# Constellation

## Project Progress Report – July 2021 to December 2021

Constellation Partners

ABB

GE

UNIVERSITY of STRATHCLYDE POWER NETWORKS DEMONSTRATION CENTRE

SIEMENS Ingenuity for life

UK Power Networks Delivering your electricity

vodafone

## Contents

# 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, eat and move, 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, electricity network operators:

- 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.

Furthermore, as network operators increase their reliance on smart services provided by Distributed Energy Resources (DER), there is a significant future risk to the network resilience. Previously the loss of distributed generation (DG) was of little consequence to the network operation, as it did not provide services in significant volumes to the distribution network. However, as we increase our reliance on DER to provide smart services, the loss of a high proportion of generation at the distribution level could lead to an increase in disconnection events and potentially blackouts. More specifically, UK Power Networks estimate 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 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. Specifically, 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 the 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 within dedicated hardware and 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] https://www.ofgem.gov.uk/system/files/docs/2020/11/constellation_nic_2020_fsp_-_public_27.11.2020_0.pdf

### 1.1.3 Solution

Technology is evolving at a rapid pace and UK Power Networks recognises the opportunities this presents to enhance our resilience and facilitate Net Zero at the lowest cost for consumers. In order to overcome the complications above we will leverage the newest advances in 5G communication and software engineering to enhance our local substations by making them more intelligent, digital, interoperable and enable 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 ANM – 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.

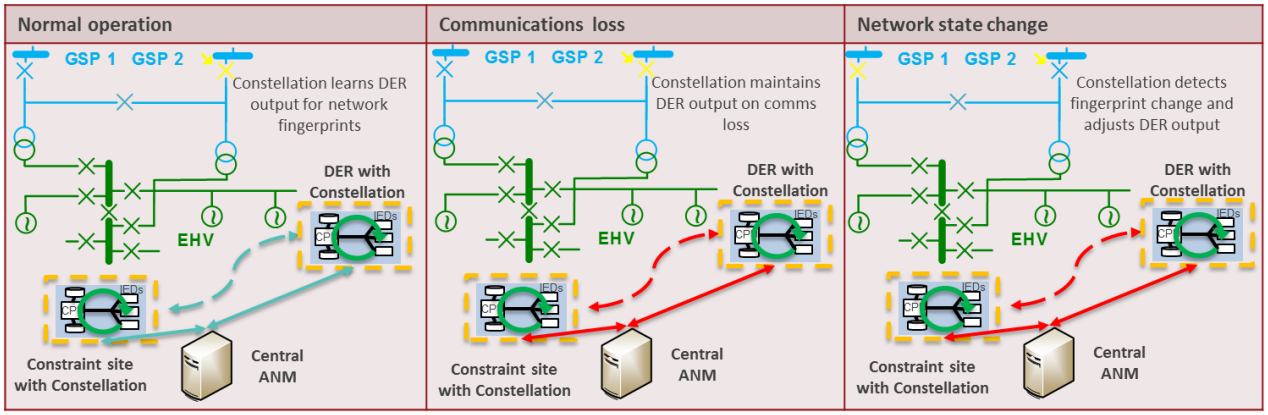


*Figure 1 - Local ANM (Method 1) summary diagram*

- 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.

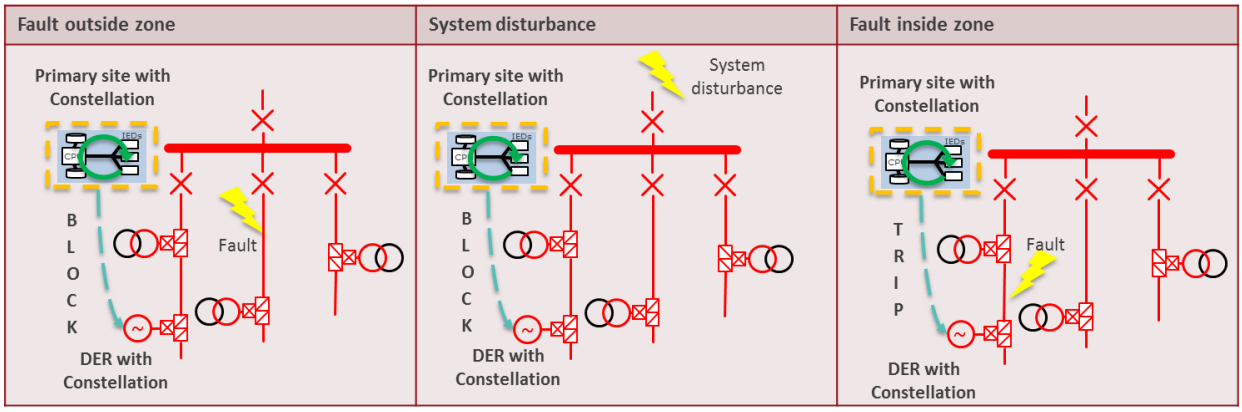


*Figure 2 - Wide area protection (Method 2) summary diagram*

    - 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.

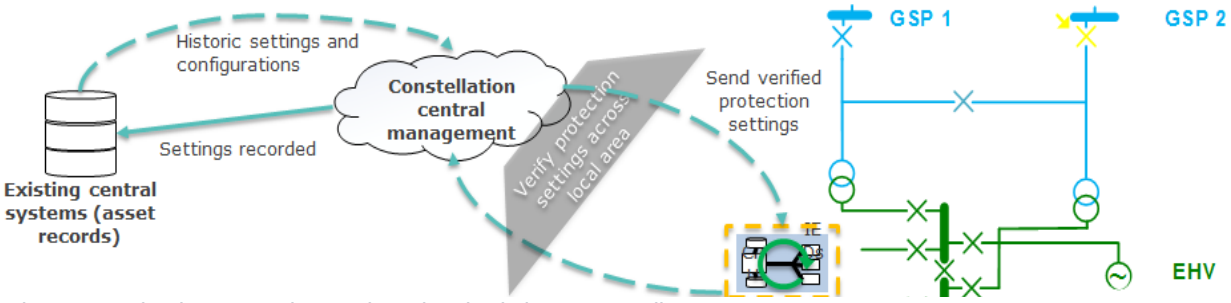


*Figure 3 - Adaptive protection settings (Method 2) summary diagram*

Constellation is UK Power Networks' newest flagship innovation project which is delivered between 2021 and 2025 in partnership with ABB, GE, Siemens, the 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 in cost efficiencies. The project Methods will also enable carbon savings 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 second for Constellation, covers the period between July 2021 to December 2021. This document, together with the previous six-monthly report, published in June 2021, will fulfil the reporting requirements of Sections 8.11 – 8.15 of v3.0 of the NIC Governance Document for 2021[2]. 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 January to June 2022. 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 aligned to the Project Direction. Over this period, the project has successfully:

- Completed requirements and design workshops between UK Power Networks and the partners;
- Published the overall specification document and completed the draft detailed specifications for:
  - Local ANM;
  - Wide area and virtualised protection;
  - Adaptive protection and central management system;
  - Cyber security;
  - 5G site-to-site communication; and
  - Intelligent Electronic Devices (IED) in substations.
- Began development of the architecture and design for each Constellation element;
- Continued site selection activities and carried out the initial 5G coverage surveys;
- Initiated the engagement with DERs sites in the trial site areas; and
- Researched Loss of Mains and adaptive protection and resilient communication architecture.

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

- **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. The non-functional requirements and architecture specifications have been published as part of the specification documentation. In addition, the software (virtualisation) environment and central server requirements have both been defined. Progress is underway to determine what the best architecture and system integration are for Constellation and its associated delivery plan.

- **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 is on track. This workstream has published an overall requirements specification for all the Constellation elements. Furthermore, six detailed specification documents were developed. The design documents are currently being reviewed, updated, and are expected to be completed by end of Q1 2022. Additionally, a list of trial sites has been shortlisted and site assessment activities are on-going.

- **Workstream 3** is responsible for the design and management of the Constellation trials, which incorporate off network trials hosted at the PNDC and live trials hosted on the UK Power Networks distribution network. This workstream is on track. The PNDC team supported all requirements workshops involving the project partners to ensure traceability of requirements is built into the trials design specification. Furthermore, an initial trials and data analysis methodology was developed focusing on the functional tests for all Constellation methods and constituent subsystems.

- **Workstream 4** is responsible for running the Open Innovation Competition (OIC), which involves incubating and testing additional methods for deployment on the Constellation platform. The activities related to this workstream start in 2022, and it is currently on track. The outcomes of the requirements elicitation phase carried out in 2021 under workstreams 1 and 2 will feed into this workstream.

- **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. Academic teams from the University of Strathclyde have been focusing on the following activities to support the Constellation requirements elicitation and provide independent scrutiny of developed designs:
    - State of the art research on Loss of Main (LoM) and adaptive protection.
    - State of the art research on secure and resilient communication architectures.

- **Workstream 6** is responsible for the dissemination of the knowledge generated from the project. The workstream is on track. Constellation was presented at the annual Electricity Network Innovation Conference. The PNDC digital substation working group has been used as a forum to engage with expert industry stakeholders. Furthermore, the project is represented by the PNDC on the IEEE P21 study group on system architectures supporting the virtualisation of substation protection and control applications. A paper on wide area protection was also jointly submitted with ABB to the DPSP conference and if successful will be presented in Q1 2022.

### 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, none of the risks registered have developed into issues impacting the project's critical path.

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 currently being scoped and agreed. The project team carefully track these risks on a frequent basis and ensure further mitigations are applied where necessary.

## 2. Project Manager's report

The project has made good progress during the reporting period (July – December 2021), focusing on the following areas:

- Development of requirements and designs for all Constellation elements;
- Trial specification and site selection; and
- Procurement of suppliers to support the delivery of Constellation;

Requirements and design

During this reporting period collaborative workshops were run in conjunction with all the partners to define the functional, non-functional, cyber security and architecture requirements as well as the high-level designs for Constellation. The outputs of these works and the formalised specification documents form the basis of the detailed designs currently being produced by the partners. These workshops were essential in garnering strong working relationships, ensuring everyone was aligned with the project vision and identifying early any potential gaps or challenges that could impact the success of Constellation. More details are presented in sections 2.1 and 2.2.

Site selection

Two geographical areas will be equipped with Constellation hardware and software functionality. Each of these areas has a main area substation[3] and a number of substations with generation capabilities. The site selection activities, including reviewing single line diagrams, running arrangements and network constraints are ongoing in close collaboration with the partners. More details are presented in section 2.2.

Partner meetings

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

- Weekly 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; and
- Monthly review sessions with all partners to review the plan, risks and issues log.

Personnel

As per the previous Project Progress Report, recruitment progressed for the workstream 1 lead. In this reporting period a suitable candidate was identified and will join the project in early December. To cover the interim need, a temporary workstream 1 lead was recruited and they will continue to support the programme until December 2021, by which time we expect the permanent workstream 1 lead to be fully onboarded and knowledge transfer completed.

### 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.

[3] A substation equipped with Constellation capabilities. During the trials it is likely these substations are grid (132kV / 33kV) sites.

**Progress during this reporting period**

Defining the requirements

As part of this reporting period collaborative workshops were carried out for each area of the solution with UK Power Networks and partner Subject Matter Experts (SMEs) to define the non-functional specifications, technical architecture, cyber security specifications and data requirements for the different methods being delivered as part of Constellation. The virtual workshops were run using digital collaborative working tools to drive engagement and insights from all present. More details on the workshop content and how they were run can be found in Section 2.2.

Based on the outputs of the specification workshops and further collaborative discussions with both UK Power Networks SMEs and partners specification documents have been created and approved, during the current report period. These include:

- An overall specification document that outlines the architecture and integration requirements for the complete solution;
- Individual specifications for each method outlining their respective, architecture, integration and data requirements;
- A separate cyber security document outlining the non-functional requirements and associated protocols; and
- A separate 5G communication specification capturing the key communication requirements.

The workshops and requirements gathering processes identified several gaps (e.g. what additional testing needs to be carried out against the production hardware, when software development is carried out against hardware with different specifications). These are expected to be addressed through:

- Information and insights provided by the literature review and academic research;
- Development of the detailed designs; and
- Development of test specifications.

From the specifications and workshops carried out, preliminary designs have been developed by the individual partners, and detailed designs will be produced during the next reporting period covering architecture, integration and cyber security.

Architecture and integration

Based on the workshop outputs and ongoing collaboration with both internal SMEs and partners, the overall architecture has been defined in the “Overall Specifications for the Constellation Project” document. More detailed architecture and integration diagrams for the individual solutions have been produced as part of the six detailed requirements specifications.

The architecture in Figure 4 aims to:

- Define the systems and subsystems in Constellation;
- Depict the complete Constellation system architecture;
- Define whether a system will be located centrally, within substations or within DER sites;
- Identify any integration requirements with existing systems within UK Power Networks;
- Identify any integration requirements with new third party systems;
- Define new interface requirements; and
- Ensure cohesion between centrally based systems and those based in substations or DER sites.

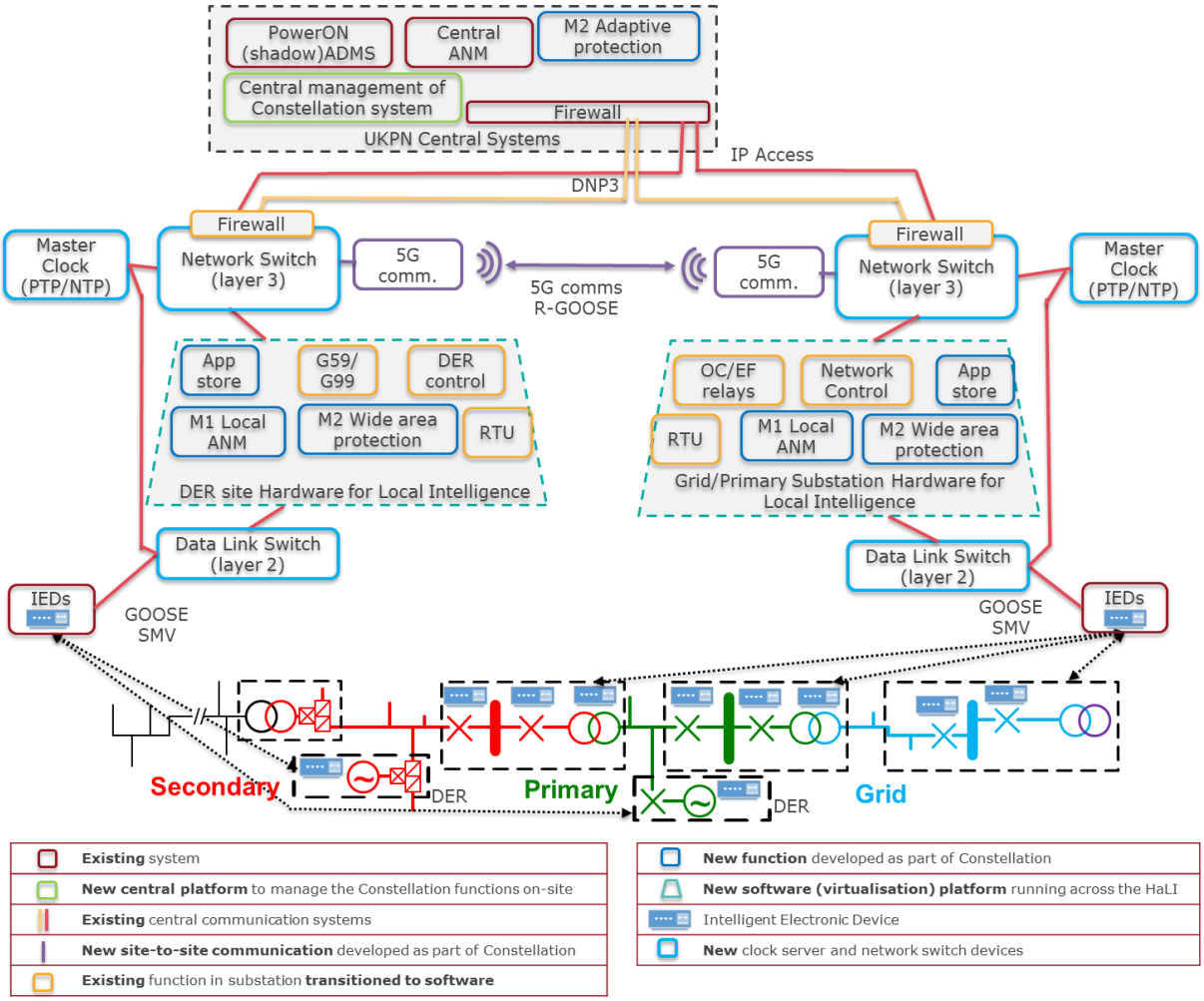


*Figure 4 – Conceptual Constellation architecture*

Central server requirements

As part of the requirements and design workshops, it was identified that two of the partners (GE and Siemens) require servers within the UK Power Networks central infrastructure. These servers will enable the functionality which will sit in the substations. The servers will host some of the software required to support GE and Siemens solutions respectively, forming a core part of the overall system architecture. These can be seen in the conceptual architecture (Figure 4) as part of UK Power Networks' central systems.

Over this reporting period:

- The server requirements and their associated architecture have been defined;
- A technical solution is in the process of being identified; and
- A delivery approach, which adheres to the overall Constellation timelines, will be outlined in the next reporting period.

Software virtualisation environment

As part of Constellation, virtualised platforms will be introduced at both substations and DER sites. The third party hardware will host the environment for software implementation of the functionality for Methods 1 and 2. The proposed approach (presented in Figure 5) is a hybrid environment, which allows functionality to run as a virtual machine (suitable

for critical, real-time applications such as protection), or as containers running on an operating system such as Linux. This was expected to be run on hardware that had previously been used in Unified Protecton (NIA project). During the specification and design workshops, it became apparent that the existing hardware would not support the technical specifications to run the real time and non-real time functions concurrently.

Once challenges were identified with the initial proposed solution, various mechanisms were leveraged to identify alternative proposals and solutions that would support the specifications defined. These methods included:

- Collaborative discussions and ideation with the partners;
- Research carried out by the University of Strathclyde; and
- A review of the global best practices

As a result, a number of options were identified and assessed. Investigations and preliminary tests are ongoing to determine the best way forward. A decision will be made on what solution to proceed with by end of the next reporting period.

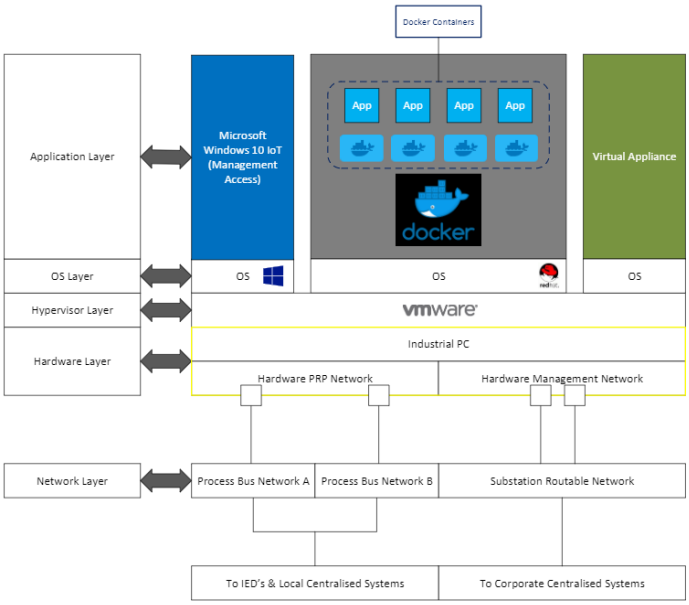


*Figure 5 – Summary diagram of conceptual architecture*

Cyber security

Despite introducing more digital points across the distribution network, Constellation has the potential to reduce vulnerabilities and protect the cyber-attack surface at UK Power Networks. Therefore, mitigating any risks around cyber security is essential for delivering a functional and scalable solution.

During this reporting period workshops were held to define the cyber security specifications and agree to an overall solution. As a result, gaps were identified in the initial proposed solution. To mitigate for these gaps Constellation is currently investigating the use of CyberArk, a privileged access management solution that controls administrative access to resources, to control and authenticate any access to the substation computer.

Based on the workshops held the cyber security specification document was created during this reporting period. Investigations are ongoing on the best solution to meet these specifications, which is expected to be finalised by the end of the next reporting period.

**Challenges and lessons learned**

Hardware for software (virtualisation) environment

Constellation aims to digitalise substations as part of this project. To increase scalability the initial proposal, as part of the bid for Constellation, was to run all necessary software on virtual machines on a single computer.. During the requirements gathering process in this reporting period, it has become apparent that the initial hardware proposed will not meet the individual partner virtualisation environment requirements.

The desire within the project is to deliver the solution on a single computer to ensure maximum learning from the project. In order to finalise the virtualisation environment, early testing will be carried out during the next reporting period. There is a risk that this testing will render the single computer an unviable option, resulting in the use of one of the backup options described.

Cyber security

During the design phase it was identified that the initial cyber security approach (from the bid for Constellation in 2020) was insufficient to reduce cyber vulnerability in the environment. Therefore, a more robust privileged access management solution (CyberArk) is investigated in the next reporting period. This solution costs more than initially allocated in the Constellation budget for cyber security. However, given the importance of cyber resilience, it is imperative that the highest cyber security standards are followed.

Collaboration

Constellation is a multi-partner project each of which has distinct but overlapping roles. It was important for the success of the project that all partners work collaboratively. During this reporting period, cross-partner collaboration has been achieved though:

- Collaborative workshops to help define project designs, dependencies and requirements;
- Regular connects with all partners to share progress, successes and challenges that others could potentially support with; and
- Regular and transparent communication between partners.

The outcome of this approach has meant that although some activities have taken longer to carry out, the quality of the outputs has been of higher quality than if the partners were working in isolation.

**Outlook for next reporting period**

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

- Finalise initial designs for each Constellation element including the associated architecture, data and integration plans to support commencement of the development stage of the project. These designs will iterate and evolve throughout the build and testing stages.
- Test the options for software (virtualisation) environments and agree on preferred solution for Constellation; and
- Commence process for delivering, building and integrating the central servers required by the partners.

### 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 specifications and the equipment to which will be trialled. The areas covered include:

1. Hardware requirements: in line with IEC 61850-3 and applicable national standards;
2. Method 1 functional requirements: deployment of local active network management (ANM) functions at the trial sites;

3. Method 2 – wide area protection functional requirements: islanding prevention and response to voltage and frequency events;
4. Method 2 – adaptive protection functional requirements: automatic update of protection settings via IEC 61850 data attributes;
5. Method 2 – virtual protection functions functional requirements: provision of protection functions that run in a virtual platform at the substation PC; and
6. 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**

Requirements and design

A key focus in this reporting period was the definition of the requirements and development of the designs for each Constellation element. Workstream 1 is focused on the non-functional requirements and design (refer to section 2.1), while workstream 2 is dedicated to the functional ones.

In order to successfully design each solution we implemented the staged and collaborative approach in Figure 6. We began by working with our partners and the academic team in University of Strathclyde to research previous and ongoing relevant work done nationally and globally. We then digested all of the industry best practice and created the high level requirements for each Constellation element. These include virtualisation requirements, system architecture, security, system integration, local ANM, wide area and adaptive protection, 5G, hardware and other general requirements.

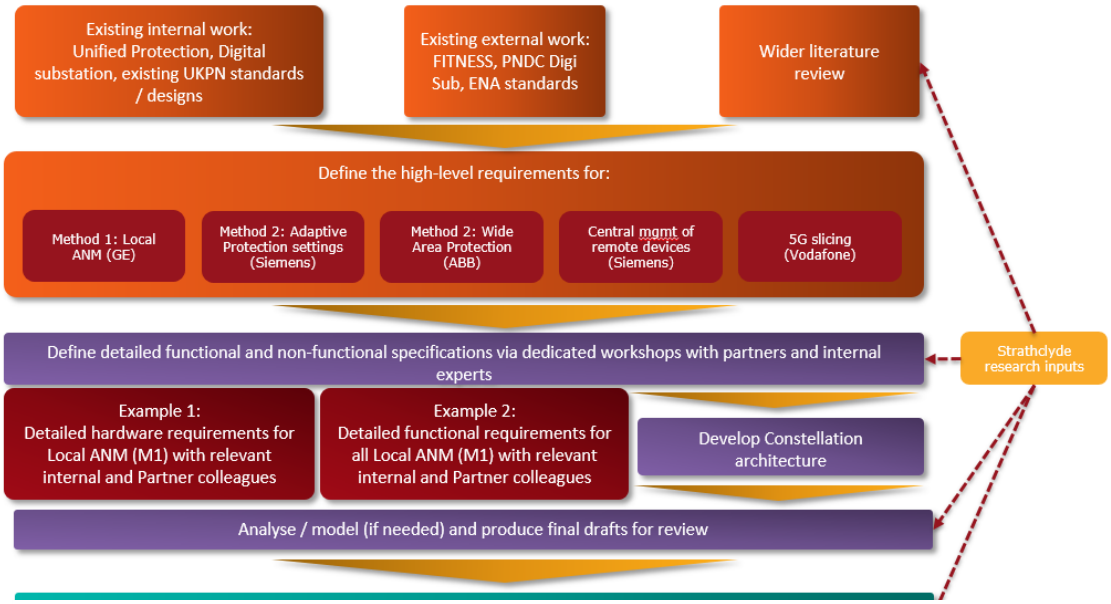


*Figure 6 - Approach to definition of the requirements and design for workstreams 1 and 2*

After that, we carried out collaborative workshops for each solution with UK Power Networks and partner SMEs to define functional and non-functional requirements. The virtual workshops were run using a digital whiteboard to support collective brainstorming. These workshops were key in setting out the detailed requirements specifications. These specifications must be considered for design and development as well as the trials and Open Innovation Competition (in the later stages of the project).

Furthermore, a number of collaboration sessions with the partners have been ongoing in a regular basis to iterate the requirements and design details. During this reporting period UK Power Networks produced the documentation in Table 2, which is going to be reviewed during the next reporting period.

*Table 1 – List of documents and status as per reporting period*

| Doc Number | Topic |
|---|---|
| **1601** | Specifications for the Constellation Project |
| **1502** | IED Hardware Specifications |
| **1603** | Method 1: Local ANM Requirements |
| **1604** | Method 2: Adaptive Settings and Database Requirements |
| **1605** | Method 2: Virtual Protection and Control Functions including Wide Area Protection |
| **1606** | Constellation Requirements – 5G Communications |

Alongside project specifications, the project partners are producing the designs for the local ANM, wide area protection, 5G communication and adaptive protection settings. These materials are key to the first Ofgem Deliverable and will be reviewed and iterated during the next reporting period.

Site selection

In order to evaluate the success of Constellation and ensure BAU adoption, the solutions need to be fully assessed and proven as functional. The testing needs to assess the operation, performance, integration and security of each Constellation element. To do this, we will first trial the solutions in a simulated environment in the Power Networks Demonstration Centre. Following that, the testing will move to the live distribution network. During this reporting period, workstream 2 worked closely with the project partners and internal SMEs to begin the site selection for the network trials.

A selection of sites that can effectively demonstrate the performance of all the solutions developed during the project is essential for achieving the project outcomes. Site selection activities started with creating the site assessment criteria and selecting the suitable trial areas. In line with this, UK Power Networks has considered and assessed the trial areas of Maidstone, Lewes, and Thanet.

- Maidstone Grid is connected to one DER site and experiences protection setting changes and restrictions on the 132kV side of the network;
- Lewes Grid is connected to several PV generation sites with firm connections and multiple points of network reconfiguration;
- Thanet Grid is connected to four DER sites with firm and flexible generation connected. In addition, this is the only area in the SPN region that has flexible generation, which makes it a suitable area for validation of the local ANM solution.

Initial site surveys have now been completed by both Vodafone and UK Power Networks on all proposed trial sites to validate their suitability. These have initiated design activities to provide 5G slice infrastructure, and engineering configurations for the protection and control applications to be deployed on each site.

The initial assessment includes engaging with the DER which are connected to the trial areas to ensure the project learnings are maximised (refer to section 2.6). Site selection activities are ongoing and will continue in the next reporting period. The full details of site selection will be included in the second Ofgem Deliverable.

Selection of equipment for substations

As part of Constellation, equipment in substations is required to provide the physical resources for the data collection, processing, communication, security of operation. The hardware will also host the software applications developed by ABB, GE and Siemens. It is based around ruggedised substation computers, communication switches, 5G hardware, Intelligent Electronic Devices (IEDs) and test equipment (for the duration of the trial). During this reporting period, the project team has been working on selecting the devices that will be required for the project. Workstream 1 covers the

specification of the substation computers and the cyber security switches and firewall devices as part of the virtualisation and security requirements and design (refer to section 2.1).

Currently, a shortlist of devices to be procured and installed on site is being created and will be validated during the next reporting period. The Constellation team is also looking for device variants to meet the space and lower functionality requirements of DER sites. In addition, devices required for testing purposes at the substation level have been identified together with PNDC and project suppliers. The Constellation team is committed to minimise the hardware requirements and maximise the project learning as much as possible through using virtualised solutions, wherever possible within the project budget and timescales. Examples include the provision of a substation RTU and Phasor Data Concentrator, which as part of the project may be a software solution at the substation computer instead of contained within individual hardware containers. After the selection of equipment is finished, procurement can commence.

Provision of data

All project partners require specific data from the distribution network to support their design and development activities. During this reporting period, each partner has identified specific data requirements, which are core to their activities. Data provision has been a continuous activity which UK Power Networks is managing:

- All project partners require single line diagrams, DER site data and protection standards at UK Power Networks and national level. These have been successfully provided for the trial areas;
- The adaptive protection solution requires specific network parameters, live measurements and live network topology (in order to define the running arrangement). Siemens are still in process of defining the specific data requirements;
- The local ANM solution requires syncrophasor data (currents and voltages) from strategic nodes on the network. The provision of this data will enhance the intelligence of the DER operation and the safety of the network. This is an ongoing task as UK Power Networks has not used syncrophasors before; and
- The wide area protection solution requires DER LoM protection details, and 5G equipment specifications to ensure the protection operates quickly and reliably. These have been successfully provided for the trial areas.

During the next reporting period the planning on how the data is provided will be established.

In order to limit the scale of the data provision activities, the project team has been working on defining the trial boundary areas. After the boundaries have been defined, only the data relevant to the trial areas will be shared.

Testing

To enable robust testing of the end-to-end solutions during both Factory Acceptance Testing (FAT) and Site Acceptance Testing (SAT) two independent specialist suppliers will be onboarded. These are:

- Omicron electronics GmbH (OMICRON) who will deliver both FAT and SAT, and provide the system testing equipment; and
- RuggedCom (owned by Siemens plc) who will support 5G testing and the provision of the communications equipment at the substation level (5G routers and switches).

**Challenges and lessons learned**

Workshop Planning

Constellation initiated in May 2021, thus under the original timelines specification workshops were to be scheduled between June and July 2021. This ended up being delayed, occurring between August and September 2021 due to scheduling challenges. The key drivers for the scheduling challenges are listed below:

- Constellation has an international team that meant school holidays and typical summer holiday periods varied across the consortium of partners; and

- Higher proportion of holidays are taken within the summer months due to COVID-19 holiday backlogs, resulting in significant numbers of people being absent, with many of the holidays being consecutive in nature increasing the span of impacted time.

A key lesson to take into future stages of the project and other innovation projects is to clearly accommodate the summer holiday period to better account for planned annual leave within the summer months.

During the reporting period, a few challenges have appeared and are being deal with appropriately. These include syncrophasor data, live network model for adaptative settings calculation, and support with 5G communication at the trial sites.

Provision of phasor data

The synchrophasor data[4] aspect is a requirement of the local ANM solution, which relies on current and voltage synchrophasor data from strategic points on the network. Provision of such data is new for distribution networks, therefore, it will take longer than anticipated during the bid stage.

To manage this, early testing of the data gathering will be done in Maidstone. UK Power Networks has purchased devices (for the project) capable to process synchrophasor data in Maidstone, including merger units and phasor measurement devices (which will send synchrophasor data via the IEEE C37.118 standard). These will send tens of gigabytes of data to a central server. From there, a secure connection will be established and enable data transfer to the partner server. This data will enable the machine learning algorithm of the local ANM solution.

Provision of network data for adaptive protection

The live network model for adaptive protection settings comprises data exports of network impedance data and live measurements. UK Power Networks hosts the required data in two different applications. The data export from one of them was compatible with the supplier application (PSS ODMS). However, the data export from the other application has encountered data specification and mapping issues.

To manage this, we are working closely with Siemens to understand their data requirements in more detail. We hosted a series of workshops to discuss and agree the best option on how the data can be provided. The selected option is suitable for BAU implementation, but requires further details of the data requirement from Siemens.

Provision of 5G coverage in the trial sites

UK Power Networks is supporting Vodafone by providing technical site data and engineering resources for site visits. However, the 5G surveyor and design suppliers (subcontracted by Vodafone) have limited experience with working on electricity sites. As such, the initial surveys and 5G design activities have been slow.

To manage this, UK Power Networks has identified engineers with local knowledge of the trial areas to assist Vodafone with their 5G coverage design.

**Outlook for next reporting period**

The next report period will focus on the design of the Methods 1 and 2 solutions, hardware procurement activities, and initial testing of some protection and control software applications:

1. Iteration of the detailed design from the partners;
2. Finalisation of the list of hardware for the trial sites;

[4] Synchrophasors are time-synchronised numbers that represent both the magnitude and phase angle of electrical quantities, and are time-synchronised for accuracy. They are measured by high speed monitors called Phasor Measurement Units (PMUs) which are hundreds of times faster than SCADA. They are typically used for transmission system applications.

3. Design of site interfaces and general arrangements for the trial sites;
4. The initial partner demonstrations of Methods 1 and 2 during development. For clarity, these will not be the formal Factory Acceptance Testing sessions;
5. Ongoing support with installation and testing of the 5G communication infrastructure at UK Power Networks sites;
6. Ongoing support with design and software development with all the partners;
7. Preparation of the PNDC and UK Power Networks trial sites for the testing phase of the project;
8. Finalisation of site selection for the network trials; and
9. Planning and start of the data provision.

### 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 Figure 7 below.

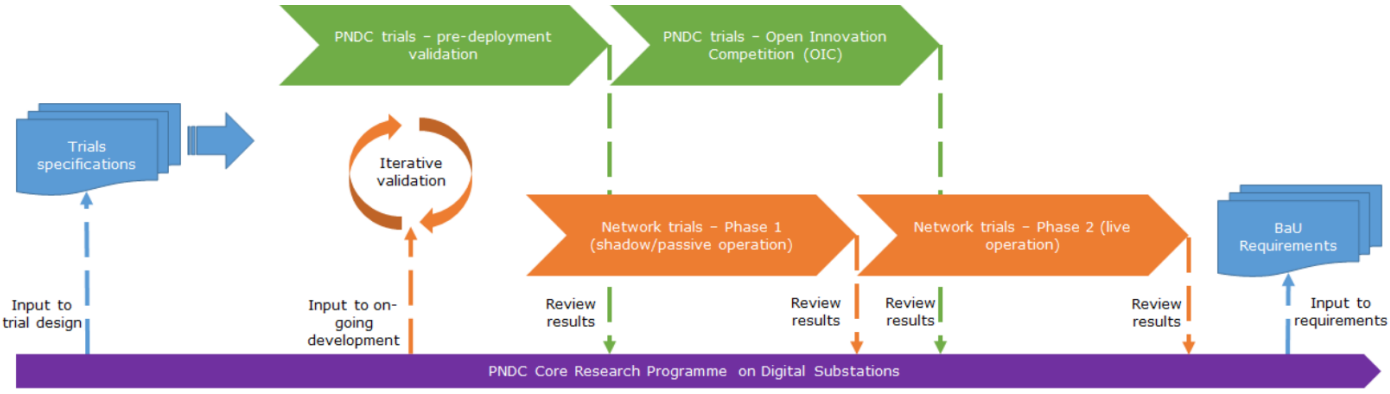


*Figure 7 - Constellation trial process*

**Progress during this reporting period**

Workstream 3 is led by the PNDC and during this reporting period it worked closely with the project partners during the requirements workshops to establish the testing requirements for the Constellation trials. Consequently, a trials and data analysis methodology was developed. This document will form the basis for the detailed trial design in the next reporting period.

Furthermore, preparatory work for PNDC trials has been launched, which includes:

- PNDC ADMS upgrade – define the interfaces between the ADMS and the PNDC test facilities, as shown in Figure 8. Furthermore, work has been launched to define the SPN trial networks' boundaries which will be modelled and simulated during the PNDC trials.
- Market review of testing tools for use during the PNDC trials. Such tools include communication traffic emulators and IEC 61850 testing tools. Shortlisted tools will be procured in the next reporting period.

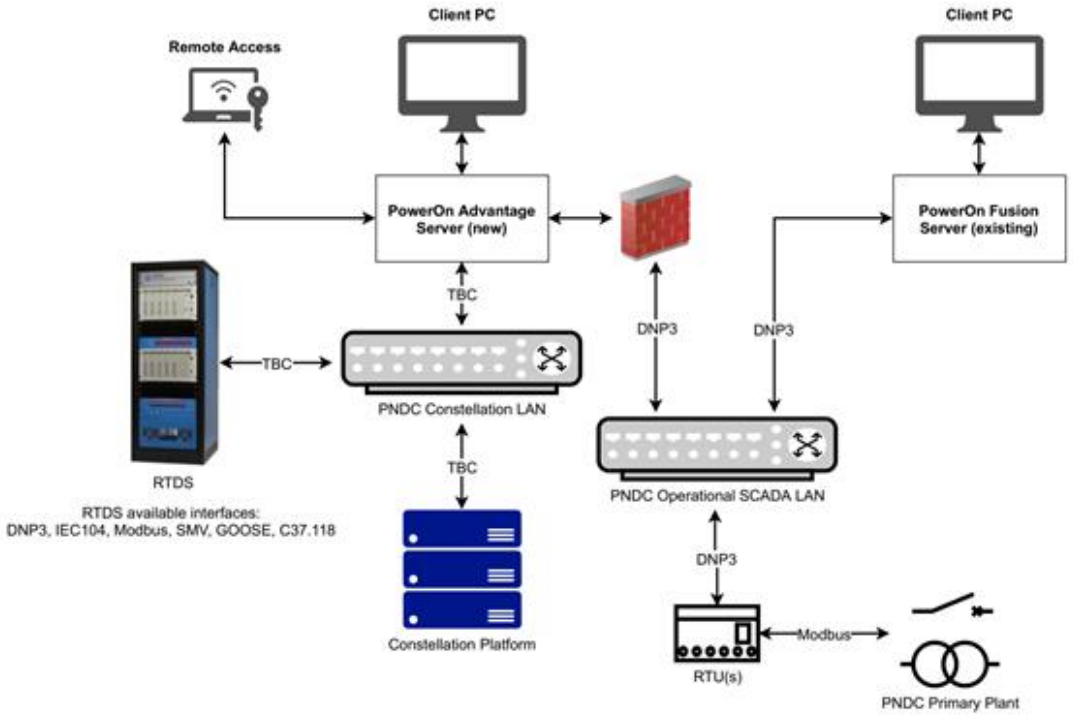


*Figure 8 - ADMS interfacing with the PNDC test facilities*

The team is currently in the process of mapping the Constellation requirements and detailed designs into a trial design for both the PNDC and UK Power Networks network trials. The key principles of the trial designs are:

- System testing of the overall Constellation solution;
- Characterising the performance and resilience of the virtualisation platform; and
- Verifying the security and performance of the communications enabling the Constellation methods.

**Challenges and lessons learned**

One of the main challenges being faced are managing the uncertainties in dependencies between the Constellation solution designs and the trial specifications. The team is engaging with all the partners continuously, particularly through workshops to establish a common understanding regarding the requirements to be tested.

Another challenge lies in unfamiliarity of some of the project partners with some of the testing methods or tools planned to be used during trials (for example the role of the RTDS in testing). This has been managed by providing early visibility of the test setup to the partners, and also through defining the role of the PNDC test environment and its constituents. Iterating the trials design with the partners will ensure a common understanding of the trial objectives and means of achieving the trials.

**Outlook for next reporting period**

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

- Iterating trial designs with input from the project partners as well as engaging with the PNDC digital substation working group to validate the trial designs;
- Finalising the PNDC and network trial designs ensuring a clear handover of learning between trial phases;
- Specification of PNDC trial equipment and software and initiating procurement; and
- Preparation of the PNDC facilities for the testing phase of the project.

### 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 2022. However, in preparation for the kick-off, stakeholder engagement was carried out to identify third parties who would be interested in participating in the OIC. The project team's continuous engagement with the PNDC digital substation working group as well as other ad-hoc and planned engagement through dissemination events served to make potential suppliers aware of the OIC and the opportunity to enrich the Constellation solution with third party methods that meet priority business use cases.

**Challenges and lessons learned**

The workstream activities do not start until 2022.

**Outlook for next reporting period**

The workstream activities will formally kick-off in Q3 2022. 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**

Significant progress has been made by the two academic insight activities that are being delivered by the University of Strathclyde, these activities are:

- **Communication and data architecture**: activities will outline options for resilient and secure communication architectures required for the Constellation Methods. In addition, requirements for site-to-site communications, and the configuration and management of virtualisation of the Constellation Methods will be considered; and
- **Adaptive and loss of mains protection**: activities will focus on the systematic evaluation of the operation of these protection schemes to understand their performance envelope and inform the requirements and design phases of Method 2. Furthermore, this work will provide a wider perspective on possible protection solutions which can be implemented using a Constellation system.

The communication research team conducted a state-of-the-art review of digital substation connectivity. This review encompassed aspects related to network security, resilience and quality of service. The research team has also supported the development of the 5G requirements pertaining to slicing and achievable performance particularly related to latency. Finally, the team provided expert opinion during the requirements workshops covering 5G and site to site communication, cyber security and the virtualisation platform.

The protection research team conducted a state of the review of wide area LoM protection and adaptive directional overcurrent protection. The research team carried out a set of simulation studies to evaluate three communication

enabled LoM protection techniques identified in the literature. Initial results demonstrated the superiority of the communication based LoM techniques. Final results will be reported in the Ofgem Deliverables as well as in a dissemination meeting with stakeholders.

A new adaptive distance protection method is also currently under investigation to evaluate the feasibility of extending Method 2 into other adaptive protection functions utilising the same virtualisation platform. Finally, the team provided expert opinion during the requirements workshops covering wide area LoM protection and adaptive protection.

**Challenges and lessons learned**

Launching the two research activities at the beginning of the project served as a valuable resource to aid in developing and scrutinising the solution requirements and designs. The contribution of the academic teams served to:

- Ensure lessons from other activities in the digital substation domain are captured via a comprehensive review of state of the art and best practice;
- Perform an early evaluation of the Constellation concepts and proposed methods by conducting modelling (protection studies) and laboratory work (5G technology testing);
- Independently review requirements and partner designs and provide input shaping key design decisions (e.g. choice of virtualisation architecture); and
- Future proof Constellation concepts and methods by considering future network operating scenarios. For example in relation to the longevity of the virtualisation architecture, or in relation to considering the supply chain maturity and lifecycle management of the substation PC.

**Outlook for next reporting period**

By the early part of the next reporting period, the two research activities will have been concluded and two academic insights reports delivered as well as input into the first Ofgem deliverable. Further work will be identified for perusal after the conclusion of this phase. Further work could be carried out via the PNDC core research programme or other suitable avenues.

### 2.6 Workstream 6 – Learnings & Dissemination

Workstream 6 is responsible for the dissemination of the knowledge generated from the project. The project has a comprehensive knowledge dissemination plan in place that is outlined in the roadmap in Figure 9.

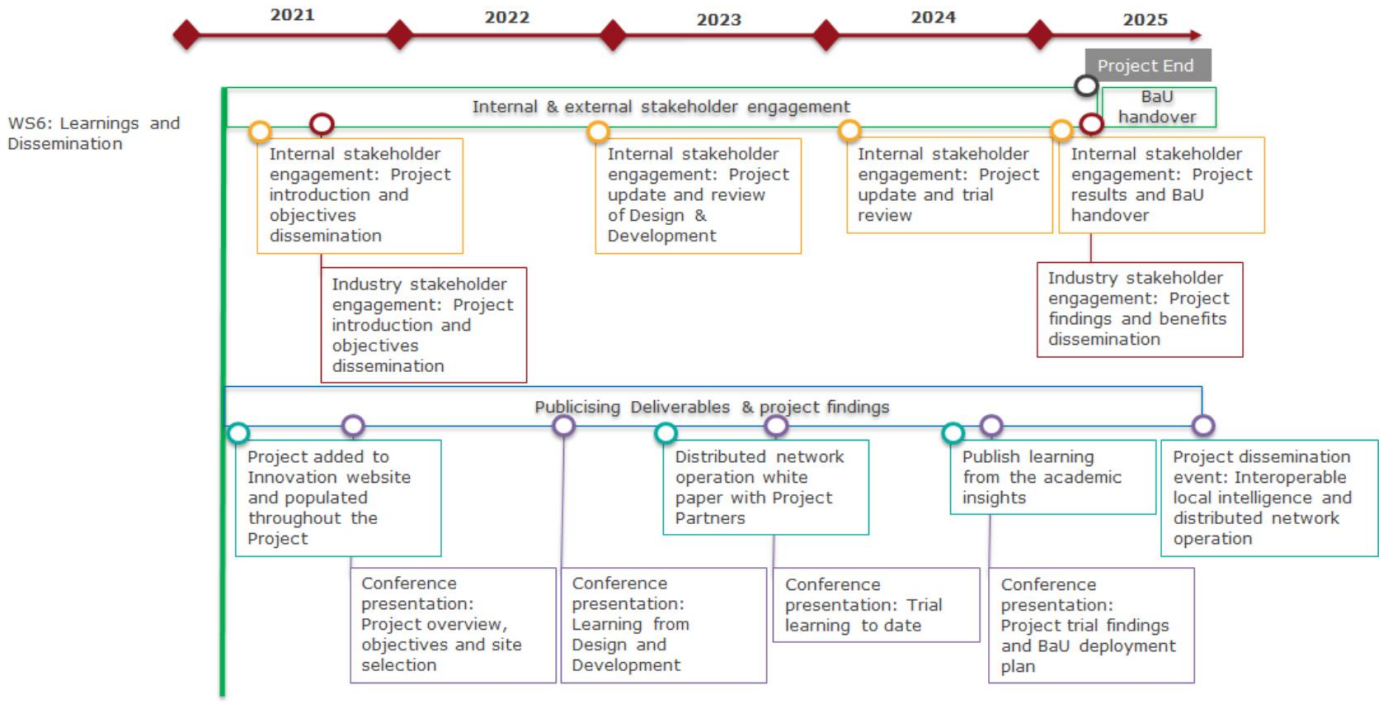


*Figure 9 - Constellation knowledge dissemination roadmap*

**Progress during this reporting period**

The following key activities have been carried out:

- Presentation of the project objectives at the annual Electricity Network Innovation Conference (ENIC). Event attendees joined the session to learn about the project and enquire on key technical aspects, such as the architecture and the virtualisation approach;
- Project updates in two PNDC digital substation working group meetings defining the role of the technical design authority (TDA). These are stakeholders external to the project partners which will ensure the scalability and validity of the Constellation requirements and designs as well as define complementary project carried out via the PNDC core research programme;
- Presentation of the key cyber security design considerations at the annual IEC 61850 Global conference. The feedback from the participants is for Constellation to provide further updates during the next conference;
- Press releases with ABB[5], GE[6], University of Strathclyde[7] and Vodafone[8] to engage with a wider audience and make them aware of the project;
- Submission of a paper on wide area protection (lead by ABB) to the International Conference on Developments in Power System Protection;
- Engagement with DERs in the trial areas, as detailed below; and
- Preparation of the wider industry review, as detailed below.

[5] https://new.abb.com/news/detail/78658/abb-technology-enables-uk-grid-to-integrate-more-renewable-energy
[6] Awaiting approval for publication
[7] https://pndc.co.uk/pndc-part-of-revolutionary-smart-substation-trial-to-spearhead-net-zero/
[8] https://newscentre.vodafone.co.uk/press-release/5g-for-uk-power-networks-world-first-smart-substation-trial/

Wider industry review

The solution delivered by Constellation is one that is expected to be scalable and reproducible in substations within Great Britain and internationally. The Wider Industry review process will enable us to obtain inputs from other industry experts and DNOs to:

- Help validate whether Constellation will meet these aims;
- Identify any potential gaps or challenges that would need to be addressed if this solution was scaled out; and
- Leverage any insights or learnings from related projects or development work.

Selected working groups and forums have been identified that represents the widest range of industry players. In the next reporting period each of these groups will be engaged introducing Constellation, the Wider Industry Review process and determining their interest in supporting the review process.

To leverage the most value out of the Individual groups and experts in a non-demanding manner, summary packs and questionnaires will be produced covering the following key areas:

- Specifications and requirements; and
- Solution design;

All feedback obtained will be reviewed, and appropriately addressed either within the current programme or as part of future learning.

DER engagement

The Methods applied as part of Constellation have the ambition to reduce curtailment at DER sites. To ensure the insights obtained during the trials are valuable and accurate, the project has chosen to engage with the companies who own DER sites within the trial areas. This will allow more accurate data collection and better understanding of the project outcomes and benefits.

Therefore, a detailed engagement approach has been developed to enable collaboration with the DERs. The following activities have been carried out during the current reporting period:

- All impacted DERs in expected trial sites were contacted, provided an overview of Constellation and asked whether they would be interested in a session to learn more;
- Those who expressed interest were invited to a follow up session where further details were shared; and
- UK Power Networks developed a charter[9] to enable the collaboration with DERs who are supportive of Constellation during the project trials.

To maintain engagement with DERs, leverage their experience during both the design and trial phase and improve the quality of the output of the trials the following engagement activities are planned during later stages of the project:

- Regular meetings to provide them with updates on Constellation progress and obtain informal feedback;
- High level review of Constellation specification and design; and
- Workshops during trial phase to validate trial progression and address any challenges or concerns they might have.

**Challenges and lessons learned**

A key lesson for future projects is to ensure there is ample context and background information when engaging with DERs. While they are aware of distribution network operators, it is important that the wider context of NIC projects is clearly set out.

[9] The Charter is a non-binding document that sets out the aspirations of UK Power Networks and the DER owners with respect to regular meetings and information sharing on matters related to Constellation

Constellation is a highly collaborative initiative delivered across six partner organisations. As such, it is essential for the lead organisation (UK Power Networks for Constellation) to have visibility of all planned press releases and stakeholder engagement opportunities. This will enable productive engagement with a wider audience and ability to follow up on stakeholder enquiries.

**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 TDA;
- Further project publications with the partners and suppliers;
- Presentation of the wide area protection paper at the International Conference on Developments in Power System Protection (if paper is accepted);
- Continued engagement with DERs in trial areas; and
- Proceed with wider industry review.

## 3. Business case update

The project team has identified that the hardware requirements for hosting the software (virtualisation) environment in the substations and DER sites, is different to those initially used in the business case. Different options are being investigated and a solution is expected to be agreed upon in the next reporting period. Depending on the outcome of this investigation, the business case may be impacted due to higher cost equipment than what was in the original bid.

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 FSP.

Figure 10 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.

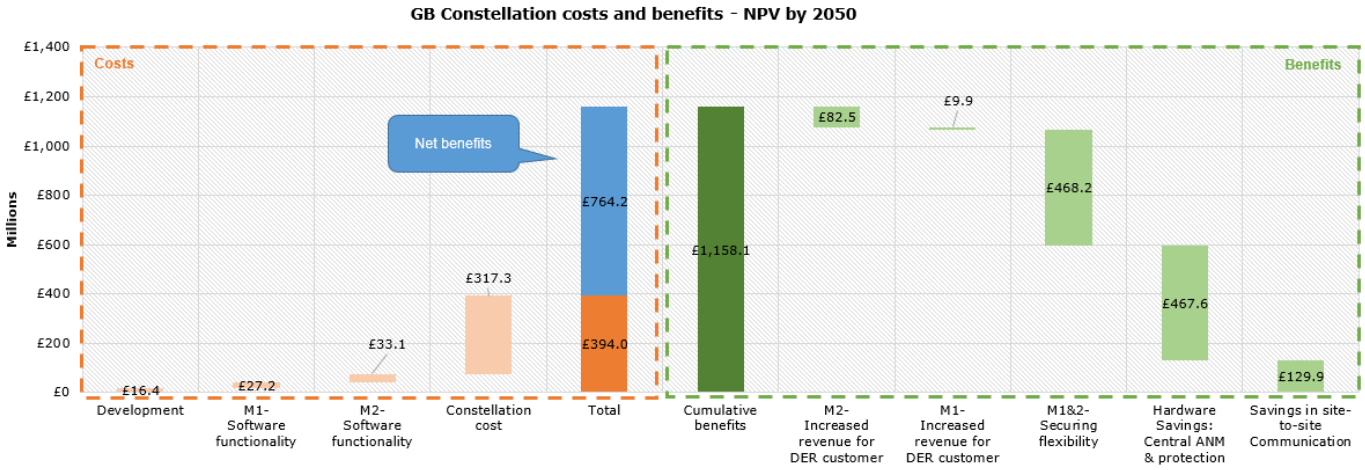


*Figure 10 - Forecasted financial benefits in GB by 2050*

## 4. Progress against plan

Figure 11 shows the high-level project plan for Constellation. The project remains on track to achieve the Deliverables by the dates shown below. In the next few sections the project team describe the progress of more specific items in the detailed project plan.

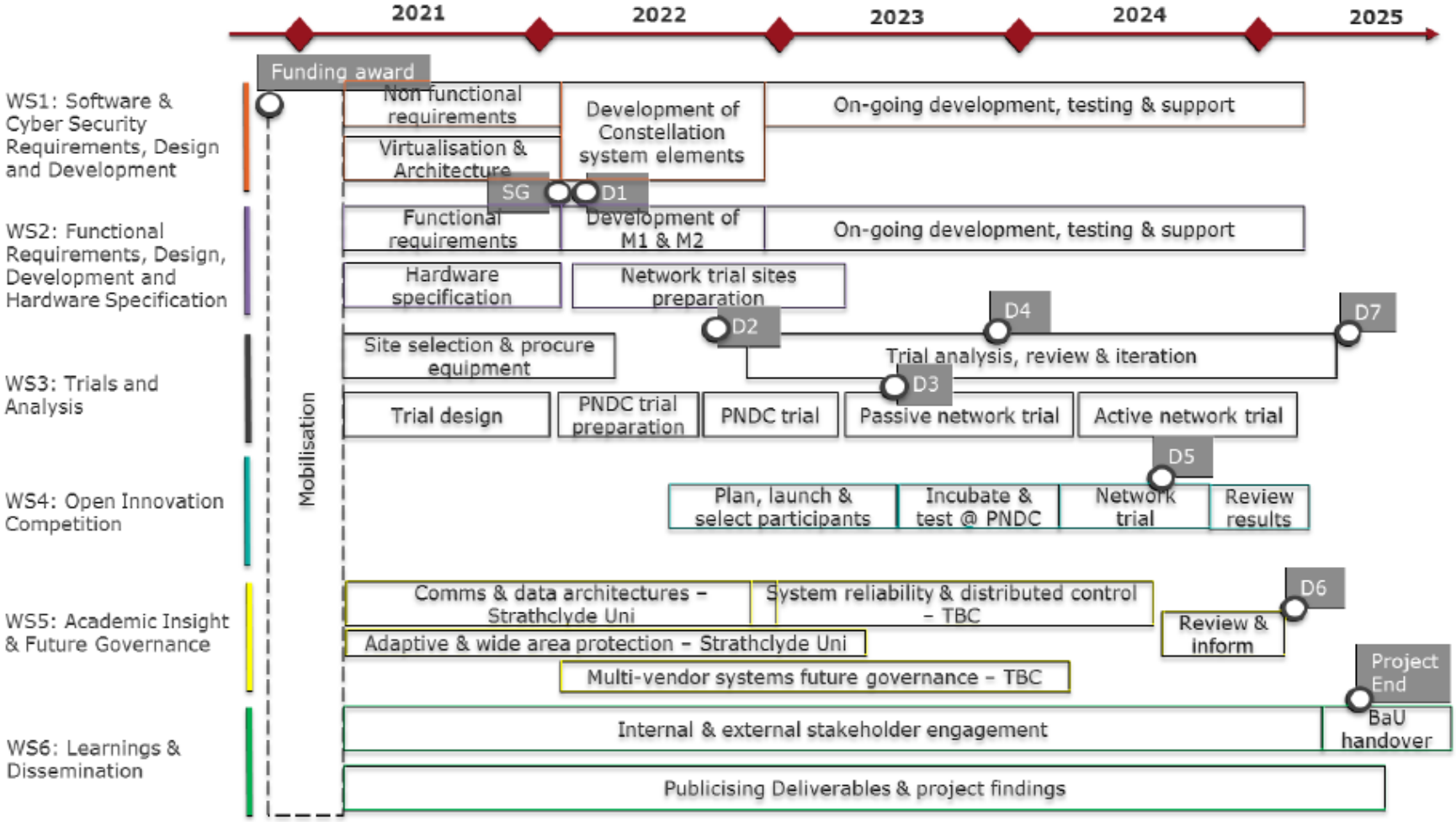


*Figure 11 - High-level Project plan*

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

Overall progress to date is in line with the high-level project plan submitted in the FSP. The PNDC trial remains on track to start in Q4 2022. However, equipment suppliers have made us aware of global electronics shortages which are impacting their equipment lead times. We will continue to closely monitor the situation but if the global shortage persists, it may impact the start of the trial period (refer to section 4.2).

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

*Table 2 – Summary of tasks started in this reporting period*

| Task description | Workstream | Status at end of period |
|---|---|---|
| Mobilise delivery teams | | In progress |
| Detail the high-level functional requirements for Methods 1 and 2 | 2 | Completed |
| Detail the high-level requirements for the hardware, software environment and 5G site-to-site communication | 1 | Completed |
| Develop the high level architecture | 1 | Completed |
| Identify suitable trial areas | 2 | Completed |
| Procure the project suppliers | | In progress |
| Produce the trial design | 3 | In progress |
| Develop overall specification document | 2 | Completed |
| Organise, plan and carry out technical workshops for requirements and design | 1, 2 and 3 | Completed |
| Develop the draft requirements and architecture for local ANM | 1 and 2 | Completed |
| Develop the draft requirements and architecture for wide area protection | 1 and 2 | Completed |
| Develop the draft requirements and architecture for adaptive protection | 1 and 2 | Completed |
| Develop the draft requirements and architecture for the 5G site-to-site communication | 1 and 2 | Completed |
| Develop the draft requirements for cyber security | 1 | Completed |
| Develop the draft requirements for the IEDs for the trial sites | 2 | Completed |
| Identify and evaluate virtualisation environment options | 1 | Completed |
| Carry out initial testing to finalise virtualisation environment | 1 | In progress |
| Identify the central server requirements | 1 | Completed |
| Plan the provision of central servers | 1 | In progress |
| Investigate the hardware required in trial substations | 2 | Completed |
| Finalise the hardware required in trial substations | 2 | In progress |
| Carry out the initial 5G surveys | 2 | Completed |
| Provide general network data for trial areas | 2 | Completed |
| Establish trial boundaries | 2 | Completed |
| Plan the provision of data for all Constellation elements | 2 | In Progress |
| Plan the testing environment at PNDC and support the ADMS upgrade | 3 | Completed |
| Develop the initial design for local ANM | 1 and 2 | In Progress |
| Develop the initial design for wide area protection | 1 and 2 | In Progress |
| Develop the initial design for adaptive protection | 1 and 2 | In Progress |
| Develop the initial design for 5G site-to-site communication | 1 and 2 | In Progress |
| Finalise academic research | 5 | In Progress |
| Engage with DER in trial areas | 2 | Completed |
| Develop charter to formally work with DERs during Constellation | | In progress |
| Complete the second Project Progress Report | | 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 certain risks might impact the overall project activities. A full list of project risks identified for Constellation is provided in Section 11. While no issues have been identified at this stage, some risks could develop into issues if they are not mitigated in the next period. However, the risks below have been identified as likely to occur and are presented below:

- 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 initial design activities. In this reporting period we have identified a higher cost requirement for substation computers, data collection, communication, cyber security and virtualisation. To manage this risk, we are reviewing the list of equipment after the initial design activities with the aim to minimise the hardware requirements at DER sites;

- Delays in provision of data for adaptive protection:
    - Adaptive protection relies on data contained across multiple systems within UK Power Networks. As such, an 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 – data validation and mapping. Additionally, the data required by Siemens needs to be specified in greater detail as part of the design activities to enable prompt data provision. There is a risk that the data cannot be provided or is delayed.
    - To manage this risk Siemens will provide a data specification and UK Power Networks will re-evaluate the project budget to ensure the data mapping activity can be completed.

- Delays in provision of data for local ANM:
    - Local ANM requires syncrophasor data at key points on the trial network. DNOs have limited experience in capturing and storing such data due to the high bandwidth requirement. As a result, there is a risk that providing this data takes longer and is more expensive than planned in the project bid.
    - To manage this risk we have purchased equipment for phasor data collection for Maidstone and intend to carry out installation earlier than planned to verify our approach. This will enable a quick and efficient deployment of the rest of the monitoring

- Software virtualisation environment – there is a risk that ABB's software cannot be implemented in parallel with other software due to its real time requirements for protection functionality. As a result, a separate hardware may be required for real time functions, which will increase the project cost. To manage this risk we are working closely with ABB and a third party virtualisation expert to carry out some early testing of an alternative approach for software virtualisation.

- Delays in starting the project trials:
    - 5G coverage – there is a risk that the deployment of the 5G coverage within the trial sites takes longer than anticipated due to delays in land acquisition in the DER sites. To manage this Vodafone and UK Power Networks have began the legal process immediately after the trial sites were shortlisted;
    - Provision of data for development (refer to risks above); and
    - Global shortage of electronic components – our equipment suppliers have made us aware of issues with their supply chains due to shortages of electronic components. To manage this risk we have agreed to test the initial 5G solutions on an existing release of 5G (v15) initially and move to a more advanced release of 5G (v16) only after the components are available, during the network trials.

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

- Successfully planned, organised and carried out all the requirements and design workshops;
- Specification of the high-level Constellation requirements;
- Specification of the draft requirements for local ANM (M1);
- Specification of the draft requirements for wide area and adaptive protection (M2);

- Specification of the draft requirements for the 5G site-to-site communication;
- Specification of the draft requirements for hardware;
- Development of the draft architecture for each Constellation element;
- Development of the draft overarching trial objectives;
- Identification of virtualisation approach;
- Specification of the draft cyber security requirements;
- Trial areas selected; and
- Engagement with DER sites connected to trial areas.

### 4.4 Look-ahead to next reporting period

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

- Completion of detailed design for local ANM (M1);
- Completion of detailed design for wide area and adaptive protection (M2);
- Completion of detailed design for the 5G site-to-site communication;
- Agreement on hardware for software virtualisation environment;
- Commencement of development activities;
- Development and agreement of plan for provision of data;
- Finalisation of sites following evaluation against site assessment criteria;
- Finalisation of hardware for substations in trial areas;
- Development and agreement of plan for provision of central servers for local ANM and adaptive protection;
- Commencement of preparation for PNDC trials and PNDC ADMS upgrade;
- Continuation of procurement activities for onboarding project suppliers;
- Finalisation of the two streams of the academic research; and
- Commencement of wider industry reviews.

## 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 text describes progress on the evidence for each Deliverable.

*Table 3 – 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 is on track. The project team have begun creating the preliminary design documents off the back of the specification documents and workshops. |

| Ref | Project Deliverable | Deadline | Evidence | Progress |
|---|---|---|---|---|
| 2 | Description of the trial design and site selection criteria process for Methods 1 and 2 | 31/08/22 | (WS1 and WS2) Report containing:<br>• A description of the trial site selection criteria process for each phase of the network trials; and<br>• Details of the trial requirements for the demonstration of each element of Constellation | This deliverable is on track. The project team have reviewed potential trial sites and narrowed it down to the preferred locations.<br><br>The PNDC are also working closely with the partners to specify the trial requirements. |
| 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:<br>• Details of the key learning from the design and development of Methods 1 and 2;<br>• Details of learnings from design of 5G slicing; and<br>• Testing preparation and early lessons from the off-network testing | The deliverable remains on track, however no progress is due in this reporting period, aligned with the programme.<br><br>Please note the risk of delays to this deliverable in section 4.2. |
| 4 | Review and insights following site installation and learning from mid trial passive network demonstration | 30/11/23 | (WS2 and WS3) Report containing:<br>• Key lessons from site installation process at DER sites and primary/grid substations; and<br>• Early learning from the passive network demonstration | The deliverable remains on track, however no progress is due in this reporting period, aligned with the programme. |
| 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 deliverable remains on track, however no progress is due in this reporting period, aligned with the programme. |
| 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. The project team and the University of Strathclyde have launched two of the four research streams. |
| 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 remains on track, however no progress is due in this reporting period, aligned with the programme. |
| **[Note this is a common Project Deliverable to be included by all Network Licensees as drafted below]** | | | | |

| Ref | Project Deliverable | Deadline | Evidence | Progress |
|---|---|---|---|---|
| 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.<br>2. Completed Close Down Report which complies with the requirements of the Governance Document.<br>3. Evidence of attendance and participation in the Annual Conference as described in the Governance Document. | Second 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 and details of the attendance at the Annual Conference are given in section 2.6 |

## 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, there are no final materials which are available for dissemination as of yet. In the next reporting period, the project team will publish the report for Deliverable 1. This will be made publicly available on the UK Power Networks Innovation website.

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

- High level requirements specification;
- Software virtualisation environment options; and
- Results of academic research.

## 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 4 – IPR generated in this reporting period*

| IPR description | Owner | Type |
|---|---|---|
| **High level requirements specifications** | UK Power Networks | Relevant foreground IP |
| **Requirements specifications for each Constellation element** | UK Power Networks | Relevant foreground IP |
| **Academic research** | UK Power Networks<br>University of Strathclyde | Relevant foreground IP |

*Table 5 – IPR forecast for next reporting period*

| IPR description | Owner | Type |
|---|---|---|
| **Deliverable 1 – Details of the system design and architecture for protection and control on a substation with local intelligence** | UK Power Networks | Relevant foreground IP |
| **Logical Architecture Design Document (LADD)** | UK Power Networks | Relevant foreground IP |
| **Site selection methodology** | UK Power Networks | Relevant 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 22-61 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 6 – Risk register*

| RISK & ISSUE LOG | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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** |
| 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<br>- Prepare key systems to be ready for integration, while detail design is taking place | 3 | 3 | 9 | WS1 Lead | 14/11/2021 | |
| 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<br>- Plan the work to align with resourcing needs | 3 | 3 | 9 | Project Manager | 14/11/2021 | |
| 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<br>- Design the trial with Vodafone and PNDC to demonstrate the resilience of the 5G service | 3 | 3 | 9 | WS3 Lead | 14/11/2021 | |
| 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 | 5 | 4 | 20 | - Stakeholders are identified and engagement approach is specified<br>- Frequent and clear communication with stakeholders is carried out throughout the project | 3 | 3 | 9 | Project Manager | 14/11/2021 | |
| 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<br>- Understand if we can leverage existing ADMS capabilities to provide<br>- Last resort is to manually identify and load the required parameters | 3 | 3 | 9 | WS2 Lead | 14/11/2021 | |
| 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<br>- Interfaces between systems (and partners) defined early as part of the requirements development stage | 3 | 3 | 9 | WS1 Lead | 14/11/2021 | |
| R55 | Risk | Open | Access to large store of data for ML development | Possible delays to the project | 4 | 5 | 20 | - Early planning and engagement with relevant experts to ensure data gathering for ML is prioritised | 3 | 3 | 9 | WS2 Lead | 14/11/2021 | |
| 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 | 4 | 20 | - Siemens provide a data specification for UK Power Networks to approve<br>- UK Power Networks to work closely with GE to ensure data can be collected early | 4 | 3 | 12 | WS2 Lead | 14/11/2021 | |
| R59 | Risk | Open | 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<br>- Install Siemens software early and do testing to confirm operation | 3 | 3 | 9 | WS1 Lead | 14/11/2021 | |
| 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<br>- Close collaboration with partners to manage the delivery of the scope within the available budget | 3 | 3 | 9 | Project Manager | 14/11/2021 | |
| 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<br>- Ensure value can be derived from the off-network testing | 2 | 2 | 4 | WS2 Lead | 14/11/2021 | 14/11/2021 |

**RISK & ISSUE LOG**

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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.<br>- Ensure knowledge sharing is undertaken across the project team to avoid single point of failure | 3 | 3 | 9 | Project Manager | 14/11/2021 | |
| 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 | 14/11/2021 | |
| 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 | 4 | 4 | 16 | - Engaged with DER operators in the provisional trial areas<br>- Ensured minimal effort and impact on DER operation during trial | 1 | 3 | 3 | Project Manager | 14/11/2021 | |
| 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<br>- Understand resource requirements and plan alternative ways of securing the necessary expertise | 3 | 4 | 12 | WS1 Lead | 14/11/2021 | |
| 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<br>- Ensure the products meet the BAU requirements or there are plans in place to meet the BAU requirements | 2 | 2 | 4 | Project Manager | 14/11/2021 | |
| 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<br>- Agree specific data management plans before the trials with the relevant business stakeholders | 2 | 3 | 6 | WS3 Lead | 14/11/2021 | |
| R49 | Risk | Open | 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<br>- Clearly communicate scope of each partner and align it to the plan | 2 | 3 | 6 | Project Manager | 14/11/2021 | |
| R52 | Risk | Open | Delay in data gathering reduces time for Machine Learning (ML) | Possible delays to the project | 4 | 4 | 16 | - Early planning and engagement with relevant experts to ensure data gathering for ML is prioritised | 3 | 3 | 9 | WS2 Lead | 14/11/2021 | |
| R53 | Risk | Open | DER sites available too late for ML | Possible delays to the project | 4 | 4 | 16 | - Ensure key lines at monitored at substation during data gathering phase | 3 | 3 | 9 | WS2 Lead | 14/11/2021 | |
| R60 | Risk | Open | Acquision 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 | 14/11/2021 | |
| R1 | Risk | Open | 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.<br>- Engage provider on fixed priced contract rather than time and materials | 2 | 3 | 6 | Project Manager | 14/11/2021 | |
| 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.<br>- Engage provider on fixed priced contract rather than time and materials | 2 | 4 | 8 | Project Manager | 14/11/2021 | |
| 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<br>- Vodafone to leverage relationship with infrastructure operator (Telefonica) in the trial areas to ensure coverage is delivered in time for the trials | 2 | 2 | 4 | WS2 Lead | 14/11/2021 | |
| R24 | Risk | Open | 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<br>- Work out the requirements and design collaboratively in workshops/focus groups<br>- Have a staged approach to specifying the requirements | 2 | 3 | 6 | Project Manager | 14/11/2021 | |

**RISK & ISSUE LOG**

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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<br>- Frequent coordination sessions in place across all partners<br>- A robust project plan is developed and it is validated and updated closely | 2 | 3 | 6 | Project Manager | 14/11/2021 | |
| 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<br>- Plan the work to align with the resourcing needs | 3 | 4 | 12 | Project Manager | 14/11/2021 | |
| 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<br>- Align substation design and IP addressing with BAU<br>- Collaborate with partners to understand hardware requirements for the software they are developing | 2 | 4 | 8 | Project Manager | 14/11/2021 | |
| 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<br>- Plan how the necessary testing and integration skills are made available in time for the Project | 2 | 4 | 8 | WS1 Lead | 14/11/2021 | |
| R40 | Risk | Open | There is a cyber security breach | Network is rendered open to cyber attack | 3 | 5 | 15 | - Specify robust cyber security requirements<br>- Compliance with cyber security requirements<br>- Develop a suitable cyber security breach response plan | 3 | 3 | 9 | WS1 Lead | 14/11/2021 | |
| 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<br>- Key interactions with other systems are planned and tested during the project | 3 | 3 | 9 | Project Manager | 14/11/2021 | |
| R50 | Risk | Open | Poor accuracy of load and generation forecasts required for the modelling | Limited outcomes from the trials | 5 | 3 | 15 | - Agree existing forecasting capabilities and identify impact during the design stage of the project | 3 | 3 | 9 | WS2 Lead | 14/11/2021 | |
| 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 | 14/11/2021 | |
| R56 | Risk | Open | 5G v16 equipment availability among global electronics shortage | Possible delays to the project | 5 | 3 | 15 | - PNDC trials and initial testing in Maidstone to be carried out on 5G v15 technology<br>- Testing later in the project (2024) to be on v16 equipment | 5 | 2 | 10 | WS3 Lead | 14/11/2021 | |
| R57 | Risk | Open | The upgrade of PNDC`s ADMS and simulation of UK Power Networks' network is not sufficient to enable the testing | Project is delayed and additional scope/cost may be required | 3 | 5 | 15 | - Close collaboration between GE, UK Power Networks and PNDC to ensure PNDC's test environment is correctly set up<br>- Simulated UK Power Networks network to be reduced and simplified | 2 | 4 | 8 | WS3 Lead | 14/11/2021 | |
| 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<br>- Leverage the R&D connections and experience of all partners | 3 | 3 | 9 | Procurement | 14/11/2021 | |
| 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<br>- Negotiation of collaboration agreement between all partners to begin after FSP submission<br>- 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 |
| 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<br>- Identified over 15 use-cases for participants to work on | 2 | 3 | 6 | WS4 Lead | 14/11/2021 | |
| 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<br>- Get PMU data from trial sites early in the project | 3 | 3 | 9 | WS2 Lead | 14/11/2021 | |

**RISK & ISSUE LOG**

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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<br>- Sufficient risk budget to ensure equipment scope change can be absorbed | 2 | 3 | 6 | WS2 Lead | 14/11/2021 | |
| 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<br>- 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 | 14/11/2021 | |
| 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<br>- Plan a suitable "plan B" alternative to secure the expertise required | 2 | 3 | 6 | Project Manager | 14/11/2021 | |
| 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.<br>- Continuously and quickly adapt to changing requirements, with iteration loops built into the project plan throughout the development.<br>- Regularly progress following UK Power Networks established project control methods | 3 | 3 | 9 | Project Manager | 14/11/2021 | |
| 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<br>- Coordinate trial preparation with the other on-going activities | 2 | 2 | 4 | Project Manager | 14/11/2021 | |
| R33 | Risk | Open | Delays caused by extended procurement processes | Project is delayed and/or requires re-scoping | 4 | 3 | 12 | - Provide Procurement with early visibility of required procurement activities<br>- Plan sufficient time to carry out all procurement activities | 2 | 2 | 4 | Project Manager | 14/11/2021 | |
| 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<br>- The partners revise the design and the products / services if necessary | 2 | 3 | 6 | Project Manager | 14/11/2021 | |
| 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 | 14/11/2021 | |
| 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<br>- Plan how these can be provided to the partners | 3 | 3 | 9 | WS2 Lead | 14/11/2021 | |
| 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<br>- Incentivise partner/supplier for success<br>- Ensure tendering/onboarding process focuses on critical project elements | 2 | 3 | 6 | Procurement | 14/11/2021 | |
| 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<br>- Sufficient time is included in project plan to resolve any issues fully and re-test<br>- No equipment will be deployed on the network into an active trial before it has successfully passed FAT and SAT | 1 | 5 | 5 | WS3 Lead | 14/11/2021 | |
| 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)<br>- Failure Mode and Effects Analysis is undertaken to ensure such failures are anticipated and designed out | 1 | 4 | 4 | Project Manager | 14/11/2021 | |

**RISK & ISSUE LOG**

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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<br>- Ensure full engagement with IT security team throughout the project<br>- Key UK Power Networks security requirements need to be fulfilled before the system is commissioned to our network<br>- Ensure test plan encompasses all relevant IT security tests | 2 | 4 | 8 | WS1 Lead | 14/11/2021 | |
| 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<br>- Review on-going work in the industry to identify if anyone else has demonstrated key Constellation elements | 1 | 4 | 4 | Project Manager | 14/11/2021 | |
| R30 | Risk | Open | Someone else develops a product which makes Constellation obsolete | Project is stopped or re-scoped | 2 | 5 | 10 | - Review on-going work in the industry to identify if anyone else has demonstrated key Constellation elements | 1 | 3 | 3 | Project Manager | 14/11/2021 | |
| R37 | Risk | Open | 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<br>- Build in sufficient time to re-iterate the design and development | 2 | 3 | 6 | Project Manager | 14/11/2021 | |
| 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<br>- Specify what separation is required for all OIC products to ensure safe operation of other systems | 1 | 2 | 2 | WS4 Lead | 14/11/2021 | |
| R51 | Risk | Open | Bandwidth and network availability for PMU to central server for data gathering is not sufficient for Local ANM | Limited outcomes from the trials | 2 | 5 | 10 | - Estimate bandwidth and advise on protocol support<br>- Close collaboration during the design stage to ensure design is fit for purpose | 2 | 3 | 6 | WS2 Lead | 14/11/2021 | |
| 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<br>- Previous engagement with wider industry provides confidence there are a number of potential organisations who can deliver some project aspects | 2 | 4 | 8 | Project Manager | 14/11/2021 | |
| R11 | Risk | Open | The specification and procurement of the equipment takes longer than expected | Possible delays to the project | 3 | 3 | 9 | - Ensure timescales on the project are realistic and have built-in contingency for high risk elements<br>- Undertake regular reviews during high risk and critical project activities | 3 | 2 | 6 | Project Manager | 14/11/2021 | |
| 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<br>- Off-network testing to simulate various network scenarios | 1 | 3 | 3 | WS3 Lead | 14/11/2021 | |
| R36 | Risk | Open | Testing scenarios cannot be replicated accurately across the different elements in the project | Limited outcomes from the trials | 2 | 4 | 8 | - Prepare a robust trial plan and specify the testing scenarios | 1 | 3 | 3 | WS3 Lead | 14/11/2021 | |

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

Signed

Date ……8 December 2021……

Suleman Alli
Director of Customer Service, Strategy, Regulation & IS
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.