Constellation

Project Progress Report – January to June 2023

Constellation Partners

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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. Consumers will depend on electricity to heat, cook and travel, in addition to keeping the lights on. 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 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 2.9GVA[1] of smart services in GB will be at risk of being impacted by loss of communication with central systems or by unnecessary interruption of DER 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, so our first step is to ensure we fully utilise the existing network capacity. 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 1.4GVA[1] 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 are also 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.

1.1.3 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

[1] https://www.ofgem.gov.uk/system/files/docs/2020/11/constellation_nic_2020_fsp_-_public_27.11.2020_0.pdf

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 communication between them.

Constellation 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.

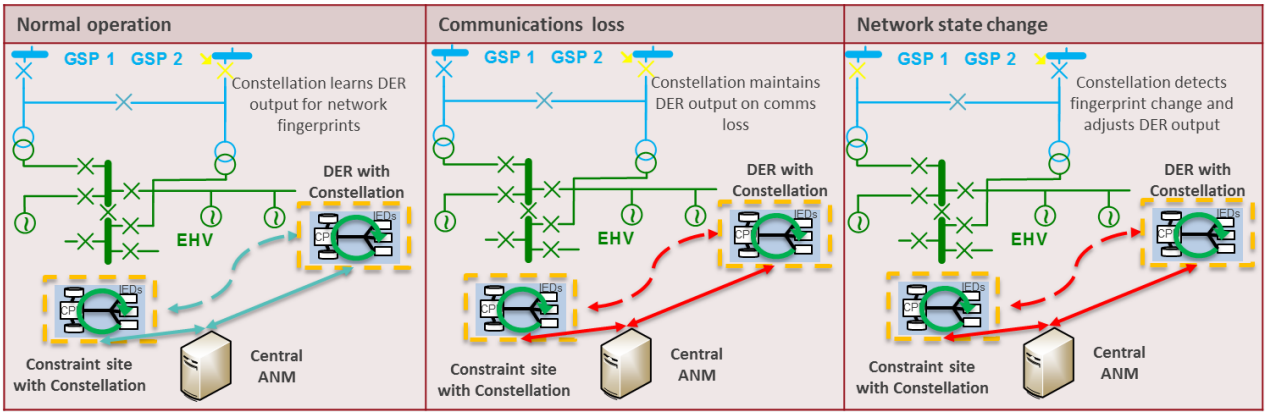

Figure 1-1 - Local ANM (Method 1) summary diagram

- 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.

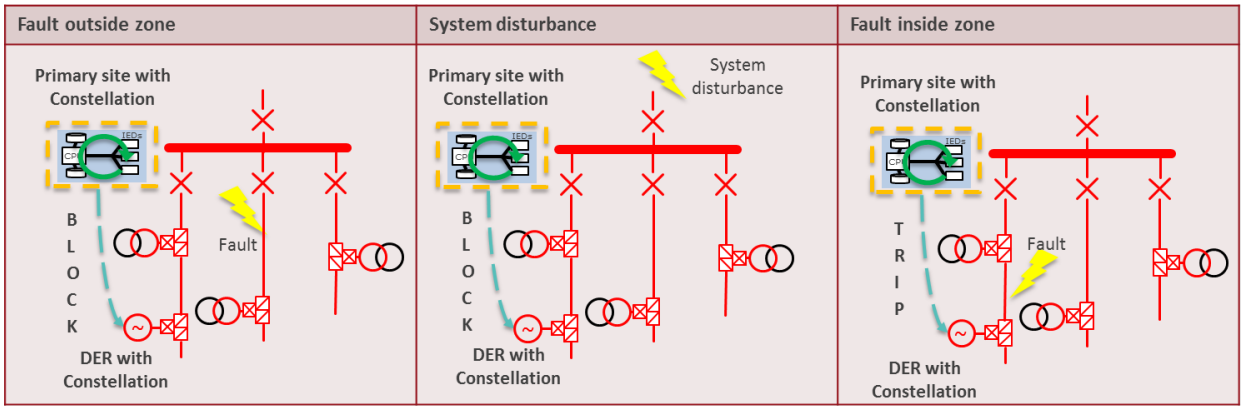

Figure 1-2 - Wide area protection (Method 2) summary diagram

    - 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.

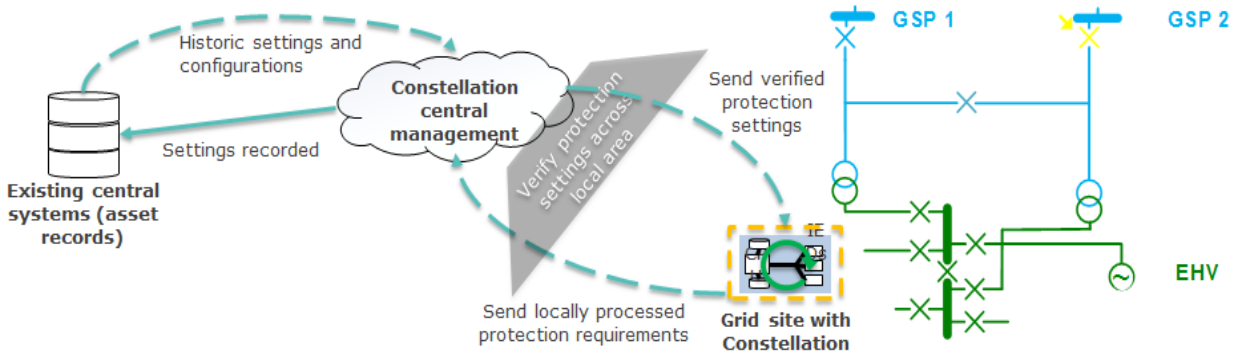

Figure 1-3 - Adaptive Protection (Method 2) summary diagram

Constellation is one of UK Power Networks' flagship innovation project which will be delivered between May 2021 and September 2025 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 savings[2] of 1.9m tCO_2 and will release an additional 1.98GVA of network capacity by 2030 in GB.

1.2 Project progress

This Project Progress Report (PPR), the fifth for Constellation, covers the period between January to June 2023. This document, together with the previous six-monthly report, which was published in December 2022, fulfil the reporting requirements of Sections 8.11 – 8.15 of v3.0 of the NIC Governance Document[3]. The Constellation team prefers to publish PPRs every six months, which is more regular than the minimum requirement of annual reporting because the project advances substantially in a six-month period. It is anticipated that other NIC projects and stakeholders would therefore benefit from being informed of the progress and learning on a six-monthly basis. The next reporting period will cover July to December 2023. 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 Project Direction. Over this period, the project has successfully:

- Completed the factory acceptance testing (FAT) for all Constellation solutions;
- Carried out the Executive Board meeting between all Constellation partners;
- Deployed the central servers required for adaptive protection to the Azure cloud;
- Continued engagement with DER owners and operators in the trial areas; and
- Continued the trial preparations for the PNDC and UK Power Networks trials.

- **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 compliments Workstream 2 as it will provide input to the hardware requirements. This workstream is on track. Central Azure servers for both the local ANM and wide area protection solutions have been deployed and software installation is in progress. The initial build of the substation server virtualised environment has been completed in a test environment. The FAT for the Vodafone 5G slice has been successfully completed.

[2] UK Power Networks Innovation - Constellation – Full Submission Proforma
[3] https://www.ofgem.gov.uk/system/files/docs/2017/07/electricity_network_innovation_competition_governance_document_version_3.0.pdf

- **Workstream 2** is responsible for the specification, design and development of the functionality (performance) of all Constellation elements and the equipment which will be trialled. This workstream manages the on-site installation and commissioning works as well as all hardware specification and procurement. This workstream is on track. In this reporting period the FAT for all the solutions was concluded and all of the solution designs were improved and updated. Trial preparations have continued in the Maidstone area and equipment orders have been placed for the Thanet area. We have continued providing the project partners with data required for the development and testing of the solutions.

- **Workstream 3** is responsible for the design and management of the Constellation trials, which incorporate off network trials hosted at PNDC and live trials hosted on the UK Power Networks' distribution network. This workstream is impacted by the non-material change request, summarised in section two. PNDC trials specifications for local ANM and adaptive protection have been approved in dedicated technical sessions. The majority of PNDC test equipment has been received and installed. The PNDC servers have been commissioned including hypervisor software and virtual machines. Work is currently underway to prepare for the start of the PNDC trials in the next reporting period, especially the development of interfaces between Real Time Distribution Simulator (RTDS) and partner solutions to be tested.

- **Workstream 4** is responsible for running the Open Innovation Competition (OIC), which involves incubating and testing additional solutions for deployment on the Constellation platform. The activities related to this workstream will start later in the project, and preparations are on track. Industry stakeholders have been consulted on use cases of interest for potential incorporation in the OIC.

- **Workstream 5** is responsible for the academic insights and research into the future governance. This workstream will feed into the requirement specification for Workstreams 1 and 2. This workstream is on track. Two academic insight activities have been completed by the University of Strathclyde covering protection, virtualisation and 5G communications. The remaining academic insight activities will be scoped and initiated later in the project.

- **Workstream 6** is responsible for the dissemination of the knowledge generated from the project. The workstream is on track. The project team continued to engage with the PNDC digital substation working group to share and discuss FAT outcomes and preparations for the PNDC trial. Three papers have been submitted to CIRED and another has been submitted to the PACWorld 2023 conference. In this reporting period, we also published an article in the March edition of the IET Magazine[4].

1.3 Risks and issues

The project continues to apply robust risk management procedures to reduce the probability and impact of risks materialising. To date, two risks have materialised as issues and are actively being managed by UK Power Networks (as described in section 4.2). One of the issues was successfully closed in this reporting period through a non-material change to Deliverables 3, 4 and 5 under workstream 3, 4 and 5 respectively.

Since the bid submission, a number of 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 are implemented and continuously reviewed. The project team carefully track these risks on a monthly basis and ensure further mitigations are applied where necessary.

[4] IET Partner News, Page 25

2. Project Manager's report

The project has made good progress during the reporting period (January – June 2023), focusing on the following areas:

- The completion of FAT for all solutions;
- Preparing for the PNDC and UK Power Networks' trials;
- Engagement with partners and DER owners and operators; and
- Management of changes in key personnel.

Completion of FAT

FAT is the final step in the development of the novel Constellation solutions. The aim of the FAT is to demonstrate the functionality and performance of each solution in isolation in the partners' test facilities. This activity began in the previous reporting period and continued in this reporting period, focusing on resolving any non-compliances of the solutions. Each FAT was validated by UK Power Networks, PNDC and Omicron to ensure the solutions are ready for the PNDC trial. All solutions have successfully passed FAT.

Preparing for the Constellation trials

We continue to prepare for the upcoming Constellation trials at PNDC and UK Power Networks. We are continuously carrying out procurement as the site designs are approved. We have commenced the site installation and commissioning activities in PNDC and Maidstone area in the previous reporting period and expect those to continue in the next reporting period. More details are available in section 2.2 and 2.3.

Engagement with partners

Constellation is an ambitious and complex NIC project with five partners delivering aspects of the solution. Therefore, it is essential to have frequent and open communication between UK Power Networks and the partners. To support this several regular meetings have continued from the previous reporting period.

- 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;
- Monthly review sessions with all partners to review the plan, risks and issues log; and
- Adhoc executive board meetings to ensure senior and executive representatives from each organisation are informed of progress and can influence the delivery of Constellation. In this reporting period, we successfully carried out the second executive board meeting in March 2023.

Personnel

In this reporting period, the Workstream 2 Lead transitioned to a new role in UK Power Networks in May 2023. All activities which were led by the Workstream 2 Lead were handed over to a number of colleagues internally. Recruitment to replace the Workstream 2 is ongoing and expected to conclude in the next reporting 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 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 PNDC who will test all Constellation elements.

Progress during this reporting period

Architecture and integration

The architecture and integration activities include the development and implementation of the overall Constellation architecture and identification of integration requirements.

During this reporting period, significant progress in finalising the network architecture and final implementation of the Constellation central servers was made. The central server architecture for adaptive protection was approved by the UK Power Networks' architecture review board in preparation for implementation. The activity to establish communication with the substation network and the GE Research and Development facility in Edinburgh was also completed. The transmission of synchrophasor data from the substation network to Azure was subsequently tested and proven successful using simulated data.

The network and security architecture (Figure below) for the remote connectivity between all project partners and the PNDC facilities was designed during this reporting period. This is required for project partners to remotely manage and monitor virtual machines during the PNDC testing. Implementation is currently ongoing and will be completed in time for the start of the PNDC trials in the next reporting period. As part of this activity, user accounts were also created, and appropriate roles assigned for all individuals required to access the servers for the duration PNDC testing and the remainder of the project. This architecture was designed to be scalable to provide remote access for the partners during the UK Power Networks' trials, which will follow the PNDC trials.

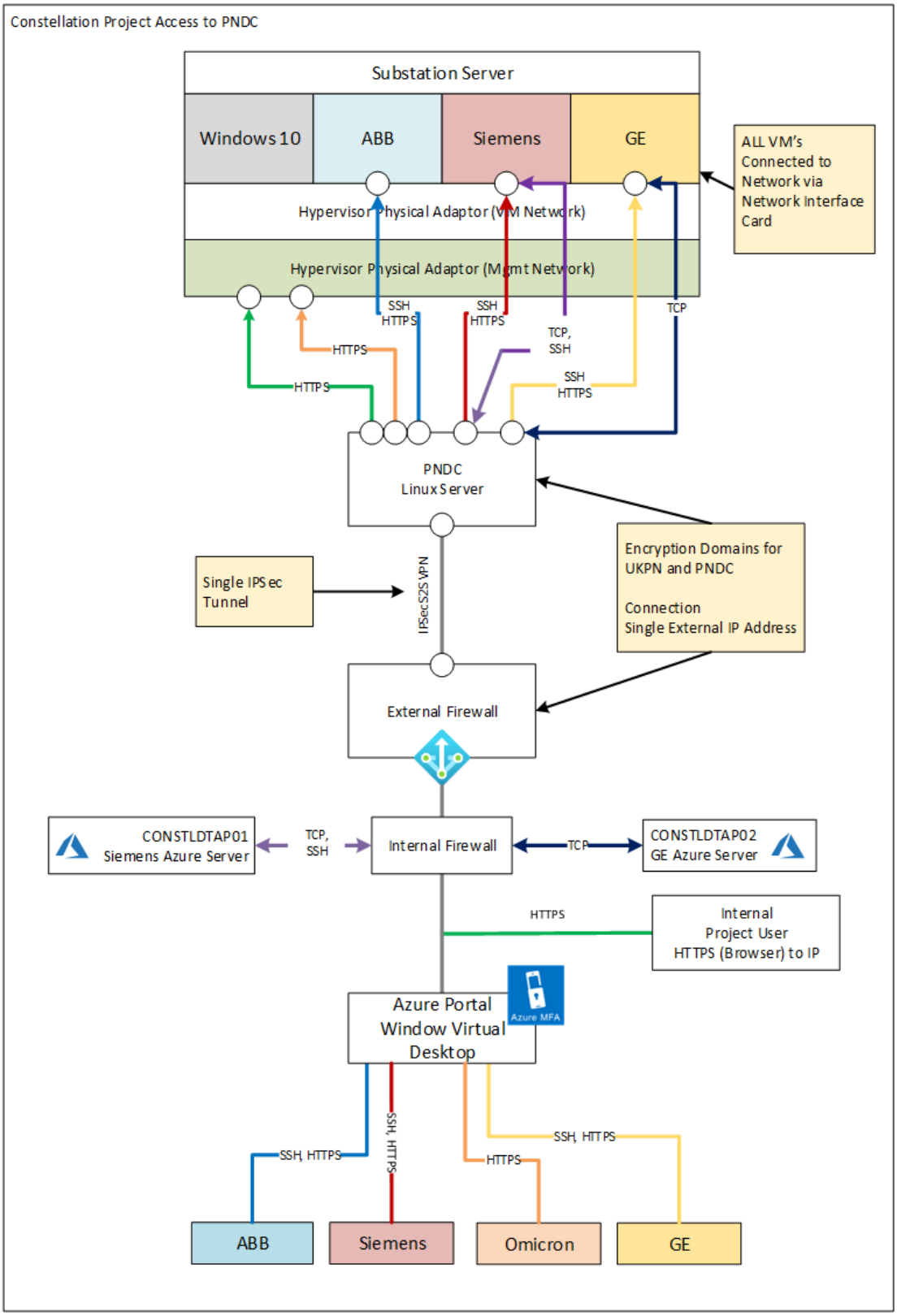

Figure 2-1 – Summary of architecture for remote connectivity

Central servers

The central servers store the data and additional software required for the adaptive protection and local ANM solutions. During this reporting period, the main activity was the approval and deployment of the Azure server for adaptive protection, and the transfer of the existing local ANM Azure servers from a development environment to a more secure production environment.

The Siemens wide area protection solution consists of two Azure servers, one for central management of protection settings, and second for network modelling and simulation to aide in the generation of new protection settings. During this reporting period, the design was updated based on file transfer and Role-Based Access Control requirements. The deployment of Azure VMs was also completed, with the software for the network modelling server being fully installed. The software for the central management server is planned for deployment in early June.

GE's local ANM solution consists of additional servers for data analytics, system monitoring and software deployment. These servers were deployed in the UK Power Networks' Azure DevTest environment in Q2 2022. In this reporting period, the architecture review board advised that the servers are moved to a more secure productive environment to remedy security concerns. The software deployment to the new environment and end-to-end testing are currently underway.

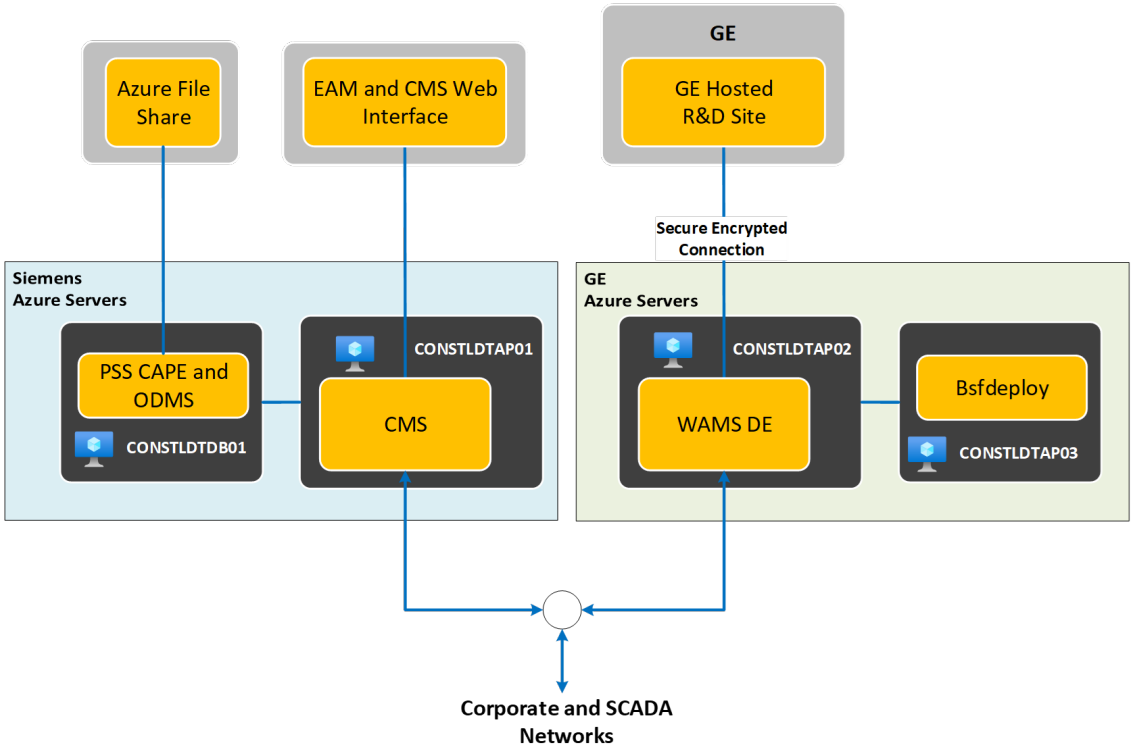

Figure 2-2 – Central servers for Constellation

Software virtualisation environment

The software virtualisation environment includes the software and hardware platforms that Constellation will use for deploying the virtualised applications and smart functionality required for the localised Constellation solutions.

During the previous reporting period, the necessary server hardware and software licenses were procured and tested. During this reporting period, the design and initial implementation of the virtualised environment for grid and DER site substations was completed. The grid site design includes a high redundancy and resilient server cluster. The server

cluster was designed, implemented, and documented in a controlled test environment. The virtual machines and latest software builds required for the Constellation solutions were also deployed as part of this activity. The servers required for the PNDC trials were also delivered on site and configured according to the design of the test server.

In addition, the activity to investigate an alternative hypervisor solution initiated during the previous reporting period made good progress. This activity aims to design, trial, and deploy a solution with the same capabilities as the current solution, but at a lower cost. This is seen as an important activity to ensure the solution remains financially viable for deployment in Business As Usual (BAU). During this reporting period, the system requirements were redefined with learnings from the project so far and a design was developed and approved.

Site-to-site communications

The 5G communications link will make use of public 5G infrastructure to enable fast, secure, and scalable site-to-site communications for messages used in wide area protection and synchrophasor data (as IEEE C37.118) for local ANM. For the purposes of the Constellation trials, dedicated 5G coverage will be deployed in the trial locations, where the public 5G network is not available within the project timescales (more details in section 2.2). The 5G slice is being developed and deployed by Vodafone. Vodafone will be providing a “slice” of their network, which is a logically separated portion of their public 5G network, designed to transmit Constellation data securely.

During this reporting period, the Vodafone 5G slice was tested during the FAT. The FAT, held at Vodafone’s Research & Development facility, primarily focused on gaining confidence in the 5G network’s capability to achieve the required minimum latencies for teleprotection, and configuration of the networking equipment. The FAT successfully proved the required sub-30ms latencies for IEC 61850 GOOSE messages across the carrier and validated the Method of measuring latencies with the Omicron tools which will be used during the project.

Cyber security

Constellation will introduce several cyber security mitigations to ensure the solution is secure, functional, and scalable. During this reporting period, the primary focus has been on starting the implementation of Role-Based Access Control (RBAC) for access to UK Power Networks’ Azure servers and user accounts required for remote access during the PNDC testing.

Constellation will be implementing approximately eight distinctive virtual machines distributed between UK Power Networks’ central Azure estate and the substation server. Each virtual machine has different access, authentication, and connectivity requirements, which necessitates the creation of unique team groups. The team groups have allowed for the separation of users based on organisation and role, this has greatly improved user security and kept the project compliant with internal UK Power Networks’ standards for RBAC.

As part of the project, a Privileged Access Management (PAM) system will be implemented at a later stage, this will enable the access and central management of Constellation virtual machines via a standard user database.

Challenges and lessons learned

Software virtualisation environment

During the research and engagement phase of the investigation into an alternative virtualisation environment, it became clear that enterprise virtualisation space is not homogenous in the way solutions are offered to customers. Our investigation has identified opportunities for both license-based software components and a subscription-based model.

Traditional substation secondary or primary devices are typically a one-off purchase with no subscription costs. Since Constellation is a software-based solution, different payment models require analysis to determine which one makes sense from an economic and practical perspective when moving to BAU. It is intended for this analysis to take place during the final stages of the project as part of Deliverable 7.

Central servers

Correct implementation of Role-Based Access Control (RBAC) is integral to ensuring infrastructure is secure. Constellation is a project with multiple partners and each partner has several engineers and developers requiring different types of access. This has necessitated the design of a comprehensive user management and role assignment document.

Roles and access requirements should be determined early in the design phase of the central and substation servers. These learnings will be used when implementing the RBAC for the substation server virtual machines in all of the trial sites.

Outlook for next reporting period

The following activities are planned for Workstream 1 during the next reporting period:

- Completing the implementation of RBAC for remote connectivity users in preparation for the PNDC testing;
- Design and configuration of networking infrastructure (L2 & L3 switches) for the substation environment;
- Start of the implementation of alternative virtualisation solution within a test environment;
- Installation of Central Management System software on Siemens Azure server;
- Start of the delivery and configuration of substation server for Maidstone and Thanet grid substations.

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

Workstream 2 is responsible for the specification, design and 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 61850-3 and applicable national standards;
- Method 1: deployment of local ANM functionality at the trial sites;
- Method 2: wide area protection functionality: islanding prevention and response to voltage and frequency events. This includes virtual protection functional requirements: provision of protection and control functions that run in a virtual platform at the substation server; and
- Method 2: adaptive protection functionality: automatic update of protection settings via IEC 61850 MMS protocol. This includes the central management system (of remote devices in substations) functional requirements: provision of a central platform to store and manage a wide range of protection and control data that is continually updated.

Progress during this reporting period

Factory acceptance testing (FAT)

In the previous reporting period, the test specifications for the FAT were developed and approved and the FAT was started. During this reporting period, significant progress was made on the FAT for each solution: local ANM, wide area protection, adaptive protection and 5G slicing (details about the 5G FAT are in section 2.1). The purpose of the FAT is to test, validate and witness the performance of each solution in isolation. All of the FAT was validated and witnessed by representatives of UK Power Networks, PNDC and Omicron.

Local ANM: The FAT for local ANM was successfully carried out in GE's facilities in March. Due to the novelty of the local ANM functionality, additional testing was required prior to the FAT. Additionally, there are challenges in providing the data required for the machine learning aspects of local ANM, described in section 4.2. To mitigate this challenge, the FAT was focused on the non-machine learning related aspects of local ANM. The machine learning aspects will be demonstrated after the data challenges are resolved.

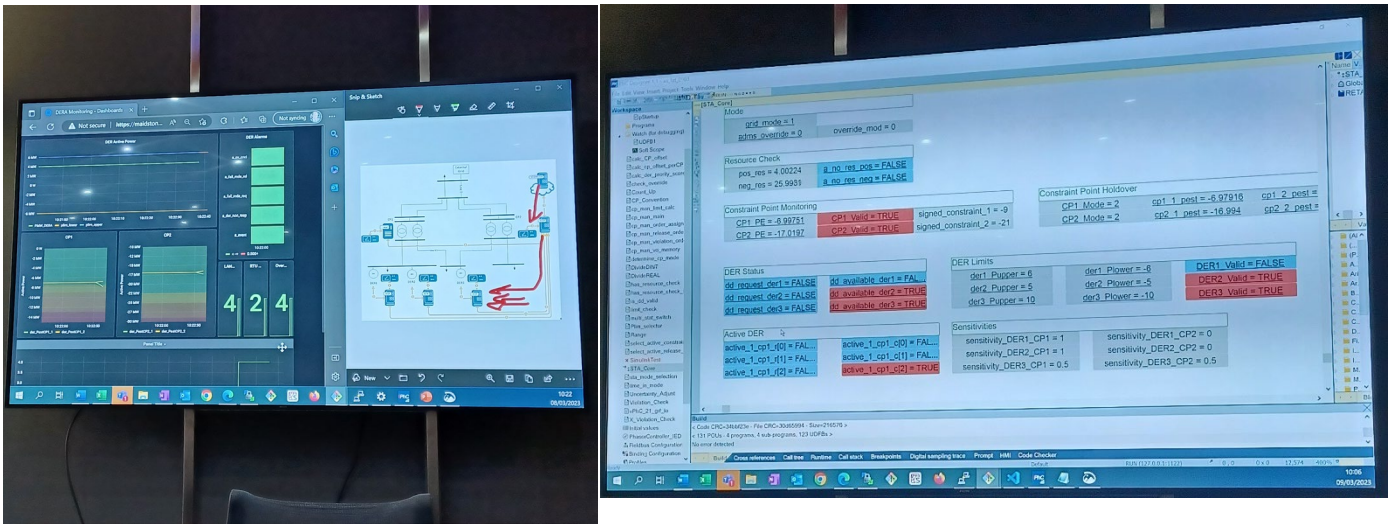

Figure 2-3 – Snapshot of FAT for local ANM

GE successfully demonstrated the novel functionality operates as per the requirements and design. A number of minor opportunities to improve the functionality were raised and resolved in the following months after the FAT. These are summarised below:

- Minor visualisation improvements of the local ANM dashboard to enable easier use;
- Addition of clarifications in the FAT specification and local ANM design; and
- Investigation of an optimum duration for holdover mode (details in Deliverable 1 report) to improve performance.

Wide area and virtualised protection: The FAT for wide area protection was successfully carried out in ABB's facilities in the last reporting period. The FAT included the demonstration of the virtualised protection, in addition to the novel wide area protection functionality. ABB successfully demonstrated the virtualisation of protection functions and the novel wide area loss of mains (LoM) protection both operate as per the requirements and design. Following the FAT, a number of minor opportunities to improve the functionality were raised in this reporting period and they were resolved. These are summarised below:

- Clarifications in the FAT specification and wide area protection design;
- Repeat the tests with summer and winter ratings to demonstrate correct operation; and
- Remove the delay in the logic to improve the protection performance.

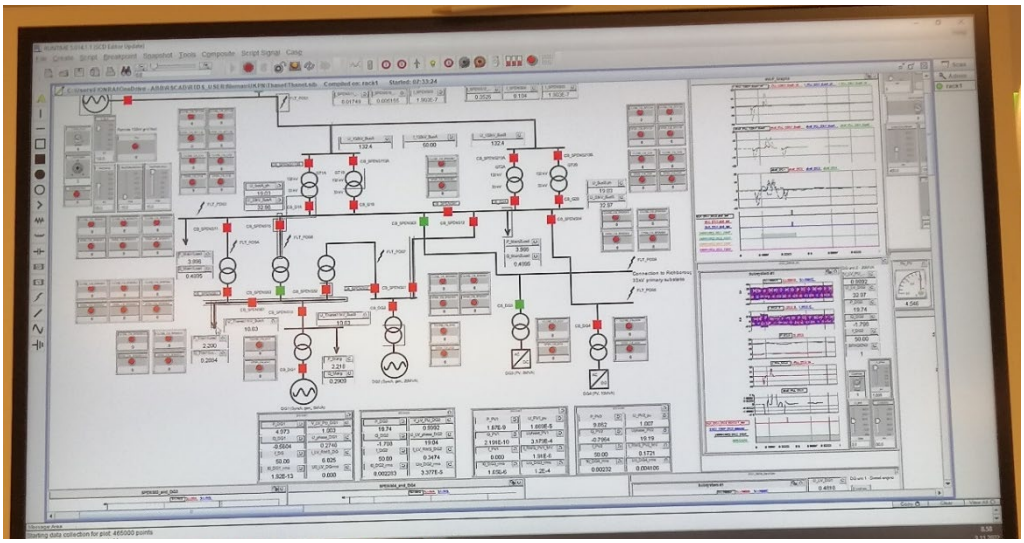

Figure 2-4 – Snapshot of FAT for wide area protection

Adaptive protection: The FAT for adaptive protection was successfully carried out in Siemens's facilities in the last reporting period. The FAT included the demonstration of the adaptive load blinding protection functionality as well as the central management system.

Following the FAT, one major and a few minor opportunities were raised. The major one was due to a limitation in the test facilities. However, in February Siemens resolved these limitations and were able to effectively demonstrate the adaptive settings data flow from a central server, where protection settings are adapted, to a physical ABB SSC600 device where protection functions and settings exist. The FAT provided confidence in the adaptive settings process and settings transfer via standard IEC 61850 MMS protocols between different suppliers of protection functionality. There are a few outstanding minor suggestions to improve the functionality which are planned to be resolved in the next reporting period.

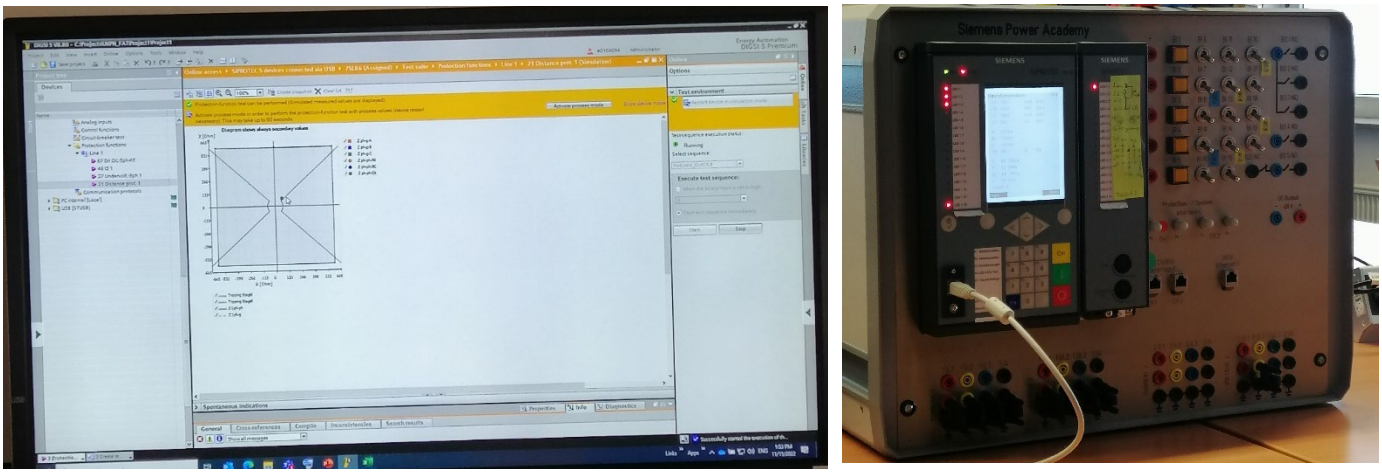

Figure 2-5 – Snapshot of FAT for adaptive protection

With the completion of the FAT, UK Power Networks is confident that the Constellation solutions are ready for the PNDC trials.

Design of Constellation solutions

The design of the Constellation solutions was approved in early 2022 and revised in the last reporting period as part of the preparations for the FAT. During this reporting period, design updates have been implemented for all solutions. These design changes resulted as part of learnings from each FAT. Constellation is a highly innovative project and it is anticipated that the design is continuously improved and updated as we carry out more testing.

Trial preparation

The trial preparation activity for Workstream 2 is focused on preparing the two trial areas in UK Power Networks' distribution network for the Constellation trials. This activity starts by installing hardware in the Maidstone area. After this is completed, we will begin work in the Thanet area. The work is delivered sequentially to alleviate operational resource limitations as well as to allow learnings from site works to be implemented in the following sites and improve the project efficiency.

We have planned to split the work in the Maidstone area into two phases due to space restrictions on site, which require more time to resolve as we need to decommission old equipment before we can install the new one. By splitting the work in two phases, we can commence the trials in UK Power Networks' distribution network without any delay:

- Phase 1: installation of all the Constellation equipment required for the passive trials. The passive trials will allow the demonstration of the Constellation solutions, without allowing them to directly control the live electricity network; and

- Phase 2: installation of all the Constellation equipment required for the active trials. The active trials will allow the Constellation equipment to directly control the distribution network.

The Thanet area does not have the same space restrictions and therefore all the work for phase 1 and phase 2 will be done at the same time for Thanet.

Site design: In order to prepare the trial areas (Maidstone and Thanet) for the Constellation trials, the electrical and civil work in each individual site needs to be designed**.** The site design has focused on production of drawings to support site works. For each device and panel these include AC schematics, DC schematics, device application diagrams and general arrangement drawings.

During this reporting period, the design has been updated for the phase 1 site work in the Maidstone area. This includes approximately 110 electrical drawings, general arrangement drawings and layout drawings. In addition, the design for the Thanet area, which started in the previous reporting period, has continued as planned. In this reporting period, the general arrangements for all the Thanet Grid panels, the detailed drawings for the Thanet Grid incomers and for four of the 16 feeders were completed.

Procurement of hardware: In the previous reporting period, we placed the equipment orders for Maidstone Grid. In this reporting period we received most of the equipment, excluding the delayed communication equipment (described in section 4.2). We have purchased a number of materials ad-hoc as the work on site in Maidstone has progressed. In addition, we have placed equipment orders in readiness for the Thanet area site works in preparation of their start in the next reporting period. The orders we have placed for Thanet include:

- Sub-racks that include sufficient merging units which will act as relays. They will also include terminal test blocks, links and the required small wiring to facilitate quicker installation on site;
- Layer 2 and Layer 3 communication equipment. Learning from the delays with the communication equipment for the PNDC and Maidstone area, we purchased the Thanet equipment earlier than planned;
- GPS clocks to enable synchronisation; and
- Small materials to support site works.

Configuration of protection relays: As part of Constellation, the protection relays in the trial sites are replaced with modern devices which can support the required Constellation functions. In the previous reporting period, the configuration of the relays for the Maidstone area was completed. In this reporting period, we have placed the order for the configuration services with ABB as specified on the Constellation Protection Policy. The configuration will commence after the equipment is available and in time for installation in Thanet.

Installation and commissioning: In this reporting period we have completed the installation and commissioning of a number of intelligent electronic devices (IEDs) at the Maidstone Grid substation. These include devices on the panel of the bus sections, the 33kV feeders, and the transformer incomers. Additionally, the installation and termination of ethernet cabling (RJ45 and fibre optic cables) has been done from all panels at Maidstone Grid switch room to the Constellation cubicles which are hosted in the telecoms room.

In the next reporting period, we will continue work on the Maidstone area and after that we will commence the Thanet area.

5G coverage: Trial preparations also include ensuring the trial sites have sufficient 5G coverage. To achieve this, Vodafone is carrying out site work to connect our locations with their 5G communications network. The provision of the 5G network has progressed as planned. In this reporting period we have successfully finished the deployment and integration of 5G network for:

- PNDC facilities;
- Maidstone Grid and the associated DER; and

- Thanet Grid and two of the four associated DER.

Figure 2-6 Vodafone 5G cubicle installed at the Maidstone Grid 33kV telecoms room

We have also commenced the site works for one of the remaining DER sites and expect that to finish in the next reporting period. The 5G work in the final DER site will take place at the same time as the UK Power Networks' site work, which will be scheduled in line with our standard outage planning process.

Standards, procedures and approval documents

It is Asset Management policy to document the approval, design and configuration of new devices being introduced on our live power network. These documents come in the form of internal standards. In this reporting period, the documents published or sent for review include the approval standards of the merger units from the different manufacturers and the GPS timeserver clock.

Provision of data

Data for local ANM: The data requirements from local ANM's design include synchrophasor data at the low voltage side of the transformers at grid sites; and at each DER site. For these, UK Power Networks will deploy phasor measurement units (PMU) merger units and phasor data concentrator (PDC) to collect measurements data and produce standard IEEE C37.118 synchrophasor data. These data streams will then be sent to the Azure server which is provisioned for local ANM.

In this reporting period we have continued to work closely with GE to resolve the challenges in providing synchrophasor data (see Section 4.2 for detail). We have identified an alternative approach to collect the data and will attempt to implement it in the next reporting period, after all of the Maidstone PMUs are installed.

Data for wide area protection: The network model for adaptive protection settings comprises of data exports of network impedance, network switch positions and live measurements. UK Power Networks hosts the required data in different software applications. The data export from these systems with the partner application (PSS ODMS) is challenging due to data specification and mapping issues.

In this reporting period, network data has been gathered for the Thanet area and has been shared with the PNDC, GE and Siemens to enable the completion of the FAT for their respective solutions and the preparation for the PNDC trial. The data provided has been compiled without issues. However, the provision of switch position data is still ongoing due to the complexity in communicating the data attributes consistently (see section 4.2).

Other data requirements: In this reporting period, protection data has also been shared with the partners on an ad-hoc basis. This included existing devices, settings and locations. Data about network operation such as normal running arrangements has been shared with the partners that have requested it.

Challenges and lessons learned

Procurement

Purchase of equipment has been moving at a slower pace than anticipated. Last year, the protection devices were significantly delayed, but we have noted that this year they are back to normal lead times of 6-8 weeks. However, communication devices have been more affected by long lead times of several months. UK Power Networks has considered these time issues and placed orders early in advance to make sure devices are delivered to site on time. In addition to this, we have regular meetings with suppliers to catch up on delivery schedules. Nevertheless, the delays in communication equipment impacted the start of the PNDC trial as explained in section 4.2.

Site works

Scheduling outages with DER site owners is complex as additional engagement and notices of outage need to be considered. To mitigate this, we have been engaging with site owners continuously through the project to make them aware of the upcoming outages and mitigation measures that we have implemented.

Electrical design is demanding, and at the same time, essential in ensuring successful installations. The design for Thanet Grid is complex as there are many records that are not easy to read due to being very old because of the site's age. We are using Constellation as a vehicle to ensure the site records for both trial areas are updated.

Data provision

The provision of PMU data to GE for the local ANM solution is still ongoing. We encountered technical issues and have relied on close collaboration with GE to resolve issues on site as they arise. We have learned that the local communication network within the substation was getting saturated with the synchrophasor data, which prevented the data collection. We resolved that challenge by reconfiguration and filtering in the communication network. However, we encountered another issue - the data lost synchronisation. We have validated the synchronisation source is operating correctly. We are now investigating the device which converts the data collected from the merging unit to syncrophasor data as we believe the synchronisation issue is likely to be occurring there.

Resources

The Workstream 2 Lead, who has been leading this workstream since the beginning of the project, has moved roles during this period. To ensure successful delivery, the tasks under Workstream 2 have been handed over to other engineers in the team while recruitment is taking place.

Outlook for next reporting period

The next report will update on progress on site works and equipment sourcing. The items to be included in the next report:

- Update on site works regarding the installation and commissioning of merging units in the Maidstone area;
- Update on the ongoing procurement for the Thanet area;
- Update on site works regarding the installation and commissioning of merging units in the Thanet area;
- Update on training for protection functions, IEC 61850 protocols and Omicron tools;
- Preparation for the UK Power Networks' network trial;
- Update on the 5G coverage on every site; and
- Update on data provision activities

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 sufficient 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 the 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 the Figure below.

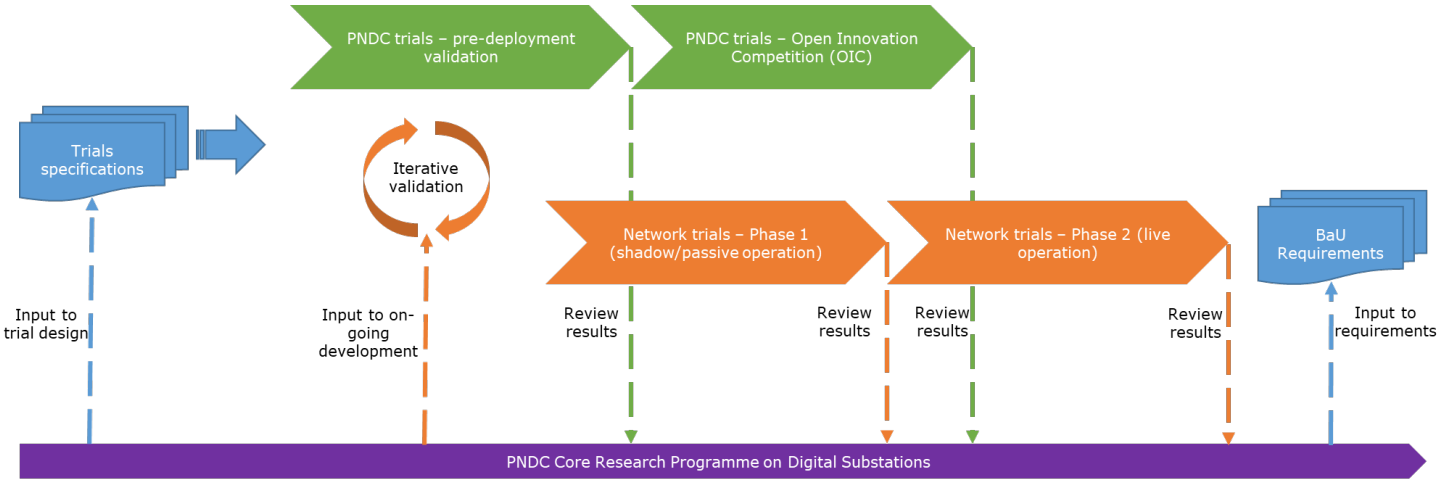

Figure 2-7 – Constellation trials process

Progress during this reporting period

Trials specification

Following on from the creation of the trials specification in the last reporting period, further work has been carried out to create more detailed test cases for the wide area protection, adaptive protection, central management system and local ANM solutions. These detailed test cases focus on defining the power system test scenarios to create suitable test conditions for verifying the functional and performance specifications of the solutions under test. Additional details include communications performance tests. The detailed test cases created for the wide area protection, adaptive protection and central management system have been approved during dedicated technical sessions. A session for approving the local ANM test cases will be carried out in the next reporting period as the technical sessions need to be staggered because the approval sessions cannot happen in parallel as the stakeholders for the three solutions overlap.

Virtualisation testing specification

Virtualisation of computing environments is at the core of the Constellation project. Therefore, it is critical to assess the functionality and performance of the virtualisation platform as part of the trials process. A virtualisation testing specification is under development and focuses on verifying the performance of time critical functions (i.e. wide area protection) when the substation server workload is increased, in particular observing the impact of increased utilisation of CPU, RAM, networking and IO on protection process latency and receipt of protection packets over the communication network.

Procurement

The procurement of the equipment for the PNDC trial is based on the equipment and software specifications provided by UK Power Networks to ensure replicability between PNDC and UK Power Networks trials phases. Some equipment specifications have been adapted to suit interfaces specific to the PNDC trials environment. In this reporting period, the

procurement for PNDC equipment and software necessary for commencing the trials has mostly been concluded with all items received and already installed in PNDC, except for the communication equipment which is delayed (further details in section 4.2).

PNDC trials environment

Figure 2-8 - PNDC test environment

The Figure above shows the under-construction PNDC test environment composed of the following key subsystems:

- **Substation servers**: two grid site servers and two DER site servers have been installed and commissioned including software installation of the hypervisors and virtual machines. Some of the software running on the virtual machines will be updated at a later date to reflect latest software releases.
- **Real-Time Digital Simulator (RTDS):** the simulator runs Maidstone and Thanet distribution network models which have been already implemented based on and UK Power Networks LTDS and PowerFactory model data. This simulator will be the main system providing the power system test scenarios seen by the solutions under test. The RTDS also integrates with the various subsystems through communication standards, namely IEC 61850, C37.118 and DNP3.
- **5G coverage equipment:** the equipment provides 5G slice connectivity to the test environment. Communication between the 5G routers and 5G dot system was successfully established. Further work is under way to establish 5G communication between the routers over the 5G slice.
- **Layer 2 and 3 communication:** switches and routers required to establish the local and wide area communication have been installed for the devices which have been delivered. Work is currently under way to configure VLANs, routing, firewalls and secure remote connectivity between the PNDC test environment and project partners. This task is impacted by the delay of communication equipment (section 4.2) and will conclude after all of the equipment is delivered.
- **DER site RTU:** a standard UK Power Networks RTU for DER sites has been installed in PNDC and work is under way to establish remote connectivity with the RTU for configuration. The RTU will be used to prove the interactions between local ANM control and a physical RTU.
- **Advanced Distribution Management System (ADMS):** The ADMS in PNDC has been successfully upgraded in this reporting period. Commissioning of DNP3 communication between the GE ADMS server and the RTDS is underway.

- **Time server:** an NTP and PTP time server has been installed. NTP time is being used by the substation servers. Work is underway to establish the PTP time dissemination required for the PRP network.
- **Testing tools:** various testing tools have been installed.

Factory Acceptance Testing

PNDC took part in each FAT and post-FAT technical discussions. Witnessing the testing and having first hand discussions with ABB, GE, UK Power Networks, Siemens and Omicron during the FATs provided a deeper understanding of the solutions being developed which facilitated the development of valid detailed test cases.

Preparation for PNDC trials

Following the completion of the FAT, approval of trials specifications and installation of PNDC test environment, preparations for the PNDC trials are well under way in close collaboration with all project partners and suppliers and is expected to commence in the next reporting period, beginning with integration testing of all solutions. Integration testing mainly involves:

- Verification of the installation of relevant hardware and software in the PNDC test environment;
- Verification of relevant configuration of hardware and software;
- Verification of physical connectivity of hardware including networked equipment; and
- Verification of specified data exchange across a range of communication standards used in the project.

Challenges and lessons learned

Substation servers commissioning

The importance of documenting software deployment and configuration cannot be understated. Prior to commissioning the servers at PNDC, UK Power Networks created a comprehensive set of documentation for the server deployment including the set-up of the virtual machines, virtual Storage Area Network (vSAN) and IP addressing scheme. This enabled a rapid, yet thorough process for completing the commissioning task.

RTDS interfaces

Since the RTDS resides at the centre of most testing scenarios carried out at PNDC, work is under way to configure and test several standard communication interfaces to enable integration with various subsystems aforementioned in this section. As with all communication interface implementations, certain features or parameters can cause interoperability issues. For instance, some DNP3 messaging is not supported by RTDS. Therefore, a change to SCADA configuration parameters in the ADMS server was required to enable successful DNP3 polling of RTDS analogue and digital points.

Outlook for next reporting period

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

- Completion of the configuration of layer 2 and 3 communications including establishing remote connectivity with the PNDC test environment;
- Performing final software updates of the solutions under test;
- Completion of the integration testing for the solutions under test (also referred to as PNDC Site Acceptance Testing); and
- Kick-off the PNDC trials focusing on functional and performance testing as defined in the trials specification.

2.4 Workstream 4 – Open Innovation Competition (OIC)

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.

Progress during this reporting period

The workstream activities do not start until later in the project. However, the project team have continuously engaged with the industry to informally gauge interest. During these discussions suppliers have provided suggestions on additional solutions that can be implemented as part of the OIC.

Challenges and lessons learned

The workstream activities do not start until later in the project.

Outlook for next reporting period

The workstream activities will formally kick-off later in the project. However, stakeholder engagement and wider dissemination of the Constellation project will continue in an effort to prime potential suppliers.

2.5 Workstream 5 – Academic Insight & Future Governance

Workstream 5 is fundamental in ensuring that 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 will be carried out through four investigation packages delivered by academic researchers and validated across the project consortium and the PNDC core research programme working group.

Progress during this reporting period

After the successful completion of the two academic insight activities delivered and reported on by the University of Strathclyde in a previous reporting period (January – June 2022), the project will launch two more activities later in the project.

Challenges and lessons learned

No activities were planned for this reporting period.

Outlook for next reporting period

The remaining academic insight activities will be kicked off at a later stage of the project. These will focus on the following two themes:

- System reliability and distributed control; and
- Future governance in a Net Zero world with distributed electricity system operation.

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 the figure 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.

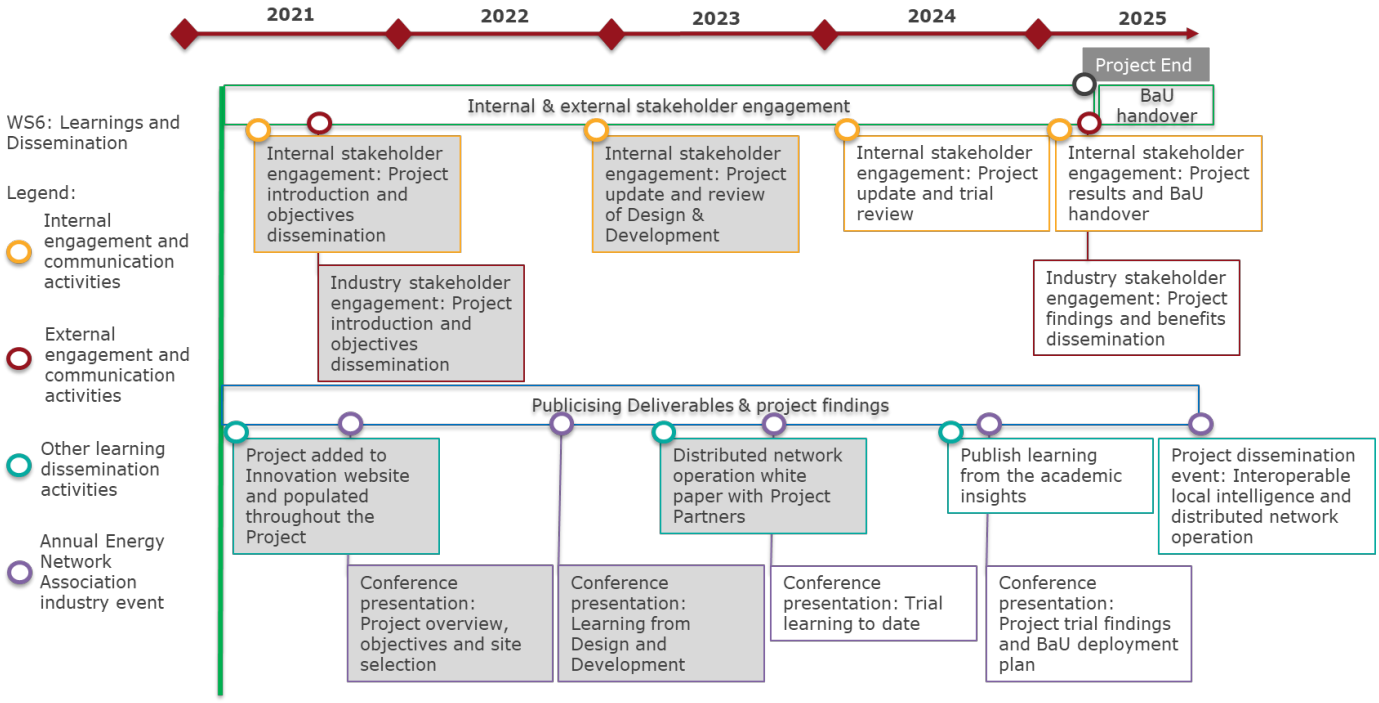

Figure 2-9 - Constellation knowledge dissemination roadmap. Shaded elements are completed.

Progress during this reporting period

The following key activities have been carried out:

<u>Engagement and communication activities</u>

- **Project update with the PNDC Digital Substation Working Group members**. The continuous engagement with this group provides further validation of the project outcomes and keeps DNOs and suppliers up to date with developments and identified unique requirements and challenges from different DNOs, thus paving the way for BAU rollout out across GB DNOs.

- **DER Engagement:** Constellation will be 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 we engage with DER owners in those areas. During this reporting cycle, engagement with DER owners continued and a workshop was carried out to get input on the Constellation solutions. Additionally, we have sent a questionnaire to the DER owners to collect the information required to support the modelling for the PNDC trials.

- **Technical dissemination**: During this reporting period, Constellation submitted the following technical conference papers:
    - A paper has been submitted to the PAC World 2023 conference, taking place in Glasgow, focusing on the development of the PNDC testing environment and the trials methodology to be adopted as part of workstream 3.
    - CIRED 2023:
        - Two ABB led papers on the development and testing of virtualised and wide area protection; and
        - Siemens led paper on the development and testing of wide area protection.

- Submission of three abstracts for the upcoming CIGRE 2024 conference. Each abstract is led by a different partner (ABB, GE and PNDC) and focuses on aspects related to their role in Constellation.

- **Presentations**: During this reporting period, Constellation was presented in the following conferences to disseminate learning:
  - ABB Green electrification 2035 in Finland: An online contribution to a Finnish conference. The Constellation project provided context to the drive for digital substations and their role in facilitating Net Zero carbon emissions; and
  - Virtualisation of protection and control webinar: The focus of the session was the benefits of virtualisation and the key challenges which Constellation has set out to resolve.

- **Other dissemination activities**: a Constellation press release was published in the March edition of the IET magazine. The press release provided a high-level overview of some of the Constellation solutions and the role of digital substations in our transition to Net Zero carbon emissions.

Challenges and lessons learned

DER Engagement
Some DERs have expressed concerns with the deployment of Constellation due to the site work and associated outages required on electricity substations prior to the trial phase. UK Power Networks has worked closely with the DERs to clarify the scope of site works required, as well as the associated impact. We will continue engaging closely with DERs in the trial areas to ensure any concerns are alleviated.

Presentations and technical dissemination
It is essential for large projects which develop complex solutions, such as Constellation, to ensure their outputs are simple and easy to digest. In Constellation we have found success through our continuous engagement with the project partners. This allows for a peer review of communication material prior to publishing and presenting which improves the quality of all public project outputs.

Outlook for next reporting period

Over the next reporting period, regular and further dissemination activities will be carried out including:
- Regular engagement through the PNDC digital substation working group meetings, particularly to seek input from the technical design authority;
- DER engagement will continue, with the aim of ensuring all site works are completed with minimal disruption; and
- Presentation of the three Constellation papers in the upcoming CIRED conference.

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 (section 2.1), which will support the business case.

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.

The figure below 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.

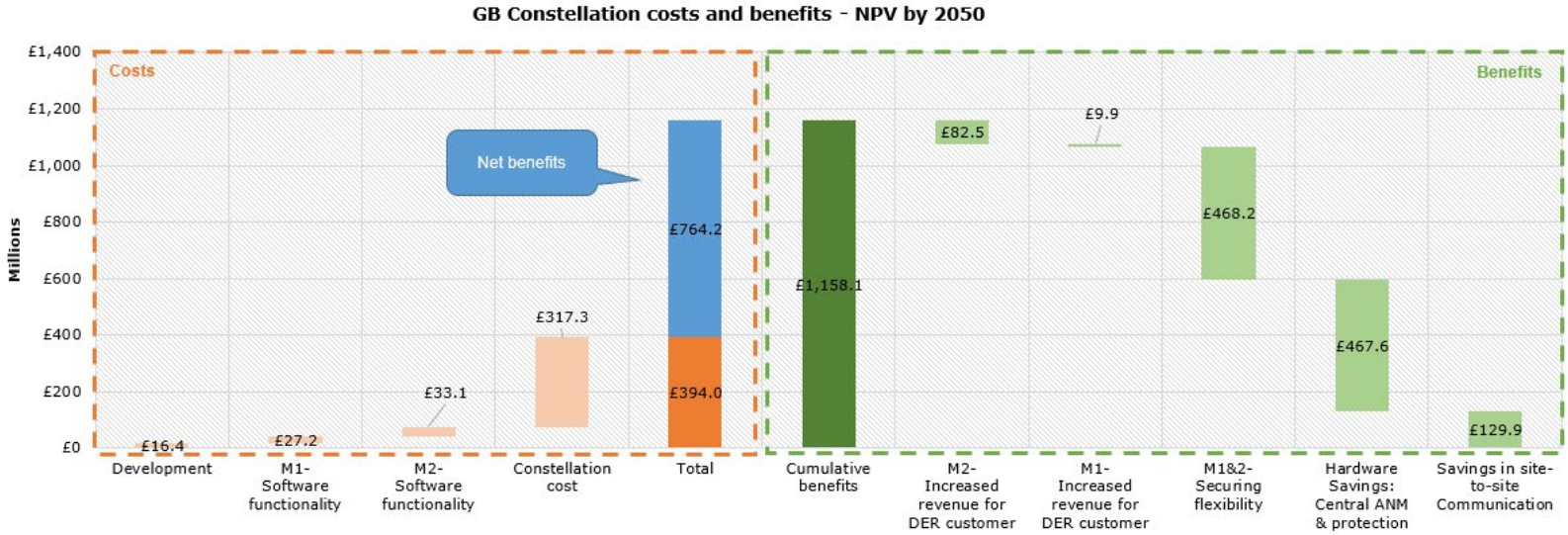

Figure 3-1 - Forecasted financial benefits in GB by 20

4. Progress against plan

Figure 10 shows the high-level project plan for Constellation. The plan is updated to reflect the non-material change request. 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.

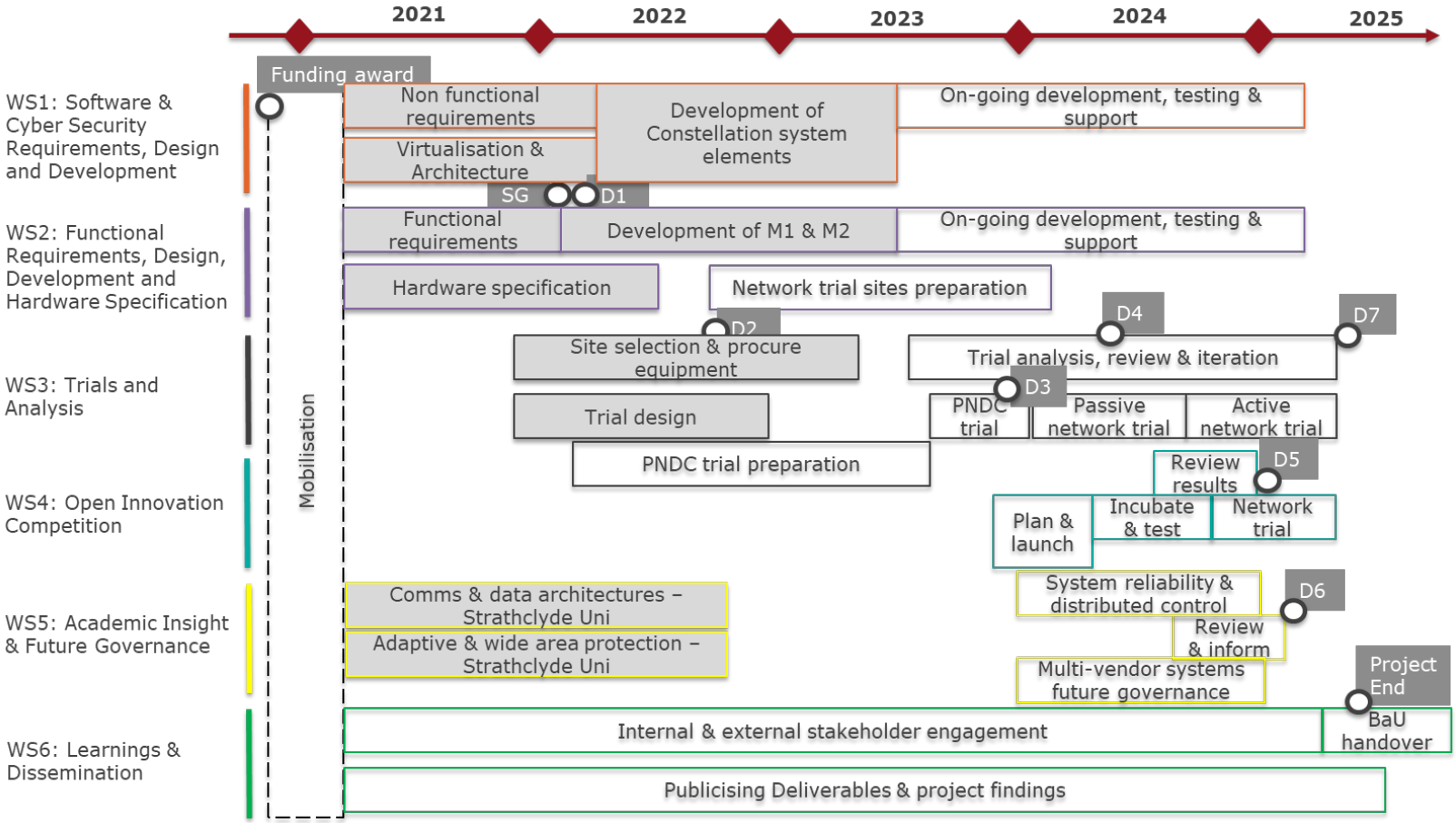

Figure 4-1 - High level plan. Shaded elements are completed.

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 one-to-one sessions with the individual partners, bi-weekly sessions with all partners as well as monthly risks and issues review sessions with all partners.

Overall progress to date is in line with the high-level project plan submitted in the FSP and recently updated following the non-material change request in this reporting period. In the previous reporting period, we highlighted a risk to the start of the PNDC trials due to delays in equipment delivery. This risk materialised, as global electronics shortages impacted communication equipment lead times.

In this reporting period, we have been working closely with our suppliers to ensure we track equipment delivery timescales closely. Based on our latest assessment the communication equipment is delayed until June and we are unable to start the PNDC trials as previously planned. Therefore, this has resulted in rescheduling the submission dates for Deliverables 3, 4 and 5. We managed this change in line with the Electricity NIC Governance Document. This change is not material as all impacted Deliverables will not be changed by more than 12 months and the project end date will not change. However, we note that if during the Constellation trials, we discover that more testing is required to validate the novel solutions, we may seek to extend the submission of one or more of these deliverables. We will monitor this risk and update Ofgem appropriately through future Project Progress Reports. Further details are provided in section 4.2.

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

Table 1 – Summary of tasks started in this reporting period

Task description	Workstream	Status at end of period
Develop the PNDC trial specification for local ANM	2 and 3	In progress
Develop the PNDC trial specification for wide area protection	2 and 3	Completed
Develop the PNDC trial specification for adaptive protection and central management system	2 and 3	Completed
Develop the integration testing specification for the integration of local ANM, adaptive protection and wide area protection to the PNDC facilities	1 and 3	In progress
Completion of FAT actions for local ANM	2	Completed
Completion of FAT actions for wide area and virtualised protection	2	Completed
Completion of FAT actions for adaptive protection and central management system	2	In progress
Completion of FAT actions for 5G slicing	1	Completed
Installation of RTU at PNDC facilities	3	Completed
Deploy a central server for wide area protection	1	Completed
Complete the fifth Project Progress Report		Completed
Develop and implement the architecture for remote connectivity	1	In progress
Deploy substation servers and install hypervisors in PNDC facilities	1 and 3	Completed
Order hardware for Thanet area	1 and 2	Completed
Carry out recruitment for Workstream 2 Lead		In progress
Executive Board meeting between all Constellation partners		Completed

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 one risk materialised into an issue (second issue below) which we are continuing the manage to reduce its impact. In this reporting period another risk materialised into an issue (first issue below) which we have managed and closed through the non-material change request.

1. **Delay in starting the project trials** – Deliverables 3, 4 and 5 are impacted:
    - Deliverable 3 is focused on the development of Constellation solutions and the early lessons from the PNDC trials. This means that the aim of Deliverable 3 is to show early insights from the PNDC testing, and the full testing results will be presented in Deliverable 7.
        - **Cause**: A global electronic shortage of specific components has impacted the telecommunication industry. Our suppliers have 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 have been working closely with our partners to minimise the impact of the issue. Siemens PLC are a partner in the Constellation project, and as such, have ensured our order is prioritised due to the strategic importance of Constellation. To resolve the challenge, we have agreed to submit Deliverable 3 by 22 December 2023.

    - Deliverable 4 is focused on the lessons from preparing the UK Power Networks sites, as well as early insights from the trials on the UK Power Networks distribution network:
        - **Cause**: Delays in starting the PNDC trial will result in delays in starting the UK Power Networks trial. This is because, we will not apply the Constellation solutions on the distribution network until they have been sufficiently de-risked in the PNDC facilities.
        - **Solution**: To resolve the challenge we have agreed to submit Deliverable 4 by 31 May 2024.

    - Deliverable 5 provides learnings from the OIC use case prioritisation, participant selection and incubation process.
        - **Cause**: The delay to the start of the PNDC trial impacts the incubation process which is part of Deliverable 5. In the original plan we had provisioned for at least 12 months between Deliverable 3 and Deliverable 5. This is because, both Deliverables will rely on testing in the PNDC facilities. The PNDC have recommended we allocate three additional months to Deliverable 5 to ensure the PNDC facilities are available for the OIC;
        - **Solution**: To resolve the challenge we have agreed to submit Deliverable 5 by 31 October 2024.

2. **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 data with GE, 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 Phasor Data Concentrator (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.
    - To manage this issue, GE 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 some risks, which could develop into issues in the next period if they are not mitigated:

- **Insufficient budget for substation equipment** – there is a risk that the budget allocated for the substation equipment will not be sufficient after the learnings from the design activities. In the previous reporting period, we have identified a higher cost requirement for substation computers, data collection, communication, cyber security and virtualisation, as well as the site preparation works themselves. This change in cost is partially due to global inflation as well as other factors external to the project. To manage this risk, we are reviewing the list of equipment after the procurement activities (with accurate equipment costs) with the aim to minimise the hardware requirements at DER sites due to space constraints without compromising the functionality. We are also investigating an alternative low cost virtualisation approach to demonstrate as part of Constellation;

- **Delays in provision of data for adaptive protection**:
    - Adaptive protection relies on data contained across multiple systems within UK Power Networks. As such, a data validation and mapping activity which was not planned for during the project bid (and only became known as part of the design activities) needs to be carried out. In this reporting period, we have made good progress in providing some of the data and validating its integrity. However, we encountered a challenge in exporting and importing data between some of the relevant systems. While this is taking longer to resolve, it is providing valuable learning for the industry.
    - To manage this risk UK Power Networks and Siemens will continue to collaborate to test and overcome the data communication challenges. We have established a focus group with key technical experts from each organisation who are dedicated to resolve the issues. UK Power Networks has also begun investigation into other possible systems to provide the data. This is being carried out separately from Constellation but may be used during the trials in UK Power Networks' distribution network.

- **DER engagement** – Two (out of five) DER sites in the Constellation trial areas have raised significant concerns with the outage duration required for the site works to deploy Constellation. In this reporting period, we have engaged closely with the DERs to understand their concerns and provide additional details to alleviate them. We will continue to work closely with the DERs and rely on best practice in engagement and delivery of site work to ensure the DER concerns are resolved.

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

- Completed the Executive Board meeting between all Constellation partners;
- Successful completion of all FAT;
- Development of PNDC specifications for:
    - Adaptive protection; and
    - Virtualised and wide area protection
- DER workshop completed;
- Deployment of a central server for adaptive protection;
- Development of architecture for remote connectivity to PNDC facilities;
- Development of site design for the site works in the Thanet area;
- Ordering the equipment required for the Thanet area;
- Continuation of the installation in commissioning of equipment in Maidstone area;
- Updating all solutions based on the learnings from the FAT;
- Completion of the PNDC ADMS upgrade;
- Continuation of preparation for PNDC trials; and
- Dissemination of learnings across a number of conferences and webinars, and submission of three CIRED papers.

4.4 Look-ahead to next reporting period

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

- Submission of Deliverable 3;
- Recruitment of Workstream 2 Lead;
- Finalisation of the PNDC integration testing specification;
- Commencement of the UK Power Networks trial design;

- Completion of PNDC trial preparation;
- Commencement of the PNDC trials;
- Continuation of trial preparation and procurement for the Maidstone and Thanet trial areas; and
- Establishment of remote connectivity to PNDC facilities.

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 2 – 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	28/02/22	(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	31/08/22	(WS1 and WS2) Report containing: • 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	30/06/23	(WS1, WS2 and WS3) Report containing: • 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. The new date is 22/12/23. The preparation for this deliverable is progressing. UK Power Networks and PNDC are leading the trial preparations, while the partners are preparing their solutions for integration.

Ref	Project Deliverable	Deadline	Evidence	Progress
4	Review and insights following site installation and learning from mid trial passive network demonstration	30/11/23	(WS2 and WS3) Report containing: • 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 changed by the non-material change request. The new date is 31/05/24.
5	Learning from the Open Innovation Competition (OIC)	31/07/24	(WS3) Report containing key learning on the OIC use case prioritisation, participant selection and incubation process	The submission date for this deliverable has been changed by the non-material change request. The new date is 31/10/24
6	Learning from academic insights and the governance required to prepare for the future world of distributed network operation	28/02/25	(WS7) Report containing analysis by the academic partner on the opportunities, risks and barriers to full distributed and interoperable future network operation	This deliverable is on track.
7	Analysis and presentation of findings from the trials and plan for BAU deployment	30/09/25	(WS3) Report containing findings from the trials and appraisal of the business case including key learning and plan for BAU deployment	The deliverable is on track.
[Note this is a common Project Deliverable to be included by all Network Licensees as drafted below]				
N/A	Comply with knowledge transfer requirements of the Governance Document.	End of project	1. Annual Project Progress Reports which comply with the requirements of the Governance Document. 2. Completed Close Down Report which complies with the requirements of the Governance Document. 3. Evidence of attendance and participation in the Annual Conference as described in the Governance Document.	Fifth Project Progress Report is completed (UK Power Networks have elected to submit a report every six months). The Close Down Report is N/A at this stage.

8. Data access details

To view the full Innovation Data Sharing Policy, please visit UK Power Networks' website http://innovation.ukpowernetworks.co.uk/wp-content/uploads/2021/11/UK-Power-Networks-Innovation-Data-Sharing-Policy-.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, published in 2019, 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 learned regarding each of the workstreams are captured in the workstream progress reports. As the project started in May 2021, the only final materials which are available for dissemination as of yet are Deliverables 1 and 2 which are published. In the next reporting period, the project team will publish the report for Deliverable 3. This will be made publicly available on the UK Power Networks' Innovation website.

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

- Test specifications and trial design;
- Constellation architecture;
- Results of wider industry review;
- Summary of FATs; and
- Description of the Constellation test rig in the PNDC facilities.

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 3 – IPR generated in this reporting period

IPR description	Owner	Type
PNDC trial specification for the Constellation solutions (local ANM, wide area protection, adaptive protection)	University of Strathclyde	Foreground IP
Summary of preparation of PNDC facilities for PNDC trial	University of Strathclyde	Relevant foreground IP
Summary of FATs	Each partner (ABB, GE, Siemens and Vodafone) owns the IP for their own FAT	Relevant foreground IP
Engineering drawings and layouts for trial sites	UK Power Networks	Foreground IP

Table 4 – IPR forecast for next reporting period

IPR description	Owner	Type
Deliverable 3 – Initial learning from off-network PNDC trial, and learning from development and virtualisation of Methods 1 and 2	UK Power Networks	Relevant foreground IP
Summary of architecture for remote connectivity to PNDC facilities	UK Power Networks and University of Strathclyde	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 1-23 are captured in the FSP. We identified Risks 24-65 since the funding was awarded. The project continues to monitor risks and issues on a monthly basis, at a 'deep-dive' risk management meeting. At this meeting, risk impacts and mitigation plans are updated.

Table 5 – Risk register

ID	Risk / Issue	Status	Description	Impact	Risk Probability	Risk Impact	Risk Score	Mitigation / Planned Actions	Mitigated Probability	Mitigated Impact	Mitigated Score	Owner	Last updated	Date Closed
R55	Issue	Open	Access to large store of data for Machine Learning (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	24/05/2023	
R52	Issue	Open	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	3	3	9	WS2 Lead	24/05/2023	
R58	Risk	Open	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	4	3	12	WS2 Lead	24/05/2023	
R13	Risk	Open	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	24/05/2023	
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	24/05/2023	
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	24/05/2023	
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	24/05/2023	

ID	Risk / Issue	Status	Description	Impact	Risk Probability	Risk Impact	Risk Score	Mitigation / Planned Actions	Mitigated Probability	Mitigated Impact	Mitigated Score	Owner	Last updated	Date Closed
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	24/05/2023	
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	3	3	9	Project Manager	24/05/2023	
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	2	3	6	Project Manager	24/05/2023	
R53	Risk	Open	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	3	3	9	WS2 Lead	24/05/2023	
R63	Risk	Open	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	
R10	Risk	Open	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	24/05/2023	
R12	Risk	Open	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	24/05/2023	
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	24/05/2023	
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	2	2	4	Project Manager	24/05/2023	

ID	Risk / Issue	Status	Description	Impact	Risk Probability	Risk Impact	Risk Score	Mitigation / Planned Actions	Mitigated Probability	Mitigated Impact	Mitigated Score	Owner	Last updated	Date Closed
								there are plans in place to meet the BAU requirements						
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	24/05/2023	
R65	Risk	Open	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	24/05/2023	
R2	Risk	Open	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	24/05/2023	
R21	Risk	Open	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	24/05/2023	
R25	Risk	Open	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	24/05/2023	
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 - Developing a succession plan for the Project Lead and any other roles, as required	3	4	12	Project Manager	24/05/2023	

ID	Risk / Issue	Status	Description	Impact	Risk Probability	Risk Impact	Risk Score	Mitigation / Planned Actions	Mitigated Probability	Mitigated Impact	Mitigated Score	Owner	Last updated	Date Closed
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	2	4	8	Project Manager	24/05/2023	
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	24/05/2023	
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	24/05/2023	
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	24/05/2023	
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	24/05/2023	
R54	Risk	Open	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	24/05/2023	
R57	Risk	Open	The upgrade of PNDC's ADMS and simulation of UK Power Networks's network is not suifficient 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	24/05/2023	
R6	Risk	Open	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	3	3	9	Procurement	24/05/2023	
R33	Risk	Open	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	24/05/2023	

ID	Risk / Issue	Status	Description	Impact	Risk Probability	Risk Impact	Risk Score	Mitigation / Planned Actions	Mitigated Probability	Mitigated Impact	Mitigated Score	Owner	Last updated	Date Closed
R11	Risk	Open	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	24/05/2023	
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	24/05/2023	
R17	Risk	Open	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	2	3	6	WS4 Lead	24/05/2023	
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 - Get PMU data from trial sites early in the project	3	3	9	WS2 Lead	24/05/2023	
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	24/05/2023	
R22	Risk	Open	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	
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	24/05/2023	
R3	Risk	Open	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	3	3	9	Project Manager	24/05/2023	

ID	Risk / Issue	Status	Description	Impact	Risk Probability	Risk Impact	Risk Score	Mitigation / Planned Actions	Mitigated Probability	Mitigated Impact	Mitigated Score	Owner	Last updated	Date Closed
								following UK Power Networks established project control methods						
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	24/05/2023	
R38	Risk	Open	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	24/05/2023	
R4	Risk	Open	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	3	3	9	Project Manager	24/05/2023	
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	24/05/2023	
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	24/05/2023	
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	24/05/2023	
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	24/05/2023	
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	2	4	8	WS1 Lead	24/05/2023	

ID	Risk / Issue	Status	Description	Impact	Risk Probability	Risk Impact	Risk Score	Mitigation / Planned Actions	Mitigated Probability	Mitigated Impact	Mitigated Score	Owner	Last updated	Date Closed
								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						
R28	Risk	Open	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	24/05/2023	
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	24/05/2023	
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	24/05/2023	
R51	Risk	Open	Bandwidth and network availiability 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	24/05/2023	
R8	Risk	Open	A partner/supplier may withdraw from the project	partner/supplier must be replaced or project descoped	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	24/05/2023	
R19	Risk	Open	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	24/05/2023	
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	24/05/2023	

ID	Risk / Issue	Status	Description	Impact	Risk Probability	Risk Impact	Risk Score	Mitigation / Planned Actions	Mitigated Probability	Mitigated Impact	Mitigated Score	Owner	Last updated	Date Closed
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
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
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
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
R62	Risk	Closed	5G transmission coverage in Manston PV 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
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

ID	Risk / Issue	Status	Description	Impact	Risk Probability	Risk Impact	Risk Score	Mitigation / Planned Actions	Mitigated Probability	Mitigated Impact	Mitigated Score	Owner	Last updated	Date Closed
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
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

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 six-month reporting period and an accurate view of our understanding of the activities for the next reporting period.

Signed ……

Date …8 June 2023……..……

Ian Cameron
Director of Customer Service and VICE
UK Power Networks

Signed ……

Date …9 June 2023……..……

Suleman Alli
Director of Finance, Regulation, Strategy and Technology
UK Power Networks

13. Material change information

No material changes have been encountered during this reporting period and none are foreseen for the next reporting period.

14. Other information

Currently there is no other information to report to Ofgem.