QUEST
An overarching control system

electricity north west
Bringing energy to your door

QUEST System Integration Lessons Learned Report (Final)

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Project Partners

nationalgridESO FUNDAMENTALS Schneider Electric

smarter grid solutions IMPACT FROM INSIGHT TO INFLUENCE

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Review

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Ben Ingham	Innovation Technical Manager	*B Ingham* 30/04/2024

Approval

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Contents

Glossary

Acronym	Description
ADMS	Advanced Distribution Management System
ANM	Active Network Management
AVC	Automatic Voltage Control – the systems that regulate system voltage at the transforming points on ENWL network
BaU	Business as Usual – refers either to business-as-usual deployment of QUEST following successful trials or current process impacted by QUEST
CAF	Cyber Assessment Framework
CB	Circuit Breaker
CI	Customer Interruptions
CID	Curtailment InDex- Refers to the permissible amount of curtailment applied to a DER before DNO incurs penalty, the exact amount of which is laid out in the connection agreement.
CML	Customer Minutes Lost
CT	Current Transformer
DER	Distributed Energy Resource
DERMS	Distributed Energy Resources Management System
DG	Distributed Generation
DBF	Demand Boost Full (CLASS Function)
DMZ	Demilitarised Zone (IT secure design)
DRF	Demand Reduction Full (CLASS Function)
DNO	Distribution Network Operator
DNP3	Distributed Network Protocol 3
EMS	Energy Management System
ENWL	Electricity North West Ltd.
FAT	Factory Acceptance Test
GSP	Grid Supply Point
ICCP	Inter-Control Centre Communications Protocol

Acronym	Description
IEC	International Electrotechnical Commission standards
IED	Intelligent Electronic Device
IIS	Interruption Incentive Scheme - regulatory performance incentive scheme based on CI and CML
ISMS	Information Security Management System
LCT	Low Carbon Technologies
LL	Load limiting (CLASS Function)
LOM	Loss of Mains
MOL	Merit Order List
MOMS	Merit Order Management System
NIST	National Institute of Standards and Technology
NMS	Network Management System
OLTC	On-load Tap Changing
OT	Operational Technology
PFR	Primary Frequency Response (CLASS Function)
RBAC	Role Based Access Control
RTS	Real Time Systems
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SE	Schneider Electric
SFR	Secondary Frequency Response (CLASS Function)
SGS	Smarter Grid Solutions
SIEM	Security and Information Event Management
SWBD	Switch Board
TSF	Tap Stagger Function (CLASS Function)
UI	User Interface
VT	Voltage Transformer

Executive summary

This report is the fifth deliverable for the QUEST Network Innovation Competition (NIC) project which is being rolled out by Electricity North West Limited (ENWL) and its partners. The aim of this report is to document the lessons learned from the installation and commissioning of the QUEST system including system integration and the results of site acceptance testing. As previously noted, this report has been updated and republished in Spring 2024, post Go-Live of the QUEST software in the ENWL production environment. A delayed go live was expected to be achieved on 5 February 2024, the ICCP connection allowing QUEST to control production control devices was achieved 18 April 2024.

It builds upon the previously published reports for the QUEST project:

1	QUEST Initial Report - Use Cases	31/07/21
2	QUEST System Design and Architecture Lessons Learned	31/12/21
3	QUEST Trials, Design and Specification Report	30/06/22
4	QUEST Interim Report – System Design and Technology Build Lessons Learned	30/06/23

The main objective of the QUEST project is to introduce a distribution network-wide, fully coordinated, overarching control system to manage and optimise voltages, with an appropriate balance between centralised and decentralised control hierarchy. In recent years, and in common with all UK Distribution Network Operators (DNOs), ENWL has introduced innovative voltage optimisation and voltage control techniques.

The project has suffered delays arising from issues and additional requirements stemming from the heightened cyber security threat to the UK Critical National Infrastructure, and how that threat is being managed across all industries. As a result, a delay in full system availability has occurred, with details of the multiple project impacts and ENWL's response are detailed in the 8 December 2023 Project Progress Update.

This report was intended to follow the completion of the delivery phase of the technology workstream. Due to challenges around the IT design, primarily driven by changes in the cybersecurity environment, the full availability of the end-to-end system had been delayed with the connection of QUEST to the real world via an ICCP being completed on the 18 April 2024. The trial period, originally planned from September 2023 to September 2024 will now complete in February 2025 to ensure a robust testing schedule is completed. This report has, therefore, been compiled and initially published as an interim document in December 23 and is now updated in April 2024 reflecting the move from Implementation to Trials phase. The project partners that have been heavily involved in the delivery and integration of their systems have compiled their own focussed lessons learnt documentation, some of which are updated versions of previous documents and provide lessons learnt from the commencement of the project.

This report, and associated reports, can be found on the ENWL QUEST website and include detail on:

- On-site works
- Development of on-site relay software for QUEST
- Overarching software development and testing, with changes from June 23
- Supporting infrastructure development
- Active Network Management (ANM) system developments and infrastructure

- An additional report specifically related to ENWL IT lessons learnt has been added to the QUEST website (April 2024).

1 Introduction

1.1 Purpose of this report

The purpose of this report is to fulfil the deliverable from the QUEST Full Submission application (ENWEN05): to publish a QUEST System Integration Lessons Learned Report on the QUEST website by 30th December 2023 and amended to provide an update 30 April 2024, to include the additional lessons from the extended installation period to Go Live.

It details project progress to date including lessons learned from:

- On-site works
- Development of on-site relay software for QUEST
- Overarching software development and testing, with changes from June 2023
- Supporting infrastructure development
- Active Network Management (ANM) system developments and infrastructure

- Extended efforts to complete the IT infrastructure including the commissioning of the relevant data links.

Project update

The project has now delivered full system availability, however delayed due predominantly to issues stemming from the heightened cyber security threat to UK Critical National Infrastructure. Ofgem and DESNZ continue to work with the DNOs on The Network and Information Systems Regulations 2018 and the associated Cyber Assessment Framework (CAF). Whilst the initial impacts of this work on the project had been identified and reported in previous deliverables and project progress reports, the full impact had been significantly underestimated. In summary these impacts were:

- Changes in the detailed infrastructure design to provide two identical systems for Test and Production, to minimise risks associated with changes to the production control system.
- Changes in the detailed infrastructure design to decouple the QUEST innovation development from the core control system infrastructure.
- Changes in the detailed infrastructure design to provide QUEST independent secure infrastructure that would interconnect to the production systems only by a secure ICCP.
- The resources required to build and support this infrastructure are limited and focussed on the ongoing CAF work within the industry.
- The QUEST independent secure infrastructure by its secure design does not have the full suite of standard access arrangements for third parties and only has limited access to the internet.
- The QUEST independent secure infrastructure has been designed with a multitude of security layers, each with independent security measures.
- This has resulted in a secure, but complex detail design where change is time consuming and difficult to approve and implement.
- The design blocks some standard IT build processes, resulting in additional unexpected design and configuration changes.

- The design's complexity results in multiple gateways to be managed, maintained, and updated to keep the limited authorised access open and appropriate for project need.

- The implementation has been impacted by a series of detail design, configuration and settings issues resulting in multiple issue resolution cycles and corrections being required.

In effect the response to cyber increased the projects IT complexity and size requiring additional specialist resources from a limited pool. Whilst QUEST has become a larger project it still remains a small-scale IT project within a growing portfolio of large high risk industry projects all competing for priority and resources.

Within the last 12 months there has been several changes in the core ENWL project team. There have also been some additional changes in partner project teams in the last 12 months.

The project has completed its remaining deliverables not reliant on the IT infrastructure, as planned, including:

- All site installations
- All relay software enhancement, testing and roll out to site
- Development and testing of the QUEST overarching software
- Commencement of customer engagement, including completion of domestic baseline
- Learning and dissemination including presentations at the Energy Innovation Summit, Liverpool and two papers presented at CIRED, Rome
- Majority build of partner ANM systems (limited by Infrastructure issues)

1.2 System design and technology build lessons learned

This report is the 5th project deliverable and builds on the previous reports

This report, first published as Interim in December 2023, has been updated in April 2024 and reflects the final lessons learned up to Go Live on 18 April 2024.

Revised project deliverables as per project progress report December 2023, now updated with revisions to accommodate the further delay to Go Live.

Ref	Project Deliverable	Deadline	Evidence	Status / Revised Date
1	QUEST Initial Report - Use Cases	31/07/21	Document introducing the Project and detailing the use cases and scenarios.	Completed
2	QUEST System Design and Architecture Lessons Learned	31/12/21	Document explaining Project progress including the following outputs: • Review of architecture options • Specification for the network models and modelling regime	Completed
3	QUEST Trials, Design and Specification Report	30/06/22	Document explaining Project progress including the following outputs: • Functional specification for chosen architecture	Completed

Ref	Project Deliverable	Deadline	Evidence	Status / Revised Date
			• Functional specification for voltage control methodology • Trial design • Detailed site design	
4	QUEST Interim Report - System Design and Technology Build Lessons Learned	30/06/23	Document detailing Project progress to date including lessons learned from: • QUEST software development and testing • Power system model development • Site installation for the voltage control and ANM equipment	Completed
5	QUEST System Integration Lessons Learned Report	30/12/23	Document detailing the lessons learned from the installation and commissioning of the QUEST system including system integration and the results of site acceptance testing.	First issue: 30/12/23 Final Update: 30/04/24
6	Customer Research Findings Report	31/10/24	Document detailing the outputs from the customer research.	Bid: 31/10/24 Dec23 Revision: 28/02/25 Apr24 Revision: 25/04/25
7	QUEST Trials and Analysis Report	30/12/24	Document detailing: • Final results from network trials • Final results from modelling trials • Output from the voltage demand relationship research • Any adaptation required to voltage control methodology	Bid: 30/12/24 Dec23 Revision: 31/04/24 Apr24 Revision: 27/06/25
8	QUEST Final Report	30/04/25	Report on the conclusion of the QUEST Project including all the lessons learned and detailing the next steps, including BaU transition.	30/04/25 Dec23 Revision: 31/05/25 Apr24 Revision: 25/07/25
9	Comply with knowledge transfer requirements of the Governance Document.	End of Project	Annual Project Progress Reports which comply with the requirements of the Governance Document. Completed Close Down Report which complies with the requirements of the Governance Document. Evidence of attendance and participation in the Annual Conference	End of Project

Ref	Project Deliverable	Deadline	Evidence	Status / Revised Date
			as described in the Governance Document.	

1.2.1 Equipment installation bulk and primary substation

The QUEST project is being trialled on the ENWL network fed from Whitegate Grid Supply Point (GSP), the 132kV connection with the transmission network. This network consists of four Bulk Supply Points (BSP) (132kV/33kV transforming points), twenty primary substations (33kV/HV transforming points) and approximately 1,300 distribution substations (HV/LV transforming points). QUEST equipment has been installed at the four BSPs and at five primaries. The remaining primaries already having compatible AVC equipment installed. At seven sites, ten feeder monitoring upgrades where also made.

Most of the equipment installation was completed by the end of March 2023, with the feeder monitoring and minor snagging works outstanding. Some of these outstanding works were due to active Operational Instructions. These are safety-related restrictions that may limit or prohibit works within a substation or substation area due to a specific issue, e.g., presence of asbestos in an area, unless that risk is removed or mitigated. The remaining works were completed between 11 October 2023 and 2 November 2023. All technical drawings have also been updated and submitted to ENWL.

Lessons

The works generally proceeded as anticipated, with most issues being common to all other network work, including:

- Access to technical drawings. Technical drawings are held in a central repository and are released in a control manner for any works planned. The availability of drawings can be impacted by other panned work on the network, where drawings have been reserved or are being updated by other projects.
- Quality of technical drawings (including scanned images of drawings made over 40 years ago).
- Arranging network outages (including payment to independent network operators when required).
- Limiting works to project requirements and avoiding incidental asset replacement.

The pause in work also coincided with a change of ENWL project personnel, resulting in a small delay in restarting, as the plan of work completed / remaining was refreshed and confirmed.

The project also lost access to its dedicated, internal, operationally authorised person, leading to an additional requirement to recruit an alternative suitably authorised resource, from a very competitive and busy market, to oversee the remaining site works.

1.2.2 Equipment installation distribution On-Load Tap Changing (OLTC) transformers

The QUEST project has installed seven distribution OLTC transformers.

The equipment installed is to the same specification as deployed on the Smart Street Innovation Rollout Mechanism, which simplified procurement and installation.

Lessons

The works generally proceeded as anticipated, with most issues being common to all other network work. The final site was the most complex site with the substation access and outage management constrained by a care home. The planning of this took some time and was additionally delayed by a change to the operational resource delivering the works.

1.2.3 QUEST relay software development and test

The QUEST project commenced by developing a series of Use Cases. These started the refinement on how and what the QUEST project will deliver. Their development was shared within the project and with external stakeholders and the work is covered in detail by the projects earlier project deliverables, published on the QUEST project website.

These use cases became the foundation for the project against which both the optimisation software and the relay software was designed.

Fundamentals then developed from the use cases a set of requirements to specify the new relay functions. The development approach was to build and test the code in a series of sprints before providing ENWL with a factory tested version at the end of June 2023.

Using a specialist resource, the ENWL Protection Policy Manager, and utilising the ENWL NMS test system, the software was tested and approved by ENWL, and the roll out to site commenced.

Lessons

The incremental process of refining requirements, starting from use cases, through specification, to software development, worked well and did highlight issues as requirements were refined to a specification, whilst minimising development risk.

The availability of an ENWL test system supported the ENWL approval process by observing the functionality in a controlled environment. The system, initially built for the NMS and CLASS roll outs, has been maintained for relay upgrades and allows the relays to be tested under a variety of network conditions with outputs to the NMS also confirmed.

Several project resources within ENWL and Fundamentals have worked together on previous projects, and those relations help support fast resolution of any issues that arose in testing.

Post QUEST development, the lessons learnt on the project have been utilised in a subsequent independent project between Fundamentals and ENWL.

1.2.4 Power system model development

Previously published by the QUEST project on the ENWL project website are two power system model development reports:

- December 2021 QUEST Research Electricity Northwest Limited Modelling Regime – 30/11/2021 Modelling Regime

- June 2022 QUEST Research Electricity Northwest Limited Functional Specification for Voltage Methodology and Scenario Analysis – 06/06/2022 Functional Specification for Voltage Methodology and Scenario Analysis

The next steps from these reports are to be addressed as part of the QUEST trials work.

The learning has also been utilised in supporting two papers co-authored by the project and presented at CIRED in Rome, June 2023, by partners SGS and SE.

- 10291 QUEST - An Overarching System Control Solution
- 10295 Voltage Demand Relationship Modelling for Future Energy Scenarios

Lessons

The modelling work identified several key conclusions, including:

- Uncoordinated responses could result in voltage excursions.
- Flexible connections could be quick to utilise network headroom created by demand boost scenario.
- Discrete tap changer limits could impact level of CLASS function response.
- The secondary voltage impact of tap stagger could impact level of CLASS function response.
- The use of QUEST could improve each of the individual techniques, but that prioritisation may reduce some benefits for techniques of lower priority.

This learning is to be tested during trial activity.

Feedback from CIRED confirmed there is significant international interest in QUEST and holistic voltage management in general, and further papers would be welcomed. The wider project team are keen to develop additional papers incorporating the learning from the QUEST trials.

1.2.5 QUEST overarching software development and testing

As described in the earlier section on relay software development, the key early project stages were to develop and agree a series of use cases from which a software functional specification could be developed. The ENWL Network Management System, in use since September 2021, was provided by and developed with SE. We therefore already had joint processes for the development and change to this system, which have been used for the QUEST project.

The functional specification provides the detail of the QUEST overarching software. It provides an overview of requirements, plus detail on each of the required functions, the logic behind the requirement and, where appropriate, screen shots of the developed software that delivers the requirement. Where the specification is found to be unclear during software development, a change process occurs between SE and ENWL, the issue is resolved, and the specification / software is updated as required.

Initial software was developed on the SE development systems in Serbia with updates and demos of software elements delivered over Microsoft Teams.

For testing the agreed functional specification is used as the basis of the test specification and the individual test script. The testing is driven by and recorded within a standard test application (TestLink)

and any issues or defects that are identified are also recorded within a bug management system (Bugzilla).

The factory acceptance test was performed in April 2023 on a system hosted by SE in Serbia. The SE test team performed the testing from ENWL offices in Salford, and the tests were witnessed by the ENWL team.

The associated documents were published to the QUEST website alongside deliverable 4: QUEST function specification, QUEST test cases and FAT final report and QUEST lessons learnt report. Two of these documents have been updated and are included as additional documents to this report.

Lessons

The process used to refine design down to a functional specification and then to build the software to that specification including test scripts and processes effectively provides an audit trail through the project for the software used in trials.

The process allowed uncertainty and inconsistencies in use cases and functional specification to be highlighted discussed and resolved. Resolution was normally in one of four ways:

- Issue discussed; common understanding agreed with no further changes
- Resolution by a change to the developing software
- Resolution by a change to the functional specification
- Issue identified as best resolved post-trial, with Issue logged as transfer to BaU issue. Examples are detailed in the associated SE document "QUEST Lessons Learnt" published with this document on the ENWL website, which includes lessons from commencement of project.

Using common systems for testing and bug resolution allows a consistent proven approach and enables issues to be reviewed by a wider expert group of NMS developments. However, it is difficult to extract reports from these systems that are suitable for public dissemination.

1.2.6 QUEST IT Infrastructure Build, Configuration and Testing

This element of work has been the significant reason for the reported delay commencing trials using the full end-to-end system. In addition to the updates within this report, a formal ENWL IT Programme project lessons learnt review has been conducted. This was led by a senior IT programme manager not directly involved in the QUEST project and identified learning broader than just for the QUEST project, some of which has already been adopted on the ENWL BiTraDER project. A report from this review has been added to the QUEST project website

The original NIC bid was supported by the ENWL control room system expert who was also heavily involved in the, then ongoing, replacement of ENWL controls systems with the Advanced Distribution Management System (ADMS). The logical decision made at this time was that the QUEST software would be developed in a similar manner as other "NMS power apps" being developed at the time within the core NMS.

The February 2022 invasion of Ukraine accelerated the already increasing focus on cyber security on critical national infrastructure, including the electricity network and its digital control systems.

Changes were made to the design proposed in the bid, separating the QUEST development from the critical core system, and improving the capability to test the QUEST system before interfacing it with the live system.

The low-level design required two identical hardware systems to be built. The test system provides a separate environment, where changes can be thoroughly tested before release onto the production system. This hardware is additional to the bid and could be financed within the project, however the purchase, installation, commissioning, and testing all required additional time from constrained resource. Additionally, it was found that elements of the equipment supplied were faulty, leading to additional time in fault identification, replacement part delivery and retesting. The base hardware systems are now fully built.

Once sufficient base hardware was built, the QUEST partners were required to load, build, and commission their propriety software onto the virtual machine. As the hardware is physically located in an ENWL datacentre and within a secure IT De-Militarised Zone (DMZ), remote access has been minimised for security. A secure physical software delivery process was also agreed that required suitably authorised data staff to implement. Configuration of the partner software was to be done remotely via a complex and limited secure access route to the QUEST machines. These processes needed to go through the standard IT approval processes before being implemented, and the implementation resulted in additional changes, needing further approval, before the remote access became reliably available.

Once the partner build processes had commenced, the security constraints in place restricted and prevented certain detailed configuration and certification of the partners' products. Additional changes then had to be made to the IT design, including a new process to allow small files to be electronically transferred into the secure zone and made available to the partner software. This approach, to allow a process to share a variety of file types through several firewalls to an area designed to be very secure, has proven difficult to achieve and to remain available during the build and commissioning process. All access to systems and between systems are further secured by user identification and passwords.

Several ENWL secure processes need specific gateway conditions to be met and limited authorised resources to make changes. Whilst secure, this has impacted significantly the time required to find faults and make corrections.

The decoupling of the overarching QUEST optimisation software from within the core NMS and onto standalone hardware, requires an interface to the real time NMS system and so the low-level design requires several inter control centre protocol (ICCP) links between system elements.

QUEST requires three ICCP links on each duplicate system, the most important being that between the QUEST optimisation software and the real time NMS SCADA system. It is via this link that the impact of the QUEST optimisation can be shown, and the results measured in real-world trials.

This main ICCP is the first to be built by ENWL in several years. These are being built by different resources in different systems to the previous links and the project underestimated the degree of complexity in building these new links and the resource skill sets available. As a result, the project modified certain delivery responsibilities, with the project partners providing additional technical and commissioning support, initially for the TEST environment where the opportunity to adopt simpler change and authorisation process had been taken.

Another consequence of the decoupling is that other core subsystems have had to be replicated in the QUEST environment. In addition to the complexity, this has added additional workload to the project resources.

Whilst the project has had a documented low-level design for some time, the actual implementation, configuration, and testing processes has continued to require additional layers of detail to be developed, agreed, documented and implemented, with corrections at regular intervals. This level of detail and workload was not originally anticipated.

The ongoing work between OFGEM, DESNZ and the DNOs required for the Network and Information Systems Regulations, 2018, and the associated Cyber Assessment Framework (CAF) has had a continuing less obvious impact to the project. The works being undertaken are significant, extensive, and are treated as the highest priority. For QUEST this has resulted in certain works, resource support and defect resolutions being slower to deliver and resolve than historic innovation projects have experienced, resulting in regular yet less obvious project slippage.

A common theme across the IT learning is a planned small change, ultimately having wider consequences, increasing complexity and the need for a wider range of specialists from a constrained pool of resources predominately focussed on critical and urgent works.

Lessons

Planning changes to a system, itself in development/deployment, increases the risk of unforeseen changes later in the project.

International trends and world events can have a significant unforeseen impact on new innovation and development projects, and the changing threat levels need to be reflected in the project requirements.

The diversion of IT resources and priorities can have a significant project impact, even though they were viewed as a small element of the original project.

Mid-project design changes can initiate several unanticipated consequences.

Increasing security to BaU systems is counter-intuitive to innovation that requires temporary flexible systems for the purpose of trials and simulation. Significant extra design and communication is therefore required early in the project to challenge security concerns and establish a common risk understanding for what is to be delivered.

Changes to systems and supporting systems experts can cause disproportionate impacts from assumptions based on past delivery. The specialist skills required to complete IT system architecture design and build are limited across the industry and availability of such resources needs to be considered in project timescales.

Where existing business systems are extended beyond their original design, e.g., to accommodate external parties, further consideration should be given to anticipate unexpected consequences.

Subsequent to the interim report in December the ENWL IT directorate have completed a formal lesson learnt project review across the scope of work ultimately delivered by that directorate.

A formal report has been uploaded to the QUEST project website; however, the summary conclusions were:

- The change between the technology support for the bid, and the project delivery team resulted in a lack of clarity of the scope and degree of collaboration required, resulting an underestimate of resources required and allocated.
    - Independently of the project, IT business collaboration experts had been added to the directorate, and the resource for Innovation was quickly co opted to support the project during the most difficult IT development period. Dedicated IT project management resources have also been allocated to the portfolio of innovation projects.
- TIM role
- Formal Change Process – The rigour of several IT change processes struggled to flex to the needs of an innovation project with any change taking weeks to implement, with corrections taking similar time
    - Additional flex was agreed for innovation work in non-critical Test environments, and a degree of fast tracking of approvals and implementation resources when possible.
- Escalation process – The formal escalation process was found to work well, however the process was very heavily used, especially during period of other IT workloads.
- Formal documentation – Partly due to the number of changes required through detailed design and configuration complexity, the IT documentation was not always complete and unambiguous, which occasionally resulted in errors being repeated and having to be re resolved across environments. Improvements are on ongoing piece of work with our IT suppliers
- Remote Access Requests – Project required selected partners to have remote access into ENWL infrastructure where QUEST environment had been built. Provision for access relied on a number of supplementary tools (including internal IT systems) and process that partners did not have access to, resulting In modifications and adaption to ENWL systems and established BaU processes.
- Detail with Low Level Design – Significant additional detail (systems, processes, and configuration work) was continuously identified during the project, including the final ICCP elements of the IT build.

1.2.7 Active Network Management solution

The QUEST project will integrate into three separate ANM solutions:

- ENWL corporate ANM solution, residing within the core NMS
- SGS provided Decentralised ANM
- SGS provided Cloud ANM solution

The December 2023 QUEST project progress report noted that the full capabilities of the ANM system are not yet mature and may result in changes during the QUEST project. It is also looking unlikely that a customer requiring a flexible ANM connection will occur on the Whitegate network during the period of the project trials. The maturity of the system will impact its integration into the QUEST solution.

The SGS Decentralised system is based on a set of servers within the ENWL data centre. It integrates with the QUEST software and will take network data sourced from ENWL real time NMS. The system will also connect to remote terminal units to simulate a connected customer. The integration between the Decentralised ANM and the QUEST machine is via an ICCP. Through this link, the network data being provided to QUEST from the real time network via a separate ICCP can be accessed.

The Cloud ANM solution provided by SGS allows QUEST to trial the use of DER flexible services, flexible services dispatch, dispatch optimisation plus demand, generation, and constraint forecasting. This is a cloud service that is accessed by QUEST via a secure ICCP link.

Since the December report the ANM ICCPs have been built and tested in the Test environment.

This work has been heavily reliant on progress on the main ICCP (QUEST <> NMS) both in terms of technical issues and the use of common resources. The creation of these ICCPs had additional complexity in that different partners configured opposite ends of the ICCP (bringing different tools, experience, and approaches to ICCP build) and ENWL IT manages the intervening infrastructure and controlling access via a series of ports and firewalls.

The previous remote access issues during the main software build, also impacted the delivery of these ICCPs as did the prioritisation of the main NMS ICCP. Where possible as much enabling works were completed in parallel with other ICCP works. Whilst learning from building the main ICCP was utilised in the ANM ICCP builds, the tri party nature of these links did generate additional issues, especially with detail configuration and issue resolution.

Lessons

The Decentralised installation and integration has been heavily impacted by the infrastructure issues, including build, access, configuration and ICCP connections. Additional lessons include:

- The security of the ENWL design prevented a standard ANM build to be able to access the internet as part of the configuration process, thus adding delay. Future builds should be aware of this risk.
- Improvements could be made in the design process such that all parties understand earlier potential changes and consequential issues from changes proposed.
- The Cloud ANM and DeCentralised system have been built in the test environment, completion in production is ongoing.
- Whilst a degree of issue resolution is expected with any ICCP creation, these have proved more difficult than expected partly due to the differing systems and partners, and partly due to the timely and consistent remote access to the required systems

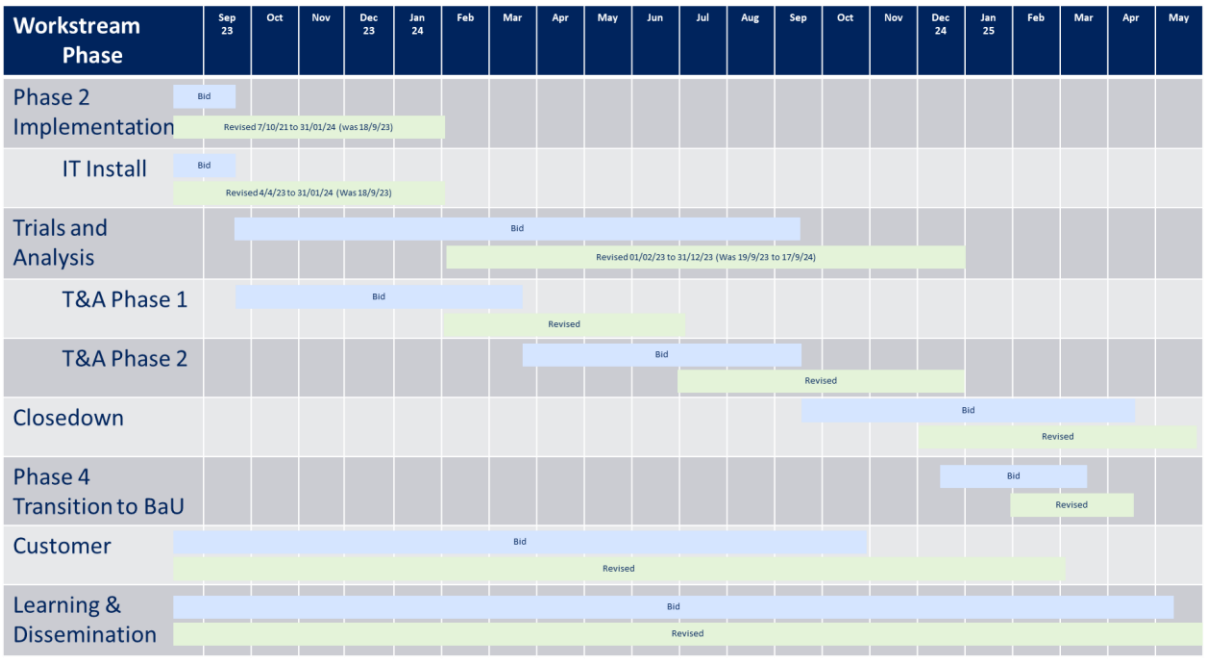
2 Limited trials

Whilst the build phase continued in 2024, elements of the QUEST installation that could be controlled by the Core NMS system have been utilised for some basic test and pre-trial activity. The information collected is helping inform the trial and analysis planning.

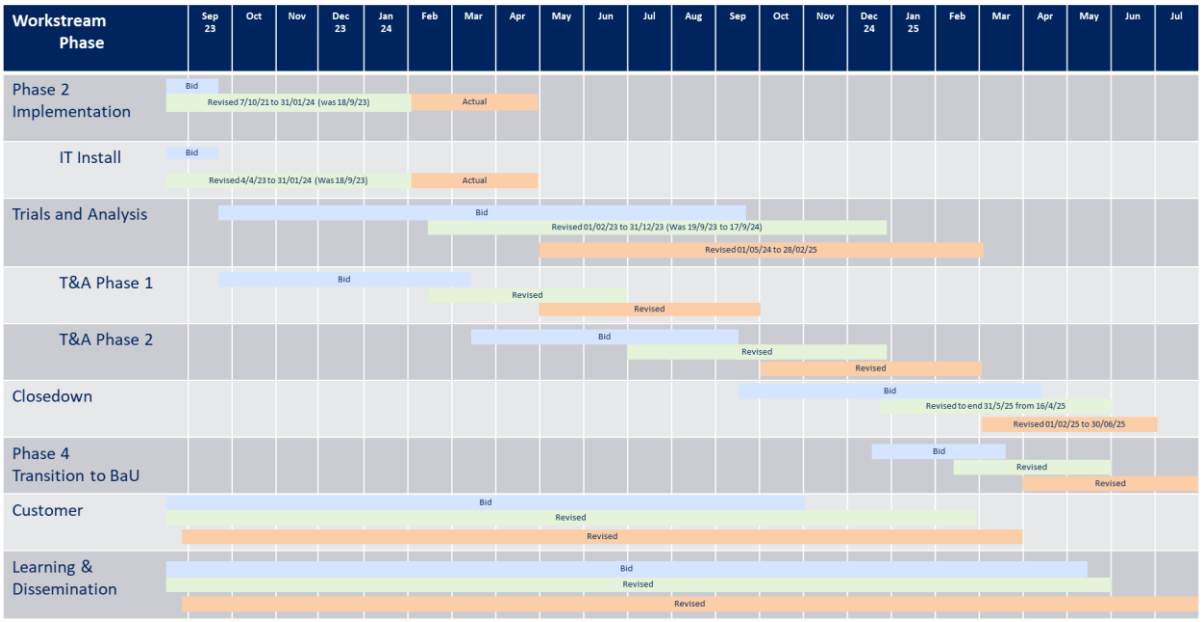
3 Next steps

The December 2023 project progress report presented a revised high-level delivery plan.

Excerpt from high-level delivery plan, December 2023 project progress report



With the additional delay in the implementation phase this plan has been adapted:



Now that we have the relevant ICCPs up and running we have an end-to-end project system, we can complete a number of minor final configurations, and testing all the new equipment points direct from Quest. This work has started.

The system availability has also allowed the training of the authorised control staff to operate the trails to be stepped up

Monitoring equipment and data collection processes are in place to record and store key information from the transformers at relevant BSP, Primary and Distribution substations within the trial area.

4 Conclusions

The work completed and reported within this report meets the requirements set out within the QUEST deliverable. It builds on the work performed and reported on to date.

The IT hardware and integration with other systems has proven to be more complex and required greater resources and time to complete than anticipated following the additional requirements after escalation of cyber security threat. During trials, a reduced level of risk remains that direct or indirect changes impact the performance of the QUEST infrastructure.

To resolve the IT issues encountered, the project has pulled in additional resources and specialist skills from within and outside of the initial project team. Access to and coordination of the availability of these resources, especially across partner teams, has resulted in cumulative small delays being incurred.

The remaining project elements, site installation, relay development, model development and software development have progressed closer to plan, except where they were impacted by IT hardware. The project team will continue to manage any unforeseen issues that may arise from interdependency with IT hardware.

Despite the delay to the full commencement of the trials and analysis phase, and subsequent extension of the trials and end of the project, it is anticipated the project can still deliver within the full budgetary allowance including contingency. A proportion of the contingency associated with the initial project risks relating to architecture design and Integration will be utilised.