to agree Project contracts between UK Power Networks and Project Partners	Project cannot proceed	3	5	15	- All partners have agreed in principle to NIC terms - Negotiation of collaboration agreement between all partners to begin after FSP submission - long lead in between project award and work start to allow time for negotiations	1	4	4	Project Manager	30/04/2021	30/04/2021
R24	Risk	Closed	Requirements and specifications are not clear or design cannot be approved	Goods and services are of lower quality and fail to deliver the benefits	3	5	15	- Leverage expertise from consortium of Partners to ensure clear requirements and design - Work out the requirements and design collaboratively in workshops / focus groups - Have a staged approach to specifying the requirements	2	3	6	Project Manager	24/06/2022	24/06/2022
R54	Risk	Closed	Substation PC unable to run Phasor Data Concentrator as software in short-term delaying data gathering	Project is delayed and/or requires re-scoping	3	5	15	- Installation of PDC as hardware at substations as backup plan	3	3	9	WS2 Lead	20/05/2024	20/05/2024
R57	Risk	Closed	The upgrade of PNDC`s ADMS and simulation of UK Power Networks' network is not sufficient to enable the testing	Project is delayed and additional scope / cost may be required	3	5	15	- Close collaboration between GE, UK Power Networks and PNDC to ensure PNDC`s test environment is correctly set up - Simulated UK Power Networks network to be reduced and simplified	2	4	8	WS3 Lead	14/11/2025	14/11/2025
R62	Risk	Closed	5G transmission coverage in DER Site 5 may not be feasible due to location in proximity to the core 5G transmission network	Project is delayed and/or requires re-scoping	3	5	15	- Vodafone working with their subcontractors to design solution options which can overcome issue	1	3	3	WS2 Lead	24/05/2023	24/05/2023

R17	Risk	Closed	Insufficient innovation competition entrants who meet the entry/procurement requirements	Project is delayed and/or requires re-scoping, limited outcomes from innovation competition	3	4	12	- Leverage partner experience in R&D incubation - Identified over 15 use-cases for participants to work on - Allow innovators to apply even if their solutions do not meet the set use cases	2	3	6	WS4 Lead	25/11/2024	30/06/2024
R22	Risk	Closed	The virtualisation approach is not suitable for real time protection & control applications	Project is delayed and/or requires re-scoping	3	4	12	- Carried out investigation to select a flexible approach which can deliver the capabilities - Included in project risk budget which will be governed with a stage gate at the end of detail design (Jan 2022)	3	3	9	WS1 Lead	24/05/2023	31/10/2023
R28	Risk	Closed	The designs of the project Methods are not innovative	Lower than anticipated value delivered and potentially project is closed	2	5	10	- Collaborate closely with all Partners to ensure novel aspects of scope remain in the design - Review on-going work in the industry to identify if anyone else has demonstrated key Constellation elements	1	4	4	Project Manager	25/11/2024	29/11/2024
R37	Risk	Closed	Project Partners/Suppliers do not pass the FAT	Project is delayed and/or requires re-scoping	2	5	10	- Work closely with the Partners/Suppliers during the design and development - Build in sufficient time to re-iterate the design and development	2	3	6	Project Manager	24/05/2023	24/05/2023
R64	Risk	Closed	Factory Acceptance Testing is delayed or cannot be completed	Possible delays to the project	4	2	8	- Work closely with partners to coordinate on the preparation and execution of all Factory Testing - Secure approval from Technical Design Authority on the test specifications	2	2	4	WS2 Lead	24/05/2023	24/05/2023

Constellation

Project Progress Report – January to December 2025

12. Accuracy assurance statement

The project has implemented a project governance structure as outlined in our innovation policies and procedures that effectively and efficiently manages the project and all its products. All information produced and held by the project is reviewed and updated when required to ensure quality and accuracy. This report has gone through an internal project review and a further review within UK Power Networks to ensure the accuracy of information.

We hereby confirm that this report represents a true, complete and accurate statement on the progress of the Constellation project in this one year reporting period and an accurate view of our understanding of the activities for the next reporting period.

Text Redacted

13. Material change information

No material changes have been encountered during this reporting period and given that this currently stands as the final PPR, any potential material changes to the project will be directly communicated with Ofgem.

14. Other information

No further information.